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FISHERIES RESEARCH BOARD OF CANADA

REPORT

of the

ATLANTIC BIOLOGICAL STATION

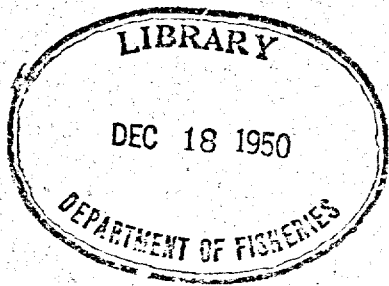
for

1950

by

A. W. H. NEEDLER, Director

With Investigators' Summaries as Appendices



DEC 18 1950

DEPARTMENT OF FISHERIES



M. V. "J. J. Cowie"

Built in 1944 by the Department of Fisheries on modified Pacific-Coast long-liner plans to test the usefulness of this method on the Atlantic coast, the "J. J. Cowie" has been operated by the Atlantic Biological Station first in this and then in other work. She was remodelled late in 1949-50 by replacing the large forward deck-house with a smaller wheel-house aft' and moving the galley and Captain's quarters below. The vessel is now both more seaworthy and more efficient. Length overall 65 feet; beam 15.3 feet; gross tonnage 48.76; 100 h.p. Caterpillar diesel engine. Ordinary crew includes Captain, Engineer, cook-deckhand and deckhand, with special observers frequently aboard. The "J. J. Cowie" has done valuable work in exploratory long-lining, halibut investigations, exploratory shrimp and flounder dragging, experimental Danish seining and gill-netting for groundfish, and in a variety of other investigations.

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REPORT FOR 1950 OF THE
ATLANTIC BIOLOGICAL STATION, ST. ANDREWS, N. B.

By A. W. H. Needler, Director

The work of the Atlantic Biological Station is to provide, through research, the basis for maintaining and increasing the supplies of raw materials for the fishing industry and for making them more available by improving catching methods. To carry out this purpose it is necessary, of course, to learn more of the principles governing the abundance and movements of the commercial species and this involves basic research in a broad field of oceanography. The more particular investigations necessary to apply these principles to the problems of the fishery are carried out along four main lines: exploration for new resources, discovery of the basis for regulating intensive fisheries to assure the maximum long-term yield, improvement of methods of increasing production by positive cultivation, and development and testing of more effective means of finding and catching fish. Some work is also done on the techniques of holding shellfish alive and on the improvement of quality through control of parasites or diseases. Progress was made in 1950 along all these lines which are, of course, closely related to one another.

Exploration. The fishery resource is only partially used and exploration for unexploited stocks of species new or familiar to the industry forms an important part of the Station's work. In 1950 the survey of new scallop areas in the Gulf of St. Lawrence was continued; and the first extensive drift-netting for herring in our waters gave promising results. Explorations were also carried out for other species including soft-shelled clams, bait worms and billfish. Such exploratory work is often associated with the use of fishing methods new to our waters and depends to a great extent on knowledge of hydrographic conditions.

Improvement of fishing methods. There is much room for the improvement of fishing methods to reduce costs or catch fish at new places and times and efforts in this direction were carried forward in 1950. In the groundfish fishery experiments were continued on the relative efficacy of various baits; mechanized gill-netting was given preliminary trials; and flounder-dragging techniques were studied. In the herring and mackerel fishery the use of sonic sounders for finding concentrations of fish received attention and the first major trials of drift-netting in our waters were carried out.

Regulation of intensive fisheries. Fisheries for species in high demand may be very intensive and maximum yield may depend on regulation, which must be based on sound knowledge if it is to be neither unnecessarily restrictive nor inadequate. The lobster fishery is our most important example of this kind and in 1950 we progressed farther towards the stage where sound adjustment of regulations will be possible. Investigations from this point of view were also continued on the smelt, soft-shelled clam and scallop

fisheries. There is no evidence that the intensity of fishing for groundfish is approaching a level dangerous to maximum production but it is necessary to hold a watching brief to recognize over-fishing should it occur and much effort is being spent on a thorough study of the fishery and the fish populations. In 1950 the first attempt to estimate the numbers in our harp seal herds, using aerial photography, indicated that they should be able to support the combined Canadian-Norwegian fishery in the West Atlantic at its present level.

Increasing production by positive cultural measures. In the preceding paragraph we have been concerned with cases in which we can increase the take only by so adjusting the fishery as to make the best possible use of natural production. With some inshore, freshwater or anadromous species it is possible to increase production itself by positive measures akin to those of agriculture, in which the conditions for reproduction, survival and growth are improved by diverse means such as protection from enemies or diseases, fertilization, thinning, special care of seed, etc. Oyster farming is perhaps the best example of this kind and in 1950 we continued our experiments on which the present Maritime Province oyster culture is based, including attempts to control eel-grass. Clam-farming experiments were continued on a reduced scale. Efforts to increase the production of smelt larvae by making larger spawning areas accessible were continued and the effects on production of marketable fish are being studied. Experiments in the fertilization of lakes to improve trout production are under way, and the experimental control of predators is giving promising results for both trout and salmon.

Improvement of quality and handling methods. Biological research also plays a part in efforts to improve the quality of the raw material of the industry and the handling of live fish and shellfish. A major effort is being made to discover whether and how the infestation of cod by round-worms can be reduced by controlling the numbers of seals in which these worms mature. A worm occurring in flounders has also been studied. The studies of paralytic shellfish poisoning which have made possible the use of soft-shelled clams without danger to the public are now reaching a conclusion and co-operation in public health supervision of the shellfish industries is continuing. Increased attention is being given to the physical factors and diseases affecting the holding of live lobsters.

Basic research. The above are examples of the investigations directed towards the solution of particular problems of practical interest but it must be emphasized that more general and basic work must be and is being continued if we are to have the scientific basis for real progress along any of these lines. Such work included, in 1950, experimental work on the reaction of fish to physical factors, attempts to relate reproduction and movements to hydrographic conditions, improvement in techniques for studying populations and study of many aspects of the life histories of many species. Last but not least is the study of the changes in hydrographic conditions and their causes, in which the Station co-operated closely with the Joint Committee on Oceanography through its Atlantic Oceanographic Group.

The long-term nature of much of the work, both basic and applied, constitutes one of the difficulties of research in fisheries biology. Conclusions can seldom be based safely on short-term investigations which cannot reveal the nature, let alone the reasons, for fluctuations in physical and biological factors. We are, however, steadily improving the long-term knowledge on which to base sound opinion on the nature of fluctuations in supply and on whether they are man-made and controllable or natural and, perhaps, predictable.

Application. 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 increasing catch and, especially in the case of oysters, on means of increasing production through culture. Close contact has been and is maintained with administration and industry to direct research along useful lines and to assure that its results are used.

Newfoundland Biological Station

The two biological Stations on the Atlantic coast work together closely in order to avoid wasteful duplication and to assist one another's work. This is done through frequent consultation at all levels. The Atlantic Biological Station has carried out investigations in the Newfoundland area on the harp seal fishery, and some exploratory herring fishing. There has been very close co-operation in groundfish investigations in which the Newfoundland Station plays a major part, especially in investigating the potentials of the very large areas about Newfoundland, on the Grand Banks and northward, while this Station has paid particular attention to the effects of the fishery on the stocks to the south-west and the life histories and fishing methods important there.

Atlantic Oceanographic Group

The Station provides laboratory space and administrative services to the Atlantic Oceanographic Group - the Atlantic coast research unit under the Joint Committee on Oceanography. The hydrographic work of the Group is so important to the Station's research in fisheries biology that the closest co-operation is needed. In 1950 important progress was made in the development of a program which will meet the Station's needs and a start has been made on a long-term plan, which is given a very high priority, while progress has continued on hydrographic work in connection with particular biological investigations.

Atlantic Herring Investigation Committee

The Committee of four governments (Canada, Newfoundland, New Brunswick and Quebec) which was reconstituted after the withdrawal of Nova Scotia and Prince Edward Island, ceased to exist as an active body at the end of March, 1950. Herring investigations were continued by the Station on a reduced scale. Dr. Leim and other members of the Station's staff will be spending a considerable effort in preparing a final report of the Committee, until its completion early in the summer of 1951.

Development of Fishing Gear

Experiments in the use of types of gear new to our fishery have constituted an important and valuable part of the Station's work. The experimental use of such methods as long-lining with power, Danish seining, flounder dragging, gill-netting groundfish and drift-netting herring has in some instances already led to their adoption by commercial fishermen and in others gives prospect of improving the efficiency of fishing or the variety of species caught. The experimental fishing, modification of gear and reporting of the results involves engineering skill in both design and description. Similar improvement is needed in catching methods for scientific purposes such as counting fences, special gear for small fish or larvae, etc. With these needs in mind an engineer, Mr. C. E. Petite, has been employed to work in close co-operation with the biologists of the Station's staff. Commencing only in May, 1950, he has already contributed substantially to progress in this field.

Progress of Investigations

The more important features of progress in 1950 are summarized below. Greater detail is given in the summaries by the investigators in charge of each major field and in the summaries of individual projects, both of which appear as appendices. A map immediately preceding these summaries shows the principal places where work was carried on.

Lobster. Investigation of this fishery, which contributes far more than any other to the income of Maritime Province inshore fishermen, was continued on a major scale under Dr. D. G. Wilder. (Appendix 1).

Tagging of lobsters has shown that movement from place to place is very limited, so that local studies and regulations are applicable, and that fishing intensity is very high, commonly taking over half and in some areas as much as three quarters of the marketable lobsters each fishing season. Size frequencies, in conjunction with estimates of growth, confirm these findings, the decline in numbers with increasing age corresponding well in any one area with the proportions of marked lobsters recaptured. Only recently has the marking of thousands of lobsters and their recovery in the next fishing season given reliable information on growth rates, which, at the sizes caught by the fishery, are about 15% increase in length per year, meaning, of course, an annual weight increase of over 40%. With total mortality estimated from extensive sampling and fishing mortality assessed by the return of lobsters tagged at the beginning of the season it has been possible to estimate natural mortality roughly as the difference between these two. The estimated natural mortality is believed to be generally too small to offset such a high growth rate. We have, thus, accumulated evidence that it would, in many of our areas, pay to let the lobsters grow to a larger size before catching them. The case for this conclusion, which has been stated rather too simply, depends of course on the high fishing intensity as it is only when a large proportion of the lobsters is caught that it pays to restrict fishing for this purpose.

Although thorough investigation leads to this conclusion it must be pointed out that it is applicable only under present conditions and that too great an increase in the sizes at which lobsters are caught might be damaging by increasing the numbers of lobsters on the grounds and, through competition, increasing the natural mortality or decreasing the growth rate. Any increase in size limits must, therefore, be regarded as experimental and its effects must be closely studied in order to learn whether it is advantageous and whether a further increase is justified. Economic factors enter the picture because the smallest lobsters caught are not as valuable per weight as are somewhat larger lobsters. With this in view the background for studying changes in numbers of lobsters has been laid in a number of typical localities by population estimates based on careful catch statistics and knowledge of the proportions caught. Results of increasing the size limit in the Fourchu, N. S., area in 1947 are being followed in this way (Appendix 2). The production of the valuable "market" lobsters (over 3 1/8" carapace measure) increased sharply while remaining constant in the neighbouring L'Archeveque area where the size limit was not changed. It is interesting to note that at L'Archeveque, where the regulation requiring wider (1 3/4") lath spaces in lobster traps has been well observed, it has proved its effectiveness by reducing the catch of sub-legal-size lobsters by about 40%.

Experiments have shown (Appendix 5) that the upper temperature lethal to lobsters increases about 1°C for each 4°C increase in the temperature at which they are acclimated, reaching a maximum of about 30.4°C (86.7°F). Salinities to be lethal must be lower in cold water (5.8‰ at 5°C) than in warm (19.4‰ at 25°C).

It was found that copper, monel metal, zinc and lead are toxic to lobsters in that order, but that iron, aluminum and stainless steel are harmless (Appendix 6). In the course of these experiments lobsters survived for six months without feeding in small tanks in which the water was circulated but not changed, suggesting the potential value of further experiments in methods of holding lobsters commercially.

Further study of the "shell disease" of lobsters, a bacterial infection causing pitting of the shells, confirmed that it is contagious and lethal; moulting, however, removed the external symptoms (Appendix 7).

The sampling of lobster larvae in Northumberland Strait was continued as part of a long-term study of changes in their abundance with associated causes and results. First-stage larvae were six times as abundant in 1950 as in 1948, while fourth-stage larvae showed little difference, indicating the importance of survival during larval development (Appendix 8).

Shrimp. Explorations for shrimps were not continued in 1950 because a suitable boat was not available, but will be continued early in 1951 using the "J. J. Cowie".

Oyster. A small but well-established oyster-farming industry is based largely on the results of our investigations and experimental farming and its continued prosperity depends on further

improvements in techniques of production. The oyster investigations under Mr. R. R. Logie (Appendix 9) continued to give such routine services to the industry as prediction of the times at which spat will settle and collectors must be placed in the water, but major attention was given to the improvement and cheapening of cultural methods and to a study of disease and mortality.

Cheaper methods of rearing small oysters on trays are being sought and extensive experiments are in progress. Experiments in the control of barnacles, which are at times important competitors of young oysters for space on spat collectors, showed that DDT in concentrations in oil which killed young barnacles also killed the oysters; but when spat collectors were dipped in oil alone settlement of barnacles was prevented without seriously affecting the oysters. Studies in the vertical distribution of oyster larvae and their survival to settlement were continued (Appendix 11) in an attempt to improve our understanding of the factors influencing spat production.

Oysters from a number of New Brunswick and Nova Scotia inlets held in trays since 1947 in the Malpeque area have shown a much higher mortality than Malpeque stock held in the same way, indicating the continued presence of the "Malpeque disease", the susceptibility of the oysters from areas where it has not been observed and the continued resistance of the Malpeque stock. The latter is also confirmed by better survival of Malpeque than of native spat when held in trays in Johnston and Enmore Rivers where the disease has occurred (Appendix 10). No cause can yet be assigned to the mortality of oysters in West River, Charlottetown, P. E. I. Investigations, including observation of the survival of oysters in test plots, are still in progress, and precautionary quarantine measures have been taken.

Paralytic shellfish poisoning. The Station's work in this field, under Dr. Medcof's direction, has now been reduced to include only assistance in supervision of the continuing program of control by the Departments of Fisheries and of National Health and Welfare (Appendix 21).

Soft-shelled clam (Mya). This species supports a million-dollar industry (Appendix 14) which has been very active and exerts strong pressure on the stocks. The Station's investigations under Dr. J. C. Medcof first attempted to develop profitable methods of clam farming but are now directed principally towards the better use of natural production (Appendix 12).

Many aspects of clam-farming techniques have now been carefully explored by experiment and observation. Methods of planting, growth and survival of various stocks under various conditions of bottom, level and crowding, the effects and possible control of enemies, and the damage caused by digging operations have been studied inter alia. It has been concluded that, although clams can be grown, the costs are too great, partly because of slow growth. In some exceptional areas it is still possible that clam farming might be profitable and investigations are now limited to field tests in three of them (Appendix 18).

The failure to develop profitable farming methods makes it all the more important to use natural production to the best advantage. The growth of clams in weight, their greater value at sizes above the smallest taken, and their natural mortalities in most areas are such that enforcement of the present 2" minimum size limit is desirable (Appendix 14). Digging of clams has been shown to increase the mortality of the small ones which are left. Experiments, which will require six years for completion, have been started in which productivities with random and systematic digging are compared, as are the yields from digging at various intervals from three months to six years (Appendix 13). Techniques of handling clams in the shell are being studied with a view to reducing breakage (Appendix 15) and the advantages of hods or boxes over bags are clearly shown. Exploration for new producing areas is proceeding and in 1950 revealed some potential production about Isle Madame in southeastern Cape Breton (Appendix 19).

Investigations on clam drills, now being brought to a close, have greatly advanced our knowledge of the two species (Polinices triseriata and P. heros) common in our clam areas. It has been demonstrated that they are abundant and among the clam's most serious enemies. Control by removal of adults or of egg-collars is not feasible, but it has been shown that the muddiness accompanying eel-grass reduced their numbers and permitted good survival of young clams in areas where they had previously been decimated (Appendix 16).

Bait Worms. Collections of worms (Nereis and Glycera) to the value of several million dollars in neighbouring United States areas has prompted us to explore the potentials of this industry as a side-line for clam diggers. Results are sufficiently promising to warrant continuation of the small effort involved (Appendix 20).

Scallop. Scallop investigations under Dr. J. C. Medcof have proceeded along two main lines: an attempt to develop the basis for the best management of the intensive fishery in the Digby, N. S., area, and exploration for new producing grounds especially in the Gulf of St. Lawrence.

The well-established intensive fishery in the Digby area constitutes the greater part of the present Canadian scallop fishery. Earlier investigations had already shown the intensity of the fishing, the growth rates of the scallops and many other aspects of their biology. In 1950 attempts to estimate the abundance on the grounds were continued by tagging and recapture of scallops on an experimental area and comparing the catch per effort on this area with those on other grounds. This method was supplemented by the use of an under-water camera (Appendices 22 and 25). An effort is being made to develop the means of predicting the abundance of marketable scallops. Development of a modified drag that will leave most of the sub-legal-sized scallops without seriously reducing the catch of the legal-sized is progressing favourably (Appendix 23).

Surveys were continued in the southern Gulf of St. Lawrence under Dr. L. P. Chiasson's supervision. An extensive new bed, populated by an abundance of small scallops, was discovered in the western end of Northumberland Strait. The periodic mass mortalities

characteristic of the region have been under observation on the Pictou Island bed discovered in 1949 and on a bed off Boughton Island, P. E. I.; evidence points to a hydrographic cause. The unreliability of supply in the Gulf which results from these mortalities and the scattered nature of the grounds makes it desirable to avoid heavy capital expenditure and the potentialities of gear which can be used from small boats are being tested (Appendix 24).

Groundfish. The fishery for the demersal species we commonly call "groundfish", although not as important as the lobster fishery to the inshore fisherman of the Maritime Provinces, is, when offshore catches are included, by far the largest branch of the industry even there; in Newfoundland it is even more important. This fishery is international and highly competitive both within and without the country; efficiency in catching methods and high quality are therefore important. Although there is little indication of immediate danger of overfishing and the Canadian catches could be greatly increased, the total fishing effort by all nations on the grounds of the Northwest Atlantic is expanding rapidly. It is therefore important to watch the effects of fishing on the stocks to recognize and attempt to remedy overfishing should it occur. The groundfish investigations under Dr. W. R. Martin are designed to meet the needs of the Canadian competitive position and of possible future international conservation. Knowledge of the life histories, migrations and abundance of the species concerned is necessary for both purposes (Appendix 26).

The Station has paid much attention to the testing of fishing methods new to our industry. The value of powered haulers in the inshore line fishery has been demonstrated. They have now been adopted by many inshore fishermen especially in Western Nova Scotia; and the Station co-operated in demonstrations in the Bonavista area financed by the Department of Fisheries and supervised by the Newfoundland Biological Station. The profitable long-lining for halibut demonstrated as a possibility by the "J. J. Cowie" in 1944-46 has been carried out in the summer of 1950 by the seven-man vessel "Alfred D".

Gill-netting, using the mechanical equipment developed in the Great Lakes, was tried in 1950 as a means of catching groundfish, the work being centred at Ketch Harbour near Halifax. Preliminary results indicate that the method would be profitable only where fish are abundant or landed price high (Appendix 29). The method is costly but might compete with line fishing when fish are not taking bait or bait is not available.

Experiments in 1949 and 1950 have shown great differences in the effectiveness of various baits in catching cod and hake in the Gulf of St. Lawrence. The possibility of using flounders or waste fish from the hook-and-line fishery was not confirmed. Squid were particularly good; herring from various sources differed in value, perhaps on the basis of fat content. Differences in the catches were so great as to indicate that it would often pay to import costly bait rather than use cheaper but poorer local supplies (Appendix 28).

The cod-worms, which are perhaps the main obstacle to the use of cod fillets in the expanding markets for fresh and frozen fish, have been shown to be the immature stage of a worm which matures in seals. The local cod in the Bras d'Or Lakes are very wormy and a study of the worm incidence there has been made in preparation for an experimental attempt to reduce the numbers of seals. This will indicate the prospects for improving the quality of cod in this regard by general reduction of seals (Appendix 27; see also Seals below).

Exploratory flounder dragging since 1947 has led to the establishment of a growing commercial fishery in the Bay of Fundy and special attention has been given to this fishery. Further exploratory work, though needed, was postponed in 1950. Tagging in St. Mary Bay in 1950 resulted in recapture of over 30%, indicating a relatively intense fishery which may not be capable of much further expansion (Appendix 32). The physical factors which govern the seasonal movements of flounders have been studied both experimentally and by field observations (Appendix 33). The life history and distribution of a trematode worm which affects the quality of flounder fillets has been studied (Appendix 34).

A great deal of effort has been spent on obtaining accurate and thorough information on when and where groundfish are caught and with what fishing effort, and in sampling the populations for age and size. These data serve as a basis for assessing the effects of fishing on the stocks and for avoiding restrictive measures if unnecessary, or advocating them if needed. They also yield information on fluctuations in abundance of various species on various areas, which has a direct bearing on what may be expected by the fishery. As examples of what is emerging from this long-term work some aspects are presented of the changes in abundance of groundfish on offshore (Appendix 30) and on inshore grounds (Appendix 31).

Herring. The herring stocks of our Atlantic coast are not intensively fished and constitute one of the major unused fishery resources. The Station's herring investigations under Mr. S. N. Tibbo continued in 1950 on a somewhat reduced scale the exploratory fishing and population studies initiated by AHIC (Appendix 35).

Further trials with the two-boat, mid-water, Larsen trawl (Appendix 36) were deferred until well-matched boats become available. Exploratory fishing efforts were concentrated on drift-netting with the M. V. "Harengus" at 22 points on the continental shelf off Nova Scotia and in the southwestern Gulf of St. Lawrence, all of which were occupied three times; the M. V. "Eastern Explorer" was also used along the west coast of Newfoundland in the autumn. Fishing was done with drift-nets with $1\frac{1}{2}$ " to $2\frac{1}{2}$ " stretched meshes. Catches on the Scotian shelf were small but good catches of herring and mackerel were made in the Gulf, sometimes exceeding 500 lb. of herring or 1000 lb. of mackerel per net (40 yd. x 25 ft.). All the larger catches were made on moonless nights (Appendix 37). All the fishing was done in the well-defined surface layer and good catches were made in temperatures up to 15.5°C. Some correlation was noted between

abundance of herring and presence of Calanus (Appendix 41).

Assistance was given to organizing sonic-sounder observations by four Department of Fisheries boats in the Newfoundland area. A review of the results, added to our own, confirm the earlier conclusion that herring form dense schools suitable for purse-seining during the late autumn and winter but are usually dispersed during the summer. Good drift-net catches were made without the herring being recorded by the two sonic sounders on the "Harengus".

Samples of herring have again been examined for ages, lengths and vertebral counts in order to follow the six herring populations in the Gulf of St. Lawrence area (Appendix 38). Fat determinations were made on the drift-netted herring (Appendix 39). Dr. Leim continued his observations on recruitment, fatness and incidence of the "pepper spot" disease (due to Ichthyosporidium) in Bay of Fundy "sardine" herring (Appendix 42).

Tuna and Billfish. Investigation of these species was continued by Mr. L. R. Day on a small scale in order to assess their potentialities for commercial fishing.

Results of trials with Pacific tuna lures have been discouraging to date and indicate that they are effective only among surface-feeding schools. Statistics of both commercial and angling catches show that the largest tuna appear early each year (July) and that the average size declines steadily until October, when the catches consist principally of "jumper" tuna (less than 150 lb.) (Appendix 43).

Preliminary attempts in 1950 to catch billfish with small-meshed drift-nets or with the Japanese "lift-net" method, which uses lights to attract the fish, met with only slight success but justify further trials with modified or better gear. Further sampling and age determinations confirmed that billfish are fast-growing with a life span of not more than three years (Appendix 44).

Smelt. The smelt not only support a valuable fishery but, being anadromous fish with a very intensive estuarial fishery, provide, as it were in miniature, an opportunity to study many of the problems presented by the salmonoids. The varied and thorough smelt investigations under Mr. R. A. McKenzie have, therefore, a general as well as a particular importance (Appendix 45). The means of increasing smelt production have been sought along two main lines: the improvement of conditions for reproduction, and the sound regulation of the fishery.

Observations and experiments described in earlier reports showed that spawning smelt were often crowded below obstructions, that crowding of eggs to degrees often occurring in such situations not only reduced the proportion hatching successfully but perhaps even the absolute number, and that smelt quickly took advantage of the removal of obstructions to occupy larger spawning areas and reduce the crowding. On this basis a policy of stream clearance has been adopted (Appendix 46) and it appears that the spawning area occupied has recently been increasing from year to

year. Collections of smelt larvae indicate an increase in their abundance in the last three years which in the early spawning has been in the approximate proportion 1:3:8. This increase occurred without commensurate increase in the numbers of spawners (Appendix 47). Determinations of the ages of smelt in the commercial catch and thorough catch statistics will make possible an assessment of the effects of the increase in the numbers of larvae.

Our investigations showed at an early stage that the fishery takes a high proportion, sometimes over 75%, of the smelt entering the estuary during the fishing season (i.e. before mid-February), and later that these fish were predominantly early spawners running to the main branches of the river and were followed by large numbers which spawned later mainly in the brooks. As the latter did not contribute to the fishery it became important to determine how distinct the groups remained as this in turn would decide on the one hand the value of protecting the late spawners and on the other the size of the stock which eventually contributed to the intense fishery. Examination of the scales of spawning smelt has, during the past year, shown that fish resulting from early spawning can be recognized by the large number of ridges in their first year's scale growth and that these fish themselves usually spawn early (Appendix 50). There is a significant difference between the early and late spawners in vertebral count as well as scale growth. It seems, therefore, that the early spawning smelt on which the fishery depends are, in the main, self-sustaining. That some contribution comes to the fishery from the later spawning run has been shown by the recapture in the fishery of a few which had been tagged in the brooks but the size of this contribution remains in doubt.

The majority of smelt in the fishery and in the spawning run are approaching two or three years of age with less than 5% four-year-olds and very few older (Appendix 48).

Trout (Salvelinus). In the trout investigations under Dr. M. W. Smith (Appendix 51) we are attempting to develop procedures for overcoming natural conditions which limit the production of this most angled fish of the Maritime Provinces.

In many of the lakes of the Maritimes trout production is limited primarily by the concentration of nutrient salts. Stocking resulted in little improvement, if any, in the low yield of eight Charlotte County lakes which have been under study for a number of years (see earlier reports), indicating that failure in reproduction is not an important factor. Competitors and predators may constitute secondary reasons for low yields of trout but the overall productivity is low too. Inorganic fertilization of Crecy Lake with ammonium phosphate in 1946 was followed by a rapid decline of the phosphorus content of the water to its original levels, but caused an algal bloom, minor increase in zooplankton and improvement in bottom fauna lasting until 1950. Growth of trout fingerlings was so improved that they entered anglers' catches in their second year which is unusual for the region, but the numbers surviving to be caught remained low. This was apparently due in part at least to increased activity of predatory birds, because their control in 1950 greatly increased the survival. Of

yearlings planted in 1949 at an average length of 7.3 inches, 28% were caught in 1950, averaging 10.5 inches. In neighbouring Gibson Lake fertilization in 1947 about one half as intense as that in Crecy Lake resulted in an algal bloom but also in a reduction in oxygen next March to the dangerously low level of 3.03 ml. per litre and no improvement in trout production resulted (Appendix 56).

In Prince Edward Island streams fertility, low temperature, steady spring-fed flow and little competition from other species result in high production of young trout. Ponds on these streams have a high productivity exemplified by that in a pond at Montague from which an average anglers' catch of about 35 pounds per acre was recorded from 1944 to 1950 (Appendix 52). Experiments are in progress in three ponds to determine the relation between numbers of trout and their survival and growth as a basis for management (Appendix 53). In a brook at Ellerslie, P. E. I., the movements of trout between stream and sea are being studied throughout the year and trout populations estimated in various parts of the stream to serve as a basis for measuring the effects of proposed pond formation on the trout stock as a whole and the run to sea in particular (Appendices 54 and 55).

Preliminary results of an experiment in which the progeny of sea-run and brook stocks of trout were introduced together in Ellerslie Brook both as fingerlings and yearlings indicate that the progeny of sea-run trout exhibited the greater tendency to go to sea through the counting fence (Appendix 54).

In 1950 work on the improvement of trout waters by poisoning competitors or predators has been continued only in the form of advice regarding operations by the Fish Culture Development branch and observation of the results. Some supervision and facilities have been given to a study of small-mouthed black bass by Mr. E. Anthony of that branch. Information on eels in Maritime fresh waters is being brought together (Appendix 57).

Salmon. Atlantic salmon, having both a moderate commercial value and a great importance to anglers and to the tourist industry, spend much of their lives in the sea out of reach of present knowledge and fishing methods. They do, however, reproduce in fresh water and spend about the first half of their lives there; the commercial fishing, too, is in inshore or estuarial waters subject to administrative control. The abundance of salmon is, therefore, more susceptible to influence by various activities of man than are most other sea fishes, and there is room for improvement in man's direction of his efforts to obtain the maximum long-term yield.

Of recent years the Station's salmon investigations have been concerned with the freshwater stages of the salmon and more particularly with the means of increasing the production of salmon smolts by planting hatchery-reared fingerlings and by the control of predators. Investigations in the Petitcodiac River system, N. B., on the effectiveness of various concentrations and various techniques of hatchery plantings, and on the distribution and habits of young salmon generally, led to the conclusion that predatory birds limited smolt production to a relatively low level - a

phenomenon which had already been indicated by observations and experiments on the Margaree River, N. S. Commencing in 1947 an experimental 10-mile stretch of the Pollett River, a tributary of the Petitcodiac, has been kept as free as possible of mergansers and kingfishers. Plantings of hatchery fingerlings comparable in number with earlier plantings and varying about 250,000 were continued (Appendix 59) and the populations of all species of fish closely studied by seining, augmented later by electrofishing (Appendix 61). The resulting smolt production has been estimated using a counting fence across the whole stream, and recently this estimation has been attempted also by a marking and sampling method using two traps, one below the other (Appendix 60). Before removal of the birds the maximum smolt production had been about 4,000; the first two runs having the benefit of this protection throughout their lives numbered about 20,000 and 13,000 in the springs of 1949 and 1950 respectively. Although the latter number was only about half the number predicted in the previous autumn it is well above the maximum without bird control and there is other evidence that the winter of 1949-50 may have been generally severe for salmonoids in Maritime Province streams. Associated with this increase in smolt production other species in the stream also increased but these have now apparently reached equilibrium without destroying the favourable effects on salmon. Control of predatory birds thus emerges as a promising method of increasing salmon production although this conclusion cannot as yet be applied to waters differing widely from the Petitcodiac or the Margaree.

In the direct-current fishing apparatus we now have an effective tool for catching eels. Its use has revealed larger numbers in our salmon streams than had been realized. Their life in these streams and more particularly their role as competitors and predators of young salmon is under study (Appendix 64).

Mr. H. C. White, having now brought together the results of his extensive work on the kingfisher, is paying similar attention to the merganser, studying the food and habits of wild mergansers and rearing young birds in captivity to learn more of their feeding and growth rates (Appendix 62). A series of bones of the freshwater fishes of the Maritime Provinces for use in identifying stomach contents is being brought together and described (Appendix 63).

As the bird-control experiments on the Pollett River are coming to a close, more attention is being paid again to the relation between degree of dispersal and survival of planted salmon fingerlings. Preliminary experiments have indicated benefits of moderate dispersal during planting (Appendix 59). It is now planned to discover experimentally the smolt production resulting from various numbers of fingerlings planted in the experimental stretch when the predatory birds are removed. It is planned eventually to compare these results with those from natural spawning of known numbers of adult salmon.

Little is now known of the contribution of various river systems to the salmon catch as a whole or of the effects of one fishery on another, and heretofore smolt production has been studied on relatively small streams. In 1950 investigations

were extended to the Miramichi, one of our most important rivers both for angling and commercial fishing (Appendix 65). Fences were installed on two branches with the object of marking descending smolts and observing the movements of adults. It was hoped that enough smolts could be marked to enable us (1) to estimate the total Miramichi production by catching smolts in the estuary and discovering what proportion were marked, and (2) to discover where they appear in the commercial fisheries. Delays in delivery of materials resulted in missing part of the run and only about 11,000 smolts were taken, of which only two were recaptured in the estuary. Early installation in 1951 is assured, and much has been learned of the problems of estuarial fishing for smolts.

On the Miramichi River control of bird predators will be tested under very different conditions from those on the Petitcodiac by removing them from only one of the two branches under study and then reversing this procedure. It is also planned to discover the relation between smolt production and the size of the spawning run - a most important point as little is now known on the numbers of adult salmon which must escape capture to make full use of the productive capacity of the streams. Knowledge of how many salmon enter, and when, is already being obtained and has a bearing on the value of regulations in force or proposed.

Seals. Investigations under Mr. H. D. Fisher were carried forward along two lines: a study of harbour and gray seals to discover the need for and means of reducing their numbers in order to reduce infestation of cod and other species with round-worms which mature in the seals, and a study of harp seals, on which the seal fishery depends, to discover what restrictive measures, if any, are needed to prevent over-hunting (Appendix 66).

Information on the numbers and habits of harbour and gray seals has been obtained through special collections and observations and through co-operation with those who kill seals for the bounty. The latter, which applies only to harbour seals, can be claimed only on submission of jaws which are forwarded to the Station for examination and record. Over 85% of the seals killed in 1950 were first-year pups and the take has been of the sort which might be prescribed in order to maintain the maximum long-term yield. The effect of increasing the bounty on seals older than one year from \$5.00 to \$10.00 is being studied in order to assess its value, or that of further increase, as a means of achieving a substantial reduction of the breeding stock. There is some evidence that the bounty, when first instituted, reduced the numbers of seals, which then reached an equilibrium at the present level. Ages of 19 adult females were estimated at from 5 to 16 years, with an average of 9, and an attempt is being initiated to follow changes in age composition of the stock (Appendix 69).

Examination of stomachs of harbour seals showed that the food varies considerably from place to place. Many species of fish and shellfish are eaten - with herring, winter flounders and squid, and perhaps shad and gaspereaux appearing important (Appendix 67).

The investigations have revealed the presence of gray seals in considerable numbers, much greater than anticipated; more intensive study of this species is planned, especially in the Miramichi area.

The adult stage of the cod-worm has been found in the great majority of harbour seal stomachs and also occurs frequently in the gray seal. These resident species are believed to be the most important hosts, although harp seals which occur in our area only during a short winter season may also carry them and further study is important (Appendix 68). As noted above preparations are being made for experimental reduction of seals in the Bras d'Or Lakes to test its effectiveness in reducing the cod-worm infestation there (Appendix 27).

Much general information on the harp seal has been brought together by discussion with sealers and by observations on sealing vessels and at the inshore net fishery for seals entering the Gulf of St. Lawrence through Belle Isle Strait; but the most important development in 1950 was the attempt to estimate the numbers of harp seals by photographing the herds or "patches" from the air. One of about 200 square miles, including most of the seals in the Gulf, and one of the two principal patches east of Newfoundland were sampled by strip photography. Estimates of seals on the ice were 348,000 adults and 149,000 pups in the Gulf "patch" where whelping was not complete, and 381,000 adults and 216,000 pups in the other. Remembering that all the adults do not remain visible, that there was another considerable "patch" east of Newfoundland and that one-, two- and three-year-old seals are not present in these concentrations, it is evident that the total Western Atlantic harp seal population is very probably over two million, of which somewhat less than half was in the Gulf in 1950. The present combined Canadian-Norwegian catch of about 225,000 annually is not believed to endanger the stock.

Much is yet to be learned of the numbers and movements of these seals. Two pups tagged in our waters have now been taken in Greenland. More extensive tagging is planned to learn more of the migrations and the degree of separation between the stocks in the Gulf and those east of Newfoundland which are much more intensively fished. Further photography from the air is planned as a check on the above rough estimate and to obtain better coverage.

Eel-grass. The investigations on eel-grass by Mr. A. R. A. Taylor were continued in 1950. Since a widespread mortality decimated it in the early Thirties, eel-grass has recovered to the stage where dense growths threaten to interfere seriously with the development of some oyster grounds and control measures need to be devised.

Experiments in 1949 and 1950 have shown that covering with shells, with gravel or with tar-paper overlaid with sand is effective in preventing eel-grass growth but is expensive. The herbicide 2,4-D and sodium arsenite were ineffective in reasonable concentrations; but Benoclor 3 and 3C (patented mixtures of chlorinated benzene compounds) gave promising results in concentrations as low as 170 parts per million or 0.4 quarts per 100 square feet

of bottom. At these concentrations, apparently, the cost of Benoclor is not prohibitive and oysters in the treated areas are not damaged. Further experiments with Benoclor are planned.

Cultivating the bottom with drags or harrows is relatively ineffective in reducing eel-grass, and cutting gives immediate availability of the area but repeated cuttings are necessary for lasting results. (Appendices 71 to 74).

Hydrography. The work of the Atlantic Oceanographic Group in 1950 is summarized in Appendices 75 to 75-P by Mr. H. B. Hachey, Oceanographer-in-Charge. The employment of Dr. L. Lauzier by the Station and the return of Mr. Hugh McLellan from extended leave has enabled the Group to make faster progress.

An understanding of the changes in the movements and abundance of marine organisms from season to season and year to year depends on a knowledge of the hydrographic conditions. In many instances it is desirable to study the relations between biological and hydrographic data over a number of years in the past. There is therefore a great need for the regular recording of representative hydrographic observations continuously over a long period. This is necessary for an understanding not only of the effect of hydrographic conditions on fisheries but also of the causes or order in those conditions themselves, a knowledge of which is necessary for predictions. In 1950 a long-term hydrographic program was formulated in consultation between the Station and the Group, and a start was made at putting it into effect (Appendix 75-I).

The Group also assisted the Station with hydrographic work in connection with a number of particular investigations, including herring gill-netting explorations (Appendix 75-F), experimental fishing for tuna and billfish (75-H), and a study of clam mortalities over winter in a small closed inlet (75-G). Progress was also made in studying various aspects of the hydrography of the Gulf of St. Lawrence, especially the low-salinity surface layer (Appendices 75-A, D, J, K and M) and a survey was made of the Grand Manan Channel (75-L).

Reference collection. The development of a well-identified reference collection was continued in 1950 under Mr. Day's supervision. Special attention was given to preparing mounts of bones, otoliths and scales of a number of the commoner species of fish for use in identification of stomach contents of seals, etc. A number of records of occurrences of rare or little-known species were made and the work on the collection is helping to extend and make available faunal records by the Station (Appendix 76).

Meeting of Atlantic Fisheries Biologists

The Society of Atlantic Fisheries Biologists, which met at the Station three years ago, again held its annual meeting there September 29 to October 1, 1950. This Society, with membership consisting entirely of biologists associated with fisheries investigations on the Atlantic coast of Canada and the United States, holds informal meetings intended to encourage frank discussion of their scientific problems. About fifty members attended and group dis-

cussions were held, inter alia, on population estimates based on tagging, standardization of scientific and common names and savings gear. The Station provided space for meetings and members of the staff contributed actively to the discussions and management.

Use of Station by other Scientists

Facilities were given to Miss Constance MacFarlane of the Nova Scotia Research Foundation for studies on seaweeds, and to Dr. Vibeke Englebert of the University of Toronto for comparative cytological work on the blood of marine invertebrates. The Station obtained much benefit from the opportunity for exchange of ideas and such contacts are extremely valuable.

Major Trips by Members of the Station's Staff

Mr. H. D. Fisher acted as scientific adviser to the Canadian representative at the meeting of the International Whaling Commission at Oslo, Norway, in July, being the only Canadian Fisheries employee present. In addition to his part in the conference, on which he has reported to the Department, he was able to make valuable contacts in Norway and England on seals as well as whales.

The Director represented Canada at a conference on herring technology called in the last week of September at Bergen, Norway, by FAO, and as an observer at the annual meeting of the International Council for the Exploration of the Sea at Copenhagen in early October. Reports on these meetings and on other information obtained on the journey are presented elsewhere.

Personnel and Organization

The personnel of the Station to December 1 and the organization as of September 1 are presented in appended statements. The Station, not including AOG, employed the following on a full-time salaried basis for an indeterminate period, with comparative figures for 1949 in brackets: scientists (not including S. N. Tibbo, still listed on Newfoundland Biological Station staff) - 17 (15); maintenance staff - 8 (6); clerical and administrative staff - 9 (7); technicians (including boat skippers so classified) - 24 (21); total - 58 (49). The increase of nine includes three maintenance personnel transferred from full-time employment by the hour to a salaried basis, one technician and one typist formerly with AHIC, two additional scientists, two additional technicians and one additional stenographer. AOG staff employed by FRB were 7 (5). The Station also employed 24 seasonal and one one-year-term scientists in 1950, as compared with 20 in 1949; AOG employed one seasonal each year.

The principal additions during the year were:

- (1) C. E. Petite, B. Sc., B. E., as Assistant Engineer from May 29 to work on gear development and assist in engineering aspects of other investigations;
- (2) J. W. Saunders, M. Sc., as Assistant Biologist from May 3 to assist Dr. Smith in trout investigations.

During October Dr. Wilder, having done the work of Assistant Director very ably for more than the anticipated two years, returned to full-time work as head of the lobster investigations. Dr. Kerswill joined the Headquarters Unit in October for two years, replacing Dr. Needler who relinquished the Chairmanship of the Unit to Mr. O. C. Young and returned to full-time work as Director of the Station. It is expected that Dr. Kerswill can continue to give some assistance to the Station's salmon investigations.

Building

When the Station's frame laboratory building was destroyed by fire in 1932, with consequent great loss of valuable records and library, it was partially replaced by a fire-proof building with about 2400 square feet on the single floor usable for office and laboratory space. As the work expanded the other frame buildings have come into full use, making a total usable space (outside measurement) of about 12,000 square feet, as compared with the 24,000 which NRC estimates should be provided for the more than 60 persons who must be accommodated. Only about one third of the space in use is fire-proof and there is high fire risk to valuable records as well as severe over-crowding.

Plans are under development, in consultation with an architect appointed by the Department of Public Works in August, 1950, for the construction of an extension to the present fire-proof building, providing an additional 14,000 square feet on three floors. It is hoped that these plans will be completed in the first few weeks of 1951.

Boats

A review of the boats operated by the Station is presented below. The principal developments in 1950 were (1) taking over the "Harengus" from AHIC, (2) improvements in the "J. J. Cowie", (3) disposal of the "Mactra S." and retirement of the "Pandalus" to seasonal use in sheltered waters, and (4) replacement of these two smaller boats.

A. Larger vessels

M. V. "Harengus". Overall length 84 ft., beam 20 ft., gross tonnage 107, two 135 h.p. Caterpillar diesels driving a single shaft. Hull lines of New England dragger with above-decks arrangement altered to give free after deck for purse-seining. Equipment includes radio direction-finder, radio telephone, Huson and Bendix sonic sounders, electric hydrographic winch, otter-trawl winch and deck fixtures, purse-seine winch, turn-table and deck gear.

Build by the Department of Fisheries and chartered to AHIC, the vessel was taken over by the Station in 1950 and operated for six months principally in exploratory drift-netting for herring. Although capable of offshore operation in good weather, this vessel is not adequate for offshore work generally.

M. V. "J. J. Cowie". See Frontispiece for details. This vessel is now a good, economical small dragger and general work boat capable only of limited offshore operation. Its past and prospective usefulness is great and varied.

B. Small mobile boats. Since 1946 the Station has operated two diesel-driven boats somewhat below 40 ft. in overall length - the "Pandalus" and "Mactra S." - in a variety of inshore investigations involving travel to all parts of the Maritime Province coast. Although they have done useful work, experience has shown that they are too small to provide adequately for both working space and long-term living quarters for crew of two and observers. Purchased second-hand from War Assets Corporation, their condition warranted disposal of the "Mactra S." in 1950 and relegation of the "Pandalus" to short-season operation in the Bras d'Or Lakes in connection with the seal-cod-worm experiment. They are replaced by AHIC's "Gulf Explorer" and a new 55-ft. modified Cape Island boat, involving no increase in crew or operating expense.

M. B. "Mactra S.". Overall length 38 ft., 82 h.p. Gray diesel. Equipped with shellfish dragging winch and used until disposal in July, 1950, principally on bar-clam and other shellfish investigations.

M. B. "Pandalus". Overall length 39 ft., 82 h.p. Gray diesel. Equipped with otter-trawl winch and gear. Used in exploratory dragging for flounders and shrimp and in other inshore investigations. Used since 1949 only in summer work in the Bras d'Or Lakes.

M. B. "Gulf Explorer". Overall length 46 ft., 100 h.p. Cummins diesel. Equipped with Bendix sonic sounder and otter-trawl winch powered by air-cooled deck engine. Owned by AHIC but cared for and used by the Station pending final decision on disposal of AHIC equipment. Used in 1950 in connection with salmon and lobster work.

New 55-ft. boat. It is planned to build in 1951-52 a new 55-ft. boat of general "Cape Island" style, powered with 106 h.p. Cummins diesel and made more seaworthy by decking. It will have good working space aft' and provision for use of a variety of equipment powered by air-cooled engine on deck.

C. Small local boats. The Station operates two small gasoline-driven boats - the "Clupea H." at St. Andrews (see Frontispiece of 1949 report) and the "Ardea" at Ellerslie. Their essentiality for local work is obvious.

Information

Individual contacts and correspondence with the administration and the industry remain the principal means of bringing our results to the knowledge of those who use them, and the volume and effectiveness of these contacts is continually increasing. The use of publications, radio, motion pictures, exhibitions and the daily press is also important. Increasing co-operation with the Information Services of the Department of Fisheries is resulting in better use of the non-technical channels.

Publications. A list of publications is attached. The volume of material being submitted is increasing and a further increase is in prospect.

Radio. A list of the Station's releases through the CBC Fishermen's Broadcasts in 1950 is appended. In all, 140 recordings have been made for this purpose - 4 in 1946, 28 in 1947, 32 in 1948, 38 in 1949 and 38 in 1950.

Motion pictures. The Station co-operated with the Information Services in the completion by the National Film Board of a film on oyster farming based largely on the oyster culture work of the Station and of the Department in the Malpeque Bay area.

Exhibitions. The Station again co-operated with the Information Services of the Department in preparing displays at the Lunenburg Exhibition. In 1950 lobster and seal investigations were featured. Displays were also prepared for the Shediac and Pictou Lobster Carnivals. The Station provided attendant personnel and material (some alive) for all these displays.

Press. Press coverage of the Station's work has been almost entirely through the increasingly effective work of the Information Services.

Annual Report. The present report with Appendices remains the most complete and up-to-date regular account of the work as a whole.

Acknowledgements

We are grateful for the continued co-operation of industry, of universities and of other agencies of both federal and provincial governments, and especially that of other branches of the Dominion fisheries service. We wish also to thank the scientists in other countries from whom we have received assistance.

ORGANIZATION

(as of September 1, 1950, except for seasonals)

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)

Sen. Biologist in charge

Technician I

Technician I

Assist. Tech. III

Assist. Tech. II

Assist. Tech. 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.W. McLeese, B.Sc.

2. Oyster

Biologist in charge (also in charge of Dept. of Fisheries Oyster Culture field staff and Prince Edward Island Biological Station)

Technician I

Main. Supervisor I

Sen. Res. Assist. - Seasonal

Jun. Res. Assist. "

R.R. Logie, M.A.

A.A. Skinner, B.Sc.

P.C. MacCaull

R.J. Kerr, M.A.

A.J. Wilson

3. Clam and Scallop (including Toxicities)

Biologist in charge

Technician I

Assist. Biologist - Seasonal

Sen. Res. Assist. "

Jun. Res. Assist. "

J.C. Medcof, Ph.D.

J.S. MacPhail

L.P. Chiasson, Ph.D.

L.M. Dickie, M.Sc.

M.E.C. Giglioli, B.Sc.

4. Groundfish

Biologist in charge

Assist. Biologist

Technician I

Technician I

Technician I

Assist. Tech. III

Assist. Tech. II

Stenographer IIA

Jun. Biologist - Seasonal

Jun. Res. Assist. "

Sen. Res. Assist. "

Jun. Res. Assist. "

W.R. Martin, Ph.D.

F.D. McCracken, M.A.

D.N. Fitzgerald

M.F. Fraser

K.G. Sollows, B.Sc.

J.H. Boyce

Arlene R. MacMorran, B.Sc.

Shirley B. Cunningham

D.M. Scott, Ph.D.

J. Shapiro, B.Sc.

R.W. Wolfgang, M.Sc.

G.A. Murdock, B.Sc.

5. Herring

Prin. Biologist

Biologist

Assist. Tech. I

Assist. Tech. III - Seasonal

A.H. Leim, Ph.D.

S.N. Tibbo, M.A.

Phyllis J. Gibson

E.G. Sollows

6. Smelt
Biologist in charge R.A. McKenzie, M.A.
Assist. Tech. III I.M. Jones
Assist. Tech. II Evelyn R. MacMillan
7. Salmon
Biologist in charge C.J. Kerswill, Ph.D.
Biologist P.F. Elson, Ph.D.
Assoc. Biologist H.C. White, B.A.
Assist. Tech. III S.D. Sedgwick
Assist. Tech. II H.W. Coates
Sen. Res. Assist. - Seasonal H. Godfrey, M.A.
Jun. Res. Assist. " P. Couillard, B.A.
Jun. Res. Assist. " E. Harris, B.Sc.
Jun. Res. Assist. " G.B. Westman, B.Sc.
8. Trout
Sen. Biologist in charge M.W. Smith, Ph.D.
Assist. Biologist J.W. Saunders, M.Sc.
Assist. Tech. II Emma A.C. Haskell, B.Sc.
Assist. Tech. II C.R. Hayes
Sen. Res. Assist. - Seasonal H.V. Pritchard, M.A.
Sen. Res. Assist. " R.M. Spence, B.Sc.
Jun. Res. Assist. " J.A. Thomson
9. Seals
Assoc. Biologist in charge H.D. Fisher, M.A.
Jun. Res. Assist. - Seasonal Jean M. Pearson, B.Sc.
10. Eel-grass
Jun. Biologist - Seasonal A.R.A. Taylor, B.A.
Jun. Res. Assist. " M.V. MacInnis
11. Miscellaneous (including Tuna and
Billfish, Museum and Library)
Assoc. Biologist in charge L.R. Day, M.A.
Clerk IIA (Library) M. Beryl Stinson
Jun. Res. Assist. - Seasonal G.W. Ann Talbot, B.Sc.
12. Statistical Consultant
Assist. Biologist - Seasonal G.F.M. Smith, Ph.D.
13. Hydrographer L.M. Lauzier, D.Sc.
(see also Atlantic Oceanographic Group below)
14. Assistant Engineer C.E. Petite, B.Sc., B.E.
15. General Laboratory Assistance
Assist. Tech. I Mary Holmes

B. Administrative and Maintenance Staff

1. Director's Secretary and Office

Stenographer III	Nina M. Parker
Stenographer III	Winifred E. Dougherty
Stenographer I	Lois G. McMullon
Typist I (and switchboard operator)	Mary E. Johnston
Stenographer I	B. June Field

2. Accounts, Stores and General
Administrative Officer II
Clerk III

J.A. Rogers, A.C.B.A.
Frances L. Stinson

3. Buildings, Grounds and Boats
Curator

Main Supervisor IV	E.G. Rigby
Assist. Tech. II (Boatman)	H.Y. Brownrigg
Truckman	W.G. Carson
Caretaker III (Groundsman)	F.E. Purton
Caretaker III	D.A. Stinson
Caretaker II	C.S. Tucker
Caretaker II (Watchman)	K. Johnston
	W.D. Stuart

"Harengus"

Master	H.F. Strum
Engineer	H. Yarn
Six additional crew	

"J. J. Cowie"

Technician II (Captain)	H.H. Butler
Engineer	B.W. Hart
Two additional crew	

"Gulf Explorer"

Assist. Tech. III (Captain)	J.A. LeBlanc
One additional crew	

"Pandalus"

Assist. Tech. III (Captain, seasonal)	C.J. Bayers
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Atlantic Oceanographic Group
(responsible to JCO)

Principal Oceanographer (Senior Oceanographer JCO
and Oceanographer-in-Charge AOG)

Associate Hydrographer	H.B. Hachey, M.Sc.
Assistant Oceanographer	H.J. McLellan, M.Sc.
Junior Oceanographer	W.B. Bailey, B.Sc.
Assist. Technician III	R.W. Trites, B.Sc.
Assist. Technician I	E.L. Graham
Stenographer I	L.H. Brownrigg
Assist. Oceanographer - Seasonal	Madelyn M. Meating
	D.G. MacGregor, M.A.

STAFF

(To December 1st, 1950)

(Total staff as of December 1st numbered 69, including 7 AOG)
(Staff other than seasonals classified as of December 1st)

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
J.C. Medcof, M.A., Ph.D.	Senior Biologist
M.W. Smith, M.A., Ph.D.	Senior Biologist
D.G. Wilder, M.A., Ph.D.	Senior Biologist (Assistant Director to October 24)
P.F. Elson, M.A., Ph.D.	Biologist
C.J. Kerswill, M.A., Ph.D.	Biologist (seconded to Headquarters October 1 for two years)
L. Lauzier, M.Sc., D.Sc.	Hydrographer
R.R. Logie, M.A.	Biologist
W.R. Martin, M.A., Ph.D.	Biologist
R.A. McKenzie, M.A.	Biologist
S.N. Tibbo, M.A.	Biologist (from April 1, seconded from Newfoundland Biological Station)
L.R. Day, M.A.	Associate Biologist
H.D. Fisher, M.A.	Associate Biologist
H.C. White, B.A.	Associate Biologist
F.D. McCracken, M.A.	Assistant Biologist
C.E. Petite, B.Sc., B.E.	Assistant Engineer (from May 29)
J.W. Saunders, M.Sc.	Assistant Biologist (from May 3)
H. Godfrey, M.A.	Junior Biologist (one year term employment from October 1)

Seasonal:

L.P. Chiasson, B.Sc., Ph.D.	Assist. Biologist (May 25 - Sept. 30)
G.F.M. Smith, B.A., Ph.D.	Assist. Biologist (June 1 - Sept. 30)
D.M. Scott, M.Sc., Ph.D.	Junior Biologist (May 30 - Sept. 21)
A.R.A. Taylor, B.A.	Junior Biologist (May 27 - Sept. 20)
L.M. Dickie, M.Sc.	Sen. Res. Assist. (May 18 - Oct. 10)
H. Godfrey, M.A.	Sen. Res. Assist. (May 10 - Sept. 30)
R.J. Kerr, M.A.	Sen. Res. Assist. (May 25 - Sept. 30)
T.M. Lothian, M.A.	Sen. Res. Assist. (May 1 - June 10)
D.W. McLeese, B.Sc.	Sen. Res. Assist. (May 9 - Sept. 20)
H.V. Pritchard, M.A.	Sen. Res. Assist. (May 30 - Sept. 9)
R.M. Spence, B.Sc.	Sen. Res. Assist. (May 15 - Sept. 15)
R.W. Wolfgang, M.Sc.	Sen. Res. Assist. (May 1 - Sept. 30)
M.E.C. Giglioli, B.Sc.	Jun. Res. Assist. (May 1 - Sept. 6)
P. Couillard, B.A.	Jun. Res. Assist. (May 9 - Sept. 10)
E. Harris, B.Sc.	Jun. Res. Assist. (May 9 - Sept. 26)
M.V. MacInnis	Jun. Res. Assist. (June 10 - Aug. 31)
G.A. Murdock, B.Sc.	Jun. Res. Assist. (June 1 - Aug. 24)
Jean M. Pearson, B.Sc.	Jun. Res. Assist. (June 1 - Sept. 30)
J. Shapiro, B.Sc.	Jun. Res. Assist. (May 30 - Sept. 3)
G.W. Ann Talbot, B.Sc.	Jun. Res. Assist. (May 15 - Sept. 9)
J. A. Thomson	Jun. Res. Assist. (June 26 - Sept. 6)
G. B. Westman, B.Sc.	Jun. Res. Assist. (May 9 - Aug. 25)
A. J. Wilson	Jun. Res. Assist. (May 29 - Sept. 13)
Stationed at Toronto without expenses:	
D.F. Alderdice, M.A.	Sen. Res. Assist. (Oct. 12 - Apr. 15)

Alfreda B. Needler, M.A., Ph.D.	Volunteer Investigator
Verna Z. Smith, M.A.	Volunteer Investigator
E.G. Rigby	Curator
A.E. Calder	Collector (to June 30)
H.Y. Brownrigg	Maintenance Supervisor IV
P.C. MacCaull	Maintenance Supervisor I
F.E. Purton	Truckman
K. Johnston	Caretaker II
W.D. Stuart	Caretaker II (Watchman)
D.A. Stinson	Caretaker III
C.S. Tucker	Caretaker III
J.A. Rogers, A.C.B.A.	Administrative Officer II
Nina M. Parker	Clerk IV
Winifred E. Dougherty	Stenographer III
Frances L. Stinson	Clerk III
Shirley B. Cunningham	Stenographer IIA
M. Beryl Stinson	Clerk IIB
B. June Field	Stenographer I (from June 12)
Mary E. Johnston	Typist I (from April 1)
Lois G. McMullon	Stenographer I
A.A. Skinner, B.Sc.	Technician I
Emma A.C. Haskell, B.Sc.	Assist. Tech. II
Evelyn R. MacMillan	Assist. Tech. II
Arlene R. MacMorran, B.Sc.	Assist. Tech. II
Phyllis J. Gibson	Assist. Tech. I (from April 1)
Mary Holmes	Assist. Tech. I
Esther I. Lord	Assist. Tech. I ($\frac{1}{2}$ time Nov.16-Mar.31)
James Craig	Technician I (to April 1)
D.N. Fitzgerald	Technician I
M.F. Fraser	Technician I
J.S. MacPhail	Technician I
R.C. Murray	Technician I
K.G. Sollows, B.Sc.	Technician I (from April 1)
G.J.W. Sullivan	Technician I
J.H. Boyce	Assist. Tech. III (from May 11)
I.M. Jones	Assist. Tech. III
L.G. Kervin	Assist. Tech. III
S.D. Sedgwick	Assist. Tech. III (from March 25)
E.G. Sollows	Assist. Tech. III (May 10 - Nov. 15)
H.W. Coates	Assist. Tech. II
C.R. Hayes	Assist. Tech. II
U.J. Walsh	Assist. Tech. II
W.W. Yorston	Assist. Tech. II
H.H. Butler	Technician II (Captain)
C.J. Bayers	Assist. Tech. III (Captain)(from Mar.30)
L.I. Cross	Assist. Tech. III (Captain)(Apr. 3 - Sept. 30)
J.A. LeBlanc	Assist. Tech. III (Captain)
W.G. Carson	Assist. Tech. II
H.F. Strum	Master (from April 1)
B.W. Hart	Engineer
H. Yarn	Engineer (from April 1)

Personnel of Atlantic Herring Investigation Committee with
headquarters at Atlantic Biological Station
(Committee discontinued March 31, 1950)

A.H. Leim, B.A., Ph.D.	Investigator-in-Charge (seconded by Fisheries Research Board, Atlantic Biological Station)
S.N. Tibbo, M.A.	Biologist (seconded by Fisheries Research Board, Newfoundland Biological Station)
Phyllis J. Gibson	Assist. Tech. I
Mary E. Johnston	Stenographer I
H.F. Strum	Master
H. Yarn	Engineer
K.G. Sollows, B.Sc.	Jun. Res. Assist.

Personnel of Atlantic Oceanographic Group with
headquarters at Atlantic Biological Station

H.B. Hachey, M.B.E., E.D., M.Sc., LL.D., F.R.S.C.	Principal Oceanographer, Oceanographer-in-Charge
H.J. McLellan, M.Sc.	Assoc. Hydrographer (on leave of absence to July 31)
W.B. Bailey, B.Sc.	Assist. Oceanographer (from May 29)
R.W. Trites, B.Sc.	Junior Oceanographer (from May 21)
E.L. Graham	Assist. Tech. III
L.H. Brownrigg	Assist. Tech. I
Marian E. Tabor	Stenographer IIB (to June 10)
Madelyn M. Meating	Stenographer I (from June 21)
D.G. MacGregor, M.A.	Assist. Oceanographer (June 15 - Sept. 23)

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- Fisher, H. D. "Seals of the Canadian East Coast." Atl. Biol. Sta. Circular No. 18, September, 1950.
- Lauzier, L. "Unusually Warm Surface Sea Water in 1949." Prog. Rep. Atl. (in press)
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- McKenzie, R. A. "An Up-to-Date Ice Chisel for Fishermen." Atl. Biol. Sta. Circular No. 16, April, 1950.
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- Medcof, J. C. "Burrwing Habits and Movements of Soft-Shell Clams." Prog. Rep. Atl. No. 50, Note No. 115, pp. 17-22.
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- Smith, G. F. M., and Elson, P. F. "A Direct-Current Electrical Fishing Apparatus." Can. Fish. Cult. (in press)
- Smith, M. W. "A Review of 'Experimental Use of Fertilizer in the Production of Fish-food Organisms and Fish' by Robert C. Ball." Can. Fish. Cult., No. 6, pp. 26-27, March, 1950.
- Smith, M. W. "The Use of Poisons to Control Undesirable Fish in Canadian Fresh Waters." Can. Fish. Cult., No. 8, pp. 17-29, October, 1950.
- Smith, M. W. "Further Observations upon the Movements of Speckled Trout in a Prince Edward Island Stream." Can. Fish. Cult. (in press)

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"MANUSCRIPT REPORTS" SERIES IN 1950

- No. 395 Chiasson, L. P. Report of Scallop Investigations and Explorations in the Southern Gulf of St. Lawrence - 1949.
- No. 397 Hachey, H. B. Vertical Temperature Distribution in the Great Lakes.
- No. 398 Giglioli, M. E. C. Some Observations on the Biology of the Whelk Polynices heros Say (1822), and Polynices triseriata Say (1826) at Belliveau Cove, N. S.
- No. 399 Thurber, L. W. Meat Yield of Clams (Mya arenaria) and Percentage Total Dry Solids of Clam Meats - 1949.
- No. 406 McLeese, D. W. Factors Limiting the Survival of Lobsters.
- No. 407 MacGregor, D. G. Review of Recent Studies in Ocean Waves.

Martin, W. R. "Measuring Groundfish Catches." Mimeographed Report to Fisheries Research Board, distributed 1950.

CBC FISHERMAN'S BROADCASTS

February 23	H. D. Fisher	Migration of seals.
March 2	H. D. Fisher	Results of last year's bounty on seals.
March 9	S. N. Tibbo	The Larsen trawl.
March 16	A. H. Leim	Do echo sounders frighten fish?
March 23	W. R. Martin	Haddock fluctuations.
March 30	W. R. Martin	Reasons for haddock fluctuations and their abundance.
April 6	W. R. Martin	Haddock populations.
April 13	J. C. Medcof	Abundance of Digby scallops.
April 20	J. C. Medcof	Scallop tagging to estimate abundance.
April 27	F. D. McCracken	Groundfish bait experiment.
May 4	H. C. White	The lamprey in salmon streams.
May 11	F. D. McCracken	Flounder tagging.
May 18	H. C. White	The beaver and salmon production.
May 30	R. C. Murray	Effects of closure on a lobster fishery.
June 1	J. S. MacPhail	The flounder as an enemy of the seed clam.
June 8	J. S. MacPhail	The flounder as an enemy of adult clams.
June 15	C. J. Kerswill	Review of salmon investigation.
June 22	P. F. Elson	Electrical fishing.
June 29	P. F. Elson	Eels in salmon streams.
July 7	H. C. White	The kingfisher.
July 14	P. F. Elson	Results of bird control in salmon streams.
September 7	H. D. Fisher	Seal count in the Gulf of St. Lawrence.
November 13	G.J.W. Sullivan	Lobster moulting and shell condition.

Interviews recorded and not yet broadcast:

L. M. Dickie	Digby scallops.
M.E.C. Giglioli	Clam drill egg collars.
M.E.C. Giglioli	Clam drills and clams.
J. S. MacPhail	Clam worm.
F. D. McCracken	Inshore flounder dragging.
F. D. McCracken	Commercial-size flounders and tagging.
J. W. Saunders	Black bass.
M. W. Smith	Arctic char in New Brunswick.
H. D. Fisher	Ambergris.
H. D. Fisher	Whaling.
L. Lauzier	The weather and the water.
H. J. McLellan	Surface-water temperature cycles.
D. W. McLeese	Temperature and salinity effect on lobsters.
R. C. Murray	Lobster growth.
S. N. Tibbo	Drift-netting for herring.

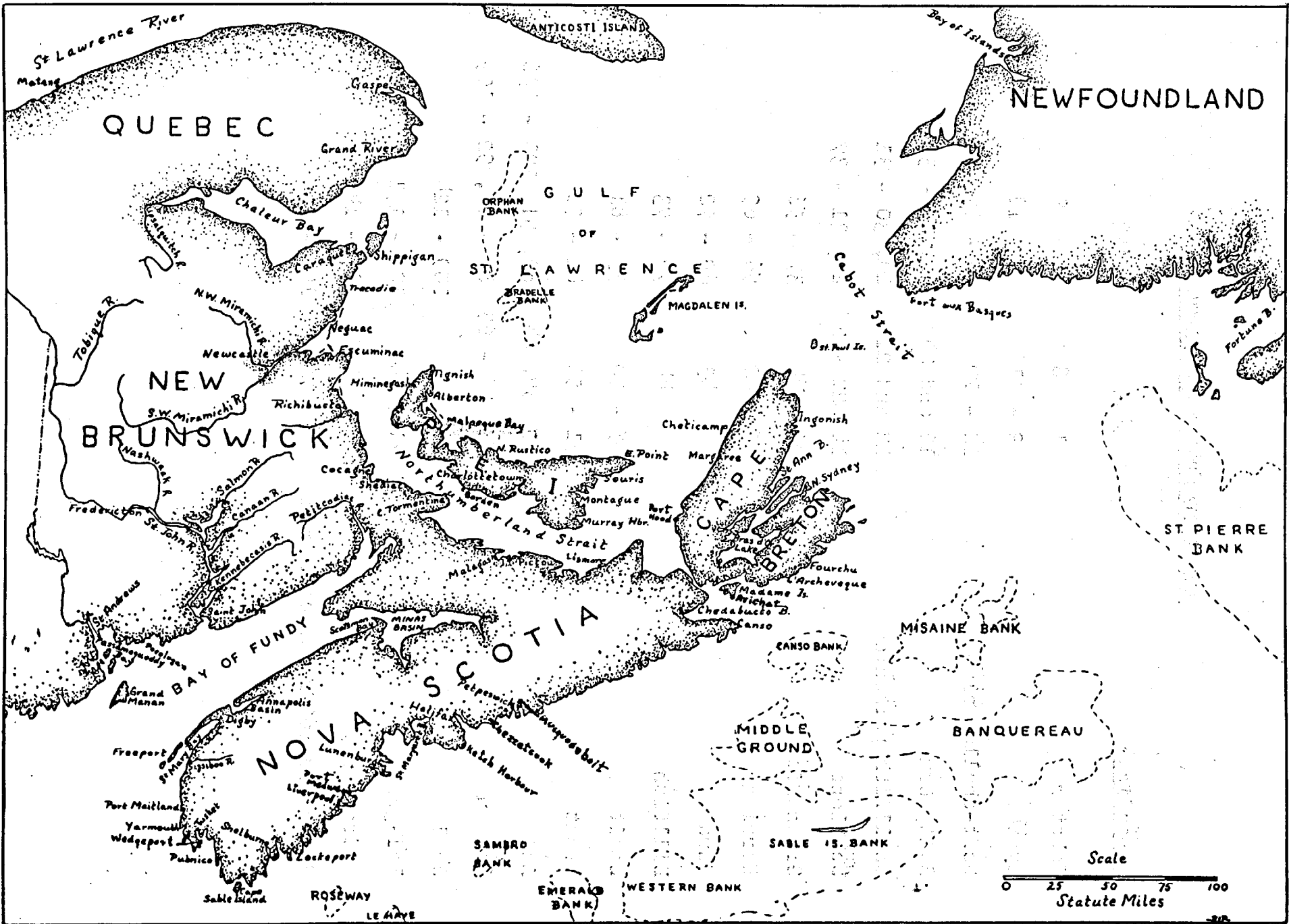
EXHIBITIONS

Shediac Lobster Festival (July 6-8) and Pictou Lobster Carnival (July 11-12). Display illustrating lobster investigations; tagging, fishing mortalities, moulting, growth, average sizes, live lobster larvae, catch statistics.

Lunenburg Fisheries Exhibition (September 12-16). Display featuring lobster and seal investigations and illustrating, by means of charts and aerial photographs, the migration routes, location of breeding grounds, and extent of harp seal herds.

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GENERAL SUMMARY OF LOBSTER INVESTIGATIONS

Population studies, which form a major part of the lobster investigation, were continued this year at six ports for which comparable data are now available for six years. The data continue to show a definite increase in the population of "market" lobsters (over 3 1/8" carapace measure) in the Fourchu area following an increase in the minimum size limit. (Appendix 2).

Growth studies, which were started in 1947 to obtain information on the growth of lobsters under natural conditions, were continued in 1950. During May and June a total of 12,521 marked lobsters were liberated on the fishing grounds at Tignish, P. E. I., Lismore, N. S., and Grand Manan, N. B. Returns from the Tignish and Lismore markings are not anticipated until the 1951 spring season. Returns obtained to date at Grand Manan show a relatively constant growth rate throughout the size range studied and indicate little annual variation. (Appendix 3).

The new minimum-lath-space regulation has been well observed at L'Archeveque, N. S., and catches there show a 41% reduction in "shorts", with lobsters less than 8.1" virtually eliminated. (Appendix 4).

Lethal-temperature and -salinity studies, which were started by D. W. McLeese in 1949, were continued during the summer of 1950. The upper lethal temperature rises at the rate of about 1°C for each 4°C rise in acclimation temperature. The ultimate upper lethal is in the vicinity of 30.4°C (86.7°F). Lower lethal temperatures of 2.0°C and 4.5°C were determined for lobsters acclimated to 17.0°C and 24.0°C respectively. Lower lethal salinities are related to acclimation temperature, rising from 5.8‰ at 5°C to 19.4‰ at 25.0°C. (Appendix 5).

An experiment to determine the relative toxicity of metals showed that copper, monel metal, zinc and lead were toxic to lobsters in that order. Iron, aluminum and stainless steel were shown to be non-toxic. (Appendix 6).

Shell-disease studies repeated this year showed that heavily diseased lobsters died faster than lightly diseased or non-diseased animals. Total mortalities among diseased animals were only slightly higher than among controls. Diseased lobsters became more heavily infected during the course of the experiment and isolated controls developed external symptoms. Moulting of diseased lobsters was accompanied by the disappearance of external symptoms. (Appendix 7).

Towing for lobster larvae in Northumberland Strait indicated that although first-stage larvae were six times as abundant in 1950 as in 1948, the catch per tow of fourth-stage larvae did not differ greatly in the two years. Survival during larval development appears to be as important as the abundance of first-stage larvae in determining production of fourth-stage larvae. (Appendix 8).

The field work involved in these investigations was carried on by G. J. W. Sullivan, R. C. Murray, L. G. Kervin, U. J. Walsh and

W. W. Yorston. Captain Jules LeBlanc skippered the M. B. "Mactra S." and the M. B. "Gulf Explorer" during the towing for lobster larvae.

D. G. Wilder

Appendix No. 2

LOBSTER POPULATIONS AND SIZE-LIMIT CHANGES

Population studies were continued during 1950 at Grand Manan, Tignish, Miminegash, Port Maitland, Fourchu and L'Archeveque and initiated at Gabarus where fishermen have petitioned for a larger size limit. Comparable data on landings, catch per unit effort, size distributions and fishing mortalities are now available for six ports for the past six years. These data will prove valuable in assessing results if Canada follows Massachusetts' lead in raising the "market" size limit from 3 1/8" to 3 1/4" carapace length.

The data for Fourchu and L'Archeveque, two adjacent similar areas on the outer coast of Cape Breton, are of particular interest. In 1947 the size limit was raised at Fourchu from 7" total length to 3 1/8" carapace length (about 9" total length). All lobsters caught in this area are now shipped alive as "markets" (over 3 1/8" carapace measure), whereas prior to 1947 the 7" to 9" lobsters (about 40% of the catch by weight) were canned. At L'Archeveque, where this larger limit was introduced in 1934, it is assumed that no further changes related to this size limit have occurred since 1945 when studies at these two ports were initiated. Average indices of "market"-lobster abundance at each port for the 1945-47 and 1948-50 periods are as follows:

	Fourchu			L'Archeveque		
	'45-'47 (lb.)	'48-'50 (lb.)	Change (%)	'45-'47 (lb.)	'48-'50 (lb.)	Change (%)
Landings	48,200	75,600	+57	37,800	39,900	+ 6
Catch per boat	3,080	5,250	+70	2,810	3,080	+10
Catch per trap set	17.2	34.2	+99	17.5	19.1	+ 9
Catch per 100 trap hauls	72	114	+58	86	78	- 9
Population density/sq.mi.	4,650	5,970	+28	8,130	7,780	- 4

These data indicate a definite increase in the population of "market" lobsters at Fourchu following the introduction of the 3 1/8" size limit, the L'Archeveque population remaining relatively static during this period. At Fourchu landings of the more valuable "market" lobsters increased to 86,500 lb. by 1950, approximating the 1945-46 average landings of "canners" and "markets" combined (90,500 lb.).

The average size of lobsters in complete catches has increased at Fourchu from 21.8 cm. in 1945 to 23.6 cm. in 1950 and at L'Archeveque from 23.0 cm. to 24.6 cm. These changes are believed to result from the recent general adoption of wider lath-spacing at these two ports.

D. G. Wilder

Appendix No. 3

LOBSTER GROWTH

Marking experiments which were started in 1947 to measure the growth of lobsters under natural conditions were continued this year at Tignish, P. E. I., and at Grand Manan, N. B., to check results previously obtained at these ports, and at Lismore, N. S., to extend our knowledge of growth in the southern Gulf area.

At Tignish a total of 3502 lobsters were measured in six 1/8" carapace-length groups and marked distinctively by means of two small holes punched in different sections of the tail fan. These were liberated on the fishing grounds from June 7 to 30, just prior to the moulting period. At Lismore 6262 marked lobsters were liberated during the same period. Recoveries of these marked lobsters are anticipated during the 1951 spring season.

In the similar marking experiment at Grand Manan 2757 lobsters were liberated from May 23 to June 22. During the first four days of the fall season which opened November 15 a total of 246 were recovered, of which 237 (96%) had moulted. The average growth in carapace length of those lobsters which moulted is compared below with similar data obtained during 1947.

Lobster growth at Grand Manan, N. B.

Carapace* length (inches)	1947				1950			
	No. marked	No. recov.	Growth inches* %		No. marked	No. recov.	Growth inches* %	
2 13/16	486	19	0.47	16.7	288	13	0.50	17.8
2 15/16	534	41	0.48	16.3	516	47	0.52	17.7
3 1/16	492	48	0.46	15.0	536	54	0.48	15.7
3 3/16	429	25	0.44	13.8	494	59	0.47	14.7
3 5/16	344	32	0.48	14.5	472	34	0.48	14.5
3 7/16					451	30	0.52	15.1
	<u>2,285</u>	<u>165</u>	<u>0.47</u>	<u>15.2</u>	<u>2,757</u>	<u>237</u>	<u>0.49</u>	<u>15.7</u>

*Carapace length x 2.9 = total length

These growth estimates are remarkably consistent throughout the length range studied (8" to 10" total length) and show little annual variation. Although summer water temperatures averaged higher in 1947 (14.2°C) than in 1950 (12.9°C) this difference is not reflected in the growth rate.

D. G. Wilder

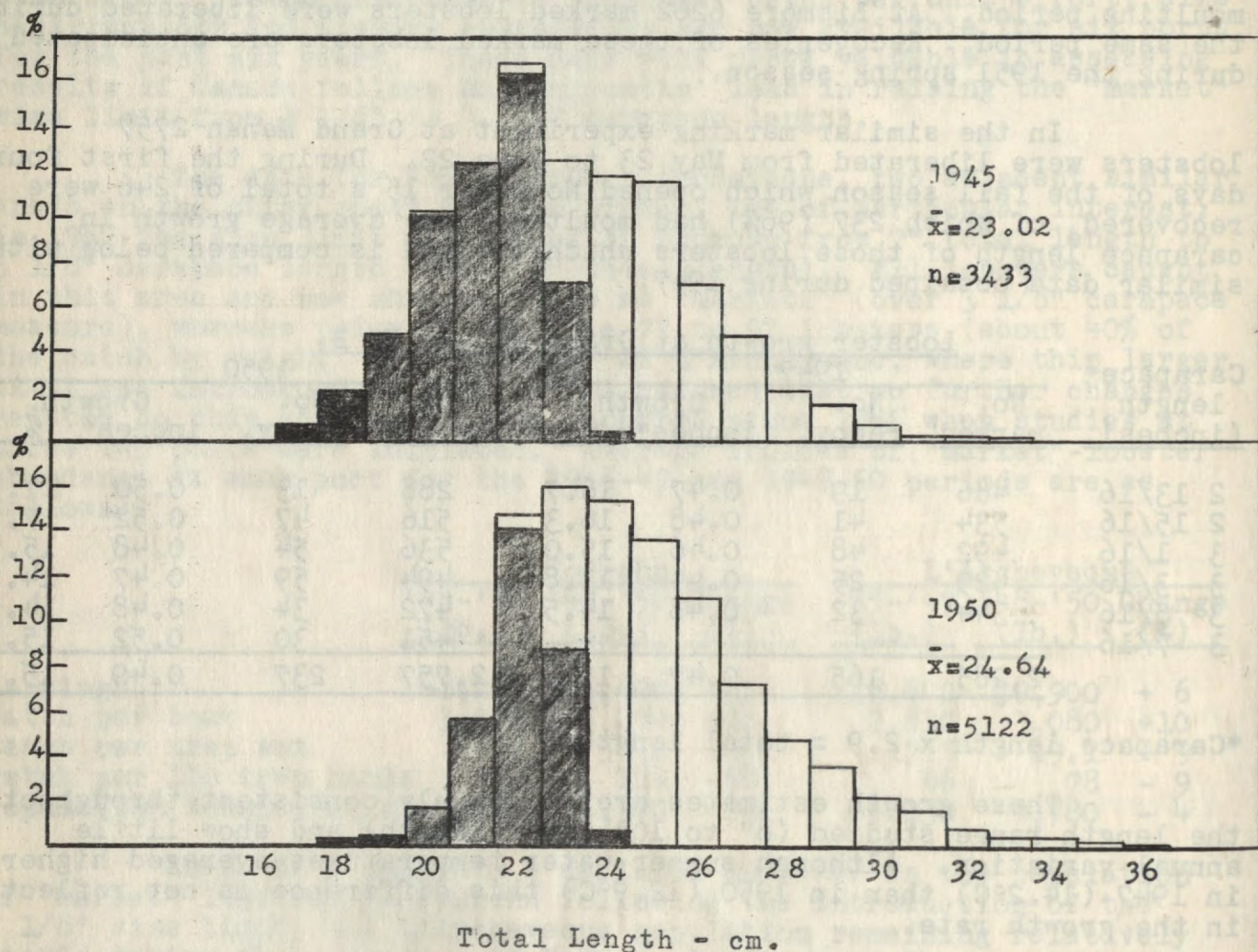
Appendix No. 4

LATH-SPACE REGULATION

Experiments conducted in six market-lobster areas during 1945 and 1946 showed that widening the lowest lath spaces on lobster traps to 1 3/4" would permit up to 80% of the short lobsters to escape without reducing the total catch of marketable lobsters. Supplementary experiments showed, however, that 1 3/4" spaces were wide enough to permit some

of the smallest legal-sized lobsters to escape. On the basis of these experiments a regulation setting the minimum lath spacing in the market-lobster areas at $1\frac{5}{8}$ " was passed effective November 1, 1949.

One of the experiments testing $1\frac{3}{4}$ " spaces was conducted at L'Archeveque, N. S., in 1945 and showed a 67% reduction in the catch of shorts. This result was enthusiastically received by the local fishermen who gradually widened their lath spaces. Whereas in 1945 trap lath spacing at this port deviated only slightly from the $1\frac{1}{8}$ " average, by 1950 spaces averaged $1\frac{5}{8}$ " with no traps spaced closer than $1\frac{1}{2}$ ". The effect of this change in lath spacing on the size composition of the catch is illustrated below. The 1950 data



Size distribution of catchable lobsters measured at L'Archeveque, N.S.

Short Lobsters - Black
Legal-sized lobsters - White

compared with the 1945 show an overall reduction of 41% in the catch of shorts, with lobsters less than 20.5 cm. (8.1") virtually eliminated from the catch.

D. G. Wilder

Appendix No. 5

LETHAL TEMPERATURES AND SALINITIES FOR LOBSTERS

Experiments started in 1949 to determine the effects of temperature and salinity on the survival of lobsters were continued through the summer of 1950. Experimental animals were obtained at Escuminac, N. B., at Grand Manan, N. B., and locally during May and June and transferred to the Atlantic Biological Station where they were held in a floating car until required. To determine lethal temperatures or salinities the lobsters were first held under relatively constant conditions until fully acclimated and then transferred immediately to the test conditions. Temperatures and salinities stated to be lethal are those which caused 50% mortality in 48 hours.

Temperature

The 1949 experiments showed clearly that lobsters could acclimate to increased temperatures, about two days acclimation time being required for each degree centigrade rise in temperature. This summer upper lethal temperatures were determined for various acclimation temperatures as follows:

<u>Acclimation Temperature °C.</u>	<u>Upper Lethal Temperature °C.</u>
5.0	25.7
9.0	26.5
14.0	28.3
19.0	29.0
24.0	30.4

The upper lethal temperature rises at the rate of about 1°C for each 4°C rise in acclimation temperature.

The lower lethal temperature for lobsters acclimated to 17.0°C was found to be approximately 2.0°C and that for lobsters acclimated to 28°C about 4.5°C.

No difference in upper lethal temperature could be detected between small lobsters (21-22 cm.) and large lobsters (26-28 cm.) from the same area, or between lobsters from a warm-water area (Escuminac, N. B.) and those from a cold-water area (Grand Manan, N. B.). Soft-shelled lobsters, however, are apparently less resistant than hard-shelled lobsters to high temperatures.

Salinity

The lower lethal salinities were determined for lobsters acclimated to full sea water (30‰) and to various temperatures. The following figures show clearly that the lower lethal salinity is related to temperature, increasing about 3.5 parts per mille for each 5°C rise in acclimation temperature.

Acclimation Temperature °C.

Lower Lethal Salinity ‰

5.0	5.8
10.0	10.6
13.0	13.3
17.0	14.1
25.0	19.4

Experiments to determine the relationship between size and lower lethal salinity were not conclusive but suggest that small lobsters (16-17 cm.) are more resistant to low salinities than large lobsters (28-34 cm.).

D. W. McLeese

Appendix No. 6

THE RELATIVE TOXICITY OF CERTAIN METALS TO LOBSTERS

At the request of Dr. S. A. Beatty, who wished to know what metal would be safe to use as lining material for a refrigerated lobster truck trailer, an experiment was conducted to determine the relative toxicity of iron, aluminum, monel metal, lead, zinc and copper. As the experiment progressed, stainless steel was added to the series.

Seven water-tight tanks having inside dimensions of 4' x 4' x 8" were constructed of 1 3/4" dressed pine. Sheets of the metals to be tested completely covered the bottoms of six of the tanks, the seventh tank serving as a control. These tanks were filled to a depth of 6" (approx. 50 Imp. gals.) with fresh sea water which was not changed during the course of the experiment, although on several occasions from 5 to 10 gallons of sea water were added to replace loss through evaporation. Oxygen was supplied by means of compressed air bubbled into each tank through two air stones at the rate of approximately one litre per minute. No attempt was made to control temperature which fluctuated between 5°C and 20°C. To delay the accumulation of organic decomposition products the lobsters were not fed throughout the experiment. The experiment was started on May 23 when ten vigorous lobsters ranging in total length from 23 cm. to 26 cm. were placed in each tank. The mortalities observed to the time of writing (October 13) were as follows:

Copper.....	all	dead	within	18	hours
Monel metal.....	"	"	"	6	days
Zinc.....	"	"	"	9	"
Lead.....	"	"	"	20	"
Iron.....	3	dead	to	date	(143 days), remaining 7 normal
Aluminum.....	1	"	"	"	(143 days), " 9 "
Controls.....	4	"	"	"	(143 days), " 6 "
Stainless steel.....	2	"	"	"	(52 days), " 8 "

These data show that copper, monel metal, zinc and lead are toxic to lobsters in that order and indicate the use of aluminum or stainless steel where metal is required in the handling of live

lobsters. Iron, although non-toxic, would not be favoured for such use because of heavy rust formation.

The survival of the lobsters in four of these experimental tanks was much better than anticipated under what were considered to be adverse holding conditions. Commercial holding of lobsters in tanks might well be improved by using compressed air to supply oxygen. This should permit greatly reduced water flows at lower pumping costs and might make cooling of the water economically feasible.

D. G. Wilder

Appendix No. 7

LOBSTER SHELL DISEASE

Shell-disease studies initiated in 1949 to determine mortalities associated with the disease and the degree of spreading among impounded lobsters were continued during 1950. On March 17, 125 diseased lobsters were obtained from Deer Island, N. B., where they had been impounded for several months. On April 2, 224 freshly-caught lobsters which showed no evidence of the disease were obtained from south-western Nova Scotia. On April 6, after initial shipping and handling mortalities had declined, all lobsters were examined externally for degree of infection, measured and tagged. Ninety-five diseased lobsters were then placed in tanks together with 97 non-diseased lobsters. The remaining 127 non-diseased were placed in separate tanks as controls.

Each day the tanks were inspected for mortalities and at approximately monthly intervals the lobsters still surviving were completely re-examined for external symptoms. The cumulative percentage mortalities at each examination were as follows:

	<u>Heavily infected</u>	<u>Lightly infected</u>	<u>Non-diseased held with diseased</u>	<u>Non-diseased controls</u>
Original no. Apr. 6	<u>42</u>	<u>53</u>	<u>97</u>	<u>127</u>
Mortality to May 11	60%	32%	7%	8%
Mortality to June 7	79%	55%	16%	9%
Mortality to July 5	98%	77%	53%	12%
Mortality to Aug. 14	100%	89%	72%	51%
Mortality to Oct. 6		96%	89%	84%

The rate of mortality is directly related to the degree of infection or exposure to it, the heavily infected dying at the fastest rate and the controls at the slowest. Total mortalities to October 6 were consistently but not strikingly higher in the diseased groups as compared to the non-diseased.

The average degree of infection in each group at each complete examination was as follows: (Number of specimens in parentheses).

	<u>Heavily infected</u>	<u>Lightly infected</u>	<u>Non-diseased held with diseased</u>	<u>Non-diseased controls</u>
Apr. 6	32.1 (42)	18.1 (53)	0 (97)	0 (127)
May 11	33.3 (19)	20.1 (37)	1.7 (89)	0.6 (116)
June 7	38.2 (13)	24.8 (30)	2.7 (88)	1.5 (114)
July 5	44.9 (7)	30.3 (15)	3.8 (52)	2.6 (108)
Aug. 14		31.0 (8)	3.7 (26)	4.7 (57)
Oct. 6		26.0 (2)	4.8 (12)	7.7 (16)

The degree of infection as judged by external symptoms increased in all groups throughout the experiment. The disease developed to about the same degree but at a somewhat slower rate among the isolated controls as compared to the freshly-caught lobsters held with the diseased individuals.

When moulting occurred the newly-moulted, soft-shelled lobsters were often badly mutilated by hard-shelled lobsters before they could be examined. It was, however, possible to make complete post-moult examinations of 17 lobsters which had shown external disease symptoms prior to moulting. None of these newly-moulted lobsters showed any evidence of the disease.

Most of the observations involved in this work were made by G. J. W. Sullivan with assistance from D. W. McLeese, L. G. Kervin and R. C. Murray.

D. G. Wilder

Appendix No. 8

PLANKTON TOWS FOR LOBSTER LARVAE

The program of systematic towing started in 1948 to determine the relative abundance of lobster larvae in Northumberland Strait was continued in 1950 from June 9 to September 27. The #000 bolting cloth (23 meshes to the inch) used in 1949 was not strong enough to withstand the strain of towing in the twelve-foot plankton net and pulled apart at the seams. This year #16 grit gauze (16 meshes to the inch) was used and found to be much more satisfactory in all respects. Engine trouble seriously curtailed the work during the early part of the season, only 9 tows being made during the month of June. Although larvae have been caught as early as June 20 and as late as September 27, both the fishing effort and the catches have tended to be erratic at the beginning and end of the season. For this reason only July and August catches are considered in comparing the three years. The numbers of each larval stage caught during these two months were as follows: (Catch per tow in parentheses).

	<u>No. tows</u>	<u>Stage I</u>	<u>Stage II</u>	<u>Stage III</u>	<u>Stage IV</u>	<u>Total</u>
1948	69	694(10.1)	297 (4.3)	178(2.6)	131(1.9)	1,300(18.8)
1949	211	6,067(28.8)	802 (3.8)	328(1.6)	79 (.4)	7,276(34.5)
1950	168	11,075(65.9)	3,048(18.1)	1,445(8.6)	337(2.0)	15,905(94.7)

Although, according to these data, first-stage larvae were over six times as abundant in 1950 as in 1948, the catch per tow of fourth-stage larvae did not differ appreciably in these two years. Survival during larval development appears to be as important as the abundance of first-stage larvae in determining production of fourth-stage larvae.

D. G. Wilder

Appendix No. 9

GENERAL SUMMARY OF OYSTER INVESTIGATIONS

Investigations were directed from the P. E. I. Biological Station and were carried on in Bideford River there; in Enmore and Trout Rivers nearby; in Johnston River, near Charlottetown; and at Shippigan, N. B. Field work on an unexplained mortality was also pursued at West River and adjacent inlets near Charlottetown, P. E. I.

Spat production. The summer of 1950 was generally cold and wet with warm weather only in the last two weeks of May and from mid-July to early September. Growth was normal or even a little better than normal, but spawning and setting were poor. By the end of May the oysters in Bideford River were ripe and a few more warm days would have initiated spawning. Instead a cold wet June set in and spawning did not occur until July 7, continuing in dribbles until a maximum spawning on July 14. Whether or not the cold June was responsible, this spawning produced a concentration of only 7 larvae per litre as compared with 500 the year before. The resulting set was late, light, and a commercial failure. The set at Shippigan was also a failure and the set at Gillis Cove, Bras d'Or Lakes, N. S., was of dubious value. Only at Malagash, N. S., was this year's set a success. It was late and the spat are smaller than they should be for the most successful handling, but it was of almost ideal intensity (1700 per filler). Being warned of a light spatfall by the P. E. I. Biological Station, most growers did not put out their collectors and thereby saved themselves considerable loss. A few growers put out strings of oyster shells at Shippigan and these were unsuccessful. The Department put out collectors for experimental purposes.

Prediction of sets. Investigations were commenced this year to improve our accuracy in predicting sets. This year larval periods were shorter and setting occurred at a smaller larval size than was expected from previous work. It remains to be seen whether this represents a previous misconception on our part or a peculiar situation in a peculiar year of very light larval production and spatfall. An interesting by-product was the discovery that spat settled in much greater numbers on scallop shell than on any other type of collector.

Control of barnacle sets. An attempt was made at Shippigan to follow up the previously-reported work on the effect of DDT as a barnacle-repellent when applied to oyster collectors. The principal barnacle set this year was earlier than the oyster set and was also very light. Oyster collectors from which it was hoped to show the comparative effects of different concentrations of DDT in repelling

oyster and barnacle settlement caught so few of either that no definite statements can be made. Such meagre results as were obtained indicated that when collectors were dipped in concentrations of 2%, 5% and 7% DDT in stove oil, and in the oil alone as a control, all but the oil alone virtually prevented the settlement of oysters and of barnacles. By comparison with untreated collectors, those dipped in oil alone seemed to prevent the settlement of barnacles without interfering seriously with the oysters. This most interesting possibility will be further investigated. A trial of the effect of mixing wettable DDT powder with the cement formula used to coat the collectors, so as to give concentrations of DDT of 2%, 5% and 7% in the mixture, showed no effect from the 2% concentration and a reduction in both oysters and barnacles by the 5% and 7% concentrations. Since both these higher concentrations would be prohibitively expensive in a commercial operation, there would seem to be little profit in further work along this line.

Vertical distribution of oyster larvae. Mr. R. J. Kerr continued his post-graduate studies into the vertical distribution of larvae and of spatfall. He was handicapped by the very poor year in Bideford and in Trout Rivers, but obtained interesting contrasts by comparing the heavy concentrations of 1949 with the very light ones of 1950. His work is reported in Appendix 11.

Investigations of mortalities. A severe mortality in oysters from West River, P. E. I., in air storage last winter necessitated the disposal of the entire stock with heavy loss to the owners. Investigations into this phenomenon are reported in Appendix 10B. It is hoped that histological examination of dying and dead oysters will be informative.

The course of development of resistance to the "Malpeque disease" in the native oysters of Johnston and Enmore Rivers, P.E.I., is reported in Appendix 10A, as is the course of the disease in New Brunswick and Nova Scotia oysters tray-reared in P. E. I. waters.

Tray-rearing of small oysters. As a part of the continuing investigation into more efficient and cheaper methods of oyster culture, which must be the principal occupation of this sub-station, an investigation was made into the efficiency of floating and of Dutch trays. These included the standard types of both these trays and various modifications of them intended to improve water circulation. The experiment was performed in the sheltered waters of Bideford River at Eilerslie and was duplicated in the more exposed waters at Shippigan. It was on an ambitious scale, and collection of the final data had to await the end of the growing season and is not yet complete. No detailed analysis has therefore been possible, but already it is obvious that the results are not clear-cut and that very careful examination of the data, and possibly repetition of the experiment, will be necessary in order to furnish the desired answers.

Certain consistent results have been obtained which will be helpful in planning future work. This year the increases in length, width, area, volume and weight of the oysters were followed; it is now obvious that measurement of length or width coupled with

any one of area, volume or weight would suffice to show significant differences where they occurred. The simplest reliable pair to measure is probably length and volume.

It is also clear that, in Dutch trays stacked in threes, growth in the middle tray is very much less than in the top and bottom trays, so much so that it would be advisable to stack Dutch trays in twos. It is not proper to compare the growing efficiency of floating and of Dutch trays until this is done.

Personnel. Mr. A. A. Skinner assisted in all investigations and took sole charge of prediction of sets in which he had the assistance of Mr. A. J. Wilson. Mr. Wilson also participated in the disease investigations. Few of these investigations would have been possible without the assistance of the Department's field staff in oyster culture and special mention should be made of the co-operation of Mr. George A. C. Wilson, Administrative Officer, Ellerslie, and of Messrs. L. A. England and H. J. Robichaud, foremen of the experimental oyster farms at Ellerslie and Shippigan respectively.

R. R. Logie

Appendix No. 10

OYSTER DISEASES

A. The "Malpeque disease"

Mortalities in P. E. I. tray-reared stock. The comparison of annual mortalities in resistant Malpeque stock and in Johnston River native stock was continued in Johnston River, near Charlottetown, and a similar comparison was resumed in Enmore River on Northumberland Strait across from Bideford. The accompanying table brings these figures up to date.

These data show the continued presence of the disease in these two rivers and demonstrate that the resistance of the native stocks is not yet as high as that of Malpeque stock; neither is there any obvious trend toward improvement of their resistance. The mortality in native Johnston-River oysters of the 1943 year-class is unusually high. This may be the cumulative effect of the disease on old oysters or may be caused by deaths from other reasons in the very few oysters of this year-class remaining.

In Johnston River all year-classes from 1943 to 1948 inclusive were placed on trays on May 10 and the 1949 year-class on July 1. In Enmore River the only year-class (1949) went on the trays on June 8. The month of May was very warm; June and the first week of July were unseasonably cold and rainy; the remainder of July, August and the first half of September were of close-to-average temperature and the latter half of September was cold and wet. On the basis of previous experience the greatest mortalities from the disease are to be expected in the warm summer weather, which usually embraces the period of recovery from spawning. The percentages of the annual mortality occurring this year in Johnston River in each of the weather periods experienced are shown in the second table.

Mortalities in experimental stock

Percentage of spring survivors which died in:		1944	1945	1946	1947	1948	1949	1950
<u>Johnston River:</u>								
Malpeque	1943	0.4	1.3	1.0	0.8	4.3	4.4	4.2
Native	1943	9.0	18.3	25.9	11.8	6.6	12.1	81.8
Malpeque	1945			0.3	1.3	0.4	2.5	1.9
Native	1945			2.5	6.6	5.7	5.0	14.8
Malpeque	1946				0.3	2.9	3.7	2.6
Native	1946				12.5	9.0	8.5	14.2
Malpeque	1947					0.6	1.8	1.6
Native	1947					10.4	5.5	19.3
Malpeque	1948						0.7	1.6
Native	1948						11.1	9.1
Malpeque	1949							1.0
Native	1949							0.9
<u>Enmore River:</u>								
Malpeque	1949							0.9
Native	1949							5.6

<u>Year class</u>	<u>Percentage of seasonal mortality</u>				
	<u>May</u>	<u>June 1-July 15</u>	<u>July 16-Sept. 15</u>	<u>Subsequent</u>	
<u>Johnston River:</u>					
Malpeque	1943	0	76	24	0
Native	1943	0	82	15	3
Malpeque	1945	0	63	30	7
Native	1945	0	70	27	3
Malpeque	1946	0	52	48	0
Native	1946	0	57	43	0
Malpeque	1947	0	0	100	0
Native	1947	0	90	10	0
Malpeque	1948	0	39	39	22
Native	1948	0	67	33	0

With few exceptions, deaths were commonest in the cold period from June 1 to July 15, which seems at variance with previous experience. As pointed out above, mortalities are usually greatest immediately after spawning when the oysters are thin and obviously in poor condition. In Appendix 12 to last year's report it was suggested that severe mortalities may occur in the later stages of hibernation, another time when the condition of the oysters is poor and presumably when their vitality is low. This year the warm May brought the oysters out of hibernation, started their growth and completed the maturation of their sexual products. The cold June delayed spawning until July 7, after which date dribbles of spawn culminated in a poor spawning burst on July 14. Larvae produced between July 7 and 14 did not grow or survive. Sexual vigour was obviously low and, if it be assumed that general vigour was also low during this unseasonable June, the three known periods of heavy mortality can be reconciled by the general theory that the disease makes its greatest inroads when the oysters are of low vitality and presumably have poor resistance for other reasons than the effect of the disease.

Mortalities in New Brunswick and Nova Scotia oysters introduced into Malpeque Bay. The progress of this experiment has been noted in appendices to the Director's Report for 1947, 1948 and 1949. The cumulated percentage mortalities to the end of the 1950 growing season are tabulated below:

<u>Area of origin</u>	<u>Percentage of original (1947) number dead</u>	
	<u>Bideford River</u>	<u>Enmore River</u>
*Malpeque Bay, P. E. I.	40	43
*Bedeque Bay, P. E. I.	32	48
Malagash, N. S.	95	76
Bras d'Or Lakes, N. S.	98	92
Miramichi Bay, N. B.	99	82
*Tracadie, N. B.	100	89
Shippigan, N. B.	97	86
*Controls		**Complete last year

The one known and the one suspected resistant stock, Malpeque and Bedeque, still show much lower mortalities than any of the others, confirming their resistance, the continued presence of the disease and the susceptibility of the other stocks.

The apparently greater resistance of Malagash stock in the Enmore River trays, previously reported, now appears only a little less than that of the others. The course of the disease in all susceptible stocks in Enmore River appears to be longer than in Bideford River, which could be due either to an actual lesser virulence of the disease there or to better growing conditions raising the resistance of the oysters and producing the same effect. So few oysters now remain in most lots that they will be abandoned. A more critical experiment is planned for the future, in which an attempt will be made to detect the disease in advance of the oysters' deaths.

B. Mortality in West River, Charlottetown, P. E. I.

Last year some 3500 barrels of oysters were taken from the public fishery of West (Eliot) River, a tributary of Charlottetown Harbour. Of these, approximately half disappeared in local and other small markets and the remainder were bought by wholesalers serving the Montreal market. They were held in two cold air storage plants in Montreal, with the exception of one small lot held in cold air storage in Charlottetown. Of these 1800 barrels, some 500 were disposed of by quick re-sale in October, bringing complaints from the retailers that they were very thin. The remaining 1300 barrels contained so many dead by late January that they had to be dumped, causing a loss of about \$20,000 plus the lost profit. It then came out that a small lot (150 barrels) which the dealers had tried to hold in 1948-49 had behaved similarly. At that time the dealers had attributed this to mishandling and had taken their loss without complaint to the Board or Department.

Last winter's oysters were examined in January by several people including the senior writer. They were of good external appearance with an apparently normal season's growth behind them, but at least half were dead in each container and the offensive odour had so permeated the shells of the living that culling for the market was useless. Further, moribund oysters looked very much like healthy ones, if indeed there were any of these latter, and deteriorated very quickly to the offensive condition of the dead.

It is normal experience to have as many as 10% of oysters die during prolonged cold air storage. The shells of these dead oysters gape, the liquor dries up and the meat shrivels and turns a yellowish-green, giving off an unpleasant odour as it putrefies. Such oysters are so obvious that they are removed before contaminating the rest. In dead West-River oysters the shells were usually closed, although they forced open very easily; they were full of liquor, more so than is usual in living oysters after this length of storage; and the liquor contained thick mucous strings; the meats were a greenish-black and the smell was overpowering. Specimens of dead oysters and of those which were considered moribund were preserved for histological examination.

These oysters were fished by at least twenty fishermen, were handled by three different wholesalers and were stored in three different cold storage plants, two of them as far away as Montreal and one as near as Charlottetown, and all well operated. Also this mortality recurred in two successive years. These facts rule out the possibility that the deaths occurred as the result of improper handling after fishing and necessitate the conclusion that the oysters were in no condition to stand prolonged storage when they came from the water. We know that, in spite of good shell growth, they were very thin as late as November. The problem then resolves itself into discovering what prevented "fattening".

This could have been caused by adverse conditions of temperature and salinity, but, while we have not been keeping such records for this river, we know of no reason why such conditions should have occurred there in 1948 or 1949. It could have been

caused by starvation, but we know of no reason why oyster food should have been scarce and one might expect poor shell growth too under such conditions. This area was depleted by the "Malpeque disease" in 1937 and the next few years. One of the symptoms of the Malpeque disease is emaciation of the meats, but it is unlikely that this is a recrudescence of this disease for the following reasons: emaciation of the meats in the Malpeque disease is accompanied by cessation of peripheral shell growth giving the oyster a "dumpy" appearance; the typical yellow pustules of the Malpeque disease were not present and the appearance of the oysters after death was quite dissimilar. We are then left with the possibilities of some hydrographic disturbance of which we know nothing, the Malpeque disease in a different manifestation, or a new disease.

Hydrographic records were kept this season and revealed nothing unusual, although a backlog of information is necessary to fully substantiate this statement. Test plots of oysters in West River, in the neighbouring East River and in the more remote Pownal and Hillsborough Bays of the same drainage system suffered from storm damage and vandalism, but were firmly established for a sufficient length of time to show that mortalities in all these areas were very light this season. An attempt will be made to hold the oysters over the winter in their respective areas to check on winter deaths and to provide a continuity of experimental stock for next year. A fresh start will have to be made at Pownal where a storm recently wrecked the trays and dispersed the stock.

West River has been closed to fishing of oysters in order to prevent the spread of any disease that might be present through the indiscriminate use of fishing gear in West River and other nearby waters. It is planned to fish small experimental lots at fortnightly intervals during the autumn, dividing them between cold air storage in Charlottetown and Montreal. They are to be examined at monthly intervals to discover whether the experience of the past two years will be repeated.

The writers examined the commercial beds of West River as soon as the ice went this year to discover whether the winter's mortality in cold air storage had been duplicated in natural hibernation. From one half to three quarters of the oysters on the two main beds were found to have died since the previous fall, but this is believed to have been due to ice damage. Whatever the cause, oysters are now so scarce on these beds that it is difficult to fish four barrels in two or three days every fortnight for the purpose outlined above.

Detailed histological examination of dead and of moribund oysters from last winter's cold air storage, and from this winter's, and from our experimental plots are planned. This is a lengthy process and as much as we have been able to do so far indicates that the moribund oysters may be more informative than the dead ones. In the latter disintegration of the tissues occurs so quickly and is so extensive as to make the recognition of localized pathological conditions very difficult.

No cause can yet be assigned to the mortality.

R. R. Logie and A. A. Skinner

Appendix No. 11

VERTICAL DISTRIBUTION OF OYSTER LARVAE AND SPATFALL
IN BIDEFORD AND TROUT RIVERS, P. E. I.

The vertical movements of oyster larvae were further studied this year and estimations of spatfall intensity at larval sampling levels calculated for 1949 and 1950.

Observations were continued at Bideford and Trout Rivers, two stations in the Malpeque Bay area. For general description of these areas, including hydrographic differences, see Report of the Atlantic Biological Station 1949, Appendix 13. With the exception of lower water temperatures in June and early July, hydrographic conditions did not differ significantly from those of 1949.

Larval sampling techniques outlined last year were again employed but due to the paucity of larvae 100-litre samples were taken at surface, 4 feet, and bottom at both stations, and at the halicline in Trout River. Collectors consisting of two concrete-coated egg-crate fillers placed side by side were suspended at larval sampling levels during the setting season, and changed at 12-hour intervals to separate "day" and "night" catches. Changes in the halicline level over a tidal cycle prevented its utilization as a spat collecting stratum; however, as the four-foot level coincides with the halicline during certain tidal phases, its productivity is to a certain extent representative of both.

The number of spat per 400 sq. cm. was determined for the 12-hour period by examining the inside surfaces of cells, removed at random from each collector, for newly-settled larvae. Only maximum larval broods (one per station for each season) and the spatfall resulting from them are considered in this report. The data show the approximate density of initial larval stages per unit volume of water, the number reaching intermediate stages, and the percentage of survivors reaching setting size. Larvae are divided into three groups: "straight-hinge", including larvae up to five days old; "intermediate", from straight-hinge to 280 microns; and "mature", over 280 microns. The accompanying tables summarize the general survival pattern and the spatfall (adjusted to 1000 sq. cm.) resulting from maximum spawnings.

The tables reveal that at both stations early and intermediate larval stages of the maximum 1949 broods occurred in greatest numbers at the four-foot level, where spatfall also reached a maximum. The number of mature stages decreased slightly from surface to bottom in Bideford River and more sharply in Trout River. The percentage larval survival to maturity was greater in Bideford River.

The numerically weaker 1950 broods appeared to produce larvae of a more viable nature. The percentage survival to maturity was greater at both stations than for the previous year. Straight-hinge and intermediate stages were more uniformly distributed between the surface and four-foot levels in Bideford River, but

Table I

Larvae per 100 litres

Spatfall per
1000 sq. cm.

	Level	Date	Larvae per 100 litres		Spatfall per 1000 sq. cm.		
			St.Hinge	Intermed. Mature	Day	Night	24-hr.
Bideford River 1949	Surface	July 4	12,012				
		" 15		1,756			
		" 19			646		
		" 19-22				331	880
	4 feet	July 4	27,794				
		" 15		7,392			
		" 19			546		
		" 19-22				517	1,199
	Bottom	July 4	10,826				
" 15			1,946				
" 19				502			
" 19-22					102	146	248
Bideford River 1950	Surface	July 16	345				
		" 27		30			
		Aug. 5			6		
		" 5-8				60	70
	4 feet	July 16	315				
		" 27		28			
		Aug. 5			29		
		" 5-8				157	160
	Bottom	July 16	75				
" 27			21				
Aug. 5				4			
" 5-8					82	196	278
Trout River 1949	Surface	July 5	15,174				
		" 14		1,202			
		" 20			1,138		
		" 20-23				26	252
	4 feet	July 5	31,174				
		" 14		6,350			
		" 20			240		
		" 20-23				100	174
	Bottom	July 5	8,560				
" 14			1,550				
" 20				16			
" 20-23					36	45	81
Trout River 1950	Surface	July 16	119				
		" 28		60			
		Aug. 3			12		
		" 3-6				23	73
	4 feet	July 16	320				
		" 28		24			
		Aug. 3			30		
		" 3-6				62	176
	Bottom	July 16	35				
" 28			2				
Aug. 3				1			
" 3-6					10	278	288

Table II

	Total larvae per brood at all depths sampled				Total spatfall			Spat per mature larvae
	St.Hinge	Inter- mediate	Mature	% Mature	Day	Night	24-hr.	
<u>Bideford R.</u>								
1949	50,632	11,094	1,694	3.3	950	2,225	3,175	1.88
1950	735	79	39	5.3	297	426	723	18.5
<u>Trout R.</u>								
1949	54,908	9,102	1,394	2.5	162	471	633	0.45
1950	474	86	43	9.1	95	527	622	14.5

still favoured the four-foot level in Trout River. Maximum numbers of mature larvae were found this year at the four-foot level at both stations. In 1950 slightly more spat set at the four-foot level in Bideford River and at the bottom in Trout River. During both seasons a larger number of larvae set by night than by day.

When the concentrations of mature larvae are correlated with spatfall intensities, it is apparent that in Bideford River the efficiency of settlement was about ten times as great as in 1949 and in Trout River thirty-two times as great.

The meagre 1949 spatfall in Trout River, where mature larvae were relatively numerous just prior to setting, may be associated with a sudden bloom of the dinoflagellate Peridinium which reached a peak during the anticipated settlement of the oyster larvae. This bloom coloured the water a reddish-green and persisted throughout the settlement period. Most bivalve larvae, including those of Ostrea, disappeared entirely during this period, for no other apparent reason. While this bloom may not be causal, the assumption that it is quite plausible when one remembers the wholesale disasters to fish during the celebrated "Red Tides" caused by blooms of other closely related dinoflagellates.

It is apparent from the data that, although the number of mature larvae per unit volume of water provides some indication, it is not a positive criterion of spatfall expectancy. The number which succeed in setting show a wide variation where larval concentrations are similar.

R. J. Kerr

Appendix No. 12

GENERAL SUMMARY OF CLAM AND SCALLOP INVESTIGATIONS

Soft-shelled Clam (*Mya arenaria*).

Since it now appears that clam farming cannot be relied on to maintain or expand production in most areas, the general direction of clam investigations has been altered somewhat. Problems associated

with the best use of our natural clam stocks are now receiving more attention, although studies of other sorts are continuing.

Management of digging. For three years now experiments have been under way in the tough clay soils of the Sissiboo River, N. S., to show how frequently a flat should be dug to give the highest yield per acre and whether random or systematic digging gives the greater return. Two similar sets of experiments were set up this year - one in the muddy gravel of Charlotte County, N. B., and the other in the muddy sand of Chezzetcook Harbour, N. S. The results which will emerge should give a sound basis for selection of the most promising management programs. (Appendix 13).

Size limit. The recent history of the clam industry has been studied carefully. There have been conspicuous internal changes in the industry and its value has steadily increased until now it is worth more than a million dollars a year - more than our scallop or oyster industries. The attendant increase in fishing pressure has reduced the stocks and makes management necessary to assure continuing high yields. The potential value of a strictly-enforced minimum legal size limit has been shown. (Appendix 14).

Breakage of clams. Breakage of whole clams before they are processed is one of the serious problems of plant operators because badly damaged clams have to be discarded. The superiority of wooden containers (hods and boxes) over burlap sacks in preventing breakage has been demonstrated and the use of these is being advocated as a device for improving the quality and increasing the commercial value of our clam production. (Appendix 15).

Clam drills. The study of clam drills (Polinices), which are perhaps the worst enemies of clams in our areas, has been rounded off and closed, temporarily at least. The inadequacy of proposed methods of control has been demonstrated and there is a suggestion that the gradual recovery of eel-grass on our coast will reduce their abundance and destructive capacity. Checking of their abundance will continue and the investigation may be re-opened if the need is demonstrated. (Appendix 16).

Winter mortality. A peculiar mass mortality of clams and other species of molluscs under the ice in winter or early spring on the upper beaches of a cove near St. Andrews has been investigated. It appears that a layer of fresh water immediately under the ice and floating on deeper salter water was responsible. The similarity between this and mortalities reported in rivers in the southern Gulf of St. Lawrence suggests that a closer study of this area is desirable. (Appendix 17).

Clam farming. Experiments are being continued on a reduced scale. Only three areas are under investigation now but one or two of these are giving promising results. In this respect they differ from all the other areas that have been examined to date. (Appendix 18).

Exploration. Exploration of the coast for clam stocks that are not being exploited to the full has revealed extensive beds

about Isle Madame on the south shore of Cape Breton Island that could be developed. (Appendix 19).

Production of Bait Worms as a Supplement to Clam Digging.

There is such a heavy fishing pressure on the clam stocks in several of our districts that it is considered desirable to reduce this by diverting the efforts of clam diggers to alternative employment. The possibilities of developing a bait-worm industry employing clam diggers on our coast are being surveyed. So far, the enquiry has not advanced far enough to permit definite conclusions but the prospects are not discouraging. (Appendix 20).

Paralytic Shellfish Poisoning.

Toxicities in 1950 were not excessive but several areas had to be quarantined. There were no reported deaths or illnesses. Clams from the New Brunswick National Park and from southwestern Newfoundland were found to be poison-free throughout the toxicity season. (Appendix 21).

Scallops.

Scallop populations off Digby, N. S. Mr. Dickie's work is expected to close after this winter's records are compiled. He has assessed the relative importance of natural causes and fishing effort in regulating the stocks. (Appendix 22).

Savings gear. The effort to protect sub-legal-sized scallops by developing a modified drag that will permit their escape without serious reductions in the catch of legal-sized is progressing favourably. (Appendix 23).

Exploration in the Gulf of St. Lawrence. The survey of southern Gulf of St. Lawrence scallop resources was continued under Dr. Chiasson's supervision. An extensive new bed was discovered in Northumberland Strait between Richibucto, N. B., and O'Leary, P. E. I. The scallops on it are still small but they should reach commercial size in another year or two. The value of south-shore Nova Scotia gear that can be used in the common small boats of the Gulf area was demonstrated. Further light was thrown on the periodic mass mortalities which have such a remarkable effect on the scallop stocks of the Gulf area. (Appendix 24).

Under-water photographs of scallops. An under-water camera that takes photographs of the bottom has been tested as a device for assessing abundance of scallop stocks and studying bottom characteristics of scallop areas. The results of the trials suggest that it may have wider use in fisheries investigations that should be examined. (Appendix 25).

J. C. Medcof

Appendix No. 13

MANAGEMENT OF CLAM DIGGING AND LONG-TERM PRODUCTION

Many people believe that the minimum-legal-size regulation, even when rigidly enforced, is inadequate for proper conservation of our clam resources. They advocate "rest periods" for the flats and a program of rotational closures of harbours or parts of harbours. A still more elaborate management schedule - controlled "systematic" digging - has been suggested for intensively fished areas like the Sissiboo River, N. S. In systematic digging diggers work abreast in an area and turn over all the soil as in spading a garden. The proposal was to dig each flat systematically once or twice a year with rest periods between successive diggings. This treatment is very different from "random" digging ordinarily practised by diggers who work wherever and whenever they please.

Frequency or organization of digging may affect production through the serious mortalities caused by the digging operation itself as well as through the thoroughness with which all available stocks are sought out and used. The former have been clearly shown in our own earlier work.

Two randomized-plot experiments have now been under way on a reserved flat in the tough clay soils of the Sissiboo River, N. S., for four years. One is designed to show how the production of clams per acre varies when the interval between successive systematic diggings varies from 6 months to 3 years. The other is to show the relative productivities of flats over a period of years when dug randomly and dug systematically. Similar sets of experiments were set up this year in two newly-established reserves - one in muddy gravel soil near St. Andrews, N. B., and one in muddy sand in Chezzetcook Harbour, N. S. Dr. G. F. M. Smith assisted in their design.

The results will emerge only after at least one generation of clams has settled in the controlled areas and grown to harvesting size - a minimum of 6 years - but the information being sought is fundamental to intelligent policy formation in regulating the clam industry.

Rotational closures and systematic digging might conceivably bring about substantial increases in production but it would certainly be unwise to institute them without assurance of increases in production commensurate with the administration costs.

J. C. Medcof

Appendix No. 14

IMPORTANCE OF THE CLAM INDUSTRY AND THE LEGAL SIZE LIMIT

Because of the increased popularity of fried clams in the northeastern United States, the Canadian east-coast clam industry has expanded rapidly since 1940. Most of the catch is marketed in the United States in the raw, shucked state but there is still considerable canning catering to Canadian trade. Last year the processed

value (see graph) of the catch exceeded a million dollars and the value to the fishermen (landed value) was almost half a million. In dollars and cents clams are now more important to the Maritime Provinces than either scallops or oysters and contribute in an important way to the income of inshore fishermen in many districts as well as to that of workers in processing plants.

This industry should be managed in such a way that it will afford our people the maximum continued return. Abuse of stocks, encouraged by competition for the diggers' catches, and resulting decreases in production have characterized the history of the clam fishery on the whole northeast Atlantic coast. Since the turn of the century Rhode Island, Massachusetts and the western counties of Maine have successively come into brief prominence and faded out again. The centre of the industry is now in the two eastern counties of Maine and in the Maritime Provinces. This is the "end of the line" so to speak because the species is not found in abundance elsewhere.

Almost all our stocks are now being exploited intensively and in the last three years, even though the catch has continued to rise, signs of depletion have appeared in a number of our areas. Surveys show that the populations have thinned and that the digger's catch per tide has fallen off. Now it stands at 1 to $1\frac{1}{2}$ barrels per tide and the current price is \$5 to \$6 per barrel. This return compares favourably with that obtained in other employment so the fishing pressure on clams is not likely to slacken.

So far, only two kinds of regulations aimed at conservation have been instituted:

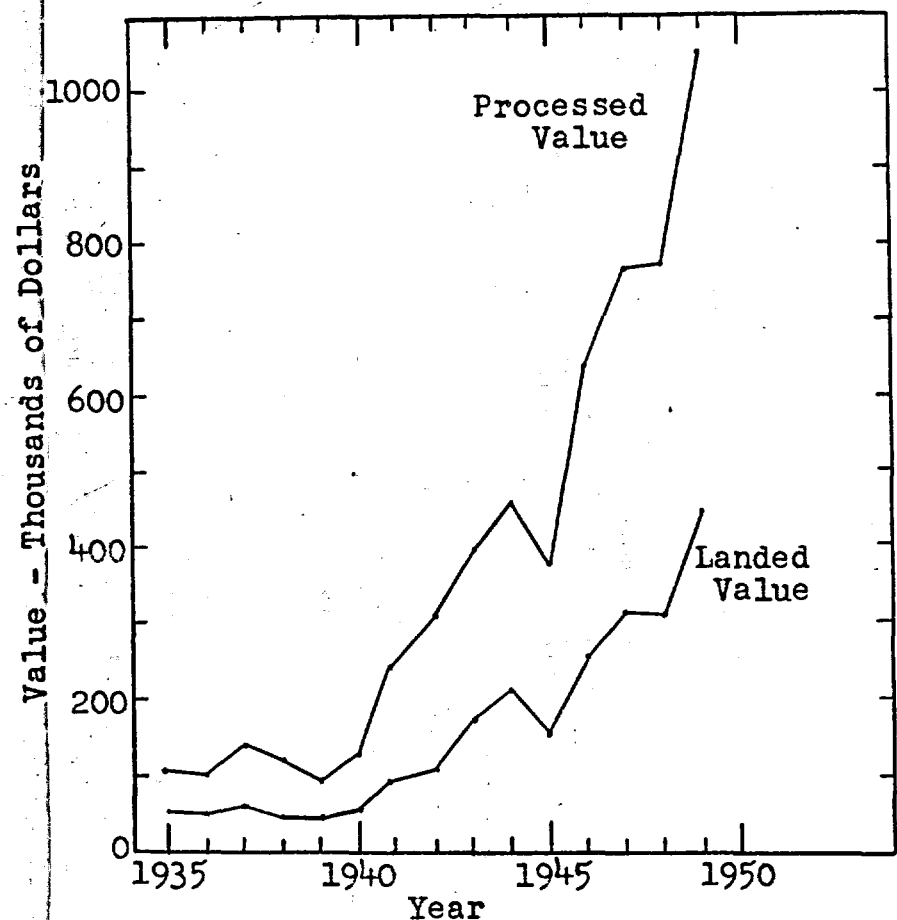
1. Export of clams in the shell is forbidden. This encourages and protects local industry and restricts digging to some extent because there is no sale for quantities in excess of the handling capacity of the plants.

2. It is illegal to take clams whose shell length is less than 2". This is thought wise because the factor limiting production right now is the number of clams that grow to maturity. Because the numbers are limited it is important to let them grow to the size at which they are most valuable before harvesting.

The first of these regulations is being well enforced but need for the second, which now seems the more important, is not sufficiently appreciated. Our observations show that violations of the size limit are frequent and indicate that they not only jeopardize the future of the industry but constitute poor business practice right now, particularly for the processor.

Some of our records are summarized in the table below the graph. By leaving $1\frac{3}{4}$ " clams, which are commonly taken, for a year or two when they reach a length of 2" or $2\frac{1}{4}$ ", their value per 1,000 to the digger and processor is nearly doubled. Natural mortalities, estimated at 5% to 10% per year, are low enough for this to mean a substantial increase in value of the brood as a whole.

Insofar as the processor is concerned this is only one side of the story. The other is that handling sub-legal-sized clams is



Value of Clam
Production from
Three Maritime
Provinces
1935 - 1949

Values and processing times for clams of different sizes and ages

Length (inches)	Approx. age (years) ¹	No. per barrel ²	Value per 1000 to digger ³	Value per 1000 to packer ⁴	Shucking time per gallon	
					hrs.	min.
1 $\frac{3}{4}$	5	5500	\$.91	\$3.08	2	22
2	6	4000	1.25	4.17	1	40
2 $\frac{1}{4}$	7	2950	1.69	6.15	1	6
2 $\frac{1}{2}$	8	2300	2.18	8.52	0	45

1 Ages apply to Bay of Fundy and outer coast of Nova Scotia clams. Growth in the Gulf of St. Lawrence is faster and the ages at corresponding sizes are less.

2 Barrels of 2 $\frac{1}{2}$ Imperial bushels each.

3 Values of 1000 whole clams at \$5.00 per barrel.

4 Values of 1000 shucked clam meats at \$4.00 per American gallon (8 lbs.).

expensive compared with legal-sized for the following reasons: (1) Labour costs for shucking are very high (see last column of table). (2) Shuckers dislike "cutting out" the smallest clams because they are hired on the "piece-work" basis and discard many without opening them. This represents a complete loss to the plant operator.

For the general welfare of the industry it is hoped that our present size-limit regulations will be strictly enforced.

J. C. Medcof

Appendix No. 15

BREAKAGE IN HANDLING WHOLE CLAMS

It takes more broken clams than whole clams to fill a bushel and therefore the digger suffers losses from breakage. In practice, large numbers of broken clams are discarded at plants and the plant operator suffers too - usually more seriously than the digger. As might be surmised, breakage is one of the "bugbears" of the industry, especially in areas where clams are thin-shelled. In some plants breakages as high as 25% have been observed in the shell stock that is ready for processing. As part of a general effort to maintain the value of the clam industry at a high level we have been trying to discover more efficient means of industrial handling and processing, and have examined the breakage problem. We believe that the rates are often needlessly high and in some areas could be reduced by simple adjustments in handling methods.

In many of our areas diggers on the beaches dump their catch of whole clams from their collection baskets into burlap sacks and transport a bushel and a quarter per sack to the processing plants where they dump them into bins. More often there is a second dumping at the beach head from sacks into barrels on waiting trucks, a third dumping from the barrels into bins at the plant, a shovelling from bins into convenient-sized baskets for carriage to the shucking tables where the fourth and final dumping takes place.

In other districts diggers dump their catches into standardized wooden containers - hods or boxes - on the beaches and the clams are never removed from these until they are finally dumped onto the shucking tables or into the steaming vats in the plants. The use of hods protects clams from breakage resulting from extreme pressures in the bottoms of full sacks and resulting from two extra dumpings and one shovelling.

Some breakage occurs on the flats during the digging and washing operations. This can be controlled to some extent by hiring only good diggers or by educating poor ones, but it is not easy. In areas where sacks are commonly used observation shows that nearly half the total breakage occurs after the washing process. An experiment was devised to see how this could be reduced in Charlotte County, N. B., by substitution of wooden containers (half-bushel hods for sacks. Hods were distributed to different diggers working for

different plants every day for several days and breakage counts were made on ten half-bushels of clams from the hods when they were returned full to the plants. At the same time counts were made on 18 quarter-bushel, random samples of bin stocks at the same plants. These had been transported in barrels after "sacking" to the beach heads. The breakages in these two series averaged 9% and 18% respectively.

More observations of this sort are planned and we propose issuing a circular to the industry on this subject. Even without this the wastefulness of sacking is already clear to several of the plant operators and diggers.

J. S. MacPhail

Appendix No. 16

CLAM DRILLS (POLINICES) AND THEIR CONTROL

The 1950 study fell naturally into two parts - an assessment of manual collection of snails and their egg collars as a method of reducing abundance of drills and a filling in of gaps in our knowledge of the biology of the animals to provide a fuller appreciation of the nature of the problem our drill populations present. The work was carried out partly at Belliveau Cove in St. Mary Bay, N. S., and partly in the district about St. Andrews, N. B. It is not planned to continue intensive drill studies in 1951.

Possibilities of Control.

In 1949 egg cases of the lesser clam drill (P. triseriata) were systematically collected from a large section of the Belliveau Cove flats. In adjacent sections these were allowed to accumulate, develop and shed their young. In 1950 a careful search was made of all areas for snails of the 1949 year-class. Very few were found anywhere and their relative abundance in the two areas was about the same. Other observations showed that conditions in the Cove are quite different from those in 1949. In the section where the collections were made the surface of the flat has become muddier and the stands of eel-grass which were establishing themselves there last year have flourished. The other section has become sandier. Besides these physical changes in bottom characteristics the relative abundance of adult drills, which was roughly the same in the two sections last year, has completely changed - they are now concentrated in the sandy area. Most surprising of all - good sets of seed clams of the 1948 and 1949 year-classes are flourishing in the muddy area, apparently with relatively small damage by drills.

Studies of developing and newly-emerged embryos and recovery of the latter in plankton tows confirmed the earlier conclusion that the larvae of the lesser drill are "semi-planktonic" and capable of transport over considerable distances by tidal currents. Regional collection of egg cases cannot therefore be expected to reduce the abundance of young snails in an area to any appreciable extent. Work done at St. Andrews with the greater clam

drill (P. heros) showed that the same conclusions apply to that species.

If artificial control of clam drills is to be found at all it must be sought in some other direction - for instance, chemical attraction to traps as is being tested in the United States.

Biological Observations on Drills.

The observations on the biology of drills were diversified because they were intended to fill in gaps in previously obtained information. Radular dentition was demonstrated to be a useful device for distinguishing our two common species of drills which are frequently confused.

A study of mating behaviour showed that it has two phases: (1) a "pre-connubial march" during which some selection of a mate by the female may take place (this has previously been mistaken for copulation); and (2) "true copulation" which is quite a different process and frequently takes place after the mating pair bury themselves in the flat.

Exposure of surfacing snails to ultra-violet and infra-red light failed to induce them to bury in sand in aquaria in spite of the fact that a few minutes' exposure of the same animals to sunlight did produce this reaction.

The discovery of the semi-planktonic nature of lesser drills immediately after they leave the egg case has already been mentioned and its significance pointed out.

Four unidentified and previously undescribed types of collars of snails of this family (Naticidae) were collected and described. Besides this, egg cases of the southern clam drill (P. duplicata) collected in Massachusetts were studied and described.

Feeding experiments in a tide pool where natural flat conditions were simulated, indicated that drills discover their prey during aimless wandering movements at speeds of about 5 cm. per minute at water temperatures around 15°C. Having once discovered an area with a supply of food organisms they stay there until that supply is exhausted. The concentrations of snails that develop in feeding areas have previously been explained on the assumption that snails are directly attracted to their food by "smell" or some other sense.

The destructive capacity of drills in the tide pool at temperatures about 15°C was about the same as that reported in earlier experiments - one clam per snail every three or four days.

Closure of Investigations.

We have demonstrated that clam drills are now abundant and among the clam's most serious enemies. Manual collection of adult drills or their egg cases has far less effect on their abundance and distribution than natural changes such as recovery of eel-grass. We are aware of a slow but wide-spread recovery of this plant and now

take the view that nature may eventually take care of the drill problem herself. It has therefore been decided to bring intensive drill investigations to a close, temporarily at least. Regular checks of their abundance in key areas should be continued to see if the drill populations actually are decreasing and the efforts at chemical control of drills presently being made in the United States should be followed closely. We should stand by prepared to follow up promising leads that may appear or to initiate further work ourselves if this seems necessary as time goes on.

M. E. C. Giglioli

Appendix No. 17

MASS MORTALITY OF CLAMS PRESUMABLY CAUSED BY FRESH WATER

Katy's Cove, at St. Andrews, N. B., is a tidal inlet from Passamaquoddy Bay with two tributary brooks whose discharge of fresh water in springtime is considerable. Several years ago the narrow Cove mouth was blocked by tide gates. These greatly reduced the water exchange between the Cove and the Bay, maintained the water inside the Cove at an almost constant level and permitted the water to warm up in summer to temperatures fit for bathing. During the winter the gates were left open constantly and the natural tidal conditions which existed in the Cove before the gates were built were more or less restored until the gates were closed again the following spring. Throughout this period of several years the Cove supported a vigorous colony of soft-shelled clams and other molluscs.

In the summer of 1948 the operators replaced the old gates with new ones which they have kept closed both summer and winter except for occasional drainings of the Cove to facilitate their work. In the autumn of 1948 the Cove was drained but nothing unusual was noticed. On draining the next spring, however, (April, 1949) the operators discovered that there had been a mass mortality of shellfish and the Fisheries Research Board was asked to examine the situation. It was found that 90% to 100% of the soft-shelled clams, common mussels, clam drills and other larger species of molluscs living near shore had died. The slipper limpet (Crepidula) survived better than the other forms but even they seemed weak. Shells of small clams $\frac{1}{4}$ " to $\frac{3}{4}$ " long lay in windrows along the upper beaches and the upper parts of empty shells of larger clams were projecting above the mud line in this region. Many still contained the rotting bodies of the dead animals. Gulls were feeding about mussel clumps and dead clam drills (Polinices heros) with the bodies still in the shells were strewn about everywhere on the surface. The stench of rotting shellfish was overpowering. At lower levels, farther from shore, the mortality of clams and mussels was less severe or inconspicuous.

During the 1949 autumn drainage another examination of the Cove showed little change from spring conditions except that the slipper limpets had disappeared.

In April, 1950, Dr. Lauzier took water temperatures and

water samples from various depths through the ice (Appendix 76-G) and made salinity and oxygen determinations. He found no oxygen shortage at any depth but there was a three-foot-deep layer of fresh water under the ice floating on deeper saltier water. Exactly how long this condition existed before the spring break-up is not known. When the Cove was drained in May, 1950, a third examination showed nothing new.

Although it cannot be proved it seems reasonable to conclude, tentatively, that the mass mortality at high beach levels was caused by the layer of fresh water under the ice in late winter and early spring. Numerous mass mortalities of clams in rivers tributary to the southern Gulf of St. Lawrence have been reported and winter hydrographic conditions similar to those described for Katy's Cove are known to exist there. It now seems reasonable to attribute these mortalities to the effects of fresh water under the ice.

A closer study of conditions in Katy's Cove is planned for 1951.

J. C. Medcof

Appendix No. 18

EXPERIMENTAL CLAM FARMING TO EVALUATE VARIOUS GROUNDS

The general conclusion from our numerous planting experiments was stated last year. Clam farming, as we know it, is commercially impractical in most, if not in all, our districts. Our planting program in 1950 has been greatly reduced accordingly. Work is continuing, however, in three areas showing good growth and high survival and still offering some promise. One is the Cocoa Sands flat in Musquodoboit Harbour, N. S., on which a semi-commercial-scale planting was made in the spring of 1948. Observations this year suggest that this planted stock will be ready to harvest in 1951. The volume of the clams recovered relative to the volume planted will be a measure of the feasibility of farming that area.

The second area is the Holland Garden flat in Pocologan Harbour, N. B. "Spot" plants made there in 1949 were so successful that a semi-commercial-scale relay was made this year. So far the result looks promising but even if it does succeed the value of farming in this area will be limited because the district is affected by paralytic shellfish poison and periodically quarantined.

The third area is in Smith Cove, Annapolis Basin, N. S. A spot planting there in September, 1949, was so successful that a semi-commercial-scale relay is being made this autumn. Although our data are incomplete, Smith Cove seems to be the most promising ground of all that have been examined.

The results of the work done in these three areas will probably determine our future planting program.

J. C. Medcof

Appendix No. 19

EXPLORATION FOR NEW CLAM AREAS

When intensive clam investigations began a few years ago it was proposed to explore the whole coast in search of unexploited clam resources and to encourage their development. This program is nearly complete. In August a first survey was made of the southern shore of Cape Breton Island from River Inhabitants eastward to Morien Bay.

The most promising grounds were at Madame Island, on both sides of Lennox Passage and on the northern side of Janvrin Island. The beaches there are steeply sloping and the clams occur only in a narrow zone at about half-tide level. However, the coastline is so irregular and the islands so numerous that the populated areas are vast. Besides this, they are densely stocked. Low growth rates and mediocre quality of meats are the worst features of these clams but there is reasonable prospect for improvement in both after commercial digging reduces the crowding and loosens the soil. All this encourages belief that this district will soon become an important source of clams.

Already, as a result of the survey, a processor has been interested in the area and has laid plans for opening a shucking plant this year.

J. S. MacPhail

Appendix No. 20

EXPLORATION OF BAIT-WORM RESOURCES

Our clam stocks are subject to such heavy fishing pressures in many areas that there is a need for diversion of the efforts of clam diggers to some other remunerative employment. Industrial digging of bait worms seems to offer such possibilities, so the writer made a special trip to the New England coast this year to study the bait industry and later began an investigation of our own worm resources.

History

The "sand worm" (Nereis) and the rarer and more valuable "blood worm" (Glycera) have been dug commercially in several of the New England States for the past 20 to 30 years and several million dollars' worth are annually sold to the salt-water sport fishery, particularly around Long Island. A few worms are used locally on our coast in line fishing for smelt but there is no sale for them in Canada.

Handling

Worms are dug with a tool resembling a clam fork and are carefully treated thereafter because they must reach the fisherman

alive. On the flats they are kept in pails of salt water and they are taken indoors and kept at low temperatures during cleaning, drying and packing. They are shipped by air freight in half-cubic-foot cardboard cartons each containing 125 to 250 worms packed in seaweed, preferably the fibrous Ascophyllum mackaii but sea lettuce (Ulva) is often used.

Exploration

Only a limited amount of exploration was possible this year and it was confined to districts that are conveniently near air-freight depots.

Suitable sand worms were found in fair numbers in parts of Charlotte County, N. B., but there is a scarcity of the best types of packing weed in this district. A substitute type (Gigartina stellata) was found and we co-operated with a local agent of an American firm in making successful trial shipments of worms in this weed.

Quick surveys of Digby, Yarmouth and Halifax Counties, N. S., and of Hillsborough Bay area, P. E. I., indicated the presence of suitable worms in at least small quantities in some of these areas and ample supplies of the best packing weed in others.

It is planned to continue the work next year.

J. S. MacPhail

Appendix No. 21

PARALYTIC SHELLFISH POISON

In 1950 this Station continued participation in the control of the shellfish industry which is made necessary by the periodic occurrence of paralytic shellfish poison on this coast. The development of this control since 1943 has been a joint effort of the Fisheries Research Board and the Department of Fisheries with the Department of National Health and Welfare but in the last two years the Research Board's part has been taken over more and more by the Department of Fisheries. Eventually the Department, through its Fish Inspection Laboratory, is expected to assume most, if not all, responsibility because the problem is now so well understood that no further research is needed for effective control.

This year the Fish Inspection Laboratory supplied a laboratory helper (seasonal), Mrs. R. Lord, to prepare shellfish extracts for toxicity assay and she also compiled the records which have accumulated since the work began in 1943. Mrs. Lord was provided working space and the use of Station equipment and worked under the writer's supervision. Several copies of the compiled records have been prepared for distribution to the authorities who are continuing or taking over responsibility for the management of the fishery as ready reference to past records facilitates the control program.

This year the poison appeared both on the Fundy shores of Nova Scotia and New Brunswick and on the south shore of the St. Lawrence River. Toxicities were not excessively high in most places

but several districts were quarantined from mid-July until late October. No deaths or illnesses were reported anywhere.

A search was made for the poison in two unexplored regions where its presence was suspected and where its presence might have created local problems. The first was southwestern Newfoundland - Port au Port Bay and Bay of Islands. There are stocks of soft-shelled clams in these areas that are now becoming commercially attractive because of heavy market demands for shucked and canned clams. The presence of up-welling and low summer temperatures off this shore suggested that the causative organism (Gonyaulax) might occur there in sufficient abundance to affect the shellfish. The other area was the New Brunswick National Park, Albert County, N. B. This newly-created Park was opened to the public in July, 1950, and its beaches were visited by unusually large numbers of tourists and picnickers. Soft-shelled clams occur there in limited numbers and are occasionally dug and eaten by visitors. Paralytic poison is common in the middle and lower Fundy and it was suspected that it might occur in the Park too. Through arrangements made by this Station with agents of the Department of Fisheries, both regions were sampled throughout the period of toxicity. No poison was found in any of the shellfish taken - a gratifying discovery.

No special program is proposed for next year.

J. C. Medcof

Appendix No. 22

DIGBY SCALLOP POPULATIONS

Studies reported in 1948 revealed great cyclic changes in the yearly landings of scallops by the Digby scallop fleet, apparently resulting from changes in abundance correlated with cyclic changes in hydrography. From this it was judged that reasonably accurate predictions of the course of the fishery several years in advance should be possible at any time, given certain easily-obtained data. The advantages such predictions would afford the industry are so great that the principal aim of the investigation in 1950 has been to develop a practical procedure for predictions by discovering (1) a reliable means for estimating relative and absolute abundance of all sizes of scallops and (2) the relative importance of natural and fishing mortality in influencing abundance.

Population Estimates

Last year a first attempt was made to estimate the population density of "catchable" scallops on an experimental area by tagging, and the estimated density was related to catch per haul on that area. The relationship so established was then used with the results of standardized experimental hauls on several of the commercially important beds to estimate their stocks by the "strip-census" method. Besides this, log-book records were obtained from several commercial fishing boats from which the relationship between daily catch per boat and estimated abundance was worked out.

In 1950, census work like last year's was continued and extended. The experimental area was 900 by 75 yards and $4\frac{1}{2}$ miles off Shelburne Cove, Digby County, N. S. Ten thousand tagged scallops were spread evenly over it and the initial population estimated from the proportion of tagged to untagged animals in the catch by special fishing. The estimate was checked this year by a new method - photography of the beds using an under-water camera (Appendix 25). Scallops show up reasonably well in bottom pictures, and because the area represented in each photograph is fixed an estimate of the stock on the plot as a whole was possible. As in 1949, this abundance estimate was related to catch per haul on the experimental plot and the resulting factor was then applied in a strip census of commercially-important beds to estimate their stocks. Log books were again distributed to boat skippers and from their records it should be possible to relate commercial catch on the various beds to estimated abundance.

This work is just completed and the results have not yet been analyzed. Preliminary inspection of records from the experimental area suggests that our estimate of the abundance of catchable scallops, based on tagging records, is considerably less than the absolute abundance of scallops, as judged from under-water camera pictures. The possibility of the tagging estimate being low was realized previously but until now there has been no method of examining it.

Prediction

Preliminary inspection of strip-census records indicates that a gradual recovery is taking place but that the inshore areas adjacent to Digby Gut, formerly the mainstay of the fishery, are still not sufficiently populated to support a commercial fishery. On the other hand, inshore beds 10 miles westward of the Gut and most of the offshore areas are well stocked and should reward a moderate fishery this year.

Estimates of Natural and Fishing Mortality

Estimates of the relative importance of fishing mortality and natural mortality in determining the abundance of stocks available to the fishery are being attempted in two ways:

- (1) By comparing the numbers of "newly-dead" shells of various size groups with the numbers of living animals in experimental hauls.
- (2) By comparing abundance changes from 1949 to 1950 on beds that were fished by the commercial fleet in the 1949-50 winter season with abundance changes on beds that were not fished during that period.

To date analysis of the records is not complete enough to justify drawing conclusions that might influence prediction.

"Newly-dead" shells are considered to be those of scallops which died during the current year and are recognized by their glossy inner faces and by the fact that their valves are still attached by the hinge ligament. To aid in the interpretation of the dead-shell counts experiments were run at St. Andrews this summer to

determine how long this attachment persists under approximately normal bottom conditions.

L. M. Dickie

Appendix No. 23

COMMERCIAL TRIALS OF MODIFIED DRAGS TO PROTECT SMALL SCALLOPS

The importance of strict observance of the minimum-legal-size limit (diameter 4") for scallops was stressed in this Station's Annual Report for 1948, Appendix 21. Detection of offences under this regulation is difficult because shucking is done on the boats when they are at sea and the shells are discarded. Nevertheless it is known that the law is evaded by many fishermen. The simplest solution of this problem seemed to be the development of a "savings gear" that would bring up negligible numbers of under-sized scallops without reducing the catch of legal-sized. Trials were made with drags having different-sized mesh (1948 Report, Appendix 23, and 1949 Report, Appendix 25) and those with rings with an inside diameter of 3 $\frac{1}{4}$ " seemed to satisfy these requirements. In the spring of 1950 a complete set of drags of this type was made up and their performance compared with standard drags by one of the "high-line" boats of the Digby scallop fleet which fished the two types of gear on alternate days.

Dr. G. F. M. Smith helped in the design of this experiment and Mr. U. J. Walsh, field technician of this Station's staff, was aboard throughout the trials, kept detailed records of the operations and studied the size and the size-composition of the catches of the two types of gear. Several beds and bottom types were tested in 17 days' operations in which the boat landed 3800 pounds of shucked scallop meats. The mean catch of meats per hour of fishing was 38 lb. with the standard gear and 26 lb. with the 3 $\frac{1}{4}$ "-mesh gear. A study of the records shows the following features of the performance of the 3 $\frac{1}{4}$ " drags:

(1) They took almost no undersized scallops. This is desirable, and accounts for a good part of the difference in the catch per hour fished.

(2) They allowed the escape of considerable numbers of legal-sized scallops. This is undesirable and accounts for much, but not all, the difference in catch per hour not accounted for in (1) above. Their clumsiness and need for repair, both undesirable features, also contributed to the difference.

(3) They were clumsy (heavier and less flexible than the standard) and therefore slow to handle so that an undue amount of fishing time was consumed in dumping and handling rather than in actual dragging.

(4) They required frequent repair. The transverse links which serve as ring-connectors wore rapidly. Holes frequently appeared in the drags resulting in loss in catch and loss in fishing

time because the links had to be replaced on the grounds.

It is believed that the three undesirable features of this gear can be overcome by further modifications and it is proposed to continue with the work next year. The need for protecting young scallops is just as great now as formerly.

J. C. Medcof

Appendix No. 24

EXPLORATION OF GULF OF ST. LAWRENCE SCALLOP RESOURCES

During the summer of 1950 the work in the Gulf of St. Lawrence was continued (see 1949 Report, Appendix 28) to discover scallop beds worthy of commercial exploitation, to collect information on the biology and ecology of scallops, to assess recent mass mortalities of scallops in the areas under survey and to test the efficiency of various types of gear. There is need for further work in the Gulf area.

Explorations. The explorations were done aboard a Digby scallop dragger, the M. B. "Singer", with Mr. Boyd Robinson as skipper. Most of the work was in the Northumberland Strait starting opposite Summerside, P. E. I., and Cape Tormentine, N. B., and continuing northwestwards to a point opposite Point Sapin, N. B., and Miminegash, P. E. I. A few days were spent prospecting in areas off Tracadie, N. B., and Shippigan Gully, N. B.

Only one bed with outstanding commercial possibilities was discovered during the summer. This one, referred to as the "Richibucto bed", runs approximately NNE from a point $46^{\circ}50'45''$ N latitude and $64^{\circ}37'30''$ W longitude, for over two miles and is about one mile wide. It yielded two to four bushels of scallops per 15-minute haul with a six-gang drag of the standard Digby type. On the main part of the bed the scallops were of uniform size, averaging a little less than 3 inches in diameter with 90% of them belonging to the 1946 year-class. At present they are too small to be worth shucking - about 85 meats are needed to make a pound - but the meat yield averaged $6\frac{1}{2}$ lb. per bushel of whole scallops and compares well with that at Digby. If they live for two years these scallops should almost double their present meat yields but natural mortalities seem unusually high.

Large numbers of newly "dead" scallop shells were found in most of the catches. The valves of these shells were still attached by the hinge ligaments. On the average there was one of these dead shells for every three or four live scallops. Because almost the whole stock was of the same year-class, it was determined from a knowledge of their growth rates and a comparison of the sizes of the live scallops and newly dead shells that this mortality occurred within the past year. Starfish (Asterias vulgaris) were as numerous in the catches as scallops and sometimes more numerous. Often 1,000 to 1,500 were taken in 15-minute hauls. They were mostly small (diameter $4\frac{1}{2}''$ - $6''$). A few were found inside the shells of partly-eaten scallops and it is thought that they are responsible for most

of the newly-dead shells. Such concentrations of starfish have not been found in any other scallop area.

Small, well-stocked beds were also found off Miminegash, and NNW of the Richibucto bed. The average size of the scallops on these beds was about 4 inches. The Minimegash scallops gave the highest meat yield yet observed in the Gulf area - 7 $\frac{1}{4}$ lb. per bushel of whole scallops.

Mass Mortalities. Several days were spent on the Pictou Island bed which was discovered last year and described to the fishermen in radio and press reports. The purpose was to determine the extent of the mass mortality which occurred there last autumn. Fishermen who took advantage of our discovery and worked the bed this summer reported that a second mortality had occurred in August, 1950, and reduced the stocks to the point where fishing was no longer profitable. The ratio of recently dead shells to live scallops in early September was about 7 to 3.

Examination of the Boughton Island bed which has been a mainstay of the fishery in eastern P. E. I. for some years revealed that a mortality involving about 30% of the stock had occurred since the summer of 1949 when we last examined it. The cause of these mass mortalities is still obscure but more and more evidence is accumulating suggesting that it is hydrographic in nature.

Trials of Small Gear. Trials of Lunenburg County "hand drags" were made in several areas with the practical assistance of Mr. Frank Vaughan, a scallop fisherman from Western Shore, N. S. Two of these towed at the same time from a lobster boat yielded 2 bushels of whole scallops per hour fished on the Boughton Island bed. On the Richibucto bed the yield was 2 to 3 bushels. Four drags can be handled from a single lobster boat. With meat yields of 6-7 pounds per bushel of whole scallops, market prices of 30 to 50 cents per pound for meats, and the low operating costs of lobster boats and hand gear, it would seem that a two-man boat could fish profitably on either of the beds mentioned. It is hoped that the demonstrations and the publicity given the results of the gear trials will encourage exploitation of the beds that have been discovered.

Comparison of Toothed and Toothless Drags. The efficiencies of toothed drags of the type used in eastern Prince Edward Island and the toothless Digby type were compared by fixing three drags of each type to the same drag bar and measuring their catches. The Digby drags consistently took more scallops but at the same time they brought up two to three times as much "trash". More observations are needed as a basis for comparison but there seems to be serious doubt of the vast superiority claimed by the Island fishermen for the toothed type commonly used off their coast.

Future Program. It would appear that in spite of irregularities in productivity the scallop resources of the Gulf of St. Lawrence could be exploited to advantage using types of boats that are common in the area and light inexpensive gear, possibly of the Lunenburg County style. Other types of light gear are used on our coast (e.g. in Charlotte County, N. B.) which might prove even more

satisfactory than the Lunenburg style and trials of these in the Gulf seem worth while. Besides this, a regular checking of the stocks on the three important beds, Boughton Island, Pictou Island and Richibucto, should be carried out for the next few years for two purposes: (1) to advise the fishermen when and where fishing is worth while and (2) to gather more information on natural fluctuations of the stocks. Subsidiary to the latter it is important to search for the causes of the periodic mass mortalities that take place. An understanding of these should permit more precise prediction of fishing conditions than is possible from periodic assessments alone.

L. P. Chiasson

Appendix No. 25

VALUE OF UNDER-WATER CAMERA IN SCALLOP AND OTHER BOTTOM STUDIES

During the past summer an under-water camera purchased from the Woods Hole Oceanographic Institution was used in deep water to study bottom characteristics of scallop beds and to estimate scallop population densities on beds in the Bay of Fundy off Digby, N. S., the Annapolis Basin, N. S., Passamaquoddy Bay, N. B., and in shallow water to study algae off Pubnico (Yarmouth County), N. S. The value of the instrument in such studies was established and some of its limitations were discovered.

Suitable Subjects. The pictures clearly showed the characteristics of bottom types varying from level, silted, soft bottom to rough, rocky ledge. Many types of animals were found to be good subjects for photography. Starfish, brittle stars, sea-urchins, sea squirts, scallops, sponges, barnacles, large snails and, occasionally, fish (eel and barn-door skate) appeared in the prints. Short seaweeds show well (rock-weeds and Irish moss) but, because of their great height, some of the kelps do not lend themselves to photography.

Limitations of Instrument. Suspended material in the water will produce "fogging" of pictures even when very short camera-to-subject distances are used. Poor pictures result from three other main causes.

(1) Shallow depth of focus. This is especially serious with tall subjects and short camera-to-subject distances.

(2) Position of camera assembly at the bottom. In strong currents the assembly "leans", reducing the expected camera-to-subject distance and throwing the picture out of focus. This trouble can be partly overcome by working at slack tide.

(3) Movement of the camera during exposure. Strong currents tend to move the camera and produce "fuzzy" pictures or no recognizable image at all. This can be partly overcome by weighting the camera more heavily or by working at slack tide.

Sample Performance and Possibilities. In two days 97 exposures were made off Digby at depths of 35 to 45 fathoms. Seventeen

of these gave good pictures, 53 were slightly fogged or out of focus but clear enough to enable one to identify objects on the bottom and 27 were unsatisfactory. The proportion of good pictures improves with the operator's practice.

The great variety of photogenic subjects and the reasonably high proportion of satisfactory exposures obtained suggest that the camera can be used to advantage in several others of the Station's investigations.

L. M. Dickie

Appendix No. 26

GENERAL SUMMARY OF GROUND FISH INVESTIGATIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

W. R. Martin

Appendix No. 27

LIFE CYCLE AND CONTROL OF THE COD-WORM

This investigation has been concerned with the discovery of the life-cycle of the cod-worm in the hope that this information would enable the development of some method of control. It was found that the harbour seal and, to a lesser extent, the gray seal were important hosts for adult worms. A reduction in the number of seals should ultimately decrease the incidence of the worm in fish. However, it is not known to what extent this seal reduction must be carried to produce an appreciable lessening in the number of worms. For this reason a seal control program will be started in the Bras d'Or Lakes in an attempt to uncover a quantitative relationship between seals and worm incidence. (See also Appendices 66 to 69).

The Bras d'Or Lakes possess several advantages for such a program: the Lakes are small and relatively isolated from the ocean; small, young cod with a high infestation are present in large numbers and seals occur only during the winter months and appear to

be concentrated often in accessible localities. The program will consist of two phases conducted concurrently. One phase will determine the amount of infestation in cod from different localities and the other phase will attempt to get detailed information on the number and distribution of seals within the Lake and will eventually involve efforts to reduce or drive out the seal population. This report summarizes the results of the first phase during the summer of 1950.

Five fishing stations were established. The location of these stations is shown in the accompanying map. Two, Baddeck Bay and Whyccocomagh Bay, had been studied in previous years. The West Bay station was chosen because of its remote situation; the Kempt Head station because of the deep water in that area; the Boisdale area as an example of a relatively shallow area in the St. Andrew Channel. Some quantitative data obtained from these localities are contained in Table I.

Table I

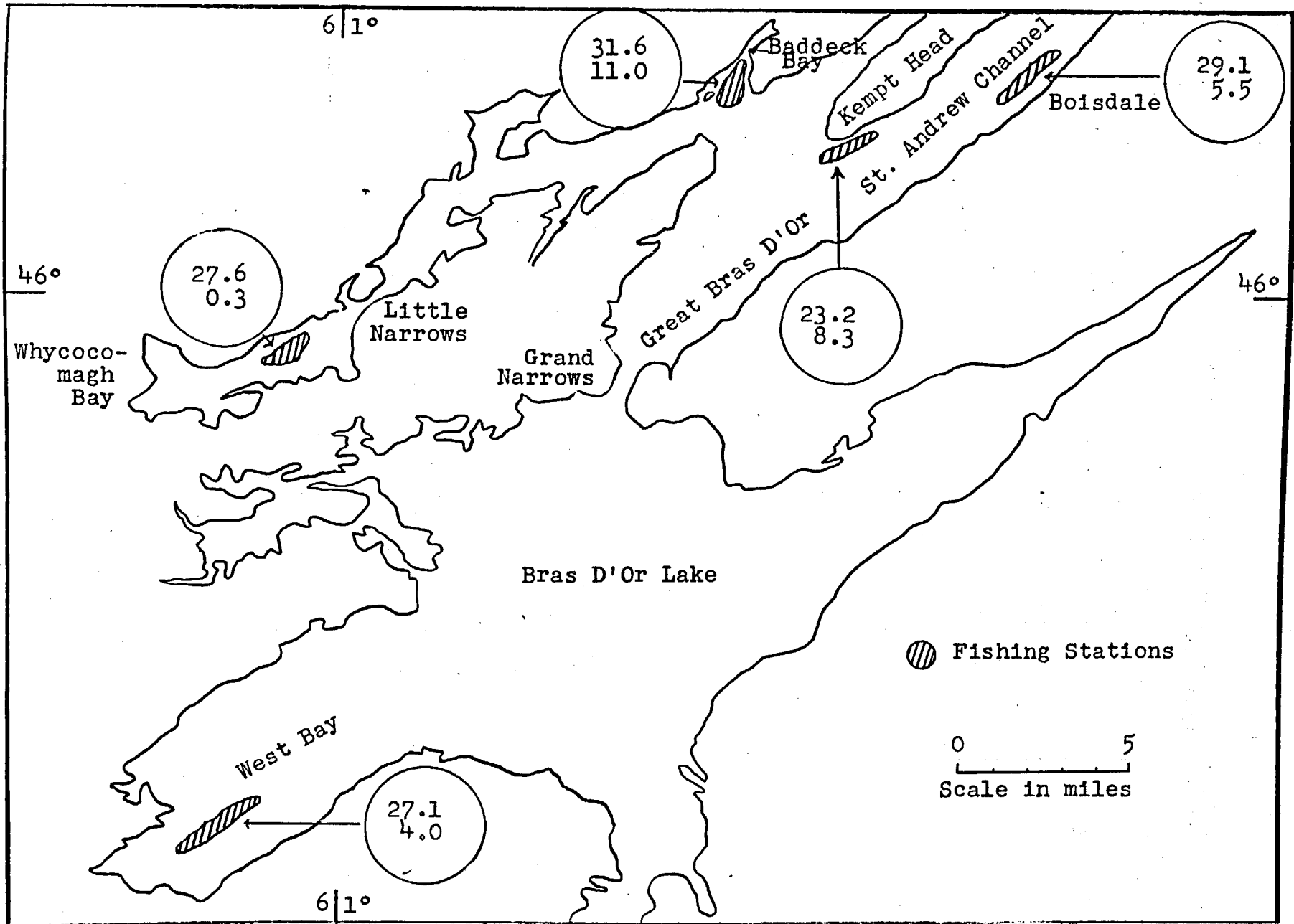
Length and worm incidence of cod from five stations in the Bras d'Or Lakes in 1950.

	<u>Year-class of Cod</u>			
	<u>1949 (I)*</u>	<u>1948 (II)*</u>	<u>1946 (IV)*</u>	<u>1945 (V)*</u>
<u>Baddeck Bay</u>				
Mean Length (cm.)	23.2	31.6	42.8	46.1
Mean Incidence**	2.3	11.0	11.9	15.2
<u>Kempt Head</u>				
Mean Length (cm.)	17.5	23.2	32.2	36.2
Mean Incidence**	5.4	8.3	14.6	16.8
<u>Boisdale</u>				
Mean Length (cm.)	-	29.1	38.1	-
Mean Incidence**	-	5.5	8.2	-
<u>West Bay</u>				
Mean Length (cm.)	-	27.1	36.5	-
Mean Incidence**	-	4.0	11.4	-
<u>Whyccocomagh Bay</u>				
Mean Length (cm.)	19.8	27.6	39.8	41.9
Mean Incidence**	0.1	0.3	0.5	1.3

*Age group in brackets.

**Percentage of fish infested.

The cod from the five localities show marked variations both in the degree of infestation and in growth rate. Whyccocomagh Bay fish have few worms, a fact which has been previously correlated with the known scarcity of seals in this region. Baddeck Bay and Kempt Head are areas of high incidence, while cod from Boisdale and West Bay are less heavily infested. The growth rate of Baddeck Bay fish is apparently the most rapid. The fish from Kempt Head, although only four miles from either Baddeck Bay or Boisdale, are much slower



Bras D'Or Lakes. Mean length (cm.) and % worm incidence in cod of 1948 year-class (age-group II).

growing than fish in those regions. The length and incidence of worms of the 1948 year-class are shown on the map. The differences between the fishing stations are sufficiently great to indicate the existence of local populations of young cod. When more detailed information on seal distribution within the Lakes is available it may be possible to correlate the variations in worm incidence with corresponding variations in the distribution of the seals.

A matter of biological and economic importance is the effect of heavy infestation upon the growth rate of the fish. Some evidence is presented in Table II to support the belief that growth is retarded by the presence of large numbers of worms. Each sample of fish was divided into two groups: one group consisting of fish containing less than the mean number of worms for a particular year-class and a second group composed of fish with more than the mean number of worms.

Table II

A comparison of the lengths of lightly and heavily infested fish

<u>Locality</u>	<u>Age</u>	<u>Mean Length of Fish with <Mean Worm Incidence</u>	<u>Mean Length of Fish with >Mean Worm Incidence</u>
Baddeck	I	23.83	22.13
Baddeck	II	31.78	31.48
Kempton Head	I	17.50	17.42
Kempton Head	II	23.97	22.47
Boisdale	II	30.07	27.86
West Bay	II	27.42	26.21

In all cases the more lightly infested fish had a greater mean length than those of the other group. It is quite possible that the presence of many worms in a fish may slow up the rate of growth. This problem will receive further attention in the investigation.

D. M. Scott

Appendix No. 28

RELATIVE EFFICACY OF BAITS FOR GROUND FISH

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

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

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

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

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

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

Table I

Average weight of cod caught per pound of bait used

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

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

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

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

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

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

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

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

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

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

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

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

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

F. D. McCracken

Appendix No. 29

EXPERIMENTAL GILL-NETTING FOR GROUND FISH

Gill-netting operations were conducted from Ketch Harbour, Halifax County, N. S., with the M. V. "J. J. Cowie" from July 17 to September 27. Commercial gill-netting is conducted in this area and the facilities at the government wharf for net storage on reels and in a net shed were well suited to the work. A Crossley No. 125 net lifter and a 9 h.p. deck engine were installed to hoist the nets and a turn-table was set into the stern deck to eliminate net twists when setting. Six- and eight-inch-mesh nets were rigged on $\frac{1}{4}$ " medium-lay cotton line or on six-thread steam-tarred rope with plastic floats and six-ounce split leads. Thirty-five six-inch-mesh nets (85 fm. long, 18 meshes deep of 12/3-thread linen) and 30 eight-inch-mesh nets (75 fm. long, 14 meshes deep of 16/4-thread linen) were rigged and cuprinol treated. The nets were hung on the half and rigged similar to two sample nets obtained from Gloucester. Two seven-inch-mesh, 210/3-thread nylon nets were also obtained.

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

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

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

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

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

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

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

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

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

haul three nets by hand.

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

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

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

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

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

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

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

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

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

W. R. Martin
K. G. Sollows

Appendix No. 30

ABUNDANCE OF OFFSHORE GROUND FISH

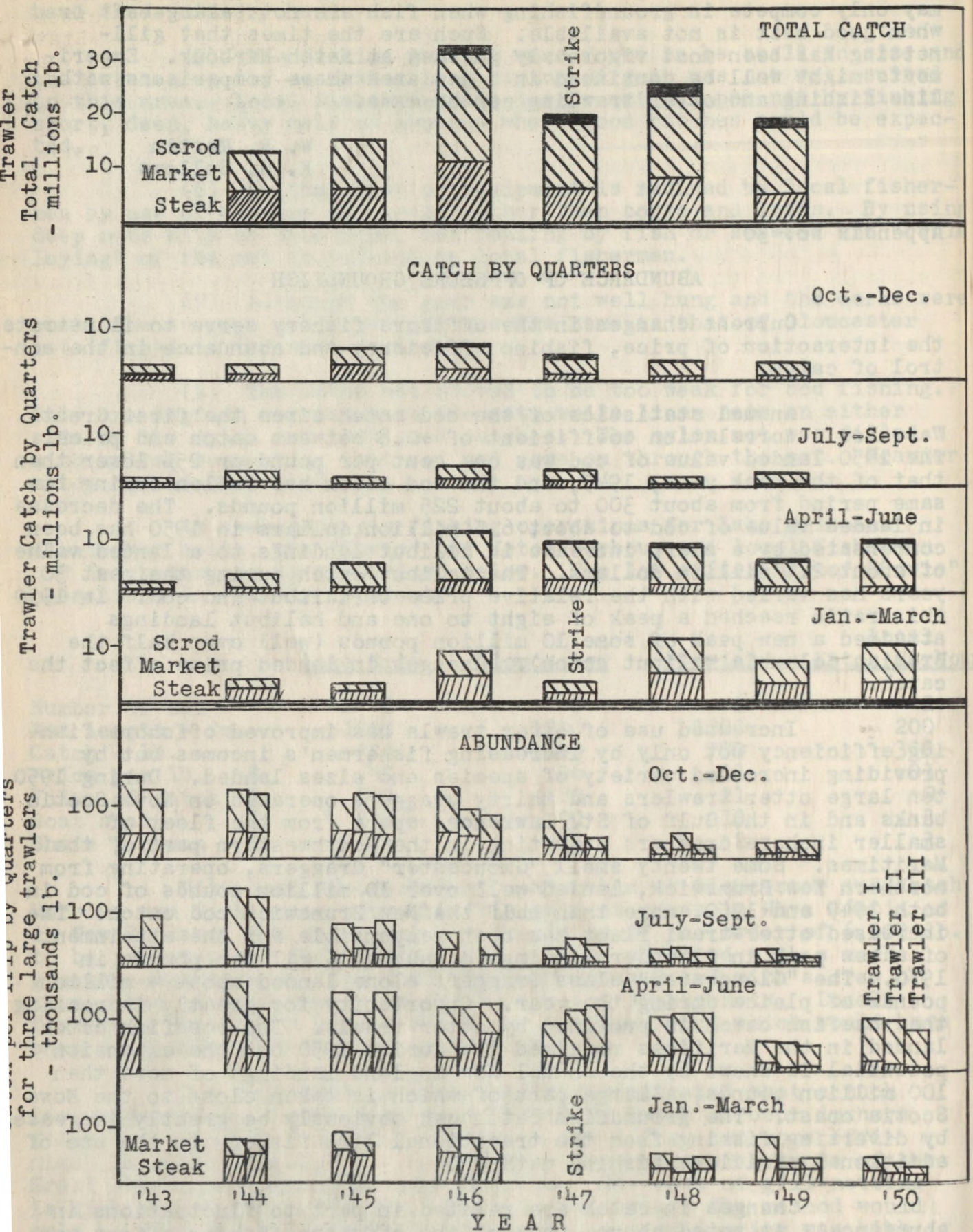
Current changes in the offshore fishery serve to illustrate the interaction of price, fishing efficiency and abundance in the control of catch.

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

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

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

OTTER TRAWL COD CATCH



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

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

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

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

W. R. Martin
A. R. MacMorran

Appendix No. 31

SIZES AND AGES OF INSHORE GROUND FISH

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

quantitative data on growth, recruitment and mortality.

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

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

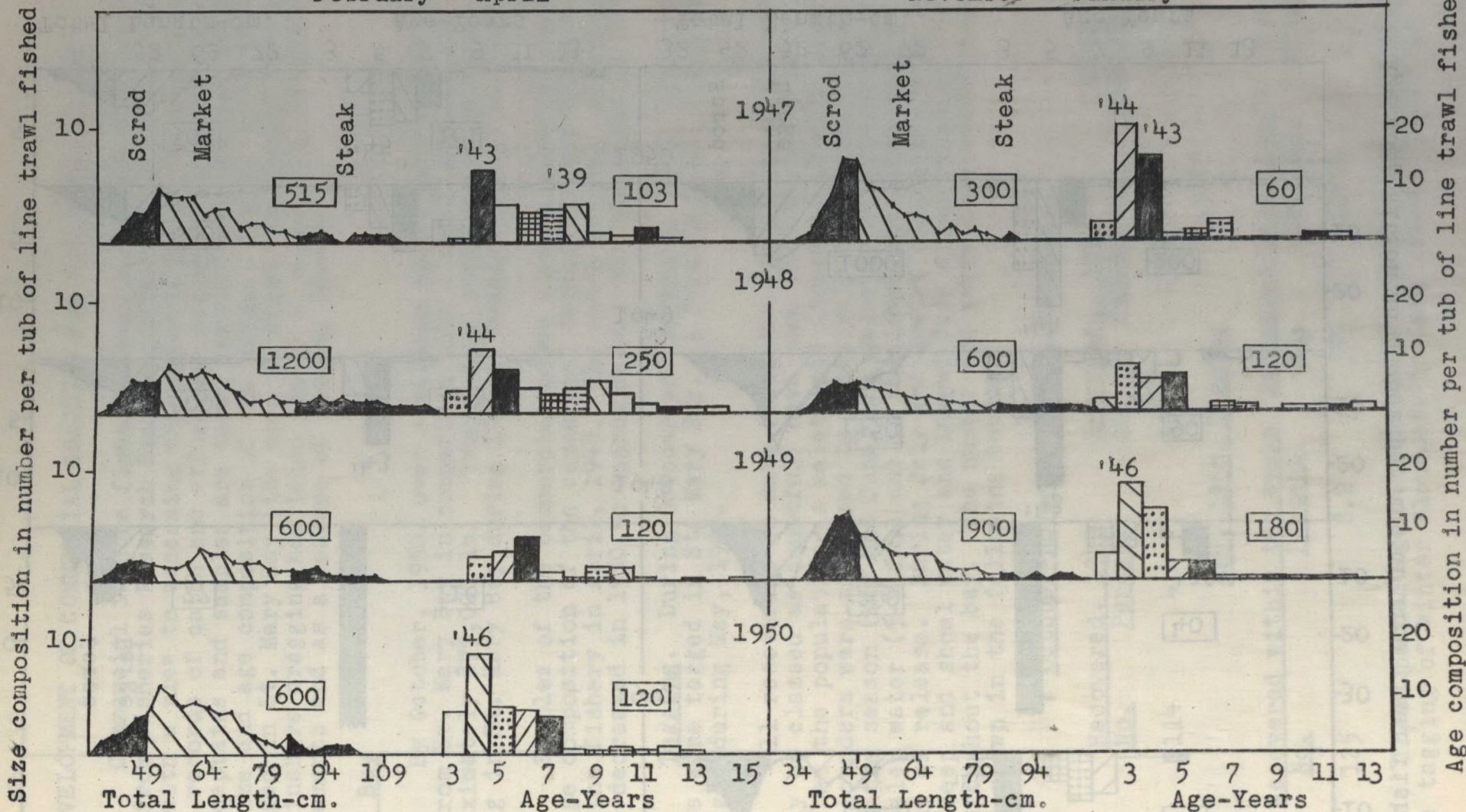
Similar data for Lockeport haddock are shown in a second diagram. In contrast to the cod, large differences are found in the contribution of year-classes to the fishery. The 1943 year-class was dominant for a three-year period. In contrast to the more stable cod fishery, large variations in the annual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

W. R. Martin
A. R. MacMorran

COD - LOCKEPORT

February - April

November - January



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

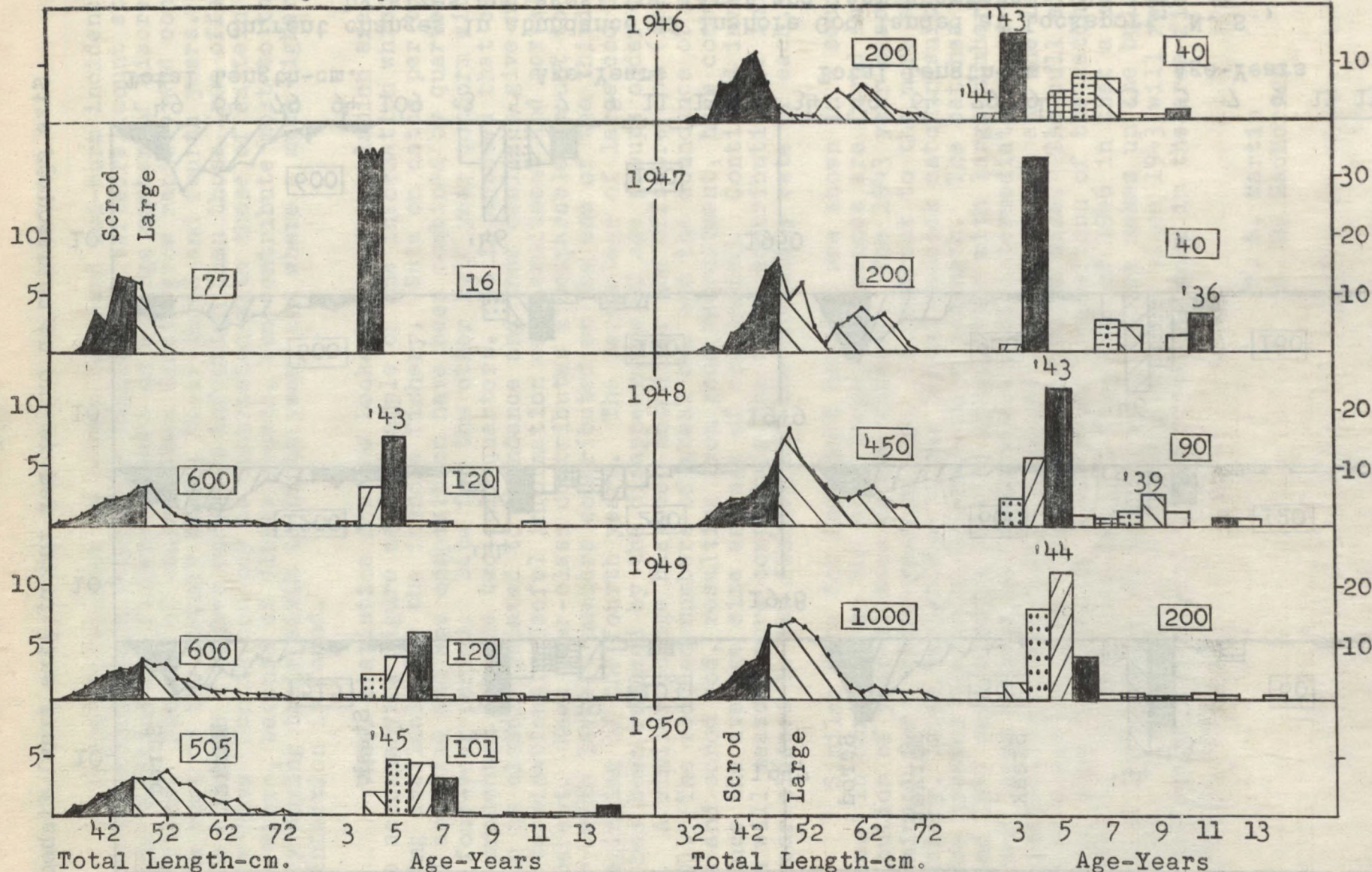
HADDOCK - LOCKEPORT

February - April

November - January

Size composition in number per tub of line trawl fished

Age composition in number per tub of line trawl fished



Current changes in abundance of inshore Haddock landed at Lockeport, N. S., by sizes and ages, for first and last quarters, 1946-1950.

Appendix No. 32

DEVELOPMENT OF COMMERCIAL DRAGGING FOR WINTER FLOUNDERS

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

St. Mary Bay

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

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

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

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

October-November, 1949, Tagging

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

May, 1950, Tagging

<u>No. tagged</u>	<u>Recovered within two weeks</u>		<u>Recovered later, 1950</u>		<u>Total percentage</u>
	<u>No.</u>	<u>Percent</u>	<u>No.</u>	<u>Percent</u>	
1523	125	8.2	387	27.6	33.6

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

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

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

Minas Basin

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

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

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

Annapolis Basin

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

Exploration

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

F. D. McCracken

Appendix No. 33

EXPERIMENTAL WINTER FLOUNDER STUDIES

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

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

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

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

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

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

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

F. D. McCracken

Appendix No. 34

LIFE HISTORY OF FLOUNDER CYSTS

The cyst infesting the fins and fillets of the winter flounder (Pseudopleuronectes americanus) is an intermediate larval stage of a trematode belonging to the genus Stephanostomum Looss, 1899.

1. The cysts are present in flounders throughout Maritime waters. Six flounder species were examined and the brill (Lophopsetta aquosa) was the only one which was free of infestation. The heaviest infestation was noted in the winter flounder.

2. Areas studied intensively were St. Mary Bay, N. S., and Passamaquoddy Bay, N. B. Incidence within each area decreases with the distance from open water and this distribution is approximately linear. Although lower incidence is found in shoal-water fish, depth is not a determining factor except as it is related to location.

3. In any given depth the larger fish are more heavily infested than are the smaller ones.

4. The infestation appears to be effected by the penetration of the host integument by a free-swimming form of the larval trematode since: (a) cysts are not evenly distributed in

both fillets but concentrated in the belly fillets (In the case of the cod-worm, a nematode which infests the fillets after being taken orally into the gut, the worms are scattered evenly throughout both fillets); (b) cysts are located mainly in the fins and close to the surface of the fillets.

5. The first intermediate host was not found but a gastropod is indicated. Methods for collecting large numbers of small, deep-water molluscs are inadequate.

6. The adult has been found in nature only in the rectum of the sea raven. Both the sea raven (Hemitripterus americanus) and the eelpout (Macrozoarces americanus) were artificially infested by feeding cysts dissected from the fins and fillets of the winter flounder. After a developmental period of two to three weeks the immature worms were recovered from these hosts.

7. An attempt was made to develop the metacercaria to the adult stage in 8% horse serum and amphibian Ringer's solution. The worm lived 32 days before being killed; no complete development was observed.

8. The flounders do not seem to be pathogenically affected by the cyst. It has not been found that the worm can infest mammals.

9. In future work emphasis will be placed on: (a) investigation of the first stage of the life history; (b) increased study of the incidence of both the cystic and adult stages in fishes now known as hosts; (c) extension of the survey to determine new hosts; (d) investigation of factors such as salinity and temperature.

10. As measures of control we suggest: (a) fishing in shallow waters to avoid high infestation areas; (b) processing flounders for market by leaving the white skin on the belly fillets to cut down the unsightly appearance of the cyst.

R. W. Wolfgang

Appendix No. 35

GENERAL SUMMARY OF HERRING INVESTIGATIONS

The Atlantic Herring Investigation Committee which had been formed in 1944 under joint arrangements between Canada, Newfoundland, Quebec, Nova Scotia, New Brunswick and Prince Edward Island was dissolved on March 31, 1950. The investigations, which were aimed chiefly at increasing the value of the herring fishery by discovering how to extend the catching of herring to other areas and longer seasons, were continued in 1950 by the Fisheries Research Board but on a somewhat reduced scale.

Exploratory fishing has continued to be the principal part of the investigation and the M. V. "Harengus" was employed from June 1 to October 31 in drift-net fishing in the Gulf of

St. Lawrence and on the outer coast of Nova Scotia. The M. V. "Eastern Explorer", on loan from the Newfoundland Division of the Department of Fisheries, was similarly employed on the west coast of Newfoundland from September 1 to November 15.

1. Bay of Islands Explorations, 1949

Mention has been made in an earlier report of the unique opportunities afforded in the Bay of Islands area for study of herring movements as related to hydrographic conditions. In November and early December, 1948, the M. V. "Harengus" operated in this area, and with Dr. Lauzier in charge made a thorough survey of the hydrography of the three sections of the Bay. Unfortunately, however, no appreciable quantities of herring moved into the area until after the completion of this cruise and it was, therefore, impossible to establish a relationship between herring movements and hydrographic conditions.

It was decided that it would be well worthwhile repeating this investigation in 1949, and also to test further the Larsen "floating trawl" which had been used with indifferent success in the Chaleur Bay area during August and September, 1949. This work was done under A. H. I. C. management, but has not been previously reported.

The M. V. "Harengus" arrived in the Bay of Islands on November 8 and remained there until December 10. Dr. Lauzier again directed the hydrographic work (Appendix 76A) but, as before, herring failed to appear in quantity and the main purpose of the study was, therefore, nullified. However, large schools of herring were located in Port-au-Port Bay about 30 miles to the south of Bay of Islands, and it was possible to make further use of the Larsen trawl. Repeated trials with this gear showed that the materials used in its construction were not sufficiently strong to withstand the strains placed on them and it is, therefore, planned to test a new trawl, similar in shape but having larger mesh sizes and heavier twine. (Appendix 36).

2. Exploratory Drift-net Fishing

During the period June 1 to September 30, the efficacy of drift-nets for the capture of commercial quantities of herring and mackerel was clearly demonstrated in the southwestern portion of the Gulf of St. Lawrence. Explorations with this gear along the west coast of Newfoundland and on the outer coast of Nova Scotia failed to reveal any substantial quantities of these fish.

In the Gulf of St. Lawrence and particularly along the southern slopes of the Laurentian Channel, catches amounting to 6,000 pounds of herring and 3,000 pounds of mackerel were made and these figures compare very favourably with average drift-net catches in the North Sea, although the effective amount of net used by the M. V. "Harengus" was often less than one tenth of that used by some commercial fishermen.

It is planned to continue this work during 1951 to include a greater coverage of the Gulf areas and the more shallow

waters off the Nova Scotia and Newfoundland coasts. (Appendix 37).

3. Herring Population Studies

The study of herring populations has been continued by sampling commercial catches at six localities, viz. Matane, P. Q., Caraquet, N. B., North Rustico, P. E. I., Lunenburg, N. S., Bay of Islands, Nfld., and Fortune Bay, Nfld. This represents one sampling station for each of the six groups of herring which make up the total population of the area.

Data have been collected for a comparison of average lengths and ages, rates of growth, mean vertebral counts, sex ratios and state of maturity of the gonads to check former evidence of segregation and to study the effect of increased fishing effort on the stocks. (Appendix 38).

4. Seasonal Variation in Condition (fatness) of Herring

Analyses of fat contents, indicative of the condition of herring, were made throughout the summer and early fall of 1950 with samples obtained from drift-net catches in the Gulf of St. Lawrence and on the Nova Scotia coast.

Fat determinations indicate that the large herring (30-40 cm.) have the best quality but that this condition is not maintained beyond the late summer when development of the gonads begins. Immature herring (25-30 cm.) are also of excellent quality, reaching a maximum fat content in the early fall. The small herring (20-25 cm.) do not become very fat at any time. (Appendix 39).

5. Sonic Sounder Explorations

The M. V. "Harengus" is presently equipped with a DRI model "Bendix" and an MS 21B model "Husun" sonic sounder, and while this vessel is cruising both of these instruments are used continuously in an effort to locate concentrations of herring. Further aid in this effort was obtained during the past season from four boats which are equipped with sonic sounders and which are operated by the Department of Fisheries in the Newfoundland area.

The results, which confirm earlier reports of similar work, indicate that herring form dense schools suitable for purse seining during the late fall and winter months and can then be located readily by the sonic sounders, but that during the summer season, when herring are feeding and are dispersed, these instruments cannot be relied on to indicate the presence of fish. Drift-net operations this year show that commercial quantities of herring and mackerel may be taken without having been previously recorded by the sonic sounders. (Appendix 40).

6. Hydrographic and Plankton Investigations

During the past season a study of temperatures and surface layers was incorporated in the program for drift-net fishing and bathythermograph observations were made both while the nets were in the water and while the vessel was cruising.

A preliminary examination of the results shows that (a) practically all of the fishing was done in a well-defined surface layer and (b) temperatures up to 15.5°C do not constitute a barrier to the movements of herring.

Plankton samples were taken at each fishing station throughout the season and showed that a relationship exists between the catches of herring and mackerel and the presence, in varying amounts, of certain planktonic organisms, chiefly Copepods (Calanus sp.). (Appendix 41).

7. Investigations on Bay of Fundy Herring

Dr. Leim has continued the study of length frequencies, fat contents and incidence of disease in the "sardine" herring of the Bay of Fundy. The results are in conformity with earlier studies and show a predominance of small fish in the spring with substantial growth during the summer months and a recruitment of a younger year-class in September. The incidence of disease was low in 1950. (Appendix 42).

S. N. Tibbo

Appendix No. 36

BAY OF ISLANDS EXPLORATIONS, 1949

During August and September, 1949, a "floating trawl" designed and constructed by Robert Larsen of Skagen, Denmark, was used by the M. V. "Harengus" and the M. V. "J. J. Cowie" in the Chaleur Bay area of the Gulf of St. Lawrence. A description of this trawl and a summary of the results of the experiment are contained in Appendix 40 of the Annual Report of the Atlantic Biological Station for 1949.

Although considerable difficulty was experienced in the handling of this gear and by the extensive tearing of the net on many occasions, the fact that some herring were taken in more than half of the drags indicated that the method was worthy of further trials. The Bay of Islands area on the west coast of Newfoundland was selected as being most suitable for continuing this experiment since there are usually large concentrations of herring in this area during the late fall and winter months.

To assist the M. V. "Harengus" in the trials with this gear two boats, the M. B. "La Parri" and the M. B. "Banti", were made available by Dunphy's Ltd., of Curling, Nfld., whose generous co-operation is gratefully acknowledged. The M. B. "La Parri", a 65-foot boat powered by two 70-h.p. Vivian engines, was unable to tow the net at the recommended speed of 3 to 4 knots and was assisted during the latter part of the experiment by the M. B. "Banti", a 55-foot boat powered with a single 88-h.p. Kelvin engine.

During the latter part of November and early December large schools of herring were located in Port-au-Port Bay about 30 miles south of Bay of Islands. These concentrations were extremely heavy and were first located by sonic sounders on the

M. V. "Harengus" and several commercial boats operating in the area. Their presence was subsequently confirmed by purse-net fishing from the M. V. "Western Explorer".

Eight tows were made with the Larsen trawl and during six of these the net was torn badly. Some herring were taken in four of the six, the largest catch being about 800 pounds and the smallest, 58 herring. It is worthy of note that the largest catch was associated with the greatest amount of tearing of the net. No fish were taken in the two tows during which the net was not torn and no explanation can be given for the tearing of the net on two occasions when no fish were captured. It should be noted too that the Larsen trawl took only sardine-sized herring although it was shown by commercial boats fishing in the area that adult herring were also present and far more numerous. This fact probably indicates that the speed of towing was too slow to capture the larger and more active herring.

Experiments with the Larsen trawl to date indicate that this net in its present form could not be used to catch herring commercially under our conditions. It is apparent that its materials are not sufficiently strong to withstand the strains placed on them and, while the principle of towing a net in mid-water and between two boats is promising, stronger materials must be used.

Further trials are planned for this type of gear using a net made by the Great Grimsby Coal and Salt Co., of Grimsby, England, similar in design but with much heavier twine and larger meshes. It is also planned that future trials will use two boats of the same size and horsepower since some of our difficulties have resulted from using boats which were not evenly matched.

During the fall of 1948 a program of hydrographic investigations to study changes in water conditions as related to herring movements was carried out in the Bay of Islands area and this work was continued in 1949. Dr. Lauzier was in charge of this part of the program and a summary of the results obtained appears in Appendix 76A of this report.

S. N. Tibbo
K. G. Sollows

Appendix No. 37

EXPLORATORY DRIFT-NET FISHING

Before 1950 very little success had attended the efforts to capture herring in offshore areas. Apparently the various types of gear used, viz. purse seine, otter trawl, Dutch herring trawl, and floating trawl, can be effective only if there are relatively large and concentrated schools of herring present. Persistent searching with echo-sounders and fishing gear for several seasons had not revealed any such schools except in inshore areas. Although occasionally some small quantities of herring have been captured, there has been no indication that any of these gears could be used successfully for commercial fishing offshore.

Offshore explorations for herring were continued during the past season, this time with drift-nets, and the results obtained are very promising. The areas surveyed were (a) the southwestern portion of the Gulf of St. Lawrence, (b) the Nova Scotia coast from Canso Bank to Roseway, and (c) the west coast of Newfoundland.

A network of 22 stations was established, of which the M. V. "Harengus" occupied 16 on three cruises from the beginning of June to the end of September. The M. V. "Eastern Explorer" made one cruise along the west coast of Newfoundland in September and occupied four of the southwestern Gulf stations in November. A list of the stations with the latitude, longitude and the general location of each is given in the accompanying table, together with the total quantities of herring and mackerel taken in the three cruises. The accompanying figure shows the relative sizes of the catches at the stations in the Gulf. The black areas in the circles are proportional to the total catches of herring and mackerel combined in the entire season at each place. Four sizes of gill-nets were used: $1\frac{1}{2}$ ", $2\frac{1}{2}$ ", 2" and 3" stretched mesh. They were assembled in the above order and in the following proportions: 1:2:2:1. Twelve nets, each approximately 8 yards deep, were included in a string, making a total length of slightly less than 500 yards. One night was spent at each station during each cruise, such a string of nets being set just before sunset and hauled back immediately after daybreak.

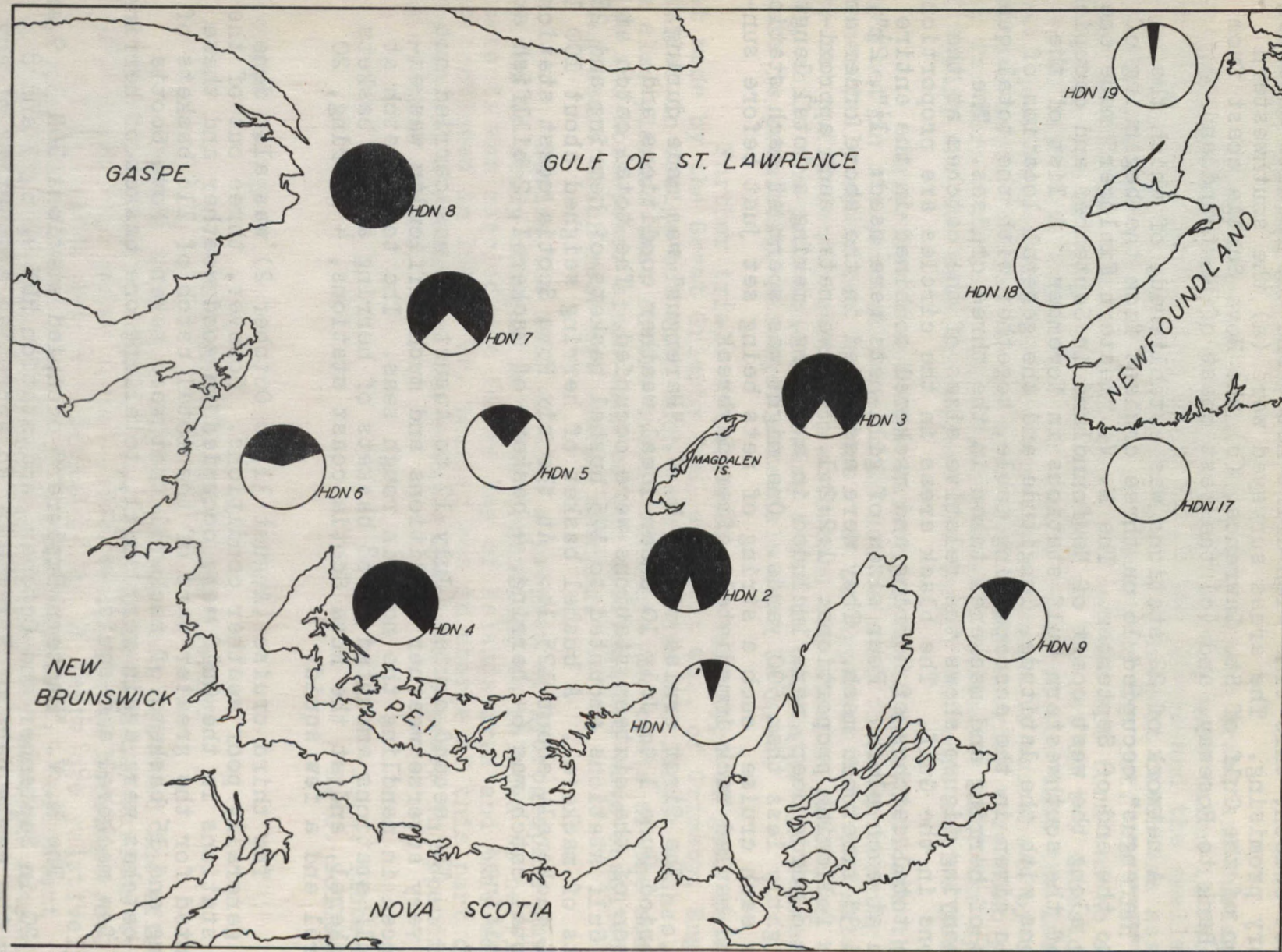
The first cruise of the M. V. "Harengus" was made during the period June 1 to July 10 under ideal weather conditions and thirteen of the sixteen stations were occupied. The total catch at seven Gulf stations amounted to 175 bushel baskets of herring and 28 baskets of mackerel. A bushel basket of herring weighed about 100 lb. and of mackerel, about 125 lb. At the six Nova Scotia coast stations the total catch was 64 herring, 4 baskets of mackerel, 2 billfish and 104 whiting.

The second cruise (July 17 to August 16) was carried out under very adverse weather conditions and much difficulty was experienced in handling the nets in rough seas. The total catch at the Gulf stations amounted to 68 baskets of herring and 13 baskets of mackerel, and at the Nova Scotia coast stations, 4 herring, 20 mackerel and a few squid.

The third cruise (August 31 to October 2) was also done under generally poor weather conditions. However, three out of the eight stations in the Gulf were occupied in good weather and these accounted for the greater part of the total catch of 116 baskets of herring and 15 baskets of mackerel that were taken. Nova Scotia coast catches were again very small, totalling one basket of herring and a few mackerel and squid.

The M. V. "Eastern Explorer" occupied stations HDN 3, 9 and 17 to 20 in September and October, and station HDN 4, 6, 7 and 8 during the early part of November. No appreciable quantity of any species of fish was taken.

A detailed record of atmospheric conditions was kept for every hour while the nets were in the water, and these show that all of the large catches (1,000 lb. or more) were made on dark nights



Catches of herring and mackerel during drift-net explorations 1950.

<u>Station</u>	<u>Latitude N</u>	<u>Longitude W</u>	<u>Location</u>	<u>No. of sets</u>	<u>Total catch herring and mackerel</u>
HDN 1	46°25'00"	61°35'00"	Off East Point, P. E. I.	3	160 pounds
HDN 2	47°00'00"	61°45'00"	LeFond Georges	3	11,500 "
HDN 3	47°46'00"	60°41'00"	Off Bird Rock, M. I.	2	7,850 "
HDN 4	46°50'00"	63°35'00"	Off Alberton, P. E. I.	3	5,800 "
HDN 5	47°32'00"	63°02'30"	Bradelle Bank	2	600 "
HDN 6	47°24'00"	64°15'00"	Entrance Miramichi Bay	3	2,950 "
HDN 7	48°14'30"	63°20'00"	Orphan Bank	3	2,450 "
HDN 8	48°38'00"	63°50'00"	American Bank	3	11,700 "
HDN 9	46°46'00"	59°45'00"	Entrance to Cabot St., W.	2	250 "
HDN 10	45°07'00"	63°30'00"	Canso Bank	3	20 "
HDN 11	44°30'00"	60°28'00"	Middle Ground	1	<5 "
HDN 12	44°40'00"	62°10'00"	Off Sheet Harbour	3	150 "
HDN 13	43°43'00"	63°17'00"	Sambro Bank	1	<5 "
HDN 14	43°12'00"	64°07'00"	Le Have Bank	1	<10 "
HDN 15	43°25'00"	64°41'00"	Roseway	3	225 "
HDN 16	44°10'00"	63°48'00"	Entrance St. Margaret Bay	3	450 "
HDN 17	47°24'00"	58°51'00"	Cabot St., Entrance E.	1	0 "
HDN 18	48°16'00"	59°27'00"	Bay St. George, Nfld.	0	--- "
HDN 19	49°10'00"	58°58'00"	Bay of Islands, Nfld.	1	150 "
HDN 20	49°49'00"	58°24'00"	Bonne Bay, Nfld.	2	0 "
HDN 21	50°21'00"	57°38'00"	Portland Cove, Nfld.	0	--- "
HDN 22	50°58'00"	57°44'00"	St. John's Bay, Nfld.	0	--- "

when there was either no moon or when the moon was totally obscured by heavy clouds.

The results indicate that during the period from June to September drift-net fishing might be profitable in most of the south-western Gulf areas but is not likely to be very productive on the outer coast of Nova Scotia. It is possible that the depth of water has some bearing on the distribution of herring. Most of the Gulf stations were located over shallow depths (20-30 fathoms), while on the Nova Scotia coast the depths were 50 fathoms or more.

Plans are being made to continue this investigation during the 1951 season. These plans will include a greater coverage of the Gulf and the more shallow areas off the Nova Scotia and west Newfoundland coasts. It is also planned to test other sizes of gill-nets and to have the nets rigged in a similar manner to the ones used for commercial fishing in the North Sea.

S. N. Tibbo
E. G. Sollows

Appendix No. 38

HERRING POPULATION STUDIES

A study of variations in certain characteristics of herring populations to corroborate former evidence of segregation into a number of local groups was continued during the 1950 season. Samples of herring were obtained from the commercial fisheries at Matane, P. Q., Caraquet, N. B., North Rustico, P. E. I., Bay of Islands, Nfld., and Fortune Bay, Nfld. A total of 3312 herring were examined for lengths; 2914 scales were taken for age determinations and 2869 vertebral counts were made. The sex and maturity of the gonads was recorded for each of the herring examined.

It has been shown previously that the herring population of the Canadian Atlantic area is made up of six major groups which are characterized by constant and significant differences in length and age composition, rates of growth, age of maturity and mean vertebral counts. It is important to test the constancy of these differences over several seasons and also, since fishing effort is increasing over most of the area, it is important to know what effect this will have on the stocks. At present the proportionate numbers of older fish in the catches in most localities indicate that fishing is not excessive and could be increased considerably.

The exploratory drift-net catches during the past season provided an additional 68 samples consisting of 6006 herring. These were examined for lengths to determine the average sizes at the various fishing stations and also to get some indication of the extent of gill-net selection.

These data have not been fully examined as yet but a comparison of some aspects with the results from the previous season (1949) is possible and is given in the following table:

	Average length (half cms.)		Mean vertebral count		Sex ratio ♂/♀	
	1949	1950	1949	1950	1949	1950
Matane, P.Q.	57.382	60.827	55.875	55.953	0.923	0.528
Caraquet, N.B.	69.875	65.504	55.638	55.638	0.953	1.422
*North Rustico, P.E.I.	60.386	61.416	55.547	55.656	1.204	1.148
Bay of Islands, Nfld.	72.118	70.841	55.696	55.612	0.930	1.000
Fortune Bay, Nfld.	72.925	72.857	55.883	55.785	1.286	0.903

*Comparison for 1948 and 1950. No samples in 1949.

S. N. Tibbo

Appendix No. 39

SEASONAL VARIATION IN CONDITION (FATNESS) OF HERRING

During the course of drift-net operations in the Gulf of St. Lawrence regular samples of herring were taken for fat determinations, to be used as a measure of the condition of the fish. A summary of the results is contained in the following table and gives the fat content as a percentage of the wet weight of the entire fish. All fat determinations were made by the ether extraction method.

Percentage fat content of herring June 1 to September 15

<u>Size (cm.)</u>	<u>Period</u>	<u>No. of samples</u>	<u>Fat content</u>	
			<u>Range (%)</u>	<u>Average (%)</u>
20-25	June 1-15	4	7.8 - 9.7	8.7
	June 15-30	2	11.9 - 12.0	11.95
	July 15-31	8	7.1 - 15.3	10.9
25-30	June 1-15	4	8.2 - 8.8	8.45
	June 15-30	2	10.8 - 11.0	10.9
	July 15-31	8	12.1 - 18.1	15.5
	Sept. 1-15	4	15.5 - 20.9	18.2
30-40	June 1-15	6	9.5 - 12.8	10.7
	July 15-31	12	15.9 - 26.8	19.8
	Sept. 1-15	6	12.7 - 18.4	16.3

The results indicate that there is both a seasonal and a size variation in the condition of herring in this area. The samples have been divided into three groups consisting of:

(a) Small herring (20-25 cm.) which are immature fish of poor quality and which, although improving in condition somewhat in the summer months, do not become particularly fat at any time.

(b) Immature herring (25-30 cm.) which are thin early in the summer but attain excellent quality and maximum fat content during the early part of September.

(c) Adult herring (30-40 cm.) which are fish of the best quality but with this condition not so well sustained as in the immature herring. The development of the gonads in adult herring during the late summer is associated with a decrease in the fat content.

S. N. Tibbo
P. J. Gibson

Appendix No. 40

EXPLORATIONS WITH SONIC SOUNDERS

The value of echo sounders as an aid to the commercial capture of herring has been clearly demonstrated in recent years and these instruments are now widely used both as an aid to navigation and for locating schools of pelagic fish. However, their use as fish finders is restricted for the most part to relatively small areas where there are known concentrations of herring or where herring fisheries have been carried on for long periods of time. There has been little effort put forward by the industry to locate herring in offshore areas or during the off season.

The principal aim of the program for herring investigations is to determine whether herring can be caught commercially over a longer season than at present, and echo sounders are used continuously during cruising or fishing operations and detailed records kept of any concentrations of pelagic fish that are located.

In the summer and early fall of 1950 special attention was given to the southwestern Gulf of St. Lawrence and the outer coast of Nova Scotia areas during the exploratory drift-net operations of the M. V. "Harengus". The catches during these operations indicate that commercial quantities of herring and mackerel may be present in an area and not be recorded by the echo sounders. However, the best catches were associated with fairly good echo-sounder recordings. In addition to this the M. V. "Eastern Explorer" operated a Bendix DR5 model echo sounder during a fishing cruise along the west coast of Newfoundland in September and, while some small catches of herring and mackerel were made, only very sporadic indications of fish were recorded.

During the latter part of November and early December, 1949, extremely large concentrations of herring were located in Port-au-Port Bay on the west coast of Newfoundland. There were four and possibly five large schools of herring in this area, each of which was conservatively estimated to contain not less than 20,000 tons. One commercial boat operated in the area and made several large catches but had considerable difficulty in landing even a small proportion of the fish which had been surrounded by the seine.

The results of sonic-sounder explorations to date indicate that herring form the dense schools, which are necessary for purse-seining operations, only during the late fall and winter months. At other seasons of the year the fish are dispersed and other types of fishing gear such as drift-nets or possibly mid-water trawls must be

used for successful commercial capture. During these seasons sonic sounders cannot be fully relied on to indicate the presence of herring.

To further the collection of data on the general distribution of herring throughout the Canadian Atlantic area during all seasons of the year, four boats, used for patrol and other work by the Department of Fisheries in Newfoundland, have now been equipped with Bendix echo sounders. These sounders are being used continuously while the boats are cruising. Indications of large bodies of herring are reported immediately to the industry and the records are sent to the Atlantic Biological Station for analysis to determine order in the appearance of herring.

The M. V. "Harengus" is equipped with both "Bendix" and "Husun" types of echo sounders and, while the "Bendix" machine is more sensitive than the "Husun", neither type appears to be capable of recording very scattered schools of fish. During the past season a new model "Husun" sounder has been installed on the M. V. "Harengus". This model, MS21 B, has some advantages over the MS12 C and MS24 models which were used previously. It has high amplification (1.0×10^6 times) and a high repetition rate of 266 r.p.m. on the foot scale. This machine is entirely electric as is the MS24 model, and thus avoids battery troubles, but it has a constant recording-paper speed for both foot and fathom scales and this is a disadvantage in getting good definition of schools of fish. It has not been possible yet to use this machine in areas where there are large concentrations of herring and further testing will be done at a later date.

S. N. Tibbo

Appendix No. 41

RELATION OF HYDROGRAPHY AND PLANKTON TO HERRING DISTRIBUTION

Hydrography. During the exploratory drift-net cruises of the M. V. "Harengus" in the southwestern portion of the Gulf of St. Lawrence and along the outer coast of Nova Scotia a series of bathythermograph observations were made at the fishing stations and at approximately nine-mile intervals while proceeding from port to a fishing station or from one fishing station to another. The procedure has been to take bathythermograph observations during or immediately before setting the nets and again during or immediately after taking back and also every hour on the hour while cruising.

A preliminary examination of the records shows that except for one station in each of the first two cruises all fishing was done within the surface layer. This layer was well defined at all times and extended from 10 to 75 feet in depth. The average surface temperature recorded during the July and August cruises in the Gulf of St. Lawrence was 15.5°C and, since good catches of herring and mackerel were made at the majority of the stations, it is evident that this temperature does not constitute a barrier to the movements of these fish.

No correlation between temperature, depth of the surface layer and distribution of herring and mackerel along the coast of Nova Scotia is possible since at no time during the three cruises

were there any appreciable quantities captured.

Plankton. Plankton samples were taken at all fishing stations immediately before or after the setting of the nets. In all cases 10-minute horizontal tows were made at approximately 3 metres below the surface with a net having an opening of 1 metre and made of a cloth with from 12 to 15 meshes to the centimetre.

During the first cruise, which lasted from June 1 to July 10, quantities of plankton, varying from amounts too small to measure to 500 c.c., were obtained and consisted chiefly of fish eggs, Ctenophores and Chaetognaths, with relatively small numbers of fish larvae (including herring larvae), Copepods and Decapod larvae. During the second cruise (July 17 to August 16) similar quantities of plankton were obtained but in this case consisted chiefly of Copepods (Calanus sp.) with small numbers of Sagitta, Cladocera, Decapod larvae, fish eggs and fish larvae. Very small quantities of plankton (1.5 to 20 c.c.) were obtained during the third cruise (August 31 to October 2) but the composition of the material was similar to that obtained during the second cruise.

There appears to be a definite relationship between the abundance of plankton and the quantities of herring and mackerel captured and this was particularly evident during the second cruise when Calanus were very abundant and were the principal constituent of the plankton hauls. For example, at station HDN 8 there were 310 c.c. of plankton and 5,000 pounds of fish taken; at station HDN 2, 220 c.c. of plankton and 2,200 pounds of fish; at station HDN 5, 130 c.c. of plankton and 550 pounds of fish, and at station HDN 1, 35 c.c. of plankton and 120 pounds of fish.

This relationship between herring and mackerel catches and the presence, in varying amounts, of certain planktonic organisms is in conformity with the results of similar studies elsewhere.

Further studies along these lines are planned for the 1951 season to get a more precise measure of the abundance of plankton by making hauls at various depths and under various light conditions.

S. N. Tibbo

Appendix No. 42

INVESTIGATIONS ON BAY OF FUNDY HERRING

Only routine work has been carried on with the "sardine" herring to provide some comparative record of the population. A large body of similar data has been gathered over the last twenty years. Mr. Michael Graham had very extensive length-frequency measurements made in 1932 and these are available for comparison. Since 1942 more or less sampling has been done every year. Fat determinations have been made annually since 1942. Attention has been paid to the percentage of sardines showing evidence of fungus or "pepper spot" disease. For some years past relatively little time has been devoted to this work but the ease with which a minimum

of observations can be made makes it possible to continue them.

During 1950 twenty-one samples of "sardines"; involving 6074 fish, were measured from catches made in Passamaquoddy Bay and near Deer and Campobello Islands. Sardines were scarce during the winter and spring months and few catches were made before the middle of May. Small fish from 20 to 28 half-centimetres in length predominated in the May catches. These increased in size as the year progressed, reaching 29 to 37 half-centimetres by August. Larger fish up to 50 half-centimetres in length were well represented in the July and August catches. In September there was an influx of younger herring from 19 to 26 half-centimetres in length. This is the usual picture of recruitment of a younger year-class during the summer months.

Determinations of fatness, using the ether extraction method, were made on 17 samples. The results are expressed as a percentage of the wet weight of the fish and are summarized in the table which follows:

Month 1950	No. of samples	Fat content	
		Range (%)	Average (%)
May	3	1.2 - 6.7	4.1
June	3	8.3 - 15.7	10.6
July	3	6.5 - 16.1	10.5
August	5	7.5 - 16.1	10.6
September	2	3.5 - 12.8	8.3
October	1	7.7 - 12.1	10.0

In 13 cases out of 17 the larger sardines were fatter than the smaller ones. The other four cases were exceptions to the general rule which has been formulated in previous years.

The herring disease, due to Ichthyosporidium, has not been very noticeable in 1950. The May samples contained up to 2.5% of affected fish. Since July samples have either been free of the disease or have shown only traces of it.

Miss Phyllis J. Gibson carried out most of the measurements and all of the fat determinations.

A. H. Leim

Appendix No. 43

TUNA IN WESTERN NOVA SCOTIA

The present demand for Atlantic bluefin tuna (Thunnus thynnus L.) far exceeds the productive capacity of fishing methods used on the Canadian Atlantic coast. Of these methods, trap-net fishing which is centred in the St. Margaret Bay area and is limited to the ten-fathom strip along the shoreline has been the mainstay of the successful commercial fishery. Surface line-trawl fishing which has the advantages of being mobile and less expensive

has been progressively poorer each year since World War II. This year no tuna had been caught on this type of gear up to mid-October. Harpoon fishing has steadily declined as evidenced by the annual catches of an ardent harpooner from St. Margaret Bay, N. S., who in 1948 harpooned 68 tuna; in 1949, 23 and in 1950, none. Hand-line fishing, carried out as a secondary effort by gill-net and ground-fish fishermen, has continued to contribute a very small percentage of the annual catch. Sport fishing with rod and reel, centred off Wedgeport, N. S., has become increasingly important not only as a tourist attraction but also as a producer of tuna. In 1949 anglers took almost 1,800 tuna averaging almost 250 pounds each from this area.

Lure trials. Since 1948 attempts have been made each summer in St. Margaret Bay to test the efficacy of trolling with the feathered lures which are used so successfully in the Pacific tuna fishery. Trials in 1948 indicated that the lure was more efficient than other methods in taking tuna. Repeated attempts in 1949 proved unsuccessful because tuna were not schooling at the surface. During three morning trials between October 1 and 6, 1950, feathered lures were trolled mainly about the west side of the mouth of the Bay, where from September 28 to October 13, 215 fish were caught out of a total trap-net catch of 236 for the entire Bay. No schools of tuna were trolled through or sighted, and no strikes were recorded.

From the results of the 1948, 1949 and 1950 trials it would appear that lures are effective only among schools of surface-feeding tuna. Trials with lures in conjunction with "chumming" (broadcasting bait) will be carried out in 1951.

Biological data on the tuna were collected during four visits to St. Margaret Bay in 1950. The visits (June 25-26, July 12-14, August 16-19, September 28 to October 13) were arranged to allow sampling during each month of the fishery. The accompanying table shows the kind and amount of data which were collected each month.

	<u>Round weights</u>	<u>Dressed weights</u>	<u>Fork lengths</u>	<u>Scales</u>	<u>Stomachs</u>
July		21		11	
August		46		41	34
September		64		64	31
October	20	103	9	47	103
Total	20	234	9	163	168

Emphasis was placed on the collection of data from which the growth rate of tuna might be established. Data on other characters are meagre since many of the fish examined had already been dressed.

Length-weight relationship. For our growth data to be comparable with that of others it is necessary to establish reliable relationships among a number of characters. Often in the case of sampling tuna catches, heads and fins have been removed before the fish can be examined. The following table shows the relationship between fork length, round weight and dressed weight for 27 of the

small "jumper" tuna taken from the St. Margaret Bay trap-net fishery during 1948, 1949 and 1950:

<u>Fork-length groups</u> (inches)	<u>Av. dressed</u> <u>weight (lb.)</u>	<u>Av. round</u> <u>weight (lb.)</u>	<u>Conversion factor</u> <u>dressed to round weight</u>
45-50	55.4	72.7	X 1.31
50-55	72.5	91.2	X 1.26
55-60	85.3	107.5	X 1.26

Although the consistency of the conversion factor indicates that a good relationship has been established for the dressed and natural weights, additional data will be collected to show the relationship in greater detail and over a greater size range.

Stomach contents. Of 168 tuna stomachs examined during 1950, 25 were from the large "albacore"-size tuna, while the remaining 143 were from "jumper"-size. Only two fish, both large, had food in the stomach; one had a large half-digested pollock while the other had two partially digested alewives. The lack of food in the stomachs may be attributed to the known rapid rate at which digestion takes place combined with the length of time which the fish may be in the trap prior to their removal. The latter varies from 6 to 48 hours or even longer on occasions.

A number of giant trematodes of the genus Hirudinella were collected from the stomach lining of two large fish and preserved for further study. These parasites are found in oceanic fishes which range through all tropical and temperate seas.

Seasonal variation in size. The following table has been prepared from data collected in 1950 on the St. Margaret Bay trap-net fishery to show seasonal variation in the size of tuna:

Numbers of tuna of various dressed weights

	<u>"Jumpers"</u>			<u>"Albacore"</u>			<u>Total</u> <u>number</u>	<u>Av. dressed</u> <u>weight (lb.)</u>
	<u>0 to</u> <u>49 lb.</u>	<u>50 to</u> <u>99 lb.</u>	<u>100 to</u> <u>150 lb.</u>	<u>151 to</u> <u>299 lb.</u>	<u>300 to</u> <u>499 lb.</u>	<u>500 to</u> <u>699 lb.</u>		
July				4	14	3	21	387.5
Aug.		1	11	8	24	2	46	326.7
Sept.		54	10				64	84.7
Oct.	11	90	2				103	71.5
Total	11	145	23	12	38	5	234	149.4

These data show that during July all tuna were of "albacore" size, while August marked the appearance of the "jumper" size which made up the entire fishery through September and October.

Similar data on the rod and reel fishery at Wedgeport, N. S., for 1946-49 are presented in the following table:

Average round weight (lb.)

	1946		1947		1948		1949	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
July	17	605.1	29	508.9	87	485.6	58	485.7
Aug.	150	563.9	91	528.2	210	479.3	188	453.4
Sept.	217	562.6	337	449.5	380	345.3	958	224.9
Oct.			30	350.3	100	236.8	561	180.8
Average	384	565.0	487	461.6	777	383.3	1,765	246.5

It is seen that in the Wedgeport area, too, there is a definite seasonal decline in the size of tuna as each year progresses. Further, there has been a steady decline in the size of tuna from 1946 to 1949.

L. R. Day

Appendix No. 44

BILLFISH INVESTIGATIONS, 1950

The trap-net fishermen of the St. Margaret Bay area have been looking for a possible market for sporadic catches of great quantities of billfish which appear during the summer months. In 1947 the inconsistent supply forced the stoppage of promising canning operations, but not before the billfish was recognized as a potential food resource of some real importance. Again during 1950 attempts have been made by the Fisheries Research Board of Canada to raise the catches to commercial proportions through trials of mobile fishing techniques based on a knowledge of the biology of the fish.

Results obtained this summer indicate that artificial lights, drift gill-nets and a modified lift-net show promise as efficient fishing methods but that further investigation is necessary.

Drift-gill-net fishing. In connection with drift-gill-net fishing for herring from June 1 to October 26 at established stations covering the Gulf of St. Lawrence and Nova Scotian coastal waters, 32 sets were made in the Gulf area using gill-nets of 1½" to 3" stretched meshes, while 16 sets were made off the Nova Scotian coast, 7 of which had additional gill-nets of 1 1/8" and 1 3/8" meshes. A total of 12 billfish were caught, all meshed half-way along the body, not gilled, in nets ranging in mesh size from 1½" to 2½". Indications are that 2½" is the largest-size mesh in which billfish can be expected to be taken. The failure of our gill-nets of mesh size less than 1½" to catch fish of any species confirmed suspicions as to their unsatisfactory nature. Plans are being made to repeat drift-gill-net trials using nets of a more satisfactory construction with 1" to 1½" stretched meshes.

Net fishing with lights. Attempts were made to verify the strong positive phototaxis observed for billfish and to utilize this characteristic to effect concentrations which could be netted. During the night of September 5 a scattered school of billfish was attracted and held by artificial light from the M. V. "Eastern Explorer" while

drifting for herring off Sydney, N. S. Eight billfish were removed from the gill-nets at sunrise. Trials with lights of different intensities indicated that the direct rays of a strong light repelled billfish.

In late September in St. Margaret Bay two 100-watt electric lights attached to the main boom of the M. V. "Harengus" 10 to 12 feet above the water level attracted and held a small school of about 15 billfish from dark until a rising full moon nullified the effects of the artificial lights three hours later. Plans to capture light-attracted billfish using a modified version of the Japanese lift-net failed when gear proved too cumbersome and was damaged. This is a rectangular net 60-90 feet long by 30-50 feet deep. It has a buoyed and rigid head line and a heavily weighted lead line to which ropes are attached for hauling. The net is set by dumping it overboard and shoving it off by means of two long poles which are attached to either end of the head line. The net hangs vertically in the water until hauled up by means of the ropes attached to the lead line. Any fish between the boat and the net are held captive and can be readily removed.

Further tests are planned using artificial light of various intensities and colours in connection with drift and stationary gill-net fishing and also lift-net fishing.

Biological observations. Personal observations and interviews with fishermen indicated that billfish were again plentiful in Nova Scotian waters in 1950.

Length and age data collected from a 1500-pound trap-net catch in early October in St. Margaret Bay form the basis for a comparison with data collected in 1947. Length, weight and age distributions were again distinctly bimodal and confirmed indications from the 1947 sample that the billfish are fast-growing fish with a life span of not more than three years. The following table compares the average lengths (greatest total lengths) of the two age-groups in the 1947 and 1950 samples, showing the rapid growth rate.

	<u>Average length (cm.)</u>	
	<u>August, 1947</u>	<u>October, 1950</u>
Age-group I	23.5	28.5
Age-group II	38.5	39.5

It is interesting to note that 1,490 of the 1,500 pounds in the 1950 sample were made up of the smaller of the two size-groups, i.e. age-group I. Further sampling will be carried out during the summer of 1951.

L. R. Day

Appendix No. 45

GENERAL SUMMARY OF SMELT INVESTIGATIONS

To obtain the maximum sustained yield from the Miramichi smelt fishery is the main objective of the investigations being carried on under the Fisheries Research Board. The attack on this problem has been along two lines: (a) the improvement of conditions for reproduction and (b) the collection of information on which

to base proper regulatory measures.

Improvement of spawning conditions. Early surveys showed a very great number of the Miramichi tributaries to be blocked to the ascent of spawning smelt. Experiments have shown that crowding of eggs, such as occurs below such obstructions, drastically reduces the number of larvae produced, and that increasing the available spawning area by clearing streams reduces the egg crowding and increases the number of larvae produced.

As in 1949, the 1950 spawning run went farther up some open streams than it had for years and went in great numbers to the upper limits of earlier clearing in certain other streams. The importance of having more streams open to the passage of spawning fish is thus emphasized. (Appendix 46).

Obstructions arising from natural causes, such as high winds, heavy rains and beavers, together with man-made ones from lumbering operations, are continually necessitating seasonal surveys and annual clearance. A considerable amount of such maintenance work, together with clearance above the upper limits of former clearing, has been financed by the Department of Fisheries during the autumn of 1950.

In its effort to overcome larger obstructions in the Miramichi area the Conservation and Development branch of the Department of Fisheries is at present installing a fishway for smelts over the falls on Indiantown Brook and providing a passage through an old dam on Sutherland (Redbank) Brook. Action to provide a completely free passage through the dam on McKnight Brook is pending.

Annual collections of larvae indicate a definite increase during the past three seasons, while various surveys of the spawners indicate no parallel increase. There appears to be no good correlation between number of spawners and number of larvae produced, under the conditions studied. (Appendix 47).

The recent great increase in larvae, especially in those hatched early, should go far towards indicating the effect of the number of larvae on the number of smelt entering the fishery two years later during the 1950-51 and 1951-52 commercial seasons. Some definite information in this respect should be forthcoming, since from 1948 to 1950 the larval increase has been roughly in the ratio of 1:3:8. Progress has already been made towards knowledge of the ages of smelt in the fishery and the spawning run - a prerequisite for assessment of the relative abundance of year-classes. (Appendix 48).

The Miramichi smelt stock. Marking has shown that the fishery is supported chiefly by fish which spawn early in the four main branches of the Miramichi and several very large tributaries. The later spawners use the brooks principally and do not contribute so definitely to the fishery because they do not enter the fishing area as early as the others.

It is of prime importance to obtain knowledge of the degree to which these two roughly-defined divisions of the stock mix or

change their habits and to this end numerous counts of vertebrae and scale circulae have been made.

The early spawners have been found to have a lower average vertebral count than the late spawners, are larger age for age, and have more scale circulae or ridges. (Appendices 49 and 50). The scales indicate that their greater growth occurs in the first year and is presumably due to the fact that early spawning and hatching gives the young about two months' lead in growth over the late ones. Fish with this greater amount of first-year growth - indicating earlier hatching - are themselves found to return to spawn early in the season on the average, beginning when they reach two years of age. These larger fish continue to spawn early as they grow older. The average size of an age-group on any one spawning ground, and on the Miramichi as a whole, thus declines as the spawning season progresses.

A comparison of the average vertebral counts among the two-year-olds in 1949 with those of 1950 indicates that there can be differences between year-classes. While the two-year-old counts in 1949 are in general similar to the three-year-olds in 1950 (same year-class), there is sufficient difference to suggest a redistribution of various components of the run in respect to the time at which they spawn.

While early and late spawners are distinguishable on the basis of numbers of vertebrae and of circulae, spawners in the main river branches are at any one time indistinguishable from those in the brooks. Since there is a tendency for late spawners to spawn earlier as they grow older, those which spawn in the brooks make some contribution to the fishery - a conclusion which is supported by the recovery in the fishery of some smelt which had been marked in the brooks. An effort is being made to assess the importance of this contribution.

R. A. McKenzie

Appendix No. 46

STREAM CLEARANCE FOR SPAWNING SMELT

It is desirable to clear streams both to increase the spawning area available and to prevent smelt being trapped above obstructions when freshet water levels drop to normal.

For the second consecutive year Miramichi smelt during the 1950 spawning season went, in many instances, to the head of former clearing and farther up some open streams than they had for ten to fifteen years. This emphasizes the importance of keeping as well as making streams clear and of opening certain others beyond the upper limits of earlier clearing. Violent storms, wind and rain increase the number of obstructions. Then, too, streams through certain types of woods are more subject to obstruction than those in open country. Seasonal surveys are necessary to determine what clearing is necessary.

Clearing operations of a maintenance and minor nature have been carried out on 12 to 15 brooks in the Miramichi area this autumn. In addition, two streams blocked by old beaver dams, etc., have been opened for distances up to a mile beyond former clearing. A third stream, blocked a short distance above the head of tide by a very old log jam on sharply rising ground, has been opened in the hope that smelt will be able to negotiate this difficult stretch, since tremendous numbers have been held up in their spawning migration at this point every year.

In the category of larger projects, the Department of Fisheries is constructing a fishway for smelt over the falls in Indiantown Brook and is removing old dams on Sutherland Brook. In the old dam on McKnight Brook a partial washout down to the rock and stone fill at the base has occurred but so far all negotiations with the owners have failed to result in permission to lower the washed-out section a few feet more to permit the free passage of smelt. Great quantities of smelt are held up at this point each spawning season, thus action is desirable before the spring of 1951. Owing to the rocky nature of the bottom it is doubtful if nature will complete the job by herself.

R. A. McKenzie

Appendix No. 47

MIRAMICHI SMELT SPAWNERS IN RELATION TO LARVAE PRODUCED

It is important to know the relationship between the number of spawners, the larvae produced and the abundance of the year-class when it enters the fishery in order to assess the value of measures to increase larval production.

Comparison of the numbers of spawners in the brooks from year to year has been made through systematic fishing of ten typical spawning brooks. Some of these have been eliminated from the picture of late years because the lower parts were blocked with logs and pulpwood. Visual estimation of the numbers of spawners in the lower fresh-water parts of the four main river branches has been continued, as systematic fishing does not seem feasible because of log and pulpwood drives and rapidly changing water levels.

Plankton collections for smelt larvae have been made regularly at a number of points every year, one of these being well down the main river at Newcastle bridge and the others at the mouths of typical spawning streams and branches of the main river.

Data on relative numbers of spawners and of larvae in the years 1948 to 1950 are given below. Because of the construction of a new pier at Newcastle bridge the plankton collecting site had to be changed in 1948 and comparison with earlier years is not possible.

Visual estimation of spawning run in <u>main river branches</u>		Total catch by systematic fishing of <u>eight brooks</u>	Total larvae collected at <u>Newcastle bridge</u>	Total larvae col- lected at six points including <u>Newcastle bridge</u>	
<u>NW</u>	<u>SW</u>				
1948	v. good	v. good	652	8,240	24,603
1949	good	fair-poor	1,028	25,483	58,077
1950	good	fair	1,118	68,793	132,829

In these three years the spawners in the brooks increased moderately while those in the four main branches of the river declined slightly. On the other hand, the numbers of larvae at Newcastle bridge, as well as the totals taken there and at a number of other points, show a large increase year by year - eight-fold at Newcastle bridge and five-fold on the whole during the three-year period.

Marking, vertebral counts and age determinations seem to indicate that the smelt supporting the fishery spawn chiefly during the first half of the Miramichi smelt-spawning season. At the prevailing water temperatures the early eggs hatch in about three weeks and the larvae from the early spawning should be taken during the first half of the larval collections. Such a break-down shows that the larvae collected during the first half of the larval season were in 1949 three times and in 1950 eight times as abundant as in 1948.

These increases in larvae are not proportionate to the changes in numbers of spawning smelt whose abundance bears no evident relationship to the numbers of larvae produced under the conditions studied.

It will be interesting to note the size of the fishery during the next two commercial seasons to see if the catches show the same relations to the 1949-50 catch as the 1949 and 1950 larval collections do to the 1948 collections. Variations in the fishing intensity, such as those caused by loss of gear and time because of ice break-ups, will, of course, have to be considered.

R. A. McKenzie

Appendix No. 48

THE AGES OF MIRAMICHI SMELT

To be able to understand the effect of the fishery properly, the ages of the fish being caught and also of those reproducing should be known. Some thousands of scales have been read. The work is not yet complete but a preliminary picture is emerging.

Samples taken throughout the commercial fisheries of 1948-49 and 1949-50 at Oak Point (near the head of Miramichi Bay) and samples taken at various times and places in the spawning runs in the springs of 1949 and 1950 were found to have the age compositions shown in the following table:

	Nos. in samples	Percentages approaching the ages of:			
		2 years	3 years	4 years	5 years
1948-49 fishery at Oak Point	446	44	52	4	
1949 spawning run	3,983	75	20	3	2
1949-50 fishery at Oak Point	1,546	75	23	2	1 fish
1950 spawning run	2,856	51	45	4	X

In 1948-49 no trends in age composition were apparent either within the samples taken from the fishery at Oak Point or within those from the spawning run, but the latter had a much higher proportion of two-year-olds. In 1949-50 the reverse was true. Samples from the fishery at Oak Point (representative of those from the fishery as a whole) had high percentages of two-year-olds, and the samples from the spawning run, lower percentages. In 1950, unlike 1949, the proportions of two-year-olds in the spawning run decreased and of the three-year-olds increased as the season progressed. The average percentages of two-year-olds in 9-day periods declined from 67% to 35%, the extremes in individual samples being 80% and 20%. This is contrary to the earlier conclusion, based on vertebral counts and scale circulae, that older smelt tend to spawn earlier. Further observations are planned.

R. A. McKenzie

Appendix No. 49

GROWTH AND SCALE CHARACTERS OF SPAWNING SMELT

In managing a fishery to obtain maximum sustained yield it is necessary to know the rate of growth. From this and other information it may be possible to determine at what age a year-class begins to lose more in weight through natural mortality than it gains through increase in size from one year to the next.

Because spawning extends over a period of about two months the larval hatch is spread over an almost equal period. Thus, in their first year of growth those hatched first have a two-month lead in growth over those hatched last. This means a considerable disparity in size at the end of the first year which is not usually overcome later in life.

The ridges on the scales give some indication of the time of hatch, for some smelt have scales showing up to 18 ridges in the first year while others have scales with no first-year ridges at all. The latter are found chiefly on fish that spawn late and in the brooks, while the former are usually found on those that spawn early in the lower fresh-water parts of the four main Miramichi branches and in several of the largest tributaries.

The proportions of two-year-old and three-year-old smelt having various numbers of first-year ridges on their scales are given in the accompanying table for ten-day periods in the 1949 and 1950 spawning runs. The average lengths of smelt of these ages are

		<u>Two-year-old smelt</u>				<u>Three-year-old smelt</u>					
		Percentages with scales having the following numbers of first-year ridges				Average length (cm.)	Percentages with scales having the following numbers of first-year ridges				Average length (cm.)
		<u>0-3</u>	<u>4-8</u>	<u>9-13</u>	<u>14-18</u>		<u>0-3</u>	<u>4-8</u>	<u>9-13</u>	<u>14-18</u>	
1950	Apr. 30-May 9	7	27	51	15	13.8	12	45	37	6	15.8
	May 10-19	16	42	36	6	13.5	56	37	7	X	15.2
	May 20-29	54	36	9	1	13.0	81	18	1	0	14.8
	May 30-June 8	66	33	1	0	12.9	83	17	0	0	14.8
1949	Apr. 20-30	6	40	51	3	13.8	15	46	35	4	16.4
	May 1-10	19	44	35	2	13.1	32	55	12	1	15.9
	May 11-20	40	46	14	X	12.7	59	34	7	X	15.6
	May 21-30	62	36	2	0	12.4	68	31	1	0	15.4
	May 31-June 9	70	29	1	0	12.3	70	28	2	0	15.3

also given for the same periods. The two age-groups constitute over 90% of the smelt in the samples.

In both years the percentage of fish with a low number of first-year ridges increased as the spawning season progressed, and along with this the average size declined. This change occurred over the Miramichi system as a whole and when the samples from any one locality are examined it is found that the same change occurred in each. It seems, therefore, that those which were spawned early tend to themselves spawn early.

The growth picture thus cannot be given by an average length for a given age, for the sizes of the different ages depend to a great extent on their time of hatching. Early-spawning fish are longer on the average than late spawners of the year-class. The average size of a sample of smelt from the commercial catches approaching two years of age will depend on when and where it was obtained, and on the proportions of the various spawning groups in it.

R. A. McKenzie

Appendix No. 50

NUMBERS OF VERTEBRAE AND SCALE CIRCULAE IN MIRAMICHI SMELT

Marking of smelt in the fishery has shown that it depends largely on fish which spawn early in the main branches of the river. It is therefore important to know how distinct these are from the large stocks which spawn later in the brooks. A year ago it was found that, on the average, late-spawning smelt had about half a vertebra more than the early spawners and considerably fewer ridges on the first year's scale growth. Extensive samples in the 1949 and 1950 spawning seasons have now been examined and it has been found that in 1949 the average vertebral counts increased as the season progressed not only on any one spawning ground but in the district as a whole. This increase in average vertebral number with advancing summer and rising water temperatures on the spawning grounds disagrees with the relationship between vertebral numbers and temperatures during development usually reported.

When the spawning season is divided into four approximately equal periods of about 10 days the average counts are as follows, with the numbers in the samples in brackets:

	<u>1st quarter</u>	<u>2nd quarter</u>	<u>3rd quarter</u>	<u>4th quarter</u>	<u>Av. of averages</u>
<u>1949</u>					
2-yr.-olds	61.57 (387)	61.71 (506)	61.93 (467)	62.02 (734)	61.81
3-yr.-olds	61.74 (141)	61.82 (84)	62.07 (188)	62.05 (220)	61.92
<u>1950</u>					
2-yr.-olds	61.84 (515)	61.81 (360)	62.23 (245)	62.11 (155)	62.00
3-yr.-olds	61.42 (271)	61.86 (349)	62.04 (366)	62.16 (180)	61.87

The increase of the average vertebral count with the advancing season was more regular in 1949 than 1950. The three-year-olds in 1949 had a higher count than the two-year-olds. This was reversed in 1950 when the three-year-olds had about the same average vertebral count they had in 1949 as two-year-olds although not sampled at exactly the same times. The 1950 two-year-olds again had a higher count.

The difference between the two-year-olds of 1949 and those of 1950 suggests that there can be distinct differences between year-classes. The difference between the vertebral counts at the beginning and end of the spawning run was greater in the 1950 three-year-olds than in the 1949 two-year-olds. This apparent redistribution of the year-class could mean a tendency of those with low vertebral counts to spawn earlier as they grow older and suggests that they may tend to join the early spawners which support the fishery.

An investigation of the numbers of first-year circulae on the scales of smelt of the spawning run shows that they decrease as the vertebral counts increase. (See Appendix 49). Among smelt of the same age and vertebral count those which spawn late have fewer circulae than those which spawn early. Among smelt of the same year-class, same vertebral count and same spawning time the average number of circulae declines with increasing age, suggesting that they spawn earlier as they grow older. Among smelt of the same age and year-class, same vertebral count and same spawning time those which spawn in brooks are not distinguishable on the basis of numbers of circulae from those than spawn in the main branches.

In summarizing it can be said that early and late spawners are distinguishable both on the basis of numbers of vertebrae and on that of numbers of first-year scale ridges. The early spawners are known to be the main support of the fishery because fish marked in the fishery were found only on early spawning grounds. However, there is some evidence from vertebrae and circulae (which will require confirmation) that late spawners may contribute to the early spawning group, and hence to the fishery, through tending to spawn earlier as they grow older. The recapture in the fishery of smelt which had been marked in the brooks supports this conclusion.

The above conclusions are the result of following one year-class through two years, i.e. two-year-olds to three-year-olds. This is all that is possible, for the Miramichi smelt survive in the fishery and spawning run to an appreciable extent for only two years. To confirm the conclusions reached so far it is planned to follow at least another year-class for two years and this can be done by making similar observations in 1951.

R. A. McKenzie

Appendix No. 51

GENERAL SUMMARY OF TROUT INVESTIGATIONS

Past assessment studies in Maritime lakes and streams have disclosed a number of natural conditions which limit production of

speckled trout. The current trout investigations are largely directed toward attempts to overcome certain of these deficiencies by altering artificially the physical, chemical and biological environment, with anticipation that procedures for the maintenance and improvement of trout stocks for angling will be developed.

The waters of the principal lake districts of the Maritime Provinces are poorly mineralized, and the low yield of speckled trout to anglers, as illustrated by results from creel censuses maintained for a number of years on eight representative lakes in Charlotte County, New Brunswick, is primarily ascribable to a low concentration of nutrient salts, notwithstanding that in some situations competitors and predators are important but secondary factors. Stocking of the eight Charlotte County lakes with speckled trout resulted in minor improvement, if any, in the angling. Therefore investigations were begun in two of these lakes in 1946 to determine if their trout-producing capacities could be improved in a worthwhile manner by the addition of inorganic commercial fertilizers. In one of the lakes predator control was also initiated in 1949. (Appendix 56).

A fortunate combination of fertility, coolness of water, favourable spawning conditions and little competition from other species conditions the streams of Prince Edward Island for a high production of young speckled trout. Ponds formed on these streams provide good angling areas as is well illustrated by the results of a creel census which has been maintained on one of them for a number of years. (Appendix 52). Since pond formation presents one feasible method of managing the stocks of young trout to provide improved angling, studies are in progress in controllable, experimental ponds on P. E. I. streams to ascertain their maximum carrying capacity for trout of suitable angling size. (Appendix 53). However, the situation is complicated by the fact that ponds restrict the movements of that part of the trout population that runs to sea and periodically returns to the stream. At Ellerslie Brook the effect of pond formation upon the trout population of a stream system, the possible distinction between brook and sea-run stocks, and the effectiveness of a fish-ladder to overcome the barriers presented by dams against the upstream movements of the trout are being studied. (Appendices 54 and 55).

Fish that occupy the same habitats as the speckled trout are also the concern of the trout investigations. The considerable data that have been collected upon the eel are being analyzed. (Appendix 57). Direction was given to investigations begun in 1950 by Mr. E. Anthony, of the Fish Culture Development branch, upon the smallmouth black bass, which, although not indigenous, is well established in southern New Brunswick and is being introduced into Nova Scotia lakes. The status of this species in trout waters needs investigation.

M. W. Smith

Appendix No. 52

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

Since 1943 a record has been kept of the anglers' catches of speckled trout from an artificial 23-acre pond on the North Montague River, Prince Edward Island. The purpose of this census was to obtain data, previously not available, upon the yield of trout to anglers from a representative P. E. I. pond and, since it has been possible to continue the observations on a comparable basis from year to year, to observe seasonal variations in the yield, and to note if the angling pressure was appreciably reducing the stock.

The pond is fed by a typical P. E. I. stream which presents favourable conditions for the production of large numbers of small trout. The results of the creel census, as shown in the accompanying table, reflect the high productivity of the stream and of the pond itself, and illustrate how well the pond serves as a fishing area for trout of suitable angling size. Seasonal variations in the total catch and in the yield per unit effort have been considerable, but the evidence at hand suggests that these variations have resulted from vagaries of the seasons rather than from angling pressure. Consistently good catches of trout in September at the close of the angling season suggest that the cropping of the trout could be greater without depleting the stock. It is planned to maintain the census on the pond unless the present facilities are no longer available.

Yield of trout to anglers

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

M. W. Smith

Appendix No. 53

TROUT PRODUCTION IN ARTIFICIAL PONDS ON PRINCE EDWARD ISLAND

Prince Edward Island is noted for its abundance of small streams which are remarkably well suited to the propagation of trout, but which are not so effective in carrying these fish to a size satisfactory for angling. Ponds formed on these streams generally provide good angling, and the construction of dams is one suggested means of producing an optimum yield of trout flesh and of making the fish readily available to the anglers.

The present work is concerned with determining the maximum number of trout of suitable angling size which artificial ponds will

produce in a minimum of time. Four experimental ponds were available in 1950: Kelly's, Simpson's, Andrew's and Stephenson's, ranging in age from one to 80 years. Basically the program calls for the stocking of the ponds with varying densities of trout and then determining the rates of survival and growth. An associated study has been concerned with the development and quantity of the bottom fauna in the experimental ponds.

Kelly's Pond (2.6 acres; 80 years)

Since 1946 this pond has been stocked annually at the rates of 400 or 800 yearling trout per acre and the yields of trout flesh during the subsequent 12-month periods assessed. As shown in the following table no clear difference in yield which might be ascribed to the two densities of stocking have emerged. It is planned to increase the density of stocking.

<u>Season</u>	<u>Stocking rate per acre</u>	<u>% survival over 12-month period</u>	<u>Yield in lb. per acre</u>
1946-47	400	25	22.8
1947-48	800	25	47.3
1948-49	400	54	36.5
1949-50	800	30	28.4

Simpson's Pond (2.3 acres; 4 years), Andrew's Pond (3 acres; 2 years) and Stephenson's Pond (3 acres; 1 year)

Except in Simpson's in 1947 and Andrew's in 1950, when sufficient trout were not available, these ponds have been stocked at a rate of 400 yearling trout per acre. Plantings have been made in early June and assessments in late August and early September by draining the ponds. Statistics on the growth of the trout and the yield (final total weight less initial total weight) of trout are presented in the following table:

<u>Pond and Year</u>	<u>No. in- troduced</u>	<u>Days in pond</u>	<u>No. re- covered</u>	<u>Inc. in av.wt. (oz.)</u>	<u>Inc./ week (oz.)</u>	<u>Av.length when re- covered</u>	<u>Yield lb./ acre</u>	<u>No.of native trout</u>
<u>Simpson's</u>								
1947	382	40	298	1.2	0.20	-	-	413
1948	920	76	871	1.4	0.10	7.2	29.0	104
1949	920	95	643	1.7	0.10	7.3	21.1	996
1950	925	71	663	1.1	0.11	7.5	9.2	686
<u>Andrew's</u>								
1949	1311	84	939	2.0	0.16	7.4	27.0	636
1950	863	72	602	0.6	0.06	6.7	0	331
<u>Stephenson's</u>								
1950	1201	73	988	1.0	0.10	7.7	13.9	677

Unfortunately the significance of the data for the introduced trout is obscured by the entrance, sometime during the experimental period, of varying numbers of small trout from the streams

above the ponds. It has proved difficult to maintain effective screens against these fish. Escapement from the ponds is prevented by screens at the dams and by small barrier dams in the streams just above the ponds. In general the data for Simpson's Pond suggest, when due consideration is given to the varying number of native trout in the pond, that the stocking of 400 yearlings per acre is not utilizing the full productive capacity of the pond, and it is planned to double the stocking in 1951.

It will be noted that the ponds have produced trout of angling size by late summer of their second year of age when introduced as yearlings.

R. M. Spence

Appendix No. 54

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

The movements of those speckled trout that run out of and into Prince Edward Island streams are obviously restricted by pond formation on the streams. Ponds have, however, been shown to provide excellent fishing areas and present a method of managing the populations of small trout in the streams for improved angling. An answer to the question of whether pond formation has a beneficial or deleterious effect upon the angling in an entire stream system is being sought at Ellerslie Brook. Since 1946 a two-way fish trap has been maintained at the mouth of this stream at all seasons of the year. Trout entering and leaving the brook are enumerated, measured and tagged. A creel census is maintained upon the stream and an attempt is made to obtain records of tagged trout captured elsewhere. A pond will be formed when sufficient data for comparison are compiled from the unobstructed stream. In the fall of 1950 a second two-way fish trap was installed just above the proposed pond site to augment information upon movements of the trout within the stream and to study the role of a pond upon those movements.

With the exception of appreciable outward movements in February, 1947, and March, 1948, few trout have moved through the traps during the periods from early January through March, or during August and early September. Strong inward and outward movements have occurred consistently from late September through December. From April until early July prominent migrations also occur, but the pattern from year to year has varied. For instance, there were short intense inward movements in April of 1947, 1949 and 1950 but not in 1948, and large movements in and out during May of 1949 and 1950 but not previously. The most consistent run of that season has been inward during late June and early July. The following data show the number of trout (inclusive of certain fish that may have moved through the traps more than once in the designated period) that have moved into and out of the Brook:

	<u>April-May</u>		<u>June-July</u>		<u>Fall-winter</u>	
	<u>up</u>	<u>down</u>	<u>up</u>	<u>down</u>	<u>up</u>	<u>down</u>
1946	-	-	902	97	1110	2049
1947	629	197	879	81	1100	1038
1948	78	88	563	15	491	1706
1949	952	1463	876	153	447	1315
1950	920	465	460	39	-	-

Statistics of the angling are given in the following table where "sea-run" designates those fish that spent some time in salt water, and "brook" those that remained in the stream. About 78% of the trout captured in 1950 were in their third year of age as against the quite constant percentage of 85 for the previous years.

	<u>Number caught</u>		<u>Average length (in.)</u>		<u>No. per rod-hour (sea-run and brook)</u>
	<u>sea-run</u>	<u>brook</u>	<u>sea-run</u>	<u>brook</u>	
1947	501	640	7.5	6.4	1.5
1948	548	538	7.1	6.9	1.5
1949	1212	730	6.9	6.8	1.8
1950	965	643	7.1	6.8	1.9

Originally it had been planned to form a pond upon the lower section of Ellerslie Brook in 1950, but the movements of the trout and the yield to anglers have varied so greatly in 1949 and 1950 from previous years that this action will be deferred for at least another year.

To study the relationship between the sea-run and brook stocks of trout, progeny from each of these stocks have been introduced into Ellerslie Brook (as fingerlings in 1948 and as yearlings in 1949) after being differently marked by fin-clipping. To date, as shown by the data presented below, the sea-run stock have exhibited a greater tendency to migrate to salt water, but until these stocks move through the population the data are incomplete. The test will be repeated after a pond is formed on the stream.

	<u>No. planted</u>		<u>No. through trap</u>		<u>Av. length (in.)</u>	
	<u>finger- lings</u>	<u>year- lings</u>	<u>finger- lings</u>	<u>year- lings</u>	<u>finger- lings</u>	<u>year- lings</u>
sea-run	1682	764	32	180	5.7	6.0
brook	1638	915	2	76	5.0	5.7

In the future of the investigation at Ellerslie Brook it is planned to evaluate a fishway as a means of overcoming restrictions imposed by a dam upon upstream movements of trout.

M. W. Smith

Appendix No. 55

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

The trap and creel-census records for Ellerslie Brook do not give information upon the stock of fingerling trout and salmon, and are imperfect for the yearling fish. Investigations, begun in 1947, have been continued to evaluate the stocks of these younger fish to determine ultimately the effect of pond formation upon them.

Eighteen areas (usually 50-yard sections) were studied in 1950, whereas fifteen were examined in 1949. While an estimate was being made each area was blocked by nets to prevent inward and outward movements of any fish. Fish were captured by seining and released in the same area after being marked by fin-clipping or tagging. From the ratio of marked to unmarked individuals an estimate was made of the total number present using Schnabel's formula. In 1950 when the estimate had been completed using seines as the method of capture, a direct-current electric shocking apparatus was employed in the same area, and an additional estimate made. Assuming that sampling areas are representative of adjacent sections of the brook, estimates of the total trout and salmon populations in the stream were made, and are presented below. (The effective stream length in summer for the production of trout has been determined by survey as 7,450 yards).

<u>Year</u>	<u>Fingerling trout</u>	<u>Older trout</u>	<u>Salmon fingerlings</u>	<u>Salmon parr</u>
1948	15,500	5,350	-	-
1949	10,500	9,600	5,050	3,450
1950*	6,450	5,670	410	2,680
1950**	8,700	9,220	1,620	10,680

*by seining

**using electrical fishing

The population of fingerling trout has decreased with each year, while that of the older trout (principally yearlings) rose in 1949 and then declined in 1950. The young salmon form a significant portion of the stream population but, as with the trout, salmon fingerlings were less numerous in 1950. (A differential effect upon the catchability of the fish may be advanced as a reason for the disparity between the estimates based upon capture by seining on the one hand and shocking on the other, although further study is required for clarification).

The same section (450 yards) of tributary Hayes Brook has been examined for four years and, as may be seen from the following data, a decrease in the number of trout of the year from 1949 to 1950 was found there as in the rest of the Brook. During the four years the numbers of yearling trout have been decidedly more constant than of the fingerlings, suggesting a constant carrying capacity for the older trout regardless of seeding.

<u>Year</u>	<u>Fingerling trout</u>	<u>Older trout (principally yearlings)</u>
1947	588	351
1948	729	342
1949	850	380
1950	426	312

(All estimates made from capture by seining)

An attempt was made to capture the total population of trout and salmon in three sections of the Brook by electric shocking. First, estimates were made as above described. As shown below, figures for capture of the total populations approximated the numbers of marked fish present in the areas upon completion of the estimates by the electrical method, i.e. practically all the fish had been handled in making those estimates. Capture of the total population by electric shocking in a small stream such as Ellerslie under summer conditions appears to give more accurate estimates of population than from marking, release and recapture.

<u>Section</u>	<u>Estimates (Schnabel's formula)</u>		<u>Number marked in section</u>	<u>Total population by removal with shocker</u>
	<u>Sampling by seining</u>	<u>Sampling by shocking</u>		
13	27	52	37	38
17	148	134	109	97
18	24	29	25	25

H. V. Pritchard

Appendix No. 56

FERTILIZATION OF NATURAL LAKES

Nutrient salts, such as phosphates and nitrates, have been found to be in poor supply in lakes of Charlotte County, New Brunswick, and correlated with this condition is a generally low level of productivity. As a result of these findings commercial inorganic fertilizers were added to two lakes in that area to determine if an economically feasible fertilization would increase the general productivity of the lakes in a worthwhile manner, most especially the production of speckled trout.

Crecy Lake. Crecy Lake (50 acres; 7.8 ft. mean depth) received one ton of ammonium phosphate in June, 1946. Following the fertilization, the phosphorus content of the water rapidly declined until by the fall of that year it approximated pre-fertilization levels and has remained so since that time. A dense algal bloom (none previously noted in the Lake) developed about two months after fertilization, but consisted of blue-green algae which normally are minor constituents of the phytoplankton in Crecy and neighbouring lakes. Such an algal bloom has not reappeared in subsequent years. Minor increases were noted in the quantity of zooplankton. The bottom fauna fluctuated with seasons but displayed a general

improvement until 1950 when the number of these organisms declined noticeably.

The fertilization resulted in decided improvement in the growth of trout, especially that of the fingerlings, to the point where these latter fish entered the anglers' catches in their second year of age, which has not occurred in other lakes of the region.

During the year following fertilization the survival of planted trout to the anglers' creels showed definite improvement, but there then followed a progressive decline in the anglers' takes until the season of 1950. In the same period the impression was gained that the number of predatory birds frequenting the lake was increasing, perhaps attracted by the annual introduction of trout. Acting upon this impression a program of bird control was initiated in 1949. In 1950 the anglers' catches were improved considerably, especially of the yearlings. The only other serious predator of trout in Crecy Lake is the eel and in 1950 a program of trapping this species was started, the possible effects from which, however, will not be apparent until 1951. Data on the growth of trout, their survival and the yield to the anglers for a number of years are presented in the accompanying tables. It is planned to fertilize Crecy Lake in 1951 and to double the stocking.

Gibson Lake. Gibson Lake (59 acres; 13.2 ft. mean depth) was fertilized with 5,000 lb. of superphosphate, 700 lb. of ammonium nitrate, 1,300 lb. of potassium chloride and 3 tons of crushed limestone in July, 1947. The amount of phosphorus and nitrogen per unit volume was one-half that added to Crecy Lake.

The phosphorus content of the water followed the same course as in Crecy, and a similar algal bloom developed. Unlike Crecy, however, a second bloom appeared in the late summer of the year after fertilization, but has not since been in evidence. An important result of fertilizing Gibson Lake was a reduction of the dissolved oxygen content to a mean value of 3.03 ml. per litre in March, 1948. This low oxygen value, which was not observed in Crecy, nor in Gibson Lake before or since, approaches the limit for trout survival and points to a real danger contingent upon fertilization.

Although the initial effects of the fertilization in Gibson Lake, as illustrated by the algal blooms, were as great in that Lake as in Crecy, yet the addition of half the amount of nutrient materials resulted in no improvement in production of bottom organisms or yield of trout to anglers. No predator control has been exercised on Gibson Lake. It is planned to continue observations upon this lake for comparison with those from Crecy. Data on the growth of trout, survival and yield to anglers are given in the accompanying tables.

Table 1. Growth and survival of trout

Stock	<u>Average length (ins.)</u>		Growth (inc.)	% Survival to anglers
	<u>When planted</u>	<u>When angled a year later</u>		
<u>Crecy Lake</u>				
unfertilized yearlings	7.5 (1945)	10.1	2.6	10.2
1st year after fertilization yearlings	8.4 (1946)	11.4	3.0	16.7
fingerlings	3.2 (1946)	8.5	5.3	3.6
2nd year after fertilization yearlings	8.4 (1947)	12.2	3.8	3.9
fingerlings	2.9 (1947)	9.3	6.4	0.5
3rd year after fertilization yearlings	6.4 (1948)	11.9	5.5	1.8
fingerlings	2.4 (1948)	8.4	6.0	0.3
4th year after fertilization* yearlings	7.3 (1949)	10.5	3.2	28.6
fingerlings	2.6 (1949)	7.5	4.9	0.9

Gibson Lake

unfertilized yearlings	8.4 (1946)	10.4	2.0	12.0
fingerlings	3.2 (1946)	4.5	1.7	0.2
1st year after fertilization yearlings	8.4 (1947)	10.5	2.1	3.8
fingerlings	2.9 (1947)	5.5	(only two recaptures)	
2nd year after fertilization yearlings	6.7 (1948)	10.5	3.8	2.1
fingerlings	2.4 (1948)		(no recaptures)	
3rd year after fertilization yearlings	7.1 (1949)	8.5	1.4	2.7
fingerlings	2.6 (1949)		(no recaptures)	

*bird control was initiated in this year

Table 2. Yield of trout to anglers

Crecy Lake

Year	<u>1943</u>	<u>1944</u>	<u>1945</u>	<u>1946</u>	<u>1947</u>	<u>1948</u>	<u>1949</u>	<u>1950</u>
No. caught	167	148	-	143	425	110	39	264
No. per rod-hour	0.4	0.5	-	0.6	1.0	0.3	0.15	0.6
Lb. per acre	2.1	1.3	-	1.5	3.6	1.6	0.8	2.7

Gibson Lake

No. caught trout	-	20	5	8	82	50	30	27
salmon	-	44	47	57	21	17	5	3
No. per rod-hour (trout and salmon)	-	0.3	0.4	0.5	0.3	0.2	0.1	0.1
Lb. per acre (trout and salmon)	-	0.7	0.5	0.8	1.1	0.8	0.35	0.3

THE EEL IN MARITIME FRESH WATERS

The eel is one of the larger members of the fish fauna in Maritime lakes and streams and occupies a dominant position numerically in most limnetic habitats. The species is probably a severe competitor as well as predator of the speckled trout where the two occur together. In the course of the trout investigations in various regions of the Maritimes, considerable data have been collected on the eel and this material is now being analyzed. Some aspects of the biology of the species as brought out by the analysis may be summarized as follows:

1. Eels made up from 1% to 99% of the estimated population by weight in seven lakes where it was possible to estimate the standing crops of fish following poisoning with copper sulphate or rotenone. The highest standing crop of eels (70.8 lb. per acre) was found in Bill's Lake, N. B., a small senescent body of water. In the other lakes it did not exceed 8 lb. per acre.

2. Histograms of length frequencies of eels from lakes poisoned in mid-summer or earlier suggests that the elvers had not yet entered the population. In Bill's Lake, near St. Andrews, N. B., poisoned in June, the length frequencies are strikingly unimodal around 38 cm. in length, although at least three year-classes are involved. The dominant length range, however, in Cassidy Lake, N. B., which was poisoned in October, was from 8 to 20 cm., reflecting a dominance of young eels which entered the Lake that season.

3. Length frequencies in eel populations are of little value as indices of age since lengths involved in successive year-classes markedly overlap. Few eels in the populations studied were over seven years of age.

4. Prominent outward movements of eels from lakes in October have been rather consistently noted. These migrations involve not only maturing but immature eels. A definite outward movement in spring was disclosed when a trap was maintained the year round on Crecy Lake outlet, N. B. The data do not in general show that size is a determining factor in the outward movements of eels from lakes at any season.

5. Trapping in Crecy Lake, N. B., during the summer of 1950 yielded 369 eels. The outward fall migration to November 10, 1950, consisted of 100 eels of approximately the same lengths as those taken in the Lake in summer. Some indication of the effectiveness of summer trapping in a lake to control eel populations is provided by these data which will be augmented by planned future observations. The possible effect of such control upon trout production in Crecy Lake is being studied.

M. W. Smith and J. W. Saunders

Appendix No. 58

GENERAL SUMMARY OF ATLANTIC SALMON INVESTIGATIONS

This year Atlantic salmon were studied in two New Brunswick river systems, the Petitcodiac where the work progressed along the lines followed for several years, and the Miramichi where a new program was started to include the sea stage of the life history.

Petitcodiac River

Here the investigations are directed towards obtaining as much information as possible on the immature freshwater stages. The river system offers a variety of conditions under which salmon can be produced either by planting hatchery stock on the blocked Pollett tributary or by natural spawning in other branches.

Planting experiments. The original object was to determine the most effective means of using hatchery stock in the Pollett River to increase smolt production. Regardless of the quantity of fingerlings planted or the method of distribution, the annual yield of smolts was found to be very small. Predation by mergansers and kingfishers was suspected to be the cause and when they were controlled a great increase in smolt production followed. Now the originally-planned experimental plantings are to be resumed in the hope of obtaining useful information with birds controlled. (Appendix 59).

Estimating smolt production. Each year the Pollett parr population is sampled systematically to provide an estimate of the total population. The information combined with examination of the composition of typical smolt runs provides data for estimation of potential smolt production in following years. The 1950 smolt run attained only about one half the expected figure owing to a loss of fish, from unknown causes, between autumn, 1949, and spring, 1950. It is not considered that this year's results invalidate the method of assessment but they do indicate the desirability of acquiring information throughout the entire year on parr populations and existing physical-chemical conditions. An attempt is being made to develop a new method of estimating smolt runs using fences which only partially block the stream. (Appendix 60).

Effects of bird control. The effects of bird control on the general fish populations as well as on the stocks of salmon are being observed closely in the Pollett River. The data for the past three years when birds have been controlled compared with earlier figures when birds were abundant indicate that there have been no disproportionately large increases in other species relative to the increases in abundance of young salmon. Also there is no evidence that the salmon are being affected adversely by the inevitable increases in other species. (Appendix 61).

Sampling methods. Attempts are being made to improve the methods of sampling fish populations in streams, chiefly by reducing to a minimum chances for personal error on the part of the operators. This year in addition to the standard method of attempting complete removal of fish by seining between barrier nets, the technique of marking and recapture was tried and proved to be effective for young

salmon. On several occasions the electrofishing apparatus was found to be a valuable accessory, since fish can be driven effectively with the positive electrode. After further experimentation these techniques may be included in a revised standard sampling method.

Merganser studies. A study of the life history and habits of mergansers similar to the earlier study of kingfishers is being made by Mr. H. C. White. The information will be useful in formulating management policies concerning this predator. Young birds are being reared and observed in captivity to learn their feeding and other habits, and their growth rates. The food of wild mergansers is being studied by examining a comprehensive series of stomachs collected throughout the Maritime Provinces. (Appendix 62).

Identification of fish remains. A method has been developed for identifying fish remains found in the stomachs of predators. It comprises the comparison of bones or bone fragments with sets of distinctively-dyed diagnostic bones of all the fishes common to an area. Progress is being made towards preparation of a publication on the method, with photographs of the bones. (Appendix 63).

Eel studies. Previous work indicated that eels are harmful to young salmon both as predators and as competitors for food. In 1950 an intensive study of the eel in relation to salmon production was begun, and an investigator is spending full time on the problem. The use of the electrofishing technique is a great help since it permits taking eels of all sizes at any time in shallow streams. Interesting figures on the populations of eels in several tributaries of the Petitcodiac River system have already been obtained. An experiment has been started to determine whether or not the production of salmon fry can be increased by removal of eels. (Appendix 64).

Miramichi River

For some time it has been considered desirable to investigate salmon on a large river system where there are important commercial and sports fisheries for the species, and to attempt an intensive study of the sea life of the salmon produced by the river. The work was started this year on the Miramichi with the establishment of counting and marking fences on two of the larger tributaries, the Northwest Miramichi above the Sevogle, and the Dungarvon. (Appendix 65).

The fences are designed to capture the descending smolts so that they can be marked by fin-clipping for the purpose of (a) estimating the annual total production of smolts by the whole Miramichi by sampling in the estuary, and (b) determining the future whereabouts of the Miramichi stock after it has been in the sea and has had the opportunity of entering the various fisheries.

The fences are used also to obtain counts and other information on the salmon and grilse ascending the two tributaries. This information is of particular interest to the officers of the Department whose duty it is to obtain statistics on the catch of salmon by anglers. Eventually it will be useful to us in estimating the escapement of adults required for adequate spawning, information

which is lacking now. It is also very useful to know the times and sizes of the various runs of fish from the sea in order to assess the value of the present fishery regulations governing the use of commercial gear and the angling seasons.

A bird-control experiment has been included in the Miramichi program since as yet there have been no attempts to demonstrate the effects of removal of predatory birds on salmon production in a large river system. One of the experimental tributaries is to receive bird control for several years so that the smolt production can be compared with that of the other tributary. Then the treatments will be reversed.

With the experience gained on the Miramichi this year, both in establishment and operation of the counting fences and in trying to capture smolts in the estuary, it is expected that full-scale operations can be conducted successfully in 1951.

C. J. Kerswill

Appendix No. 59

EXPERIMENTS IN PLANTING ATLANTIC SALMON, POLLETT RIVER

From 1947 to 1949 the experiment on the Pollett River to study planting procedures was suspended to permit evaluation of the effects of bird control on smolt production. This was done because it appeared obvious that bird predations were so restricting smolt yield that wide variations in technique of planting, and numbers used, gave uniformly low crops. After three years of bird control fish populations generally, and young salmon in particular, appear to have reached new and higher levels of balance. Accordingly 1950 has seen a reversion to the original purpose, that is, studying techniques of seeding on the 11-mile mid-section of the Pollett. During the interval a four- to five-year experiment on the value of dispersing hatchery stock at planting has been inaugurated on the upper Pollett and the results of the first year's planting are now at hand.

The main planting experiment as originally conceived involved well dispersed, sparse plantings with the number of under-yearlings planted (16,000) equal to the estimated numbers of parr or smolt which the River could produce. The purpose behind the sparse plantings was to obtain a measure of the best rate of survival which could be expected. A heavy planting (250,000) was then made to ascertain the actual capacity of the stream in terms of young salmon. Presumably the best planting from the aspects of both cost and harvest would lie between these two extremes.

Measurements of parr populations during the last three years have shown that the capacity of the area is at least double that originally estimated. Before attempting to learn how high a rate of survival may be expected it seems desirable to establish the approximate capacity for parr. Accordingly the 1950 planting has been kept at the same general level of numbers of hatchery fish used but, in accordance with preliminary results from the experiment

on distribution, dispersal has been increased to a degree indicated as giving relatively high survival.

Dispersal of underyearlings planted in the Pollett River
(Approximate width of stream 25 yards; length used 11 miles)

<u>Year planted</u>	<u>Number planted</u>	<u>Length of stream used for planting</u>	<u>Degree of dispersal</u>
1947	273,000	1,000 yd.	273 per yd.
1948	235,000	1,000 "	235 " "
1949	243,000	1,400 "	174 " "
1950	246,000	6,400 "	38 " "

If the results of this planting and of the four-year dispersal experiment continue to show value in a moderate amount of spreading, future plantings will incorporate such a procedure.

Following reasonably good establishment of the best yield from the numbers of underyearlings currently being used, other plantings will involve much larger and much smaller numbers (tentatively five times and one fifth present numbers). This should give estimates of maximum production for the area and best survival rate to be expected, and lead to establishment of the most satisfactory planting procedure. Thereafter the original object of comparing yields from hatchery stock with yields from natural spawning should be attacked through carefully designed experiments.

The rate at which progress can be made in these plans will depend, at least partly, on the year-by-year results of each trial.

Access to the area for mature salmon has been provided this year by a Denil-type fish ladder over the dam at the lower end of the experimental section. This was built by the Department's Conservation and Development Service. It incorporates, at the upper end, a trap and pound where ascending salmon can be counted and retained. With present plans, no salmon will be allowed into the experimental area before about 1953. The ladder will serve now, however, to give information on homing of salmon marked as smolts in the experimental area. It is hoped that it may also provide a source of salmon eggs for studies of eel-salmon relationships. Some adult salmon have ascended the pass this fall.

The experiment on the value of dispersal at planting is carried out on a stretch of the Pollett extending from 5 to 10 miles above the main experimental stretch. It was undertaken because various observations had indicated that the majority of planted young salmon, whether underyearlings or yearlings, moved only limited distances (about 1 mile) from the places of liberation, within the first year at least. Such behaviour seems unlikely to give best use of potential rearing waters unless adequate dispersal is assured at seeding.

The test plantings have been made in each of three similar sections of stream. These sections are spaced 2 miles apart and all intervening water is excellent rearing ground. Each planting involves 4,000 underyearling salmon which were distinctively fin-clipped

for each area. The fish were dispersed over 8, 80 or 800 yards in one section each year, with the density being varied for each section in each of the last three years. The final assessment of results will be based on the numbers of smolts from each planting counted in the main smolt weir. This year the planting schedule was completed as well as assessment of the two-year smolts from the first planting.

Relation between dispersal at planting and smolt production

	<u>Lower section</u>	<u>Middle section</u>	<u>Upper section</u>
Total number planted	4,000	4,000	4,000
Number per yard of stream length	50	500	5
Number of two-year smolts	1,097	628	947
Rate of survival (%)	27	16	24

There is indication of better production with moderate dispersal at planting.

This year seinings of sample areas were made in the center of each planting and $\frac{1}{2}$ mile up- and downstream. The results show widest dispersal, and suggest greatest survival, for the fish widely dispersed at planting. The validity of conclusions drawn in regard to production can be mathematically tested when returns are in on the 1952 smolt yields.

P. F. Elson

Appendix No. 60

SMOLT PRODUCTION FROM THE POLLETT RIVER

Count of smolts from bird-control experiment. The annual production of Atlantic salmon smolts from the 11-mile experimental section of the Pollett River was again counted as the smolts passed through the trap installed at its lower end. The 1950 crop was the second to be afforded fairly complete protection from bird predators (mergansers and kingfishers) throughout its life history. A total of 13,190 smolts passed through the counting weir. Lengths and scale samples were taken from about 8% of these fish for future analysis of the run. The crop represents the production of three-year-old smolts from a planting of 273,000 hatchery underyearlings and of two-year-olds from a planting of 235,000. On the basis of the returns of three-year-olds from 10,000 specially marked fish of the earlier planting, about 2,000 of this year's smolts were three-year-olds and 11,000 were two-year-olds. This ratio of two- and three-year smolts (85% and 15%) appears to be the usual condition for the Pollett. The mean length of the 1950 smolts was about the same as in former years (about 16 cm.).

Estimate of production based on parr populations. A complete count of descending smolts, while the best measure of smolt production, is not always obtainable because of difficulties involved in operating counting fences. Furthermore, in the bird-control experiment on the Pollett there was a desire to have

intermediate checks on production between planting of underyearlings and resultant smolt runs. During the past four years such checks have been obtained through summer seining and have led to estimates of late-summer parr populations. Attempts have been made to develop, from these estimates, prediction of the magnitude of smolt runs. From scale examinations of smolts descending the Pollett it has been found that about 85% come as two-year-olds and almost all the balance as three-year-olds. By applying scale examinations to parr populations, estimates of the proportion of yearlings and two-year-olds in the river have been made. Estimates of smolt run have been derived by combining these figures. The comparisons between estimated runs and counted runs are given in the table below:

Comparison of Pollett River smolt production (a) estimated by seining parr the previous summer and (b) obtained by count of descending smolts

<u>Year</u>	<u>Two-year</u>	<u>Three-year</u>	<u>Total</u>	<u>Two-year</u>	<u>Three-year</u>	<u>Total</u>
1947	-	-	4,000	4,000	300	4,300
1949	-	-	23,000	19,000	1,000	20,000
1950	23,000	5,000	28,000	11,000	2,000	13,000
1951	24,000	5,000	29,000			

Variable smolt production with bird control. Information obtained in former years has indicated a high rate of survival of yearling and older parr to smolt stage in the absence of bird predations. Consequently, estimates of smolt production based on population studies made in the preceding summer have assumed almost complete survival. A fairly good correspondence, in two years, between estimated production and counted smolts gave some confidence in the validity of estimates. Hence it is believed that the relatively low smolt count in 1950 (13,000) as compared with the estimate made in 1949 (28,000) represents not so much an error of estimate as an error in the assumption of a high percentage conversion of parr to smolt within the area. Both 1950 trap records and summer seining have given some indication of unusual movement of parr downstream during the period between August, 1949, and this summer. Such shift could have been associated with an unusually prolonged and cold early winter last year and might have resulted in a winter loss of parr within the experimental area, but this year's smolt run followed the normal pattern of descent in respect to calendar and to water temperature, and there is no good basis for supposing an earlier-than-normal run of transformed fish.

Whatever the reason, the production in 1950 with bird control applied was somewhat less than in 1949, also with bird control, and between August, 1949, and May, 1950, about half of the potential smolt crop disappeared. Nevertheless, the production of 13,000 smolts, while only two thirds that of the previous year and one half the estimated production, is still about three times better than the best yield and five times better than the average yield when no protection from birds was afforded.

A new method of estimating smolt runs. There are obvious mechanical difficulties involved in maintaining a perfect counting

weir in flood-swept streams when it is required to take all fish down to 10 cm. (about 4 inches) total length. An attempt is being made to circumvent these difficulties by testing, above the regular Pollett fence, the usefulness of a battery of two weirs each of which occludes only a part of the River channel, but with the data from both combining to give an estimate of descending smolts. In the trap farther upstream all smolts taken are counted and given a distinctive mark before liberation below the trap; in the lower trap marked and unmarked smolts taken are counted separately. The figures from the two traps permit an estimate of the number of smolts passing the battery and the validity of the estimate is measured by its correspondence with the records from the main weir. The partial fences are $\frac{1}{2}$ and $1\frac{1}{2}$ miles above the complete fence, with their locations determined largely by accessibility and effectiveness for different heights of water. Since sampling data rather than complete counts were sought, loss of water around fences, or even by overflowing during freshet, was not considered serious as long as the installations remained in place and took reasonable numbers of fish.

As in 1949, unusually low water conditions made smolts difficult to trap, this difficulty increasing as the water continued to drop in level; however, experience was gained in making traps more effective under such circumstances. On larger streams with deeper water such conditions would probably be less likely to occur.

Data obtained this year for various times during the run give estimates which are about 25% above or below the number known to have passed the counting fence during these intervals. When low water resulted in an almost complete lack of fish taken, first by the upper trap, then the lower, estimates became consistently lower as compared to the counting-fence records.

A total of 836 smolts was marked in the upper trap; 1,518 were taken in the lower, of which 122 were marked fish. The resulting estimate of 10,400 smolts compares with 14,300 smolts put through the main weir during the period of the test. The value of such an estimate depends on the purpose behind it. Repetition of the test is planned for 1951.

P. F. Elson

Appendix No. 61

EFFECTS OF BIRD CONTROL ON POLLETT RIVER FISH POPULATIONS

Effect on general fish populations. In the Pollett River salmon studies, populations of all species of fish present have been followed. This has been done so that there may be the necessary background of facts to show whether any other species increases to the final detriment of salmon. Such information was especially desirable while all species were increasing following the application of bird control. Although summer-seining records suggest that new levels of balance may now have been attained, it is desirable that the observations on species other than salmon be maintained from year to year to verify this. There is a possibility that the number

of adult suckers (Catostomus commersonii) is still increasing since these are not taken extensively in the usual operations. There is still no certainty that eel populations have attained a new balance, particularly in respect to numbers of large eels present.

Sampling of most species was done at the same time and in the same places as for salmon. Eels were taken with other residual fish by electrofishing after completion of seining. Comparable catches of fish from the sample areas in successive years are shown in the table.

Total catches of fish from sample areas in the middle Pollett River

Year	Total length seined (yards)	Eel	Numbers of fish taken					Total seined
			Catos- tomus	Coue- sius	Rhin- ichthys	Salmon parr	Other species	
<u>No bird control</u>								
1947	375	5*	242	1,301	160	100	10	1,728
<u>With bird control</u>								
1948	380	22*	568	2,639	486	396	22	4,133
1949	380	42*	1,678**	391	2,645	1,117	3	4,748
1950	392		1,043**	629	1,633	935	10	4,883

*taken by seining

**taken by electrofishing and not included in total

In the case of all fish other than salmon, year-to-year variations have been compared on the basis of relative total catches from the sampling areas. This is because many of these fish are small and it has not been found practical to estimate thoroughness of removal by such techniques as marking and re-seining. Keeping this limitation in mind, it appears that populations of Catostomus, Conesius and Rhinichthys have maintained similar orders of magnitude after one year of protection from birds. For eels, although knowledge regarding the completeness of catch is lacking, the population seems to have reached a maximum after two years of protection and may have suffered a small decline during the third year. In general, populations other than salmon have doubled or trebled with the three years of bird control.

Effect on salmon populations. Salmon parr are more easily handled than the other fish present. Because of this and because the investigation deals primarily with salmon, more effort has been made to convert the catch figures for parr to estimates of the total numbers in the experimental area. For the years 1947 to 1949 these estimates have been based on the assumption, supported by tests of the effectiveness of the seining, that only four fifths of the parr in sample areas were caught. For 1950 the effectiveness of seining is believed to have been increased somewhat as a result of greater experience by the operators, and it has been assumed that the number seined plus 71 additional parr taken by electrofishing after seining represents practically the total parr population of the areas. To obtain maximum estimates of parr populations these figures have been extended to the total experimental area (19,300 yards long) on a

direct length-of-stream ratio. On the basis of scale readings from some of the parr caught, the 1949 and 1950 populations are believed to have contained about 15% of two-year-old parr in addition to 85% of yearlings. No such stock of two-year-olds was involved in the 1948 population.

Estimates of salmon parr in the middle Pollett River

<u>Year</u>	<u>Number of parr seined</u>	<u>Estimate of total parr in area</u>	<u>Estimate of yearling parr</u>
<u>No bird control</u>			
1947	100	6,000	5,000
<u>With bird control</u>			
1948	396	25,000	25,000
1949	550	35,000	30,000
1950	704	35,000	30,000

It is evident that parr production has attained a much higher level since the imposition of bird control. Moreover, there is no evidence of disproportionately large increases in other species after three years of bird control, nor of increases in other species causing any decrease in parr production.

P. F. Elson

Appendix No. 62

FURTHER STUDIES ON THE MERGANSER

The American Merganser is the main subject of investigation but incidental studies are being made also on the Red-breasted Merganser. Observation and experiments have shown that in the Maritimes the American Merganser is a limiting factor in the production of salmon smolts, and experimental bird-control measures to increase smolt production are being conducted. However, a fuller understanding of the life history of the merganser is a prerequisite to a rational program for general control of mergansers on our salmon waters.

The primary object of this year's experiment is to determine the quantity of live fish required by the ducks at different stages of their growth and the rate of conversion of fish. This is considered especially important in its relation to merganser control. In one sweep or drive down a river a crew of hunters may destroy most of the mergansers but some, especially the ducklings, escape and the destruction of these may be expensive. An estimate should be made of the number of salmon of various sizes required for the seasonal growth of such ducklings.

It was planned to capture ducklings not more than a couple of days old on the Kennebecasis River where in other years several broods could have been caught rather easily. After mid-June several searches of the different branches and down the main

River as far as Sussex failed to show a single brood or evidence of breeding females. Their absence there this year may have resulted from the breeding females having been killed on the experimental section of the Pollett River.

During late June some young mergansers were taken in the Miramichi smolt traps and liberated. On July 2 four downy ducklings about ten days old were driven into the trap, transported to Petitcodiac on the same day, and on July 4 placed in a prepared pen in the Petitcodiac River.

The pen. The pen is 10 ft. long, 4 ft. high and 4 ft. wide with board bottom and 1-inch mesh screen on sides and top. Over this screen an 18-inch strip of copper fly screen has been fastened around the lower part of the cage so that live fishes put into it cannot escape. About a foot of water is kept in the pen, and there is a board platform on which the ducks can roost above the water level, and space enough for them to exercise when capturing fish.

Food fishes. Live fishes of suitable sizes for the ducks have been seined or trapped from the local streams and a supply maintained in screen pontoons. To get enough fishes has required seining several miles of streams. Our seinings proved to be so thorough that second trips to the same areas yielded very few fish. At first only fishes under $3\frac{1}{4}$ inches were used but late in the season fishes up to $7\frac{1}{2}$ inches were kept. The fishes have been mostly minnows of several species, young suckers and freshwater killifish. The ducks have refused to eat many of the killifish. Also used were a few small eels and late in the summer several hundred young sea lampreys.

Food consumption. Mergansers are harmful to salmon because they consume large quantities of the young fish. We cannot state that the conversion factor for salmon parr is the same as that for other fishes of similar size but it is probably of the same order. Since the caged ducks are getting less exercise than ducks in the free state, they are probably making better growth on their food and thus show a somewhat better conversion. The food consumption by the experimental ducks has varied from day to day but by giving them frequent feedings of live fish they have had all that they would consume.

When placed in the cage on July 4 the ducklings weighed, with empty stomachs, 6, 6, $5\frac{1}{4}$ and $4\frac{1}{4}$ oz., making a total of 21.5 oz. On August 3 they weighed a total of 70.75 oz. In the interval they had gained 49.25 oz., and had consumed 617 oz. of fish, which gives a conversion factor of 12.5 for the period. The conversion factor for the intervals between weighings is shown for each interval in the accompanying table.

<u>Interval</u>	<u>A</u> Conversion factor	<u>B</u> Av.wt. during interval	<u>C</u> Av. daily consumption during interval	<u>D</u> % body wt. consumed daily
July 4 - Aug. 3	12.5	11.53 oz.	5.0 oz.	43.2
Aug. 4 - Aug. 21	14.7	21.53 "	7.3 "	33.9
Aug. 22 - Sept. 8	20.5	27.19 "	8.4 "	30.9
Sept. 9 - Oct. 31	74.3	38.0 "	12.6 "	33.4

These figures show that the conversion (A) is best in the youngest ducklings and that they consume relatively larger quantities (B, C and D). Later they eat approximately one third of their weight in fish (D). The composition of this "one-third" determines whether or not they are harmful or beneficial.

Stomach analyses. We have formerly made analyses of merganser stomachs from two areas of Nova Scotia but analyses of collections from the entire Maritimes are required. Instructions for collecting stomachs and containers have been supplied to a number of Fisheries officers throughout Nova Scotia and Prince Edward Island.

We have completed the analyses of 135 merganser stomachs from New Brunswick containing sufficient food. Of these 65 are from the Pollett River where the constitution of the fish population will be available for comparison with the stomach analyses. These 65 stomachs contained remains of 79 salmon parr, 21 trout, 122 suckers, 121 minnows, 19 eels and 19 miscellaneous forms. Here salmon constituted numerically 21%. For comparison 12 stomachs from the Southwest Miramichi near Doaktown contained 37 salmon parr and 30 other fishes, salmon constituting 55%. Stomachs from 16 immature mergansers killed on the Northwest Miramichi contained 135 fishes of which 85 were salmon constituting 53%.

Our later analyses have confirmed preliminary observations which showed that in the better salmon waters salmon constitute a high percentage of the merganser's food. On the lower parts of the Nashwaak and Kennebecasis Rivers in areas where one could scarcely expect to find salmon the mergansers have fed to some extent on the parr.

Mergansers are nervous. American Mergansers flee from anything unusual. From the start the four captured ducklings have shown individual characteristics. Any unusual disturbance causes the more nervous ones to disgorge the food from their gullets and sometimes for several hours after being frightened they refuse to take food.

The nervousness of mergansers might well be put to advantage by the deliberate placing of strange objects along our salmon streams.

H. C. White

Appendix No. 63

BONES FOR IDENTIFYING FRESHWATER FISHES

For the purpose of identifying fishes eaten by fish-eating birds, we have assembled a fairly complete reference set of bones of the freshwater, anadromous and estuarial fishes of the Maritime Provinces. In order that the bones of the various species might not become mixed when being used for identification, the bones were stained contrasting colors. Such a set is useful for the study of the food of any animal which feeds upon our freshwater fishes but its efficiency is rather dependent upon a thorough familiarity with the bones. We had found that drawings of the specific bones, especially those of the minnows, accelerated the work of identification.

To make the method available to other workers it had been proposed to prepare instructions, accompanied by drawings of the specific bones of all the freshwater fishes of the Maritimes. Although there are only 41 species recorded as inhabiting our fresh waters such a set of drawings would require expert technique and a considerable amount of painstaking work. It was suggested that photographs might serve the purpose.

Dr. G. F. M. Smith has undertaken the photography of the bones and has submitted sample photographs including some of bones of the smallest species. These photographs appear to be entirely satisfactory for the purpose. However, the stained bones of our present collection are not suitable for this work as no uniform background can be arranged for the variously coloured specimens. This has necessitated the making of an entirely new set. This past summer this set was started and to date we have specimens of 30 of the 41 reported species.

H. C. White

Appendix No. 64

A NEW EEL INVESTIGATION

For several years salmon investigators in Eastern Canada have suspected that the American eel, Anguilla bostoniensis (LeSueur), might act as a serious competitor for food, and as a predator upon young Atlantic salmon. The desire to investigate such an interspecific relationship was given impetus when the use of the D. C. electrical shocker revealed that eels were present in New Brunswick streams in unsuspected abundance. During the past summer an investigation was begun in streams of the Petitcodiac River system. To date it has been chiefly of an exploratory nature, directed towards general observations on the biology of the eel and methods for its control.

Eels are readily collected in relatively shallow streams with the electrical shocker. During the summer a large machine delivering 500 volts at approximately 2.5 amps., and a smaller

machine delivering 125 volts at 0.5 amps., were used whenever available.

Food and predation. Since the eel is primarily a nocturnal feeder, collections for food studies must be made at night so that the stomach contents will not be too digested at the time of capture. About 300 eels 10 to 45 cm. long have been preserved for examination during the winter. Preliminary analyses have shown most to contain bottom insects such as mayfly nymphs, stonefly numphs, larvae of the Diptera, and caddis worms.

Distribution. Eels have been found in every stream of the Petitcodiac River system in which it has been possible to use the electrical shocker. Presumably during high water they can ascent all but the steepest falls, as they occur, for example, above the Gordon Falls on the Pollett River. Precisely what presents a physiological or ecological barrier to the further entrance or ascent of eels is not known. The relative scarcity of eels in cold-water streams suggests a possible temperature barrier.

Abundance. The abundance of eels in the Pollett River, Coverdale River and the Turtle Creek, can be very roughly estimated from collections by electrofishing on selected sections as follows:

<u>Place</u>	<u>Area (sq.yd.)</u>	<u>Length (yd.)</u>	<u>No.of eels</u>	<u>No.per sq.yd.</u>	<u>No.per 100 yd.</u>	<u>Total wt. (oz.)</u>	<u>Av.Wt. (oz.)</u>
Coverdale R.	1,912	115	231	.121	201	-	-
Turtle Cr.	1,050	150	275	.262	275	-	-
Pollett R.	8,490	373	1,125	.133	294	956	.85

From these figures it can be estimated that in a mile of stream, such as the Pollett River, the number of eels present would be about 5,000 and the weight 275 lb. Evidence from collections from other streams suggests, moreover, that only about 60% of the eels present are taken in a single shocking of a small area of stream.

Size-frequency distribution. Size-frequency curves have been plotted from measurements of collections of eels made from the Pollett (average width 60 ft.) and Coverdale Rivers, Turtle Creek, and Nigus (average width 4 ft.) and Bennett Brooks. For the larger streams, at least, there seems to be a tendency for the curves to be bimodal, the first mode occurring at a length of about 250 mm. In view of the fact that it is a common practice to consider the "larger" and older eels as females (possibly around 300 mm. and over), and the smaller eels as males or young females, this second mode may reflect the disproportion of female eels present in streams. It seems, however, that the sex of eels in freshwater streams is still a matter of controversy requiring histological proof.

Marking eels by branding. Attempts were made this summer to brand eels with a "pencil-point" electric soldering iron heated directly from the small D. C. shocker apparatus. The results were encouraging, as eels branded with dots and retaken after periods up to one month were in good condition with well-healed, distinct brand marks.

Movements of elvers. This year it was not possible to witness the massed migration of elvers from salt to fresh water in the Petitcodiac system, but they were first reported entering the River in mid-May. When first observed by the writer the upstream movement of the elvers was dispersed and sporadic. Throughout June and July along the upper Petitcodiac they were commonly observed resting on the bottom mud or on flat stones, or were seen moving upstream in small numbers, seldom exceeding a rate of about one per minute. They appeared most active in the heat of bright, warm days, and no distinct movements were observed after dark. In the Nigus Brook many newly-entered elvers were seen during August, therefore entrance from the sea may extend over several months. The distance travelled in their upstream movement is indicated by the fact that small eels from this year's run were taken in a collection from Elgin about 15 miles up the Pollett River which enters the Petitcodiac about $\frac{3}{4}$ mile above tidewater.

Movements of larger eels. A distinct upstream migration was observed in the Pollett River in mid-August on a hot, bright afternoon. These were small eels, probably not exceeding 250 mm., but none were elvers. Similar fall movements of small eels have been reported from New Zealand.

Two sources of experimental evidence indicate that, apart from distinct migrations, eels tend to remain in the territory they normally occupy. In the Bennett Brook the 100 yards of stream from which all eels had been removed remained free of them for a period of about two months (i.e. when last checked). Furthermore, from a total of 50 eels marked at a short distance above and 50 eels marked at a similar distance below the cleared area only three of these were found in the cleared area over a period of two months. In the Nigus Brook following a thorough removal of all eels 90 mm. and over from the lower 625 yards, only 30 eels were found there a month later (as compared with 1368 from the original collections).

A trap designed to take maturing eels as they migrate seawards was erected in the Anagance River on September 19 and is still in operation at the time of writing. Seventy-six eels have been taken to date (October 31), only ten of which were distinctly silvered.

Experimental control to protect salmon redds. Some small eels are suspected of entering salmon redds to feed on developing eggs and alevins. An experiment has been initiated to determine whether the production of fry can be increased by the removal of eels. For this purpose a suitable length of stream (Nigus Brook) has had all eels of 90 mm. and over removed from it by four overall shockings; an equal length of the same stream has been left with its normal population of eels. Fertilized salmon eggs have been planted in artificial redds in each section of the stream and it is planned to plant eyed eggs in the early spring. Prior to the expected time of emergence of the salmon fry, wire cages will be placed over the redds so that the emerging fry can be collected and counted and comparisons made between the two sections of stream. To serve both as a check on the downstream movement of eels and salmon fry, and as a barrier to elvers entering the stream, a Wolf trap

will be erected at the lower limit of the experimental section.

H. Godfrey

Appendix No. 65

A NEW SALMON PROGRAM IN THE MIRAMICHI RIVER AREA

In 1950 the Atlantic salmon investigations were extended to the Miramichi River, New Brunswick, an important salmon stream providing unexcelled angling and also supporting a valuable commercial fishery. The chief object of the long-term study is to learn how many young salmon are produced annually, and where and in what quantities they are taken later in the various commercial and sports fisheries on the coast. Such work is needed because there is little information on the history of Atlantic salmon after they leave the freshwater streams, and on the effect of one salmon fishery upon others. Included in the investigation are a bird-control experiment and the counting of salmon and grilse ascending two tributaries with a view to learning eventually the escapement required for adequate spawning, and to give other useful information on the ascending fish.

The smolt run. An effort was made to erect counting fences across the Northwest Miramichi just above the mouth of the Sevogle and the Dungarvon about $\frac{1}{4}$ mile above its mouth in time to capture and mark by fin-clipping the descending smolts. Bad road conditions delayed delivery of materials which could not be ordered before spring, and neither fence was in operation in time to take all the smolts. On the Northwest Miramichi the trap was operating on May 26 and by July 24 10,500 smolts had passed; most of these descended before June 7. The Dungarvon trap was operated first on June 6 when the run was nearly over, and only 260 were counted and marked. At both fences the run of gaspereaux seriously interfered with operations, but methods have been developed to alleviate this difficulty.

It is hoped that next spring, with all the necessary materials on hand, both fences can be in operation before many smolts have descended. Log runs are the most likely cause of delay.

Capture of smolts in estuary. To estimate the total smolt production of the Miramichi it is necessary to obtain the proportion of marked to unmarked fish by capturing a good sample of smolts in the estuary throughout the smolt run. Two double-end smelt box nets were operated off Bushville and with the experience gained this year it is expected that they can be modified to give reasonably good results. From May 28 to July 26 42 smolts were taken, of which two were marked, mixed with 220 barrels of gaspereaux and a few eels, trout and grilse. A new trawl, specially designed for smolts, is being developed and it may be useful next season.

Salmon and grilse runs. (a) Northwest Miramichi. The first salmon from the sea reached the fence on June 2 and the peak

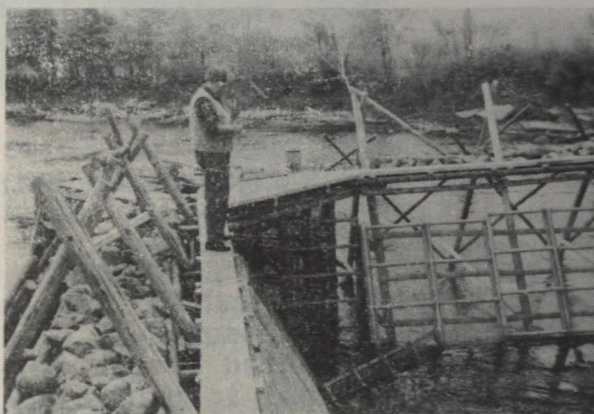
of the run of early salmon occurred on June 13 when 23 ascended in a 24-hour period. Through June the run averaged five per day, in July about three per day, and by August only occasional fish moved



Northwest Miramichi Counting Fence

during small freshets. From June 2 to October 10, 296 salmon ascended. The fall run started on October 11 and by November 5, when the trap was dismantled, 531 late-run salmon had passed through. Thus the total run of salmon during the counting period was 827. Only a few fish are believed to have ascended before completion of the fence in the spring.

Early in the season grilse were about seven times as plentiful as the salmon, 2176 ascending before October 10 and 241 accompanying the late salmon until November 1, giving a total of 2467



Northwest Miramichi Trap

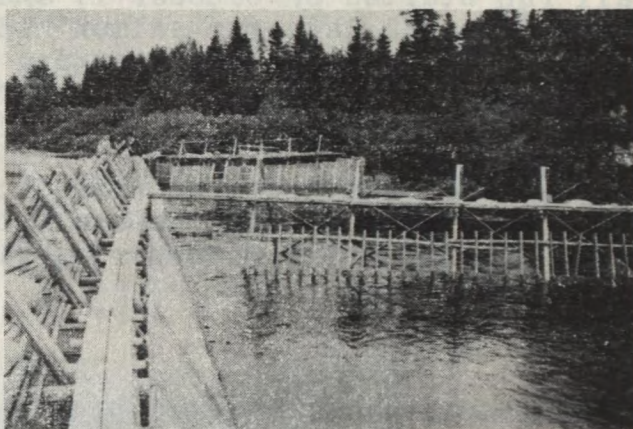
grilse for the period June 1 to November 5. The average weight of the grilse was $2\frac{1}{2}$ pounds and 65% of those carefully examined were males.

Both salmon and grilse provide good angling and the combined total run for the angling season, which extends from May 24 to September 30, was about 2300 fish. For the whole counting period the run totalled 3294.

(b) Dungarvon. From June 12 to August 22 when the early run was over, 138 salmon and 1118 grilse ascended. No further movements occurred until August 28 and from then until November 10, 889 salmon and 406 grilse went upstream. Thus the total run for the period June 12 to November 10 was 1027 salmon and 1524 grilse, or a total of 2551 fish, of which 1409 ascended during the angling season.

Tagging. To determine when and where fish were taken by anglers after passing through the fence, 275 salmon and grilse were tagged at the Northwest trap through the season. The returns indicated that salmon were not affected adversely by the counting fence or by tagging but proceeded rapidly upstream for distances up to 25 miles and were quite catchable.

Bird control. By annual drives and patrols mergansers are to be removed and kept off one of the two experimental branches for several years. On the other they are to be left undisturbed, but



Dungarvon Counting Fence

their numbers are to be estimated; then the birds will be allowed to return to the first tributary and for several years they will be kept off the other one. The results of bird control should be shown by the numbers of smolts counted at the traps as they descend each year. The Northwest Miramichi is receiving bird control first and a drive was made in July starting at the headwaters and proceeding down to the head of tide. Later many mergansers were shot in the lower stretches of the tributary. Experience gained this year indicates that for large river systems like the Miramichi certain modifications are needed in the existing techniques for merganser control.

Other activities. Other aspects of the 1950 program included (1) systematic seining to determine the size and age

composition of the parr population and to provide information on the other species present; (2) census and banding of mergansers in adjacent tributaries to determine their movements; (3) interviewing camp-owners and anglers to learn their problems.

C. J. Kerswill

Appendix No. 66

GENERAL SUMMARY OF SEAL INVESTIGATIONS

Investigations begun in 1949 were continued along two major lines: (1) studies on the biology of the harbour seal (Phoca vitulina) and gray seal (Halichoerus grypus), chiefly to determine the need for and method of reduction of these species as a means of control of cod-worm infestation in fish, and (2) studies on the biology of the harp seal (Phoca groenlandica), and of the fishery for this species, on which to base management regulations designed to ensure maximum long-term yield.

Harbour and gray seals. Stomach contents of harbour seals are being recorded chiefly from material obtained by continued arrangement with bounty hunters in various parts of the Maritimes. While 154 seal stomachs have been obtained in this way to date, the majority have contained no food, and the assembling of data on food habits is, therefore, a slow process. Most of the stomachs contain nematode parasites, however, which are being preserved and examined in an effort to study the seasonal and geographic variation, if any, in incidence of the worm in the seal. (Appendices 67 and 68).

As a further means of utilizing the bounty for studying harbour seals, arrangements were made this spring with the Department of Fisheries to have all lower jaws submitted in support of bounty claims forwarded to this Station for examination. In this way the bounty kill will be recorded in three groups: pups, sub-adults and adults. Such information will be a valuable aid in assessing the effect of the bounty kill on the population of harbour seals. Furthermore, it is expected that study of sectioned teeth, together with counts of corpora lutea in females and examination of bacula or penis bones of males, will enable still more accurate age determinations to be made. During the summer, upon the recommendation of this Station, the Department of Fisheries doubled the bounty on seals older than one year as a means of increasing the kill of sub-adult and adult seals. The effect of this on the age composition of the population will be followed. (Appendix 69).

The status of the gray seal in the Maritimes has been further clarified both through bounty claims and during aerial survey operations on harp seals. The existence of considerable numbers of gray seals is indicated and a more intensive study of this species is becoming desirable.

During June a reconnaissance of the Bras d'Or Lakes and Cape Breton Island coast was conducted and interviews with fishermen and others in these areas were made as a preliminary to intensive studies of the seals occurring in the Lakes during the winter.

This area is being made a "test area", in collaboration with the groundfish investigation, to determine the effect of seal reduction on the incidence of worms in the cod of the Lakes. (Appendix 27).

Plans for future work include study and reduction of seals in the Bras d'Or Lakes, continuation of stomach and jaw collections, collection and examination of reproductive organs of both sexes to assist in determining the population dynamics of the seals, tagging of harbour seal pups to determine the range of movement, and intensive study of harbour and gray seals in the Miramichi area.

Harp seals. Much general information on the sealing industry and on the Arctic seals was brought together during a meeting of representatives of Canadian sealing interests and government officials at St. John's, Newfoundland, early in December, 1949. Plans for aerial survey and other research were thereby facilitated. Late in December a trip was made to La Tabatière, P. Q., on the lower North Shore of the Gulf of St. Lawrence, to observe the net fishery for those harp seals moving into the Gulf on the southward migration. Stomachs of over 100 seals were examined, and reproductive material and nematode parasites were collected (Appendix 68). It became obvious that this locality can serve as a valuable key station for a study of harp seals since the fishery there appears to be non-selective with regard to age groups of seals.

A concentration of harp seals in early February in the vicinity of Port Hood, N. S., which became known through lower jaws submitted as bounty claims, gives some indication of the distribution of harp seals in the Gulf of St. Lawrence before pupping time on mid-Gulf ice in March. There is some evidence that harp seals might be important vectors of cod-worms in late winter months before hauling out on the ice from late February to April. (Appendix 68).

Aerial-survey flights for population estimates of harp seals on the ice fields began on February 26. Adverse weather conditions held up photographic operations considerably. Photographic strips of high-altitude vertical overlaps in the Gulf of St. Lawrence and low-altitude verticals off the east coast of Newfoundland have enabled population estimates to be made of two herds or "patches" which indicate that, at the rate of killing which has prevailed since the end of the war, the populations should not be in immediate danger of depletion (Appendix 70). We still have no knowledge of the relationship between the population seen in the Gulf and that seen off the east coast of Newfoundland, and it is felt desirable to repeat the survey during the next season to see if any change is detectable in numbers in the Gulf of St. Lawrence, and to obtain, if possible, a better coverage of the population off the east coast of Newfoundland.

Information on rate of weight increase of harp seal whitecoat pups off the east coast of Newfoundland during the killing in March was gathered by two government whaling Inspectors from the Department of Fisheries, St. John's, Newfoundland, who were kindly accommodated on a sealer by Bowring Bros., Ltd.

While ice conditions this season made the biological observations particularly difficult, 59 harp seals, mostly pups, were tagged by these men and released off the east coast, and a few stomachs of adult harp seals were collected for parasite identification (Appendices 70 and 68). Valuable observations also were made on the seal hunting in general which can be used in conjunction with aerial observations made at the same time.

Through arrangements with Mr. Per Høst, a Norwegian biologist who was on a Canadian sealer which hunted the Gulf of St. Lawrence herd, 125 harp seal pups were tagged with our tags and released in Cabot Strait. At least two recoveries have been made, both from Greenland. (Appendix 70).

Tagging from light aircraft based on the Magdalen Islands, which was planned, had to be abandoned this year because of failure of the seals to drift close enough to the land base.

Plans for future work on harp seals include further aerial survey, tagging of pups in the Gulf using light ski-equipped aircraft, continued collection of material from La Tabatière and from sealing vessels, and collection of material through the seal fishery with set-lines on the Magdalen Islands in May and June.

Porpoises. During the course of harbour seal observations in August in the lower Bay of Fundy, great numbers of porpoises were observed. Since the worm Porrocaecum is known to occur in porpoises in Europe, it is considered essential to collect a series of porpoise stomachs for examination. It is proposed to undertake this as opportunity permits.

Personnel. During the summer Miss J. M. Pearson was employed as Junior Research Assistant to assist in preparation and examination of much of the material on hand (stomachs, jaws, worms, etc.).

H. D. Fisher

Appendix No. 67

STOMACH CONTENTS OF HARBOUR SEALS

The 142 stomachs which form the basis of the accompanying table were collected in the period May to December; 35 in 1949 and 107 in 1950. There is a considerable gap in our knowledge of the habits of harbour seals during winter months, and more material needs to be collected then, and collections generally should cover a larger area before any definite generalization is made about the effect of harbour seal food habits on commercial fisheries, aside from the cod-worm problem. It is of interest, however, to record the contents of the harbour seal stomachs obtained to date through the co-operation of bounty hunters (see table). The large proportion of empty stomachs (58%) arises partly from the fact that 29 stomachs were of first-summer pups which apparently had not begun to feed on marine organisms, and partly because the remaining 53

Stomach contents of 142 harbour seals

Common	Scientific	Stomachs containing item	% by volume	Analysis by locality					
				Pownal Bay, P. E. I.		S. E. Nova Scotia		Lower Bay of Fundy	
				No.	%	No.	%	No.	%
Unidentified fish ²		18 ³	14.1	1	34.2	1	3.9	16	8.3
Squid		15 ³	11.9					15	19.1
Herring	<u>Clupea harengus</u>	14	23.8			1	3.9	13	37.1
Winter flounder	<u>Pseudopleuronectes americanus</u>	11 ³	23.8	3	59.3	4	57.6	4	11.9
Gadidae		6 ³	2.9					6	4.8
Shad	<u>Alosa sapidissima</u>	1	10.4			1	30.8		
Rosefish	<u>Sebastes marinus</u>	3	1.5	1	5.7			2	1.2
Smelt	<u>Osmerus mordax</u>	3	4.5			1	3.8	2	6.0
Shrimp		3	1.5					3	2.4
Gaspereaux	<u>Pomolobus pseudoharengus</u>	2	4.5					2	7.7
Selachian egg cases		2	0.15	1	0.4			1	0.2
Hake	<u>Urophycis tenuis</u>	1	0.35					1	0.7
<u>Sebastes</u> sp.		1	0.25					1	0.4
Pollock	<u>Polachius virens</u>	1	0.25					1	0.2
Crab		1	0.10	1	0.4				
No. stomachs examined		142 (60) ⁴		16 (6)		17 (7)		109 (47)	

1. Thirty-five of these stomachs were collected between May and December, 1949, and 107 between May and October, 1950.
2. Suspected from otoliths to be chiefly hake.
3. Includes occurrences of hard parts such as anal spines, "beaks", otoliths.
4. Sixty contained the food items listed; 82 were empty.

empty stomachs were from seals which had been shot after they had been hauled out on a ledge for several hours. Digestion appears to be very rapid and within a couple of hours all but the very hardest parts are digested and pass into the intestine in unrecognizable form. Collection of stomachs with no food items will continue, however, as they nearly all contain varying numbers of nematode parasites, the incidence and identification of which are under study (Appendix 68).

The importance of herring and squid in the diet of seals in the lower Bay of Fundy is indicated, while winter flounders appear to be taken frequently in all of the areas covered. It is possible that shad and gaspereaux may prove to be important food items also, as the stomachs containing these items (from Port Medway for shad, and from Grand Manan for gaspereaux) were filled to capacity with them.

Analysis of stomach contents will be continued as a routine and efforts will be made to increase the area covered.

Miss J. M. Pearson carried out most of the stomach analyses recorded here.

H. D. Fisher

Appendix No. 68

INCIDENCE OF COD-WORMS IN SEAL STOMACHS

All nematode parasites in stomachs of all species of seals obtained are being collected, counted and identified to assist in clarifying the status of the various species of seal as vectors of the cod-worm. Worm counts and identifications have been made to date from 72 harbour seal stomachs, 5 gray seal stomachs and 41 harp seal stomachs. Counts and identifications made thus far for these species are recorded in Table I for harbour seals and in Table 2 for gray and harp seals.

Almost all worms found in harbour seal stomachs were Porrocaecum decipiens. The data in Table 1 suggest that there is a decrease in the average number of worms per stomach from May to December. The largest percentage of stomachs containing no worms was collected from August on. Further collections should clarify this point, and special efforts will be made to obtain winter material. It is expected that worm collections covering all seasons will show some correlation with food habits, which are being determined from the same stomachs.

That gray seal food habits may differ in some respects from those of harbour seals is suggested by the higher proportion of Contracaecum sp. in gray seal stomachs. One stomach taken at Grand Manan, N. B., early in June, when harbour seal stomachs taken at the same place and time had 100% Porrocaecum decipiens, contained 100% Contracaecum sp.

Table 1. Incidence of cod-worm, Porrocaecum decipiens, and of Contracaecum sp., in 72 harbour seal stomachs*

Area	Time of year	No. of stomachs	Total no. of worms	Av.no.per stomach	No.worms examined	<u>Porrocaecum decipiens</u> (%)	<u>Contra-caecum sp.</u> (%)	Unidentified (%)
Lower Bay of Fundy	May-June	10	1,120	112	157	100		
	July-Aug.	17	639	38	102	100		
	Sep.-Oct.	16	285	18	97	95.5		4.5 (larval)**
	Nov.-Dec. (1949)	1	50		50			100 (larval)
S.E. Nova Scotia	May-June	8	290	36	77	93.7	6.3	
	July-Aug.	4	142	36	28	92.3		7.7 (larval)**
	Sep.Oct.	-	-	-	-	-	-	-
	Nov.-Dec. (1949)	3	12	4	12	100		
P.E.I.	May-June	8	390	49	36	100		
	July-Aug	5	268	54	50	96.3	3.7	
Totals for all 3 areas	May-June	26	1,800	69.2	197	99.0	1.0	
	July-Aug.	26	1,049	40.3	180	98.0	1.0	1.0 (larval)**
	Sep.-Oct.	16	285	17.3	97	95.0		5.0 (larval)**
	Nov.-Dec. (1949)	4	62	15.5	62	19.5		80.5

* Stomachs collected in 1950 unless otherwise indicated. Stomachs of first-summer pups not included.

**Does not indicate true proportion of larval worms, as identifiable stages were selected for examination as much as possible.

Table 2. Incidence of cod-worm, *Porrocaecum decipiens*, and of *Contraecum* sp., in 5 gray seal and 41 harp seal stomachs*

<u>Area</u>	<u>Time of year</u>	<u>No. of stomachs</u>	<u>Total no. of worms</u>	<u>Av. no. per stomach</u>	<u>No. worms examined</u>	<u><i>Porrocaecum decipiens</i> (%)</u>	<u><i>Contraecum</i> sp. (%)</u>	<u>Unidentified (%)</u>
<u>Gray seals</u>								
Passamaquoddy Bay, N. B.	June	1	125		25		100	
Arichat, N. S.	June Nov.	1 1	100 0		20	15	30	55 (larval)**
Miramichi, N. B.	August	2	600	300	350	53.5	46.5	
<u>Harp seals</u>								
Strait of Belle Isle	January	21	581	28	168		100	
Port Hood, N. S.	February	4	1,238	310	1,038	71.0	19.3	9.7 (larval)**
East Coast, Nfld.	March Apr. (1949) May (1949)	11 1 4	2,858 30 102	260 26	277 30 32		100 100 65.4	

*Stomachs collected in 1950 unless otherwise indicated, from seals over 1 year in age.

**Does not indicate true proportion of larval worms, as identifiable stages were selected for examination as much as possible.

Two collections of harp seal stomachs contained considerable numbers of Porrocaecum. Four stomachs taken in May, 1949, just southeast of the Gray Island, Newfoundland, contained 34.6% Porrocaecum, and 4 stomachs taken near Port Hood, N. S., in February, 1950, contained 71% Porrocaecum (see Table 2). In the latter case, considerable numbers of harp seals showed up near Port Hood on the coastal ice early in February. Over 400 were taken by landsmen for bounty claims and the four stomachs were obtained subsequently from frozen carcasses. The indication that harp seals may prove to be important vectors of cod-worms at certain seasons makes more intensive collection of stomachs desirable, and it is planned to do this in the coming winter.

Most of the work of sorting and identifying the worms was carried out by Miss J. M. Pearson, who was instructed in identification techniques by Dr. D. M. Scott.

H. D. Fisher

Appendix No. 69

AGE COMPOSITION OF BOUNTY KILL AND EFFECT ON POPULATION OF HARBOUR SEALS

Adult harbour seals are difficult to hunt, and when they are shot the majority sink quickly and usually are not recovered. Pups, however, up to one or two months after birth are relatively easy to secure since they are tamer and can be approached more closely than adults, and a greater proportion of those killed will float after being shot. For this reason one might expect that bounty hunters would concentrate on the pups, and that the majority of kills would occur during the pupping season which occurs from mid-May to mid-June and during the one or two months following. Examination of past bounty-claim records reveals that the majority of kills do indeed occur in the months of May, June and July, with a sharp peak in early June, the peak also of the pupping, and with a gradual tapering off in the autumn. From personal experience with hunters and fishermen on the Pacific as well as on the Atlantic coast, it is estimated that over 80% of the bounty kill in the years that the system has been in operation has been of first-year pups. Since lower jaws submitted with bounty claims are now being forwarded to this Station for examination, it will be possible in the future to know definitely the proportion of pups to older seals in the kill, and possibly of the several stages of sub-adults to adults, by examination of the teeth.

A preliminary examination of 953 harbour seal jaws submitted from April 15 to September 14, 1950, has indicated the proportion of pups to older seals shown in the following table:

<u>Period</u>	<u>% pups</u>	<u>% older seals</u>
April - May 14	80.0	20.0
May 15 - June 14	91.5	8.5
June 15 - July 14	86.1	13.9
July 15 - August 14	62.7	37.3
August 15 - September 14	<u>62.0</u>	<u>38.0</u>
Total	84.5	15.5

It is stated by the hunters that a fairly good percentage of pups escape from being killed each year. It appears further, according to both fishermen and experienced hunters, that until this year the population generally has been keeping level, though a decline was noted during the early stages of the bounty system. The sort of kill which has been taking place through the bounty system appears in fact to be almost what one would prescribe if the seals were commercially valuable and it was necessary to ensure a long-term yield, whereas what is required is a reduction in present numbers. Professional bounty hunters recognize this situation, and in fact are not too anxious to reduce the breeding stock since it would mean a reduction in their income. In July of this year, therefore, the bounty for harbour seals older than one year was raised to \$10.00, while that for pups was left at \$5.00. It is expected that in most areas this will provide a greater inducement for the killing of older seals. This is known to have occurred already in the Bay of Fundy area, and the increase in percentage of older seals from July 15 on is considered to be mainly a result of the doubled bounty, though there are no previous records for comparison.

An accurate age indicator in adult female seals is the number of old scars of pregnancy, or corpora lutea, in the ovaries. Ovaries therefore will be collected and examined on as large a scale as possible in order to keep a record of the age composition of the breeding stock. Bacula or penis bones of male seals also give an approximate indication of age, while sections of canine teeth apparently are good age indicators through seasonal growth rings in the root, the latter method being a recent development in aging by other workers. It should be possible, therefore, to observe the effect of increased reduction of harbour seals on the age composition of the stock. The bounty system in ways such as this is contributing materially to a biological study of the harbour seal.

An examination of the ovaries of 19 adult female seals taken this summer revealed ages ranging from 5 to 16 years, with an average of 9+ years. A reduction of adult seals should result in a lowering of the average age.

H. D. Fisher

Appendix No. 70

AERIAL PHOTOGRAPHIC SURVEY AND TAGGING OF HARP SEALS

1. Aerial Photographic Survey

Photography in Gulf of St. Lawrence. Because of the experimental nature of this first attempt, operations were begun in the Gulf of St. Lawrence where the seals are relatively easy to locate and to keep under surveillance. Charlottetown was used as a base. Photography was carried out by Spartan Air Services, Ltd., Ottawa, Ontario, and flying was done by Maritime Central Airways, Ltd., Charlottetown, P. E. I. The seals were located on February 26 north of Deadman Island of the Magdalen Islands. They were hauled out on the ice in one large group, and owing to prevailing and strong westerly winds drifted rapidly due east instead of breaking up as usual and drifting around both sides of the Magdalens. Because they stayed in one general group it was easier to take sample photographic strips upon which to base population estimates. Weather suitable for aerial photography occurred first for about one hour on March 5 when one strip of overlapping photographs was taken from 3,000 feet, with telephoto shots about every tenth exposure. On this date it appeared that whelping was not yet at a peak. On March 8, the next opportunity afforded by the weather, six strips of overlapping verticals, with accompanying telephoto shots, were run over the herd which by this time was 30 miles north-east of St. Paul Island in Cabot Strait, and which was spread over 200 square miles of ice. This series was made from 2,000 feet. Oblique photographs also were taken from varying heights down to 100 feet.

Photography east of Newfoundland. Operations were then transferred to the east coast of Newfoundland with Gander as a base. The seals located on the "Front" by the industry were in two major patches, one southeast of Belle Isle and the other southeast of the Gray Islands. According to observers aboard the industry's spotting aircraft, including our own, the more southern patch as seen on March 11 was the larger of the two. By the time our aircraft had reached the "Front", however, on March 15 the southern patch, in addition to being worked over by three vessels, had broken up and apparently had drifted apart. Photography therefore was carried out over the more northern patch. Here the seals were very evenly distributed, so much so that high-altitude overlaps were not felt to be necessary. Photography was carried out from 300 feet, a zig-zag course being flown over the patch, which covered 50 square miles of ice, with the 6-inch-lens camera photographing every 4 seconds.

Further searching on the east coast of Newfoundland, off the Labrador coast and in the Gulf of St. Lawrence failed to reveal any other whelping patches of any size, though scattered small groups were seen.

Counts of seals from the photographs were made by pinning a sheet of transparent plastic, on which a grid had been drawn, over the vertical photographs. Within each square of the grid the seals were individually blacked out with ink, while a hand tally recorded the count. While adult seals in the Gulf photographs showed up well (Figs. 1, 2 and 3), whitecoats were difficult though not

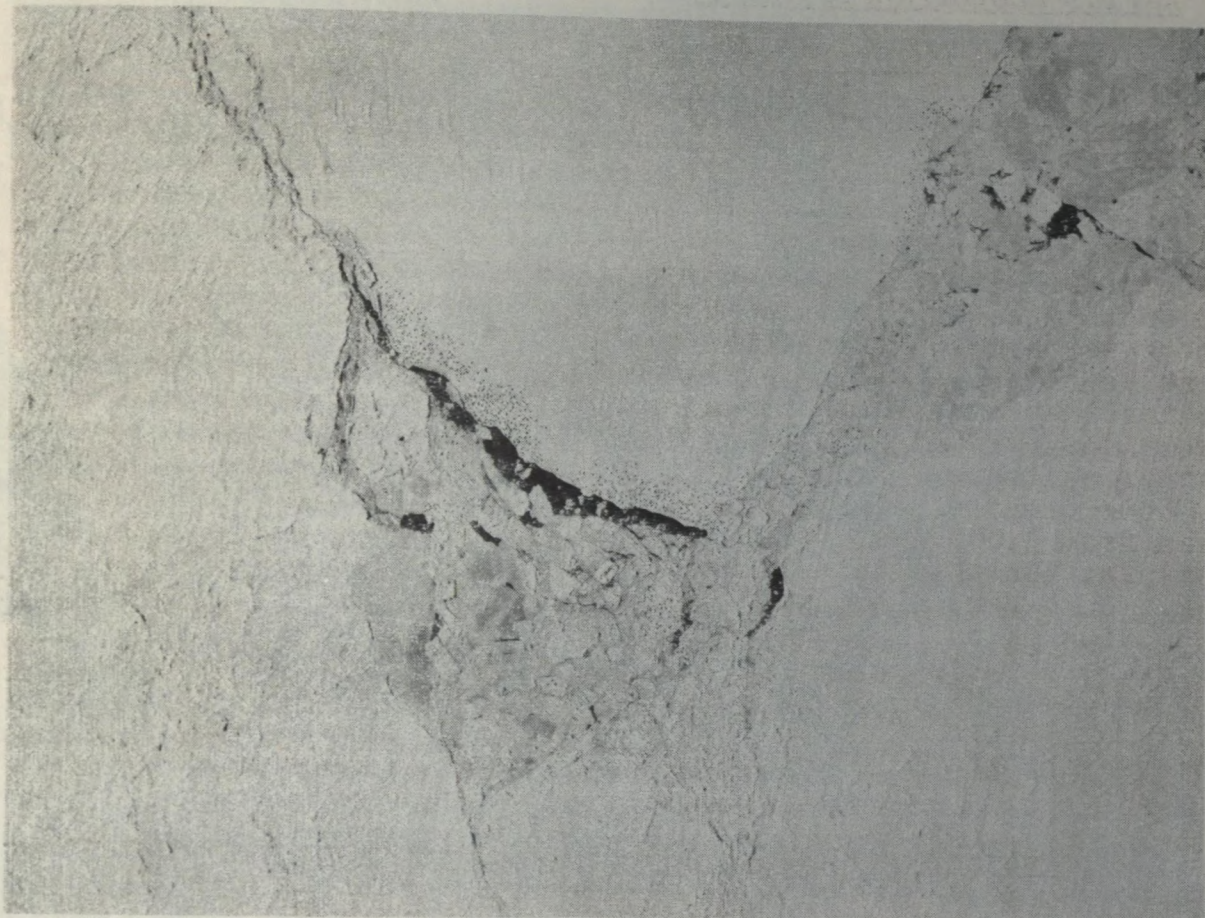


Fig. 1. Vertical aerial photograph from 2,000 feet with 6" lens camera of a group of adult harp seals on ice pans in upper Cabot Strait, March 8, 1950. These are believed to be males, as no pups were present, yet pupping was well underway in large whelping patches immediately adjacent to this area (See fig.2).

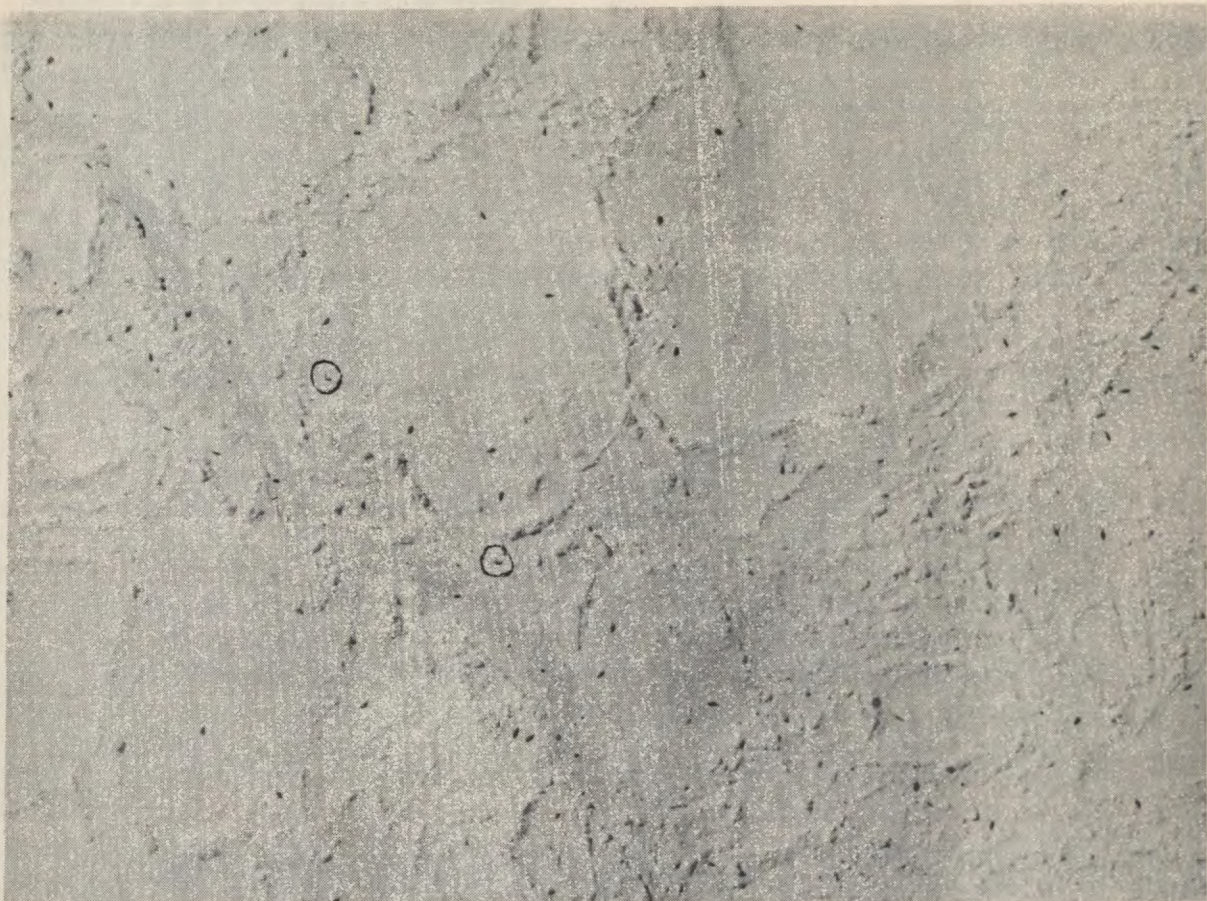


Fig. 2. Portion of vertical aerial photograph of whelping patch of harp seals taken from 2,000 feet with 20 lens camera, in upper Cabot Strait, March 8, 1950. From similar photographs proportion of white-coat pups to adults was determined through examination with a magnifying lens. Within the two circles can be seen female harps suckling their pups. Note breathing holes in the frozen-over lead left of centre.

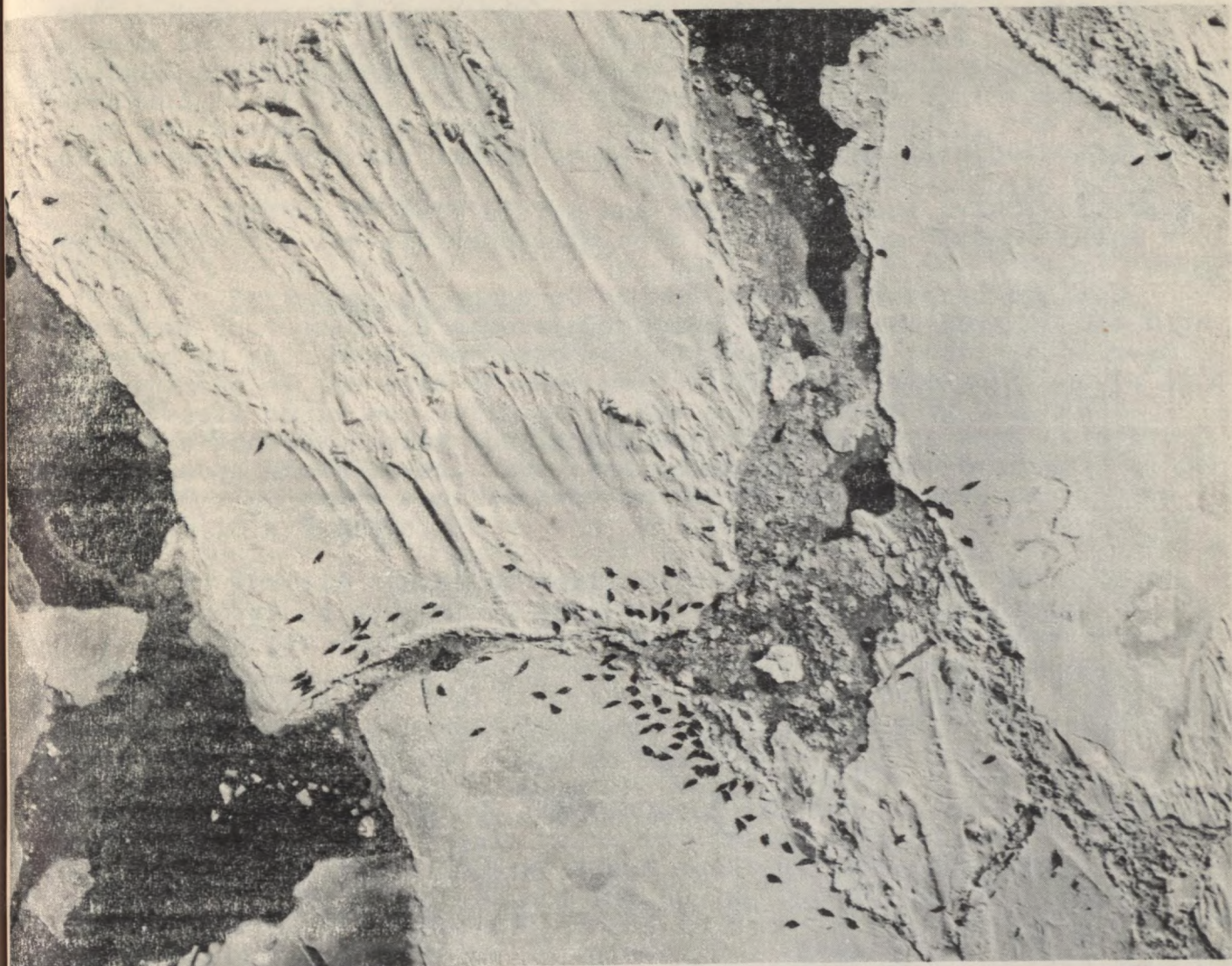


Fig. 3. Vertical aerial photograph, taken from 200 feet, of adult harp seals on edges of ice pans north of Deadman Island, Gulf of St. Lawrence, March 3, 1950. Seals were just in the process of mounting the ice pans along the open leads at this date, and whelping was just beginning.

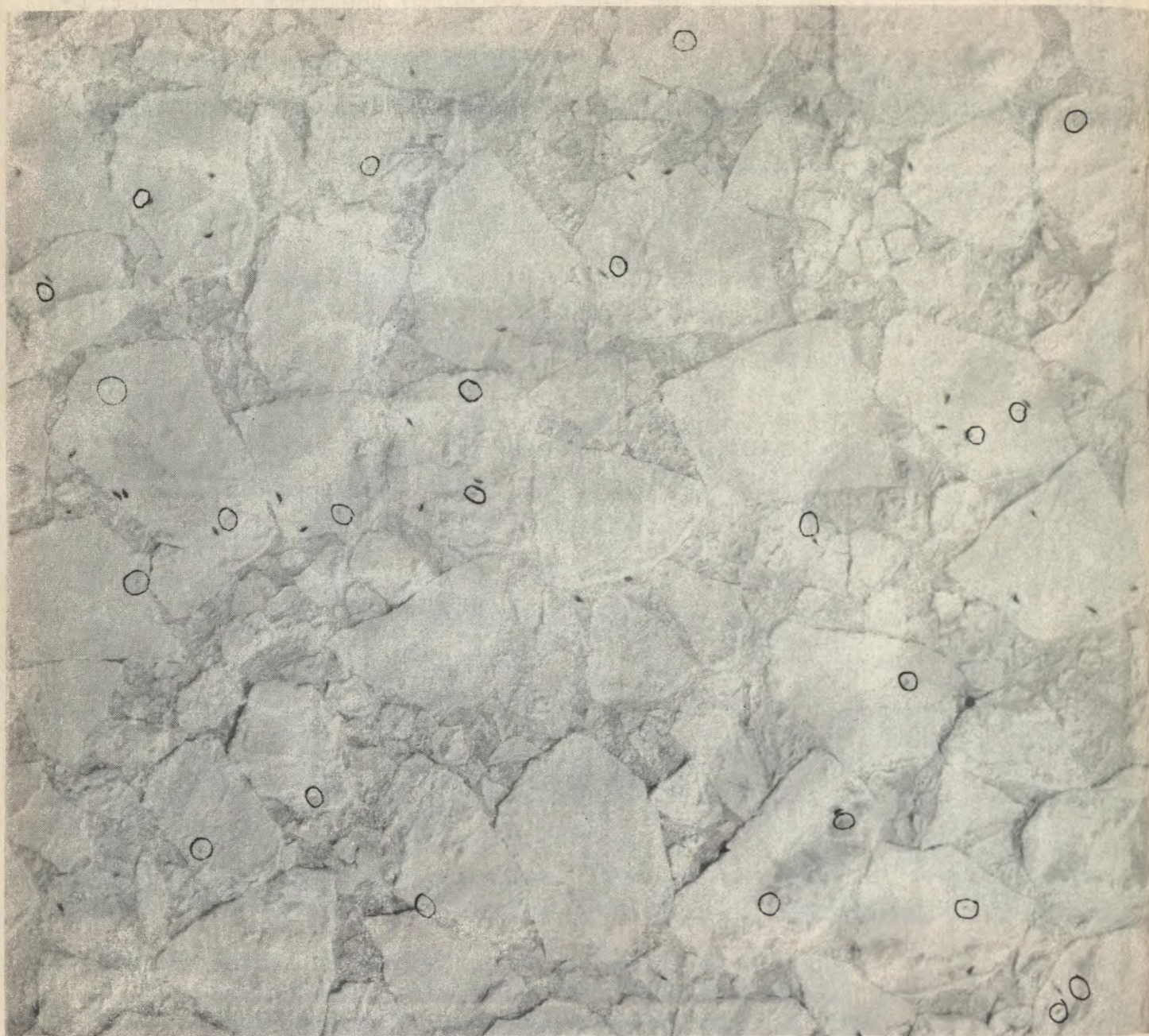


Fig. 4. Vertical aerial photograph taken from 300 feet over large patch of seals southeast of Belle Isle on the "Front." Ice is arctic drift ice and is 10-12 feet thick, and in smaller pans than in the Gulf of St. Lawrence. White-coats are ringed. March 15, 1950.

impossible to distinguish in the telephoto shots made with the 20-inch lens from 3,000 and 2,000 feet. Owing to the irregular distribution of the Gulf seals it was felt that an actual total count in the photographs was preferable to an estimate based on counts of random sections. Such a count, therefore, was carried out and was checked at least once for all counts made. These counts represent an absolute minimum, as it was obvious from tracks on the ice that some adult seals were under the ice during photography, and not all of the whitecoats are likely to be visible in the telephoto shots.

Counts of both adults and whitecoats were relatively easy to make in the low-altitude verticals taken on the "Front" (Fig. 4).

Estimates of numbers. Since the area covered by each vertical photograph is accurately known, and an estimate of the area covered by each herd photographed was made, it is possible to make an estimate of the size of each herd. The most important source of error would be in our estimate of the area covered by the herds. This was done by flying the length and width of each herd at several points at a known speed. The herd in the Gulf covered an area of at least 10 x 20 miles and the herd on the "Front" covered an area of at least 10 x 5 miles.

The six strips of vertical overlaps taken in the Gulf on March 8 cover an area of 21 square miles, in which an average of 1738 adults per square mile was counted. This results in an estimate of 347,600 adults photographed in this herd. The proportion of whitecoat pups to adults in the telephoto shots is 43%, resulting in an estimate of 149,400+ pups at that date, on which it was observed that whelping was still taking place.

The low-altitude verticals of the "Front" herd cover an area of 11 square miles, in which an average of 7617 adults and 4314 whitecoats per square mile was counted. This results in an estimate of 380,850 adults and 215,700 whitecoats for the herd. The proportion of whitecoats to adults here is 57%, and whelping appeared to be completed.

It is assumed that the proportion in the Gulf herd eventually was of the same order. The percentage of pups suggests that adult males were present in the herd also, otherwise one would expect a greater proportion of pups. Unfortunately there is no sure way of distinguishing males from females from the air, and it is not known whether each herd had its full complement of adult males present (sex ratio is equal at birth). In the early phases of the pupping season the males are believed to keep to themselves, joining the females two to three weeks after birth of the pups (Fig. 1).

It should be borne in mind in speculating on the magnitude of the total population that sub-adult seals (one-, two- and three-year-olds) are not included in the photographic survey. They haul out on the ice during the latter half of April. It is desirable eventually to carry out a survey of this portion of the population.

Russian biologists in the past have estimated the population of harp seals in the White Sea to be composed of 40% adults, 40% immatures and 20% pups of the year. If we assume that the composition of the population under study is similar, and that 380,850 adults represent 40% of the population involved in the more northern of the two "Front" patches, we can arrive at an estimate of 952,000+ for that patch. Many adults were seen slipping below the ice as the aircraft approached, however, and it would be more logical to assume that the 215,700 whitecoats represent 20% of the population of that patch, in which case we can arrive at an estimate of 1,078,500 for population which is represented by the patch. Since the herd in the Gulf was of similar size, and since one large patch was not covered on the "Front", we might estimate that we have a harp seal population of between two and three million.

The commercial take of harps is composed of over 80% young of the year, and currently is in the order of about 225,000 annually, counting the take of the Norwegian fleet. Most of these are taken on the "Front". This year only about 25,000 were taken in the Gulf. It does not seem that at this rate of killing the population is in immediate danger of depletion. More information is required, however, on the age composition of the stock, and a better coverage with aerial survey is desirable before conclusions can be drawn. It is proposed to study the age composition of net catches along the lower North Shore of the Gulf of St. Lawrence during the coming season as this fishery appears to be non-selective with regard to age groups.

Miss J. M. Pearson assisted in making the counts of seals from the photographs.

2. Tagging

Tagging of whitecoat pups from light ski-equipped aircraft based on the Magdalens, which can land on the large pans of Gulf ice, did not materialize this year because the smallest distance of the seals to the aircraft base (50 miles) was too great for safety. It is planned to carry this out in the coming season if possible.

Fifty-nine pups were tagged and released by R. L. Stevenson and T. Reddy from sealing vessels on the "Front" and 125 were tagged with our tags and released by Per Høst from a sealing vessel in Cabot Strait. One tag, placed on a pup near St. Paul Island on March 17, has been returned by the Danish administration in Greenland, who report that the seal bearing it was taken near Quagsimmuit, south Greenland, on June 17. This indicates that at least some of the seals migrating north cross over to the Greenland side. The Danish administration also reported to Dr. A. W. H. Needler in Copenhagen this fall that some Norwegian tags had been recovered. Since Per Høst tagged 95 seals on the "Front" in 1949 with Norwegian tags, it seems possible that these may be the ones involved. These early results are encouraging in view of the relatively small numbers of seals which it is possible to tag.

H. D. Fisher

Appendix No. 71

GENERAL SUMMARY OF THE EEL-GRASS INVESTIGATION

The investigation of the biology and control of eel-grass, Zostera marina L., was continued for the third summer in the Malpeque Bay area near Ellerslie, P. E. I., and at the Shippegan area of New Brunswick. Mr. M. V. MacInnis was employed as a seasonal research assistant at Ellerslie, and Mr. R. J. McGuire again assisted in soil analyses made at the University of New Brunswick during the winter of 1949-50.

General observations on the biology and condition of the eel-grass were continued, but the principal investigation was into means of local control of the plant in the oyster culture areas. Observations again confirm the belief that the wasting disease symptoms are enphytotic in our Canadian population of eel-grass.

Experiments to determine the effect of the presence of eel-grass plants on the growth of oysters were continued. The overall results do not show the pattern reported last year, in which those oysters on the bottom amongst eel-grass plants increased much less in weight than those on clear bottom or raised above the bottom. Rather, there was no greater difference amongst groups in the larger of two experiments than within any one group.

Methods of control by covering the eel-grass plants continued effective, and were extended to include an additional shell-covered area and an area covered with tar-paper heavily protected with sand. Cutting the eel-grass plants gives immediate availability of the area so treated, but repeated cuttings as new plants appear seem to be necessary if results are to be lasting.

Sodium arsenite, 2,4-dichlorophenoxyacetic acid ("2,4-D") and a patented chemical, "Benoclor", were tried in attempts to effect an easy chemical control. The first two were ineffective in concentrations which were not less than 1,000 p.p.m., but the Benoclor was effective in producing an almost total kill at concentrations as low as 170 p.p.m. or 0.4 quarts per 100 square feet of bottom.

A. R. A. Taylor

Appendix No. 72

BIOLOGY OF EEL-GRASS

Routine weekly observations showed that the eel-grass population was continuing in the same pattern of growth and health as in the two previous years. The diseased appearance was present from early June, when observations were started, until mid-September when they were discontinued. Measurements of lengths of plants and of widths and lengths of leaves were followed as an index with which any fluctuation might be compared, but no noticeable change was observed. Similarly, plant density was followed in the same

area as in the two previous years and was found to follow the same distribution in depth, and largely the same in time. No appreciable change in coverage was evident, suggesting that the plant is not spreading shoreward or seaward in areas in which it is now established, but has taken up its range in depth from mean low-water spring tides down to a depth of about three and one-half feet.

The transplants set out in the summer of 1949 survived the winter and insofar as they could be identified were vigorous in the present season.

A. R. A. Taylor

Appendix No. 73

EFFECT OF EEL-GRASS ON OYSTERS

One experiment was commenced in 1948 and a second in 1949 to discover whether eel-grass influences the growth of oysters where it occurs in relatively heavy growth. Both these experiments were continued again this year.

In the experiment initiated in 1948 all of the oysters were from the 1946 year-class and at that time measured 58 mm. (approx.) in length. In this case, as in the next experiment, the oysters were divided into four groups arranged to test if the presence of eel-grass or the subjection to silting on the bottom were more important. The arrangement of groups and the results of the measurements are shown in the accompanying table. All length measurements were made with vernier calipers; weight measurements were made this season only. The duration of the growth periods measured were as follows: 1948, July 22 - Oct. 23; 1949, June 3 - Sept. 10; 1950, June 12 - August 23.

<u>Position of oysters</u>	<u>Inc. in length (mm.)</u>			<u>Weight inc. (gm.)</u>
	<u>1948 (n)</u>	<u>1949 (n)</u>	<u>1950 (n)</u>	<u>1950</u>
On bottom				
A - In eel-grass	4.2 (46)	10.7 (44)	4.8 (45)	5.61
B - On clear bottom	6.7 (43)	9.7 (40)	5.2 (39)	7.58
On stakes 3"-4" above bottom				
C - In eel-grass	6.6 (46)	9.3 (38)	3.9 (36)	8.11
D - On clear bottom	6.5 (47)	9.9 (37)	4.2 (36)	10.79

(n = number of individual oysters used).

No clear correlation can be seen in growth in length over the three years. In the weight measurements those oysters on the bottom in eel-grass grew markedly less in weight than those in the clear or on stakes. As will be seen from the table which follows, the above weight data alone follow the pattern observed in last year's weight measurements in the second experiment.

In the second experiment, changes in weight, length and volume were followed. The individually-numbered oysters were arranged in four groups at random irrespective of their 1949 habitat.

The four groups were as before: A, resting on the bottom amongst eel-grass plants; B, on bottom clear of plants; C, on stakes about 3"-4" above the surface of the bottom amongst eel-grass plants; and D, on stakes clear of eel-grass. The duration of the experiment was from June 12 to August 23. The lengths were measured with vernier calipers, the volumes by weighing the oysters individually in air and in water. All oysters were of the 1947 year-class. The results are tabulated below:

Habitat	1949		1950						
	Weight increase (gm.)	(n)	(n)	Weight (gm.) June	Incr.	Length (mm.) June	Incr.	Volume (ml.) June	Incr.
On bottom									
A-in grass	8.68	(91)	(84)	25.81	10.68	59.0	10.1	14.41	6.39
B-in clear	14.13	(79)	(87)	26.05	10.03	61.9	10.0	14.68	6.13
On stakes									
C-in grass	14.52	(90)	(79)	24.24	10.03	58.3	7.0	13.59	5.81
D-in clear	16.41	(81)	(80)	23.02	11.42	57.8	6.0	12.96	6.43

It will be observed from the above table that growth as expressed in length, volume or weight change was of the same order in the 1950 season for all four groups of oysters; there was also much greater variation within individual groups than amongst the four groups. On the other hand, in the 1949 results from this experiment there was much greater growth in the oysters of groups on stakes, or on clear bottom, than of oysters on bottom in eel-grass. It is difficult to understand or to explain the variation in results from the one year to the next. One might venture to suggest that the factor of the presence or absence of eel-grass has less effect on oysters in their third full season of growth than earlier or, perhaps, that there was some other factor operative this year which obscured any differences in response to the presence or absence of eel-grass. Certainly, it can be observed that there was no biologically significant difference in growth of oysters in and out of eel-grass, or at the bottom, or 4" above its surface, during this present experiment.

A. R. A. Taylor

Appendix No. 74

METHODS OF CONTROLLING EEL-GRASS ON OYSTER GROUNDS

Cultivation of the bottom. No further experimentation was attempted in this direction, since it was decided that the time available could be better applied to other methods to be discussed below. Mr. S. Andrews of Shippegan, N. B., finds that where he has used his oyster drags on leases on which growth of eel-grass occurs in patches there is a considerable amount of eel-grass pulled up resulting in partial eradication. He finds it advantageous to engage in cleaning operations of this nature whenever time allows. This is in harmony with the opinion that regular fishing with the oyster drag will keep attached perennial aquatic plants in check.

Covering the eel-grass. The initial covering plots set out in 1948 at Basse Bay, Shippegan, N. B., were found to be still intact and continuing successful. These plots were covered with: (1) clamshell, (2) coarse gravel, and (3) concrete slabs. No seedlings seem to be established, and no serious encroachment of old plants from the edges has occurred. The 1945, 1946 and 1947 oysters placed on the plots in 1948 have grown well and appear to have remained on the plots unaffected by storms or ice.

In October, 1949, an area near Ellerslie, P. E. I., was covered to a depth of 2"-3" with oyster shells obtained in cleaning Departmental oyster beds. During the present summer it was extended to take in an area 55' x 85'. This coverage required 525 barrels of shell and 130 man hours in labour. Over the period observed, this method again proved successful.

An area of 15' x 30' was covered with overlapping strips of tarred felt paper overlaid with beach sand in October of 1949. It remained successfully in place over the winter and was extended this season to cover an area 50' x 75'. It required about 210 man hours' labour laying about 20 rolls of tarred paper and covering it with approximately 125 "dory-loads" of sand. Some difficulty occurred in getting the strips flat in deeper water (3' at low tide), and such work requires that at least one person work in waist-deep water or beyond.

Cutting the eel-grass. During the year 1949 the effect on growth density of cutting away the above-ground parts of the eel-grass plants was followed in two small experimental plots. One of these could not be located this year because of the removal of its markers by ice; the other was used again. In 1949 all the above-ground plant parts were removed from one half of the total area, which was treated as a 2 x 2 Latin Square; the other half acted as control. The area so cleared was kept clear by cutting away at intervals any shoots which grew up anew. This season no plants were removed, but the number of plants present was counted at intervals of one or two weeks. A reduction in number of plants had been effected, but not all were eliminated by the previous year's cutting, as the following figures show:

	<u>Number of plants per square metre</u>					
	<u>1949</u>			<u>1950</u>		
	<u>July 8</u>	<u>Aug. 6</u>	<u>Aug. 30</u>	<u>June 1</u>	<u>Aug. 4</u>	<u>Sept. 9</u>
Cut area	(111	7	4	20	28	38
Control	(not counted	140	118	121	113

A new plot, duplicating the 1949 one mentioned above, was set out, and counts made regularly through this summer at two-week intervals. In this case the shoots were cut just above the growing point. A gradual reduction in numbers from 150 plants per square metre to 6 plants per square metre occurred from June 30 to September 9, while the density on the control increased from 150 to 200 plants per square metre. It was felt that this would enable us to follow the effects of continued cutting such as might be practised with a cutting machine in an attempt to keep down the eel-grass population.

An area 25' x 25' was cut with scythes during September, 1949; however, there was so little difference between it and its surroundings that it could not be located this year following loss of its markers by ice. This season a Hockney Weed Cutter was purchased and used to cut experimental plots. In order to learn if repeated cutting in one season would be sufficiently more valuable than a single cutting, two areas 25' x 50' were cut in the Departmental reserve area. One of these was cut once only, on July 13; the second was cut then, and again on August 16, and once more on September 8. The cutter works best in a dense growth of long plants and, therefore, the first cutting showed the greatest result. However, a slight reduction in numbers of plants occurred. The cut plants continued growing.

Through the co-operation of oyster farmers, two at Malpeque and one at Shippegan, areas were cut on private leases to demonstrate the method to the industry. Where cut, the grass floats away and leaves the bottom in a condition which makes fishing very much easier. This is not thought of as a permanent remedy, but rather as a temporary or seasonal control. If the cut grass were harvested and sold it might provide a means of making the control economical.

Chemical methods of control. Tests were made this year to determine the efficacy of four herbicides in killing eel-grass in oyster culture areas. Of these, 2,4-D and sodium arsenite proved ineffective when sprayed on to the plants at the bottom in amounts sufficient to give final concentrations of 1,000 p.p.m. if fully dispersed in the volume of water over the plants. The concentration around the plants must have been very much higher at the time of application. Sodium arsenite crystals tied in a cloth bag and left at the bottom among eel-grass plants also proved ineffective in killing adjacent plants. Similarly, an area treated at a concentration of 12 p.p.m. during the 1949 season appeared as healthy as the untreated areas this year. In the light of this year's results this was to be expected, but even this concentration is below that recommended for freshwater ponds.

The remaining chemicals tried, Benoclor 3 and Benoclor 3C, both proved effective in killing eel-grass plants in relatively low concentrations. Series of experiments were done to determine the most effective and economical means of using them. Benoclor 3 is a mixture of chlorinated benzene compounds almost insoluble in water and possessing a density of approximately 1.42 gm./cc. Benoclor 3C is similar to Benoclor 3 but has a dispersing agent, probably mahogany soap, added to allow it to mix with water. Its density is about 1.26 gm./cc.

A small piece of equipment was designed and built to spray mixtures of these chemicals with water below the surface of the water and on to the eel-grass plants. It consisted of a reservoir tank, a pump with connected hose, and a 2' wide sprayer-head made from pipe with fine holes drilled in it to allow the chemicals to spray out in fine jets. This apparatus, used on a raft, proved satisfactory as a means of spreading all the chemicals tried, although the Benoclor 3 could not be kept in suspension and therefore sprayed out quickly.

A simple and inexpensive method of spreading the Benoclor was developed. It consisted of mixing the required volume of Benoclor with a standard amount of sand sufficient to cover a definite area. When well mixed the sand was spread by broadcasting with a shovel, or by hand, evenly over the area to be treated. The sand particles, coated with the oily liquid, sank to the bottom holding the Benoclor in separate small amounts. The effect of this chemical when used against the eel-grass is to kill the basal parts of the plants to a level 3-5 cm. above the soil. This usually includes the meristematic growing region. Thus, although at first many plants still appear healthy, they are alive only in the upper parts which break off and wash away after a short period.

A range of concentrations was tried for both Benoclor 3 and 3C under three conditions of treatment: (1) sprayed on to uncut plants; (2) sprayed on to plants which had been cut; and (3) spread with sand on to uncut plants. General results are indicated in the table.

	% Affected										
	Uncut							Cut			
	Concentration Qts. per 100 sq. ft.							Concentration			
	0.1	0.2	0.4	0.5	0.6	0.8	8.0	0.5	0.8	3.0	4.0
<u>Benoclor 3</u> (sprayed)	.0	20	75	95	-	100	-	100	-	-	100
<u>Benoclor 3C</u> (sprayed) (p.p.m.)	X (25)	10 (50)	75 (100)	-	-	100 (175)	100 (1800)	-	100	100	-
<u>Benoclor 3</u> (sand)	50	-	92	-	100	-	-	-	-	-	-

(X = affected plants present).

The time which elapsed between treatment and last observation in the case of the higher concentrations was much more than in the others; therefore it may be assumed that a greater effect might appear as time progresses. There was sufficient effect at the concentration of 0.4 qt. of Benoclor 3 per 100 sq. ft. when spread with sand to warrant its use as a basis for larger scale experimentation. This was done both near Ellerslie, P. E. I., and at Shippegan, N. B. In both cases, areas of about 1,500 sq. ft. were treated on private leases - with the permission of the lessees. A distinct effect could be seen soon after treatment at each place; further observations will have to be made next year. The cost of chemical for treatment is about \$160.00 per acre.

Effect of Benoclor on oysters. Benoclor is poisonous to animals when taken internally. However, workers in agriculture have shown that cows refuse to drink water in which it occurs in quantities sufficient to have even a slight effect on them. It is unlikely, therefore, that toxic amounts would be ingested inadvertently by humans or other mammals. Small aquatic animals are killed by lower concentrations than were used in these experiments. Crustaceans, worms and other small animals could be seen dead after the

application of the chemicals.

Insofar as oysters are concerned, they can be killed by extended immersion in water with sufficient Benoclor 3 or 3C to give concentrations of 100 p.p.m. Not all are killed, however, and some which appeared weakened and did not close their shells recovered after removal to normal sea water. Oysters subjected in nature to treatment with the Benoclor at concentrations of 0.4-0.8 qt. per 100 sq. ft. (150-200 p.p.m., dependent on water depth) survived.

Oysters which are strongly affected show greenish patches on the viscera. These are due to accumulations of blood cells in the sinuses and blood vessels; the mantle is also much retracted and the shell may remain open in some cases. Those which recover from strong dosage with Benoclor often show shell blisters on the inside, where the mantle has developed new shell over particles of sediment, and perhaps Benoclor, which entered while it was retracted and the oyster was sick.

It is thought that concentrations of Benoclor which will be used for control of eel-grass will not greatly affect the oysters. This will be known only after reports have been received from the oyster fishermen on whose leases large-scale experiments were tried.

A. R. A. Taylor

Appendix No. 75

ANNUAL REPORT
ATLANTIC OCEANOGRAPHIC GROUP

Introduction

1. Considerable progress can be reported in the organization and development of the Atlantic Oceanographic Group during the past year. The staff has been supplemented by the return of Mr. H. J. McLellan from leave of absence after a two-year period of study at the Scripps Institute of Oceanography, the appointment of Mr. W. B. Bailey as Assistant Oceanographer, and the appointment of Mr. R. W. Trites as a Junior Oceanographer. The C. N. A. V. "Whitethroat" was made available in late June as an oceanographic vessel, and meets our needs in every respect. We have also had assistance, upon occasion, from the Naval Research Establishment and the H. M. C. S. "New Lisheard". In return, we have co-operated with the Naval Research Establishment in some of their projects.

Atlantic Oceanographic Group

2. The staff of the Atlantic Oceanographic Group consisted of the following:*

*The classifications of Fisheries Research Board employees seconded to AOG are listed on page 3 of the staff list of the Atlantic Biological Station earlier in this report. Dr. Lauzier is a member of the Station's staff working with the Group under instruction from the Director.

Dr. H. B. Hachey	Oceanographer-in-Charge
Dr. L. Lauzier	Hydrographer
Mr. H. J. McLellan	Associate Hydrographer (on leave of absence to July 31)
Mr. W. B. Bailey	Assistant Oceanographer (from May 29)
Mr. R. W. Trites	Junior Oceanographer (from May 21)
Mr. E. L. Graham	Assistant Technician III
Mr. L. H. Brownrigg	Assistant Technician I
Miss M. E. Tabor	Technical Secretary (to May 31)
Miss M. M. Meating	Technical Secretary (from June 31)

Summer Season

Professor D. G. MacGregor June 15 - September 23

3. Mr. Fothergill, a graduate student in the Department of Geography of McGill University, spent two weeks abstracting temperature data from A.O.G. files to be used in a study of the interactions between air and water in the Gulf of St. Lawrence area. He was assisted in his abstracting work by Mrs. Fothergill.

4. Professor D. G. MacGregor, Head of the Physics Department of Mount Allison University, was employed for the summer season to review in detail recent studies in wave problems of the ocean in order to formulate recommendations on what might be attempted in Canadian Atlantic waters.

Oceanographic Investigations in 1950

5. The C. N. A. V. "Whitethroat" became available in mid-July and a program of activities, involving the H. M. C. S. "New Lisheard" as well, was drawn up as follows:

C. N. A. V. "Whitethroat"

July 15-22	To St. Andrews, N. B., for "shake-down" cruise.
July 23 - Aug. 15	Out of Halifax in work associated with Naval Research Establishment.
Aug. 15 - Sept. 15	Cruise of Bay of Fundy, Scotian Shelf, Gulf of St. Lawrence, St. Pierre Bank, with possible calls at St. Andrews, Halifax, Canso, Gaspé, Grand River, Anticosti and Sydney (with assistance from H. M. C. S. "New Lisheard").
Sept. 18 - Oct. 6	Survey of Grand Manan Channel and vicinity and involving Jog Log Current measurements (with assistance from H. M. C. S. "New Lisheard").
Oct. 9-21	Out of Halifax in work associated with Naval Research Establishment.
Oct. 24 - Nov. 15	Cruise of Bay of Fundy, Scotian Shelf and Gulf of St. Lawrence, with possible calls at Halifax, Canso, Gaspé and Sydney.

H. M. C. S. "New Liskeard"

July 12-20 BT Survey Scotian Shelf.

Aug. 15-31 Joint oceanographic cruise with C. N. A. V. "Whitethroat". ("New Liskeard" covering St. Pierre Bank, etc., and two sections across Laurential Channel, involving BT and Jog Log observations).

Oct. 1-6 Joint oceanographic cruise at Grand Manan Channel with "Whitethroat", and involving BT and Jog Log observations.

6. High priority was given to the program of oceanographic investigations recommended by the Fisheries Research Board of Canada, the details of which are given in the attached appendices. In particular, seasonal cruises were made covering the Bay of Fundy, the Scotian Shelf and the Gulf of St. Lawrence. Such seasonal cruises will be a continuing long-term program. In the summer cruise, with the co-operation of the Naval Research Establishment and assistance from the H. M. C. S. "New Liskeard", the investigation was extended to Newfoundland waters.

7. Specific attention was given to Grand Manan Channel, where there has long been a requirement for a detailed survey. New equipment, allowing rapid sampling, enabled the ships to cover the area much more expeditiously than heretofore and at various stages of the tide.

8. While taking part in the initial organization of OPERATION CABOT, a six-ship co-operative survey of the northern edge of the Gulf Stream, the "Whitethroat" was not available early enough to take a more active part in the investigation. Dr. Lauzier, however, was assigned to H. M. C. S. "New Liskeard", and the Canadian BT data were assigned to A.O.G. for preliminary analysis. This co-operative project involved the Woods Hole Oceanographic Institution, the U. S. Hydrographic Office, the U. S. Bureau of Fisheries, the Canadian Naval Research Establishment, and the Atlantic Oceanographic Group.

9. The Canadian Hydrographic Service continues to collect oceanographic data and forward same to A.O.G. for analysis and recording. During the 1949 season the observations circled Newfoundland and involved two ships. In 1950 four ships of the service were equipped to take similar observations.

10. The Naval Research Establishment continues to give attention to the waters of the Scotian Shelf, and made several BT sections over the Shelf during the year. All of these data are recorded in A.O.G. files.

11. The Fisheries Research Board, in various fishery investigations, collected considerable hydrographic data which were turned over for processing. In particular, extensive BT cruises were made in connection with herring investigations. The hydrographic data from the Eastern Arctic Investigations, under Dr. Dunbar,

have been processed and a joint report on some hydrographic features of the Ungava Bay waters is in preparation.

MS Reports

12. A number of manuscript reports have been prepared for circulation under the following titles:

- (a) Hydrographic features of Belle Isle Strait. (Bailey)
- (b) The Surface Layer in the Gulf of St. Lawrence. (Lauzier and Trites)
- (c) Review of Recent Studies in Ocean Waves. (MacGregor)
- (d) High Surface-Water Temperatures in 1949. (Lauzier)
- (e) The Effect of Storms in the Southern Gulf of St. Lawrence. (Lauzier)
- (f) Variability in the Structure of the Waters of the Gulf of St. Lawrence. (McLellan)
- (g) The Waters of the Bay of Islands, Newfoundland, in 1949. (Lauzier)
- (h) The Waters of St. Margaret Bay in 1949. (Lauzier)
- (i) Vertical Temperature Distribution in the Great Lakes. (Hachey)

Publications

13. The following papers were submitted for publication and are in press:

- (a) An Increasing Atlantic Influence in Hudson Bay. W. B. Bailey and H. B. Hachey.
- (b) The Vertical Temperature Structure of the Labrador Current. W. B. Bailey and H. B. Hachey.
- (c) High Surface-Water Temperatures in 1949. L. Lauzier.

Fishermen's Broadcast

14. Radio talks were prepared for the C. B. C. program broadcasts to fishermen as follows:

- (a) The Weather and the Water. L. Lauzier.
- (b) Trends in Surface-Water Temperatures. H. J. McLellan.

Lectures and Addresses

15. The writer gave a lecture entitled "Some Aspects of Oceanography" to the following:

- (a) Dalhousie Science Club.
- (b) U. N. B. Scientific Society.
- (c) Geological students of St. F. X. University.

16. The writer also delivered the address to the graduating class of St. Thomas University.

Collected Data

17. Approximately 3000 BT records and 2000 water samples were collected during the past season. The BT records alone involve

the processing of approximately 15,000 records. Charts showing the main cruises made by various co-operating organizations are appended as Figures 1, 2, 3 and 4.

Summary Reports

18. The following summary reports are attached:

- (a) The waters of Bay of Islands in the late autumn of 1949. L. Lauzier.
- (b) Modification of a commercial echo-sounder for fish finding purposes. L. Lauzier.
- (c) High surface-water temperatures in 1949. L. Lauzier.
- (d) The effect of storms in the Southern Gulf of St. Lawrence. L. Lauzier.
- (e) Multiple ship survey of the Gulf Stream, Operation Cabot. L. Lauzier.
- (f) Hydrographical observations during herring drift-netting operations. L. Lauzier.
- (g) Katy's Cove survey. L. Lauzier.
- (h) The waters of St. Margaret Bay in the summer of 1949. L. Lauzier.
- (i) Long-term oceanographic program. L. Lauzier and H. J. McLellan.
- (j) The surface layer in the Gulf of St. Lawrence. L. Lauzier and R. Trites.
- (k) Variability of the vertical structure of the waters of the-Gulf of St. Lawrence. H. J. McLellan.
- (l) Grand Manan Channel survey. H. J. McLellan.
- (m) Hydrographic features of Belle Isle Strait. W. B. Bailey.
- (n) Observations by the Canadian Hydrographic Service. W. B. Bailey.
- (o) Oceanographic observations by R. C. N. ships. W. B. Bailey.
- (p) Review of recent studies in ocean waves. D. G. MacGregor.

H. B. Hachey

Appendix No. 75-A

THE WATERS OF BAY OF ISLANDS IN 1949

The hydrographic exploration of Bay of Islands was carried out during the late autumn of 1949 for the second consecutive year on the M. V. "Harengus". The purpose of the investigation was primarily to study the cooling of the waters in the area and the variations in the distribution of temperature and salinity during November and December as compared to previous years.

In 1949, as in 1948, the horizontal temperature gradient was rather small. The data also show that in mid-November the waters of the upper layers were cooler in 1949 than in 1948. This difference was more pronounced inside than outside the Bay. The surface layer was somewhat thicker in 1949 than in 1948 in the Bay proper, but of the same thickness outside. During the early part of December, the waters were much less stratified in 1949 than in 1948, the vertical gradient of temperature being greatly reduced in 1949. The lower temperatures in the upper layers as compared to those in 1948 apparently resulted from a more intense mixing in 1949.

At the surface the horizontal salinity gradient was steeper in Humber Arm than in other Arms and the Bay proper. It was observed for the second year that the outflowing brackish water from Humber Arm is diverted to the east side of Woods Island. However, in one instance of extremely strong outflow the brackish water was also detected on the southwest side of Woods Island.

At a depth of 20 metres and more the horizontal salinity gradient was rather small and the variation from 1948 to 1949 was almost negligible.

The tidal variations of salinity in the top layer (0-5 m.) of the Humber Arm waters were greatest between 0.9 and 1.2 metres, damping out gradually towards 5 metres.

L. Lauzier

Appendix No. 75-B

MODIFICATION OF A COMMERCIAL ECHO-SOUNDER FOR FISH-FINDING PURPOSES

With the assistance of Bendix Corporation, a new set of recording styli has been tested on the M. V. "Harengus" sounder Bendix DR-1 (0-200 feet or fathoms). This new set suggested by the author differs from the original one by the number of styli. It has four styli instead of two and was designed to double the sounding range on the foot-scale without changing the pulse rate, the repetition rate, and the definition of the bottom contour and schools of fish. The tests were carried out in Bay of Islands where a large range of depths exists and also where schools of pelagic fish were apt to be detected. The tests were very satisfactory in finding the limits of the use of the modified gear.

For locating pelagic fish, like herring, the modified sounder has limited use because it may give misleading and ambiguous information. However, a trained observer can always identify a mid-water object (like a school of fish), the bottom echo, and the second echo, and also compute their depth and thickness.

Although the modified sounder has not been tested in finding bottom fish, it will give an improved definition of objects near the bottom. It is suggested that the sounder, in its new form, should be tested in actual groundfish operations from a trawler.

L. Lauzier

Appendix No. 75-C

HIGH SURFACE-WATER TEMPERATURES IN 1949

The annual mean surface-water temperatures at St. Andrews, N. B., the Halifax Lightship and Entry Island, Magdalen Islands, P. Q., for the year 1949 have been above normal. The

1949 annual mean at St. Andrews was a record temperature, 8.3°C, as compared to the previous record of 7.8°C in 1947. The monthly means were slightly below the 1947 values for three months and above them for the rest of the year. The monthly means for the last four consecutive months were the highest on record since 1921. (Record temperatures were also obtained in January and February, 1950).

At the Halifax Lightship the annual mean was above the average, but it was not a record temperature. All monthly means were either equal to or above the average, and during the last two months of the year they attained a record value.

At Entry Island monthly means were slightly higher than the average, and also below the 1947 level.

The relationship of the 1949 temperatures to the long-term average at the three stations for the period April to October is given in the following table.

<u>April - October</u>	<u>Stations</u>		
	<u>St. Andrews</u>	<u>Halifax Lightship</u>	<u>Entry Island</u>
1949 Mean	11.2	11.7	10.5
Long-term average	9.5	10.8	10.5
Difference	1.7	0.9	0.3

L. Lauzier

Appendix No. 75-D

EFFECT OF STORMS IN THE SOUTHERN GULF OF ST. LAWRENCE

From 1945 to 1949, inclusive, a series of shore stations has been established in the Southern Gulf of St. Lawrence for the purpose of collecting weekly or bi-monthly samples of sea water and determining temperatures at different depths from the surface to the bottom. The stations were located off North Rustico, P. E. I., Cheticamp, N. S., and in Northumberland Strait. At times the temperature and salinity of the water at certain depths underwent sudden variations related to the passage of a storm. From May, 1946, to August, 1949, seven outstanding cases of temperature and salinity variations were observed at the shore stations mentioned above.

During the passage of a storm, movements of the surface waters are initiated and compensated by movements of deeper waters. The onshore movement of surface waters drives warmer, less saline water to greater depths along the shore (subsidence). Conversely, offshore movement at the surface is counterbalanced by onshore movement of deep waters which drives colder, more saline waters near the surface (upwelling). The onshore surface movement thus brings about an increase of temperature and a decrease of salinity; the offshore movement, a decrease in temperature and an increase in salinity. The greatest observed temperature variation

was 9.6°C at North Rustico and the greatest change in salinity was 1.98 parts per thousand also at North Rustico.

It is important to emphasize that the changes were temporary, so that when storms subside the water temperature and salinity returned to approximately the values recorded previous to the storm.

In certain cases there are opposite effects at Cheticamp and North Rustico, decrease of temperature and increase of salinity at the first (upwelling), and increase of temperature and decrease of salinity at the second (subsidence).

L. Lauzier

Appendix No. 75-E

MULTIPLE-SHIP SURVEY OF THE GULF STREAM, OPERATION CABOT

As a representative of A.O.G., the author was a member of the scientific staff on board H. M. C. S. "New Liskeard", under Dr. W. L. Ford, Chief Scientist of the Naval Research Laboratory. With five other ships the "New Liskeard" cruised over 4300 miles, along and across the Gulf Stream front, the "cold wall", from June 6 to June 22.

The operation of the "New Liskeard" was divided into two phases. During the first phase the survey consisted of the collection of a large amount of synoptic observations in order to locate the "cold wall", from a position south of western Nova Scotia, eastward to the tip of Grand Banks. During this phase, 356 BT slides were obtained, as well as 300 water samples. The Geomagnetic Electrokinetograph (GEK) supplied hourly observations of surface current.

The second phase of the survey consisted in tracking down a large eddy which had just been formed. This eddy, of an oblong shape, had an area almost equal to the Bay of Fundy (about 40 miles wide by 150 miles long). South of the average position of the "cold wall" this eddy contained relatively cold water in its centre and was revolving counter-clockwise. During the second phase, 343 BT slides, 250 water samples and 136 GEK observations were obtained.

Between June 6 and 22 the "New Liskeard" made four crossings of the coastal-water-slope-water boundary between 100 and 200 miles from the Nova Scotian coast. This boundary was easily detected on the surface salinity recorder trace since the salinity changed at least from 31.8‰ to 34.0‰ within few miles. The temperature change was more gradual than the salinity change.

The position of the ship throughout the cruise was determined by Loran. An accompanying chart shows the tracks of the ship during the two phases.

L. Lauzier

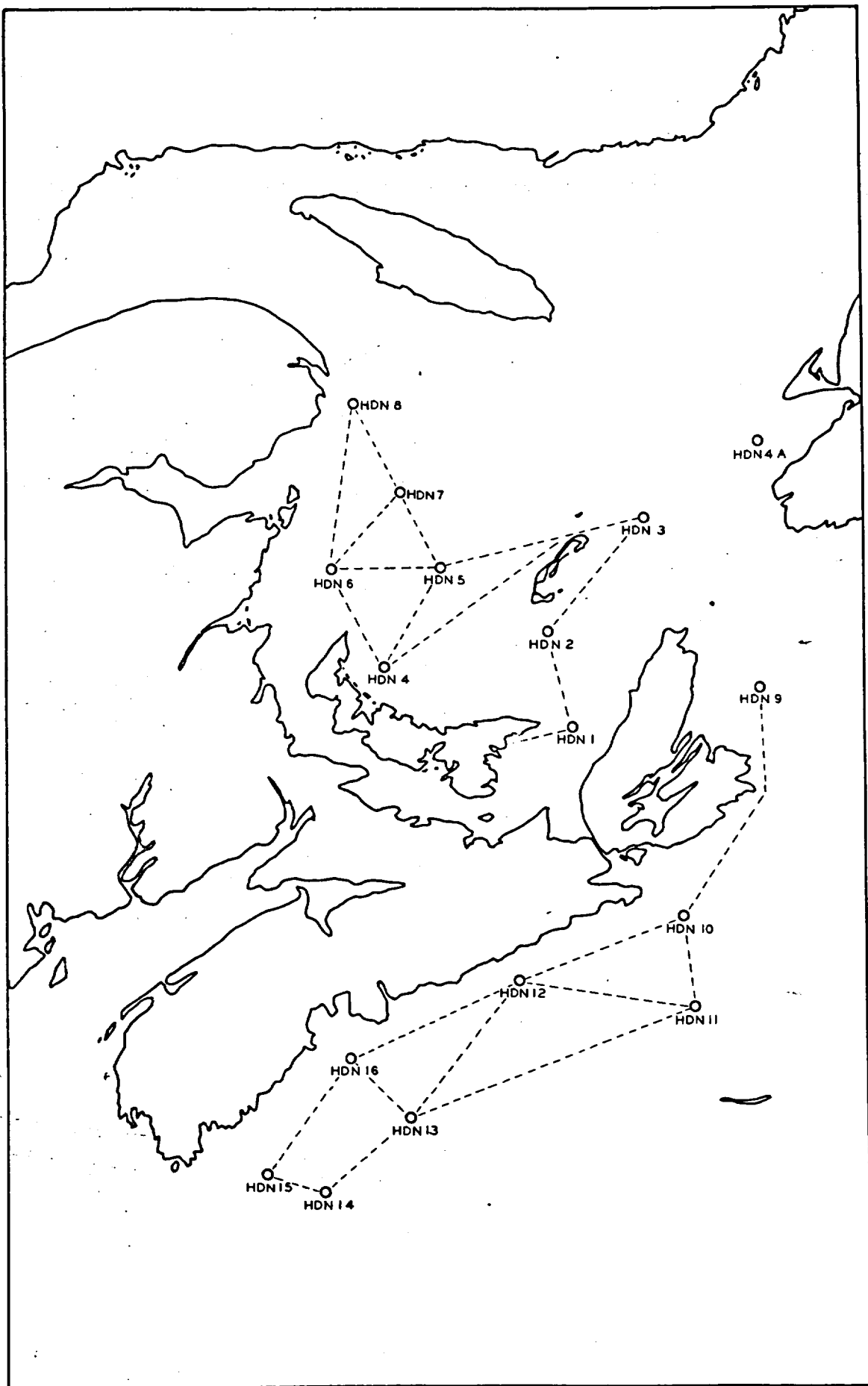


Fig. 1 Oceanographic Cruises by Fisheries Research Board relative to Herring Investigations.

Appendix No. 75-F

HYDROGRAPHY ASSOCIATED WITH HERRING DRIFT-NETTING OPERATIONS

During the first three cruises of the M. V. "Harengus" over the network of herring drift-net stations (see preceding chart) 336 bathythermographic (BT) observations were made. Among these, 67 were made immediately before and after the setting of the nets. The rest of the BT observations were taken en route between the stations. The observations were made especially to obtain data pertinent to fishing operations. The area covered consists of the Southern Gulf of St. Lawrence from Gaspé to St. Georges Bay, Nfld., and of a 50-mile-wide strip on the Scotian Shelf from Roseway Bank to the Laurentian Channel.

L. Lauzier

Appendix No. 75-G

KATY'S COVE SURVEY

In co-operation with the clam investigation, a survey of hydrographic conditions under the ice was carried out on April 8 and 14. Normally a tidal cove, this one had been dammed up for the winter months. The dam practically stops any exchange of water from Passamaquoddy Bay to the Cove. Furthermore, in late winter before the ice disappears fresh water is flowing in the Cove under the ice where very little mixing occurs.

Water samples were collected through the ice from ten different positions in the Cove. The vertical distribution of salinity shows a very sharp halocline at the depth of 3 feet. From 1.6‰ at 2 feet, the salinity increased to 14.8‰ at 3 feet, to 24.6‰ at 4 feet and finally to 28.1‰ at 11.5 feet. The highest salinity recorded in the Cove was apparently lower than the minimum salinity outside the Cove. This could be attributed to some mixing with inflowing fresh water before the ice was formed and after the dam has been closed. The sharp halocline indicates the occurrence of very little mixing under the ice.

Oxygen samples were taken, and no depletion was indicated.

L. Lauzier

Appendix No. 75-H

THE WATERS OF ST. MARGARET BAY IN THE SUMMER OF 1949

From August 15 to September 14 water conditions in the St. Margaret Bay area have been studied in relation to tuna and billfish investigations. The survey consisted of four cruises over the Bay and one cruise off the mouth of the Bay. Observations at one station in the centre of the Bay were repeated frequently.

The general conditions may be summarized as follows:

1. The horizontal range of temperature within the Bay during any one of the cruises was generally lower than 2.0°C except in mid-water where the thermocline occurred. The waters were usually somewhat colder in the S-SW sector and warmer in the N-NW sector. The observed limits of variation of surface temperature were 11.8°C and 18.2°C .
2. The waters were highly stratified and the thermocline was generally deeper on the west side of the Bay than in the middle or on the east side. The thermocline deepened from an average depth of 6 metres on August 24 to about 25 metres on September 12. The lowest bottom temperature recorded in the Bay was 3.4°C .
3. At the surface the horizontal gradient of salinity was usually lower than 0.4‰ but once it was as high as 1.5‰. From 5 metres down to the bottom the horizontal gradient was lower than 0.3‰ and most of the time around 0.1‰. The minimum salinity recorded at the surface was 29.4‰ and the maximum on the bottom was 32.2‰.
4. The surface temperature inside the Bay was approximately the same as outside, but the thermocline seemed to be deeper outside than inside; it was also deeper toward Peggy's Cove than towards Mahone Bay.

L. Lauzier

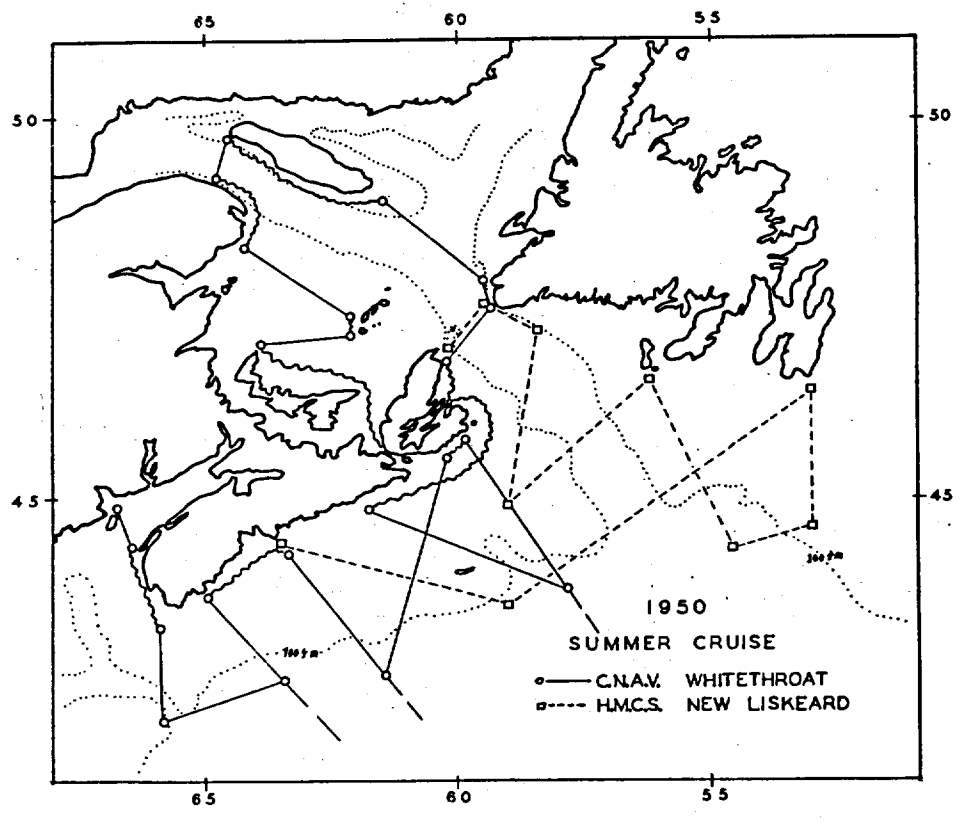
Appendix No. 75-I

LONG-TERM OCEANOGRAPHIC PROGRAM

Upon request from the Atlantic Biological Station, a plan has been laid down for systematic collection of hydrographic data which will permit review and prediction of East-Coast water conditions. The aim is to log information which will be sufficient to indicate year-to-year variations from the normal and provide a background of hydrography for correlation with Fisheries data.

Surface-water temperatures are being obtained twice daily at St. Andrews, N. B., Halifax, N. S., Sambro Lightship off Halifax, Entry Island, Magdalen Islands, P. Q., Ellerslie, P. E. I., and Grand River, P. Q., as a continuing service. To this list has been added Lurcher Lightship off Yarmouth, N. S., which has provided this service since August of this year. Plans are in hand to add a station at Borden, P. E. I. In addition a thermograph is on order for installation on the C. N. R. steamer which makes regular trips from North Sydney, N. S., to Port aux Basques, Nfld.

The Lurcher Lightship has been equipped to observe bottom temperatures, and the Sambro Lightship makes regular bathythermograph lowerings to the bottom twice daily. It is planned to equip the station at Borden, P. E. I., for bottom-temperature observations.



Areas covered by Seasonal Cruises.

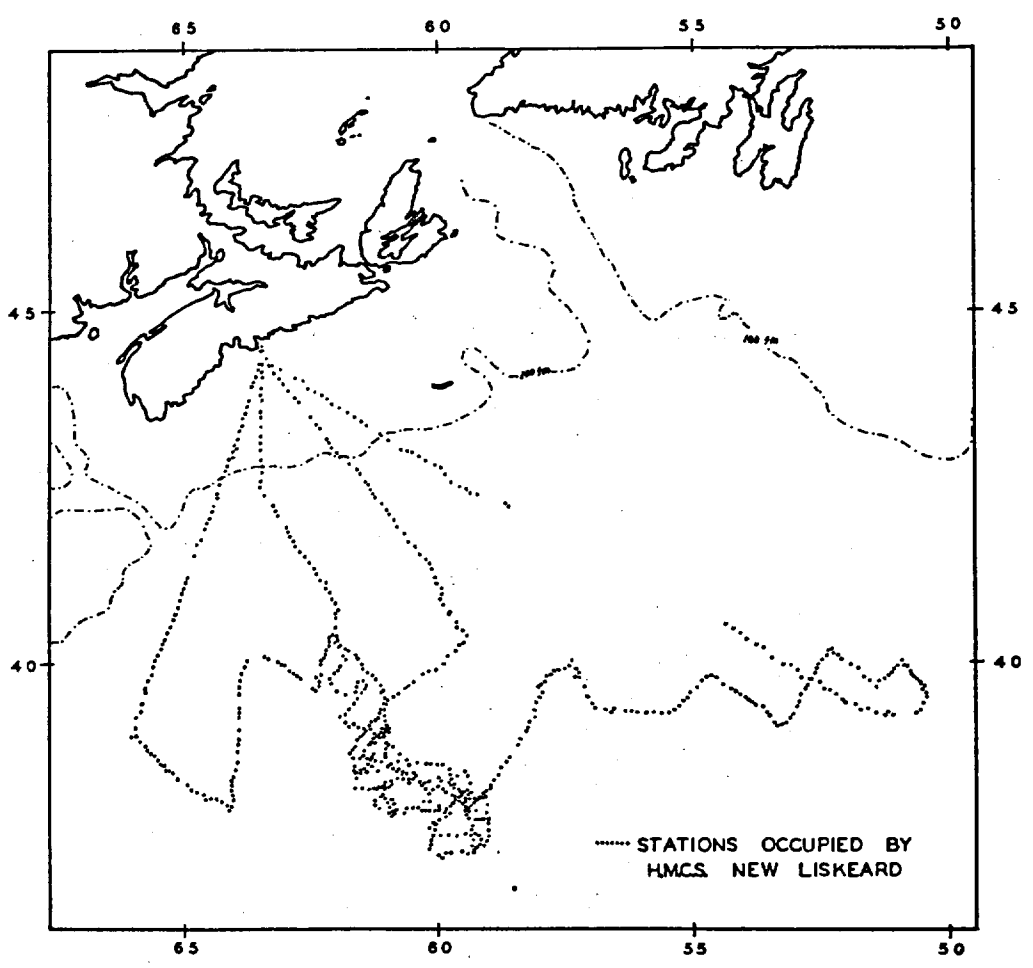


Fig. 2 Canadian Contribution to Operation Cabot, a Six Ship Survey of the Gulf Stream.

Water-column temperatures are observed monthly in the St. Croix River and at Station 5 just outside Passamaquoddy Bay by personnel of the Atlantic Biological Station. The Sambro Lightship's BT observations on the water column are taken twice daily. It is planned to have bi-monthly observations of the water column off Malpeque Bay, P. E. I.

Seasonal cruises will be run regularly in February, May, August and November. The plan covers the Bay of Fundy (5 stations), Scotian Shelf (28 stations) and Gulf of St. Lawrence (25 stations) with lines of hydrographic stations crossing all important fishing areas. Bathythermograph lowerings are to be made to the bottom between stations and on runs between lines. The first of these cruises was made in August, 1950, with supplementary data on Cabot Strait and the South-West edge of the Grand Banks being gathered by H. M. C. S. "New Liskeard". A second cruise was completed in November. The course of these cruises is shown in the accompanying chart - "Areas covered by Seasonal Cruises".

The question of what can be done in Newfoundland waters has yet to be dealt with. The method and means of extending oceanographical cruises to include waters to the east and south of Newfoundland will require careful consideration.

L. Lauzier and H. J. McLellan

Appendix No. 75-J

THE SURFACE LAYER IN THE GULF OF ST. LAWRENCE

All the data from A.O.G. files pertaining to the waters of the Gulf of St. Lawrence have been analyzed to map out the distribution of monthly means of the surface temperature and of the surface-layer thickness. The means were obtained by averaging all available data (from 1917 to 1949) in each one-degree square for each month.

In May the thickness of the surface layer ranged between 10 and 25 metres. The surface layer reached greater depths (25 metres) in the lower Laurentian Channel where the mean surface temperature was a minimum (1.0°C) as compared to a shallow surface layer (10 metres) of higher surface temperature (4.0°C - 5.0°C). During June and July the surface layer throughout the Gulf was generally shallowing, its thickness reduced to 5 and 10 metres. At the same time the surface temperature had increased all over the area and reached the summer maximum in the northern half of the Gulf.

In August, on the one hand, the surface temperature was still increasing up to a maximum in the southern half of the Gulf, including Magdalen Shallows, Cabot Strait and part of Newfoundland's west coast. On the other hand, the cooling of northern surface waters had begun. In general the summer maximum was between 15.0°C and 16.0°C in the northern half of the Gulf as compared to 18.0°C and 19.0°C in the southern half.

From August to November the surface layer was thickening and the surface temperature decreasing at a slower rate in the south-western Gulf than in the rest of the area. The thickest surface layer (60 metres) was observed in November on the north side of Anticosti Island, Passage Jacques Cartier.

L. Lauzier and R. Trites

Appendix No. 75-K

VARIABILITY OF THE VERTICAL STRUCTURE OF THE WATERS OF THE GULF OF ST. LAWRENCE

A review has been made of evidence pointing to short-term fluctuations in the depths of isotherms in the Gulf of St. Lawrence, previously reported upon by the Atlantic Herring Investigation Committee. A report is also made on two series of bathythermograph observations which were made on September 7 and 8, 1947.

Both series show marked oscillations in almost all isotherms down to four hundred and fifty feet, the maximum depth of observation. At station "A" in the Gaspé current there was a definite oscillation in the well-defined thermocline, while station "B" mid-way between Gaspé and Anticosti did not exhibit this to any detectable degree.

At station "A" the 45° isotherm had a range in depth from forty-five to eighty-five feet with the suggestion of a two-and-a-half-hour period. Other isotherms varied in depth by as much as sixty-five feet over the twenty-four-hour period.

The study indicates that internal waves, or other short-period fluctuations in the vertical structure of the water mass, must be thought of as being quite general in the Gulf of St. Lawrence. Studies of seasonal cycles, patterns of movement, or other phenomena inferred from widely-spaced hydrographic observations, must recognize the possibility of short-period internal disturbances, as much as twenty metres in amplitude, unless they treat with regions shown to be free from such disturbances.

H. J. McLellan

Appendix No. 75-L

GRAND MANAN CHANNEL SURVEY

The first of a planned series of surveys of the Grand Manan Channel was made during the last half of September and the early part of October. It is proposed to delimit the departures from isothermal conditions in the Channel and to correlate these with the stage of the tide, seasonal variations of the Bay of Fundy waters, and meteorological conditions. An opportunity for the study of the fundamental nature of tidal mixing should be presented.

Between September 18 and 25, with C. N. A. V. "Whitethroat", observations were made over five lines crossing the area, each line being covered at high water, low water and half tide. A Spilhaus-Miller sea-sampler was used for all observations. This permitted the completion of a line in under two hours, with about one and a half miles spacing between stations. Approximately half of the samples collected were preserved. The data (98 temperature-depth traces and 450 water samples) have yet to be worked up.

H. M. C. S. "New Liskeard" was made available from October 3 to 5 with a "Jog Log" (Geomagnetic Electrokinetograph) on board. Three lines, one across each end of the Channel and one across the northern approaches, were subjected to continuous current measurement, each over a twelve-hour period. Besides recording the current variations transverse to the lines, one hundred and eleven jogs were made to permit vector reduction. These data have yet to be reduced and analyzed.

H. J. McLellan

Appendix No. 75-M

HYDROGRAPHIC FEATURES OF BELLE ISLE STRAIT

Work is being completed on hydrographic data taken during the Belle Isle Strait Expedition of 1923. The data were collected by M. V. "Prince" of the Atlantic Biological Station and the C. G. S. "Arleux", a Canadian Fisheries Protection steamer, during the months of August and September, 1923. While reports were no doubt made on this work at the time, they are not available to present investigators.

A total of ninety-five hydrographic stations are being used to plot eleven sections in profiles of temperature, salinity and density (σ_t), and plans of temperature and salinity at serial depths of 0, 10, 25 and 50 metres.

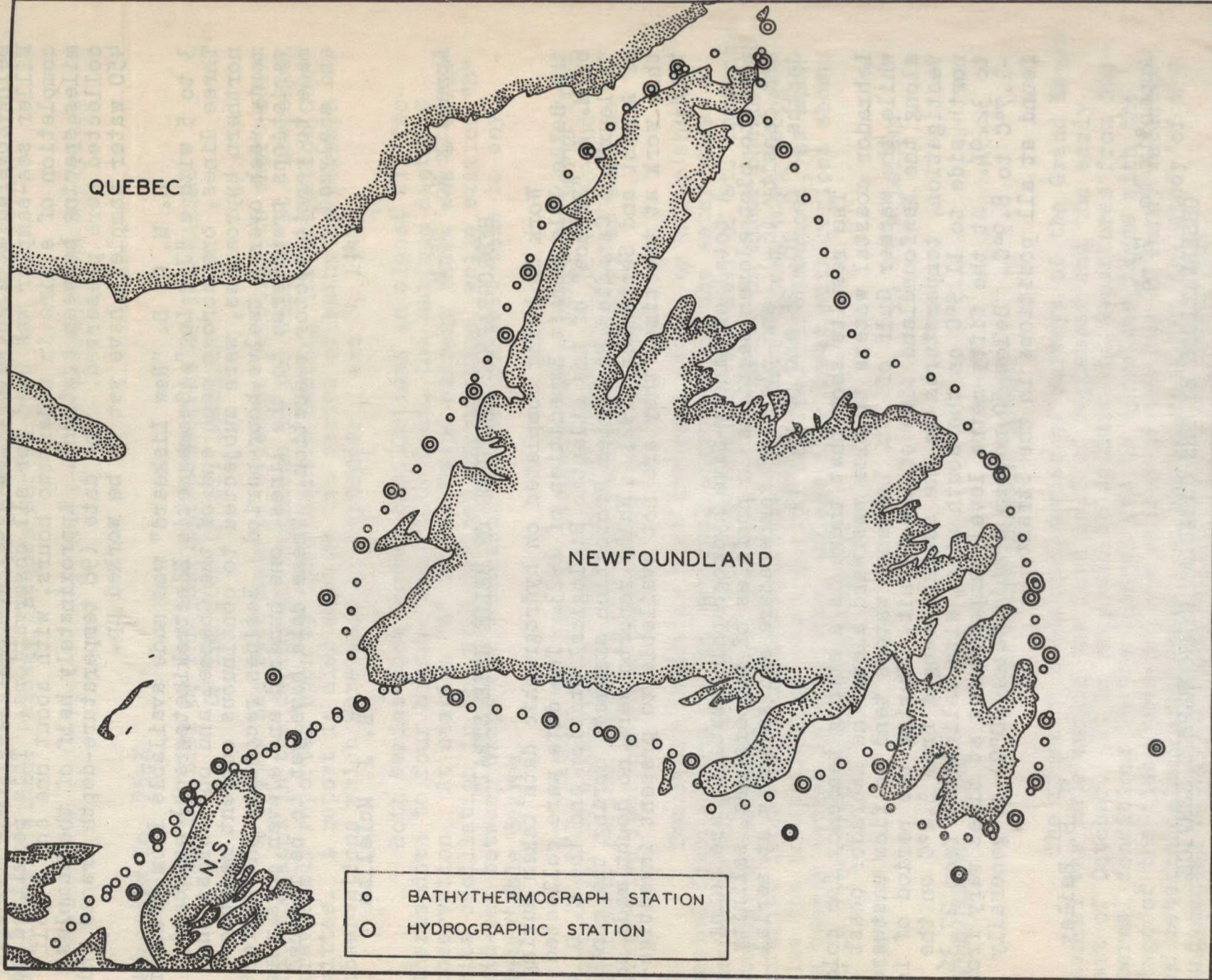
The results show that there is a strong tendency for cold Labrador coastal waters to flow westward along the Labrador coast while the warmer Gulf of St. Lawrence waters tend to flow eastward along the Newfoundland side of the Strait. During the period of investigation, temperatures on the surface ranged from 3.2°C on the north side to 11.9°C on the south side, with salinities from 27.3‰ to 32.9‰. At the fifty-metre level temperatures at times vary from -1.7°C to 8.9°C. Below 50 metres Arctic water (0°C) is generally found at all positions in the Strait.

W. B. Bailey

Appendix No. 75-N

OBSERVATIONS BY THE CANADIAN HYDROGRAPHIC SERVICE

In 1949 two vessels of the Canadian Hydrographic Service, C. S. S. "Cartier" and C. G. S. "Acadia", were engaged in making



Locations of Observations by the Canadian Hydrographic Service, 1949.

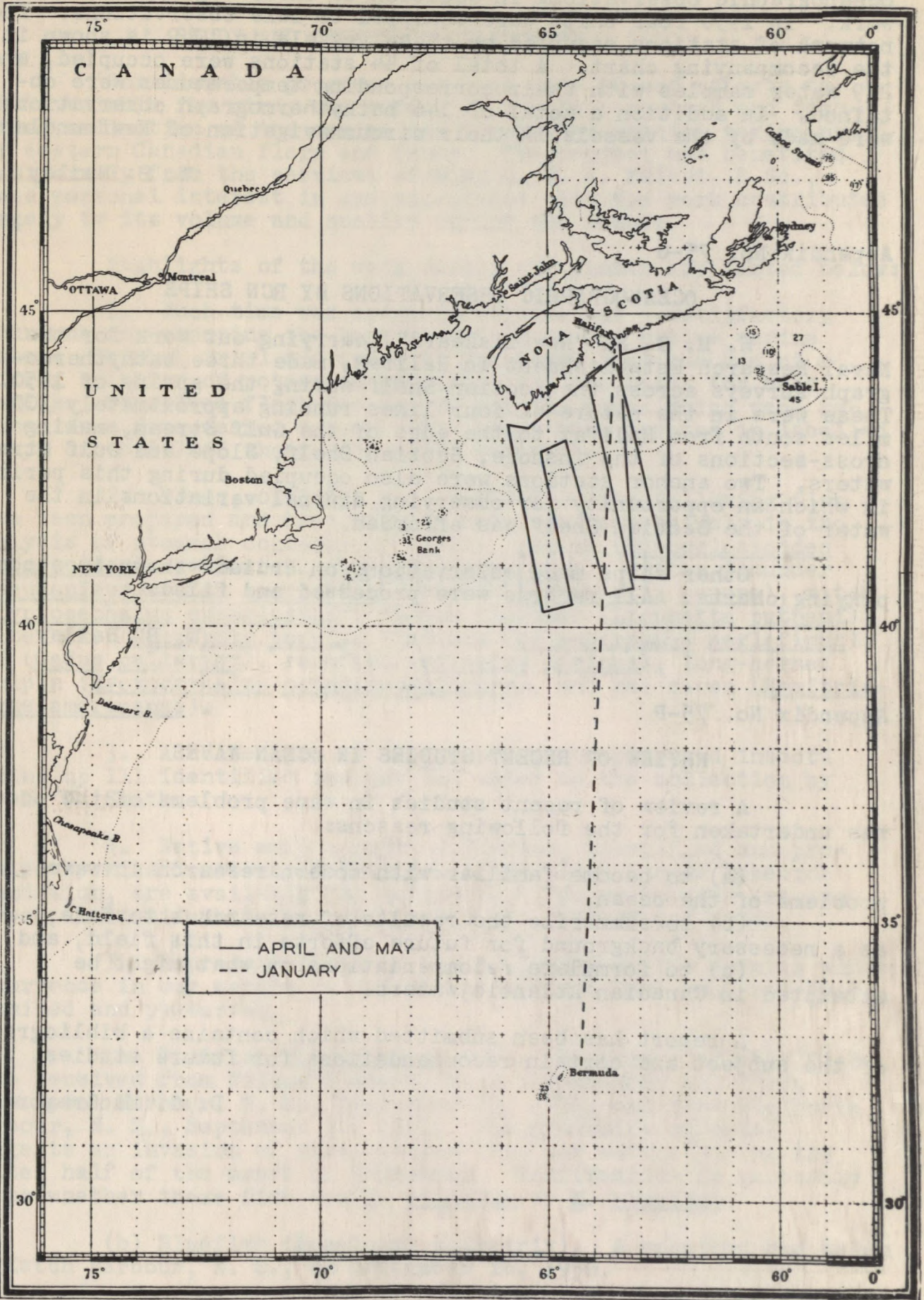


Fig. 4 Oceanographic Cruises of H.M.C. Ships in 1950.

oceanographic observations in addition to their regular survey work. In 1950 four ships were equipped to take observations. The network of stations occupied by these vessels in 1949 is shown in the accompanying chart. A total of 44 stations were occupied, and 259 water samples with their corresponding temperatures were obtained. In addition a total of 146 bathythermograph observations were made by the vessels in their circumnavigation of Newfoundland.

W. B. Bailey

Appendix No. 75-0

OCEANOGRAPHIC OBSERVATIONS BY RCN SHIPS

H. M. C. S. "New Liskeard", carrying out work for the Naval Research Establishment in Halifax, made three bathythermograph surveys across the Scotian Shelf during the spring of 1950. These were in the nature of four lines running approximately 300 miles south from Halifax to the edge of the Gulf Stream, making cross-sections of the inshore, Scotian Shelf, Slope and Gulf Stream waters. Two anchor stations were also occupied during this period in which an opportunity for observing diurnal variations in the water of the Scotian Shelf was afforded.

Other ships made observations on cruises shown in accompanying charts. All records were processed and filed.

W. B. Bailey

Appendix No. 75-P

REVIEW OF RECENT STUDIES IN OCEAN WAVES

A review of recent studies in wave problems of the ocean was undertaken for the following reasons:

- (a) to become familiar with modern research in wave problems of the ocean,
- (b) to summarize the results of researches to date, as a necessary background for future efforts in this field, and
- (c) to formulate recommendations on what might be attempted in Canadian Atlantic waters.

A report has been submitted which contains a bibliography of the subject and certain recommendations for future studies.

D. G. MacGregor

STUDY AND REFERENCE COLLECTION - 1950

Considerable progress has been made in our efforts to make available for study and reference a well-organized and identified collection of the marine and freshwater species making up our eastern Canadian flora and fauna. The project has benefited considerably from the services of Miss G. W. A. Talbot, B.Sc., whose personal interest in and experience with the work contributed largely to its volume and quality during the summer.

Highlights of the work during the summer are listed below:

1. Much time was spent in working out a satisfactory technique for exposing the bony skeletons of our native marine fishes. Through trial and error it was found that the use of a boiling solution of potassium hydroxide was the basis for best results. Dissolved flesh was washed off the bones which were retained on a fine-meshed screen. The bones were mounted in labelled groups on celluloid sheets for ready reference.

2. Bones, otoliths and scales from the following fish have been prepared and have already been used extensively in the analysis of stomach contents of seals: plaice (Hippoglossoides platessoides), yellowtail (Limanda ferruginea), winter flounder (Pseudopleuronectes americanus), brill (Lophopsetta aquosa), witch (Glyptocephalus cynoglossus), smooth flounder (Liopsetta putnami), white hake (Urophycis tenuis), haddock (Melanogrammus aeglefinus), cod (Gadus callarias), rosefish (Sebastes marinus), long-horned sculpin (Myoxocephalus octodecemspinosus), and sea raven (Hemitripterus americanus).

3. A collection of freshwater gastropods and insects making up 111 identified species was added to the collection by Dr. M. W. Smith.

4. Native marine algae collected, identified and presented by Miss Constance MacFarlane of the Nova Scotia Research Foundation, are available for reference. Twelve species are preserved in liquid while twenty species are pressed and dried.

5. Representatives of the following marine species whose occurrence in our waters is rare or occasional have been received, examined and preserved.

(a) Filefish (Monacanthus sp.). Specimens of this fish were received from Wilson's Beach, N. B., September 27, 1950; from Ketch Harbour, N. S., September 11, 1950, and from Shelburne Harbour, N. S., September 28, 1950. The proximity of dates suggests an invasion of this species into our waters during the latter half of the month of September. Confirmation is necessary as to whether these fish are M. ciliatus or M. hispidus.

(b) Bluefish (Pomatomus saltatrix). A specimen was taken at Ketch Harbour, N. S., on September 16, 1950.

(c) Bonito (Sarda sarda). A specimen was taken at Ketch Harbour, N. S., on September 27, 1950.

(d) Porgy or scup (Stenotomus chrysops). A specimen was taken in a flounder drag in St. Mary Bay, N. S., on September 29, 1950.

(e) Pilotfish (Naucrates ductor). A specimen was taken off Halifax in late July, 1950.

(f) Triggerfish (Balistes carolinensis). A specimen was taken off Halifax in late July, 1950.

(g) Swordfish remora (Remora brachyptera). A specimen was taken off Halifax on August 4, 1950. It was found attached to an ocean sunfish (Mola mola) which was harpooned.

(h) A microsporidian parasite (Plistophora Gurley) was identified from the fillets of an infected catfish (Anarhicas lupus) taken June 9, 1950, from St. Mary Bay, N. S. Identification was confirmed by the Institute of Parasitology, Macdonald College, P. Q. Stained smears of the infecting organism and sections of the infected area are available for reference.

Efforts will be directed primarily next summer to adding the bones, otoliths and scales of more of our native marine fishes to our reference collection. Collection and identification of species of our marine flora and fauna will continue.

L. R. Day

Report. 1950.

F.R.B. At. biol. stn.

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