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Fisheries Research Board of Canada

ANNUAL REPORT

OF THE

BIOLOGICAL STATION

London, Ontario



for the period

APRIL 1, 1961 to MARCH 31, 1962

BY

W. A. KENNEDY

Director

With Investigators' Summaries as Appendices

FISHERIES RESEARCH BOARD OF CANADA

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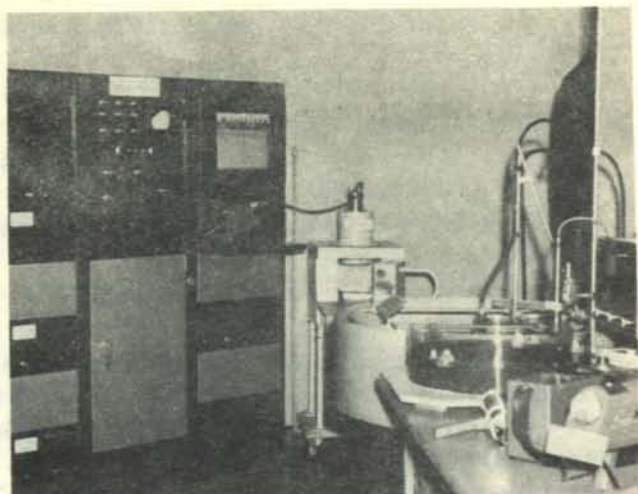
by

W. A. Kennedy, Director

With Investigators' Summaries as Appendices



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"Open House" at the Station
Nov. 29-30, 1961

1. Biologist D. Dodge discusses wall charts with Messrs. Werner and Davis of the Ontario Department of Lands and Forests.
2. Pulse height analyzer and other apparatus used to develop a technique for tagging with radioactive elements.
3. Technician G. McRae demonstrates tagging techniques used at Heming Lake.
4. Biologist R. McCauley adjusts a microscope on the stage of which are partially developed lamprey eggs.

Fisheries Research Board of Canada
Report of the Biological Station, London
for 1961-62

by W. A. Kennedy

The Biological Station at London is concerned with freshwater fisheries problems in central Canada. Its research program is primarily directed at establishing the basic biological principles requisite to the sound management of inland fisheries. In fulfillment of a contractual arrangement between the Fisheries Research Board and the Great Lakes Fishery Commission, the Station also carried out work on sea lampreys in the Canadian waters of the Great Lakes during 1961.

The administrative headquarters of this Station are in a rented two-storey building at 539 Richmond Street, London, Ontario, which is shared with the London Technological Unit. To expedite the analysis of data and the conduct of experimental work, facilities include a library, I.B.M. equipment to punch and sort data cards, equipment for determining the ages of fish from their scales, several laboratories suitable for experimentation with live fish, and associated shops. The building serves as a base for most field parties, although satellite field stations are also maintained for this purpose. A relatively large warehouse and workshop at Sault Ste. Marie, Ontario is used for storage and maintenance of equipment used in the lamprey control experiment, and about half of the men on that project are permanently stationed there. A sizeable field station at Heming Lake in northern Manitoba is occupied seasonally for research on fish populations. A field station at Hay River, N.W.T., is permanently occupied by two men in connection with research on Great Slave Lake.

In addition to a number of small boats, the Station has two 45-foot, steel-hulled, diesel-powered motor vessels. M.V. Cottus is used on Lake Superior in lamprey and fishery problems, and M.V. Stenodus is used in a study of the Great Slave Lake fisheries.

HEMING LAKE

Population Studies:

In their attempts to predict fishery yields under various conditions, fishery scientists use mathematical models of fish populations. These models are essentially equations whose terms are manipulated to represent various sets of conditions which might influence a fish population, so that the theoretical effect of various changes might be studied. All concerned have long realized that it would be most advantageous to test the validity of such mathematical models by attempting to apply them to an actual fish population.

Heming Lake has been chosen as such a testing ground. It is small enough that relatively few men can apply sufficient fishing pressure to greatly affect the population and can tag a sizeable proportion of the fish present. It is remote enough that outside interference with the experiment is unlikely. At the same time, a good deal is known about the lake and its biota because of a previous study conducted there on Triaenophorus crassus, and the physical plant used for that study is available.

Although there was preliminary work on populations in 1960, serious work started for the first time in 1961. Construction of barriers to fish migration both downstream and upstream, which was begun in 1960, was completed in early 1961. The fish of Heming Lake are now isolated from all other fish populations. Especially designed trap nets were used for the first time in 1961 to take fish for tagging. Six different variations of tags were used and nearly 5,000 fish were tagged and released. The disease of fin rot caused some difficulty during tagging, but techniques were worked out to minimize this difficulty.

The experiment consists mainly of recording the time and place of recapture and other particulars about recaptured fish, and of using this information to assess various population parameters. Data are forwarded to London weekly and transferred to I.B.M. cards. This method of handling data has greatly facilitated operations.

The experiment must run at least ten years before enough data is accumulated to test mathematical models in the intended fashion. However, one minor but important fact has already emerged. Evidence has been produced that the colour of the tag has an effect on the tagging experiment; fish with yellow tags appear to be much more susceptible to predation than do fish with clear (uncoloured) tags.

Triaenophorus crassus:

The Triaenophorus experiment has been terminated, but some information concerning it is still being collected. A heavy mortality fishery is avoided because of the requirements of the population study. For the fourth successive year the intestines of all pike examined have been completely devoid of Triaenophorus.

Other Observations:

The occurrence of black spot disease in various species of fish was noted and is being investigated. The collection of limnological data has continued. Data on the age and growth of burbot have now been worked up and a published paper is expected shortly. Two new species of minnows were identified at Heming Lake for the first time in 1961.

GREAT SLAVE LAKE FISHERY

The fishery of Great Slave Lake has been studied continuously since commercial fishing first began in 1945. The study has served to document the effect of fishing on the fish populations and the effect of the changes in the fish populations on the fishery. The resulting information has been used by the Department of Fisheries which manages the lake, and in most cases where pertinent information is available the fisheries regulations are based on the results of the study. But more important than this use of the data is the fact that information gathered from such an intensive study has wide application. Great Slave Lake is particularly appropriate for an intensive study because (a) the collection of data began with the unexploited condition and has not been interrupted, (b) the catch is landed at very few places, (c) there are relatively few species in the lake and only two are important in the commercial catch, (d) only one type of fishing gear is used, and (e) the lake is entirely under federal jurisdiction, which eliminates some problems which would arise in a similar study of any other Canadian lake of comparable size.

The main source of data has been, and remains, the commercial fishery. Samples are examined regularly from the fishermen's catches to get information on sizes of fish caught and their ages. Daily interviews of the fishermen produce information on catch per effort and on places fished. Data on total commercial catch is accumulated by officers of the Department of Fisheries and made available to us, but it is necessary to supplement this data with information gathered by other means in order to arrive at a true figure of biomass removed from the lake. Data from sources other than the commercial fishery have played a minor but important part in the general study.

Early in the history of the fishery the Department accepted our recommendation that the permitted catch from Great Slave Lake be considerably greater than had been contemplated. Because of fears that this increased catch might be too large, it was for several years necessary to closely follow the effects of the fishery on the fish as a precaution against overfishing. During this period changes in the average size of fish, in catch per effort and in age structure were closely followed. However, it was eventually established: that average size is a reliable and sufficient index of the effect of removing fish from the lake; that all over the lake average size, after an initial decrease, has become stable at a slightly lower level, indicating equilibrium between the fish population and the fishery; and that this equilibrium level is far above the overfishing level. Having thereby demonstrated that fears of overfishing are unfounded, it has been possible in recent years to suspend the time-consuming annual computation of these indices and to concentrate on a more detailed analysis of the data in order to derive more useful basic information.

The major work in 1961 has been translating data to punch cards in preparation for a much more thorough-going analysis than has been practical with the data processing methods used to date. Because this has required concentration on the development of appropriate techniques, there are

relatively few results to report from Great Slave Lake. The data have been scanned sufficiently, however, that had there been any indication of over-fishing it would have been noted.

In the field more emphasis was placed on taking observations on board fishing vessels. As a result of these extra observations, we have gained considerable confidence in our previous estimates of fish discarded "at sea". Until now these estimates have been based almost entirely on reports from the fishermen. We are very pleased to learn that actual observations confirm previous estimates.

Some fish are removed from Great Slave Lake other than by commercial fishing. There is a domestic fishery by local residents, mostly Indians, for personal use, and there is also an angling fishery. In order to assess the total effect of fisheries on fish populations of Great Slave Lake, it is necessary to know the magnitude of both the angling and domestic fisheries. The domestic fishery has been studied sporadically since 1945 and especially during the last three years. In 1961, for the first time, the angling fishery was studied. The data from these two fisheries have not been completely analyzed, but it is obvious that neither is a major contributor to the total catch from the lake.

Material collected in 1951 and 1952 on the biology of the longnose sucker, and used by a summer student as an M.A. thesis, has finally been published in the Board's Journal.

LAKE SUPERIOR FISHERIES

The Great Lakes Fishery Commission is carrying out a program designed to control sea lampreys in the upper Great Lakes. The basic purpose of their program is to enable lake trout, which sea lampreys have almost exterminated in Lakes Huron and Michigan and greatly reduced in Lake Superior, to be re-established. The immediate purpose of our Lake Superior studies is to assess the effect of lampreys on the lake trout populations and the effect, in terms of improved lake trout production, of the efforts to control the lampreys. Because the stocks of spawning lake trout have been so greatly reduced, the Province of Ontario and the States of Michigan and Wisconsin have planted millions of hatchery-reared trout in Lake Superior in recent years. Collecting data on the contribution of these planted trout, which may be recognized by distinctive patterns of fin clipping, is an increasingly important part of the Lake Superior study.

As on Great Slave Lake, the commercial fishery provides the major source of data. Because so few trout are now being taken, an attempt is being made to sample as much of the commercial catch as is possible. Increasing emphasis is being placed on putting observers aboard fishing vessels so that they may sample the fish as they are caught. A valuable supplement to our usual collecting methods is the practice of paying trustworthy fishermen to sample their own catches. This technique has proved well worth the month spent. Among the information collected are data on length and weight of fish and on the number of open wounds and healed wounds made by lampreys.

Scales are collected so that ages may be determined later.

Analysis of the data has been greatly facilitated by the use of I.B.M. punch-card equipment. Up-to-date analysis of the data was required several times during 1961 for the use of various governmental agencies who needed good information as a basis for important decisions affecting the future of the fishery. Because a system had been worked out for processing data by I.B.M. methods weekly, it was possible in every case to meet these urgent requests for accurate and up-to-date information. Without I.B.M. or something similar, these requests could never have been met.

Catch per effort declined still further in 1961. Effort also declined markedly as some fishermen became discouraged and quit fishing and as others fished less gear in view of the declining catches. As a result, the Canadian catch from Lake Superior dropped to about 44,000 pounds compared with 107,000 in 1960. The Canadian catch in 1961 was about 11% of the catch in 1958; the catch in the United States was about 28% of the 1958 catch.

The percentage of trout which bore fresh lamprey wounds dropped markedly during the latter half of the year, i. e., after the year-class of lampreys which were spawning in 1961 had left the lake for spawning. This drop could be interpreted as indicating a decline in the number of lampreys in Lake Superior and attributable to lamprey control efforts. However, it should be noted that there was still considerable lamprey wounding.

Among the fin-clipped, hatchery-reared fish recovered in 1961 were individuals released in each of the years 1954 to 1961 inclusive, most of them being those released in 1958, 1959 and 1960. Although hatchery-reared fish have until recently been only a minor segment of the population, the year-classes which were 2, 3 and 4 years old in 1960 included considerable proportions of hatchery-reared fish. There has obviously been a rapid decline in natural reproduction in recent years. Extrapolation suggests that within a very few years the fishery, if any, will be supported almost entirely by hatchery products.

In 1961 we began collection of data on fisheries for species other than lake trout, particularly whitefish.

RESEARCH ON SEA LAMPREYS

Radioisotopes:

Work on radioisotopes was terminated during 1961. Two papers were published.

Field work consisted of using radioactive caesium (Caesium-137) to tag ammocoetes as a means of assessing population size. Radioisotopes were used to tag ammocoetes because conventional tags and other methods of marking have never proved suitable. A number of animals were tagged with Caesium-137 and released in three different streams on St. Joseph's Island, North Channel, Lake Huron. The experiment successfully

demonstrated the usefulness of this radioisotope for tagging ammocoetes.

Physiology:

Experiments on the physiology of sea lampreys have been conducted for several years; first strictly as a Board project, later as an agent for the Great Lakes Fishery Commission. Since the project is being terminated, it seems appropriate to summarize results.

The thermal tolerance of sea lampreys has been studied during each life history stage. During most stages the responses of lampreys to lethal temperatures correspond to those exhibited by fish. Except in the egg stage, lampreys can, given time to acclimate, live at all temperatures between 0°C and approximately 30°C. However, the temperature range within which eggs will develop is much narrower.

During 1961 experiments were concerned solely with temperature tolerance during the egg stage. In order to lengthen the period over which the eggs would be available, spawning was delayed in a number of mature sea lampreys by holding them at low temperatures until required. Unfortunately, the fertilized eggs which resulted did not develop successfully. However, it was possible to demonstrate that, although eggs require temperatures between 15° and 25°C in the early stages, they will tolerate a wider range at later stages of development. This information will in some cases be useful in deciding whether lampreys can use certain streams for breeding purposes.

Swimming Speed of Ammocoetes:

A summer student, largely on his own initiative and mainly after hours, has conducted a number of experiments on the swimming speed of sea lamprey ammocoetes. Previous attempts to determine their swimming speed by conventional methods had been unsuccessful. However, a suitable technique was developed. It was found that ammocoetes, unlike fish, do not have a minimum rate of swimming which they can maintain indefinitely. Ammocoetes swim for a limited time only and then rest; the faster they swim the shorter will be the time that they can continue to swim.

Ammocoetes:

The biology of sea lamprey ammocoetes has been studied for several years, first strictly as a Board project, then as an agent of the Great Lakes Fishery Commission. The project has terminated and the results are almost ready for publication. It seems an appropriate time to review findings.

It has become apparent from these studies that sea lamprey ammocoetes are much more adaptable than was previously realized. Ammocoetes tend to remain in their burrows in the stream bottom during daylight and to emerge, if they emerge at all, only during darkness, particularly immediately after nightfall. They seldom leave their burrows, but do move a good deal within the substrate. Freshets tend to dislodge them. Either active emergence from the burrow or passive movement as a result of being washed out of the

stream bed results in a consistent movement downstream; usually they are not able to swim against even moderate currents, so any movement must be downstream. As a result, ammocoetes from comparatively short streams reach the open lake long before metamorphosis. They seem to develop just as successfully in the open lake as if they had remained in the parent stream. Lake-living populations of sea lamprey ammocoetes were found off the mouths of six of the eight streams investigated. In the inshore areas they occurred at a rate of approximately 1.7 animals per 1,000 square yards, and the limited data available indicates comparable concentrations in the offshore areas.

None of the conventional methods for determining fish ages are applicable to sea lamprey ammocoetes, since they have no scales, fins, otoliths, etc. However, information recently published in Britain has provided a clue for assessing their ages. As a result, ammocoetes in Big Creek (Lake Erie) are now tentatively regarded as 5½ and 6½ years old at the time of metamorphosis, and it is tentatively concluded that ammocoetes in other Great Lakes watersheds are of comparable age. There is evidence to suggest that metamorphosis takes place at a specific age rather than at a specific size, as had been assumed until recently.

Lampreys in the Welland Canal:

Observations were made in the Welland Canal in 1959 and in 1961 to determine whether lampreys use that waterway extensively for migrations between Lake Ontario and Lake Erie. The Canal is emptied after navigation closes in December each year and it was at that time that observations were made. Thirteen species of fish were collected in the locks, including white perch, a new record for the area. No lampreys were collected.

LAMPREY CONTROL EXPERIMENT

Lamprey Barriers:

Electrical barriers were operated from mid-May until July 31 on eight streams tributary to Lake Superior in order to assess the magnitude of migrant sea lamprey runs. Two barriers, the Goulais and Michipicoten, which had been operated in 1960 were not operated in 1961, since experience had showed that at these barriers only part of the run was counted, that the proportion counted varied from year to year and that it could not be estimated with reasonable accuracy.

The total number of adult sea lampreys killed and collected from the eight barriers on the Canadian side of Lake Superior in 1961 was 2,895 compared with 3,887 collected from the same barriers in 1960. Comparable counts from previous years, that is, counts at the eight barriers operated in 1961 for roughly the same period, are shown in the accompanying table. Counts from the 29 United States barriers operated until July 12 in 1961 are shown for comparison, along with counts from the same barriers in previous years for roughly the same period; not all of the 29 barriers were run in 1955 or 1956, so approximate comparative values for those years are

calculated knowing that the recorded count at the 24 used in 1955 was 10,146 that year, 21,364 in 1956 and 33,903 in 1957. All values in the table are rounded to avoid a false implication of accuracy in the counts.

	1955	1956	1957	1958	1959	1960	1961
Canada	2,000	2,100	2,100	1,600	2,300	3,900	2,900

U.S.A.	15,000	30,000	48,000	58,000	45,000	38,000	68,000

The overall 1961 count is the highest yet recorded. The table could be interpreted as indicating a steadily increasing population from which fluctuating "catches" are made by a fixed amount of "gear", because of the variations in "catchability" which seem to be an inevitable part of any fishery.

Stream Surveys:

Stream surveys are carried out to determine lamprey distribution as a necessary preliminary to attempts at lamprey control. Frequent re-surveys are necessary to follow the effects of lamprey control attempts and to see whether lampreys are spreading to previously unused streams. Usually surveys are carried out by electro-shocking devices which have tended to become more powerful in recent years. A recent innovation is the use of lampricide in high concentrations for a short time as a survey tool. Lampricide used in this way brings the ammocoetes out of their burrows where they may be collected and has demonstrated ammocoetes in places where other methods had failed to find them. Most of the surveys in 1961 were confined to Lake Superior where streams on St. Ignace Island and nearby areas were surveyed in early summer and streams in the vicinity of Marathon were surveyed later in the season. Streams in the Marathon area had been surveyed earlier with negative results, but recent evidence of adult lamprey activity there has created a strong suspicion that one or more streams in the area may be producing considerable numbers of lampreys without our knowledge.

A number of streams which had been treated with lampricide in 1959 and 1960 were re-surveyed during 1961 and in some of them ammocoetes were discovered which, on the basis of their size, were judged to have been present during, and to have survived, the chemical treatments. Discovery of these ammocoetes has suggested further refinements of lampricide application techniques; these have since become standard practice.

Lampricide Application:

Twenty streams, tributary to Lakes Huron and Superior, were treated with lampricide as specified in a Memorandum of Agreement between the

Fisheries Research Board and the Great Lakes Fishery Commission. All were treated at a concentration and for a duration of time which bio-assays had indicated would produce at least a 99.9% level of mortality to lampreys. The streams treated were: Chippewa, Pancake, Batchawana, Sable and Wolf Rivers on Lake Superior; and Root, Gawas, Two Tree, Richardson's, Gordon's, Brown's, McBeth, Mississagi, Lauzon, Serpent, Nottawasaga and Livingstone Rivers, also an unnamed stream (H-114) and Lafontaine Creek on Lake Huron.

The Wolf River in western Lake Superior was treated, then immediately retreated as an experiment. No ammocoetes were recovered during the second treatment, indicating a high percentage mortality during the first and demonstrating that areas left dry when stream flow is artificially restricted do not harbor ammocoetes. Details on individual stream treatments are given in Appendices 28, 30 and 31.

PUBLICATIONS

- Applegate, Vernon C., John H. Howell, James W. Moffett, B. G. H. Johnson and Manning A. Smith. Use of 3-trifluormethyl-4-nitrophenol as a selective sea lamprey larvicide. Great Lakes Fishery Commission, Technical Report No. 1, 35 pp., May, 1961.
- Cormack, H. E. Can ultrasonics be used to control sea lampreys? Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, p. 36, May 1961.
- Harris, Roy H. D. Growth and reproduction of the longnose sucker, Catostomus catostomus (Forster), in Great Slave Lake. J. Fish. Res. Bd. Canada, Vol. 19, No. 1, pp. 113-126, 1962.
- Johnson, B. G. H. The development of specific lampricides and techniques for their use. Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, pp. 27-31, May 1961.
- Keleher, J. J. Largest fish from Great Slave Lake. Fish. Res. Bd. Canada, London, Ont., Circular No. 3, pp. 12-16, Aug. 1961.
- Keleher, J. J. Comparison of largest Great Slave Lake fish with North American records. J. Fish. Res. Bd. Canada, Vol. 18, No. 3, pp. 417-421, 1961.
- Kennedy, W. A. Scale reading - what, how and why. Fish. Res. Bd. Canada, London, Ont., Circular No. 4, pp. 1-8, March 1962.
- Lamsa, A. Fish and lamprey movements in Silver Creek, Ontario. Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, pp. 21-24, May 1961.
- Lawler, G. H. Abnormalities in Lake Erie whitefish. J. Fish. Res. Bd. Canada, Vol. 18, No. 2, pp. 283-284, 1961.

- Lawler, G. H. Egg counts of Lake Erie whitefish. J. Fish. Res. Bd. Canada, Vol. 18, No. 2, pp. 293-294, 1961.
- Lawler, G. H. Silver pike, another fish to watch for. Fishing, A Bulletin for Commercial Fishermen, Vol. 2, No. 3, pp. 8-10, March 1961. Manitoba Department of Mines and Natural Resources, Winnipeg.
- Lawler, G. H. Silver pike, a fish to watch for -- and to report. Wildlife Crusader, Vol. 7, No. 4, p. 6, May 1961. Manitoba Federation of Game and Fish Associations, Winnipeg.
- Lawler, G. H. Heming Lake experiment. Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, pp. 48-50, May 1961.
- Lawrie, A. H., and J. J. Tibbles. The operation of electrical barriers to sea lamprey migration on the Canadian tributaries to Lake Superior -- 1959 and 1960. Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, pp. 25-26, May 1961.
- McCauley, R. W. The action of electrical barriers on sea lampreys. Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, pp. 18-20, May 1961.
- McCauley, R. W. The sea lamprey's position in the animal kingdom. Fish. Res. Bd. Canada, London, Ont., Circular No. 3, pp. 1-3, Aug. 1961.
- McCauley, R. W. A trout farm in the Black Forest, Germany. Fish. Res. Bd. Canada, London, Ont., Circular No. 4, p. 9, March 1962.
- Roberts, K. G., and J. J. Keleher. M.V. Stenodus, research vessel at Great Slave Lake. Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, pp. 3-4, May 1961.
- Roberts, K. G., and J. J. Keleher. Fisheries vessel is valuable. News of the North, Yellowknife, Vol. 17, No. 9, June 29, 1961.
- Scott, D. P. Radioactive iron as a fish mark. J. Fish. Res. Bd. Canada, Vol. 18, No. 3, pp. 383-391, 1961.
- Scott, D. P. Radioactive caesium as a fish and lamprey mark. J. Fish. Res. Bd. Canada, Vol. 19, No. 1, pp. 149-157, 1962.
- Smith, G. F. M. Counting fish. Fish. Res. Bd. Canada, London, Ont., Circular No. 3, pp. 17-18, Aug. 1961.
- Smith, Manning A., Vernon C. Applegate and B. G. H. Johnson. Physical properties of some halo-nitrophenols. Journal of Chemical and Engineering Data, Vol. 6, No. 4, pp. 607-608, Oct. 1961.
- Thomas, M. L. H. Ammocoete biology. Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, pp. 14-17, May 1961.

- Thomas, M. L. H. Lamprey fisheries, past and present, of North America and Europe. Fish. Res. Bd. Canada, London, Ont., Circular No. 3, pp. 4-7, Aug. 1961.
- Tibbles, J. J. Preparations for lamprey control in Lake Huron. Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, pp. 32-35, May 1961.
- Vladykov, V. D., and G. N. Mukerji. Order of succession of different types of infraoral lamina in landlocked sea lamprey (Petromyzon marinus). J. Fish. Res. Bd. Canada, Vol. 18, No. 6, pp. 1125-1143, 1961.
- Watson, N. H. F. The status of the commercial trout-rearing industry. Fish. Res. Bd. Canada, London, Ont., Circular No. 3, pp. 19-21, Aug. 1961.
- Watson, N. H. F., and G. H. Lawler. Studies on the eggs and first intermediate stages of Triaenophorus at Heming Lake, Manitoba. Fish. Res. Bd. Canada, Prog. Rept., London, Ont., No. 2, pp. 51-52, May 1961.

MANUSCRIPT REPORTS

- Keleher, J. J. A documented review of Great Slave Lake commercial catch regulations. MS Rept. Biol., No. 715, 148 pp., February, 1962.
- Kennedy, W. A. Daily catch record of Crewe Brothers Fishery, Lake Erie - 1904 to 1956. Volume I. MS Rept. Biol., No. 706, pp. 1-66, Oct., 1961.
- Kennedy, W. A. Daily catch record of Crewe Brothers Fishery, Lake Erie - 1904 to 1956. Volume II. MS Rept. Biol., No. 706, pp. 67-330, Oct., 1961.
- Kennedy, W. A. Daily catch record of Crewe Brothers Fishery, Lake Erie - 1904 to 1956. Volume III. MS Rept. Biol., No. 706, pp. 331-411, Oct., 1961.
- Le Maire, H. Elizabeth. Experiments to determine the effect of pH on the biological activity of two chemicals toxic to ammocoetes. MS Rept. Biol., No. 691, 3 pp., May, 1961.
- Thomas, M. L. H. The distribution of sea lamprey ammocoetes in the lake off eight rivers draining into the Canadian waters of Lake Superior. MS Rept. Biol., No. 710, 74 pp., Nov., 1961.

LIST OF FILMS AVAILABLE AT LONDON STATION

1. Expedition to Great Bear Lake - 1945:

Prepared by: The late Dr. R. B. Miller for the Fisheries Research Board.

Size: 8 mm.

Time to run: 20 min.

Description: Colour - silent - two reels.
A pictorial record of the Board's expedition to Great Bear Lake in 1945, including considerable footage of free-swimming fish which can be seen surprisingly well through the remarkably clear water.

2. Fisheries of Great Slave Lake 1956:

Prepared by: National Film Board for Dept. of Fisheries.

Size: 16 mm.

Time to run: 19 min.

Description: Colour with sound.
In the heart of the blossoming Mackenzie district, commercial fishermen are drawing rich harvests of some of the world's finest whitefish and lake trout from the chilly depths of Great Slave Lake, whose commercial possibilities were explored by government scientists in 1944. The film takes a look at this northern enterprise showing operations of independent fishing companies as they catch, process and ship huge quantities of fish to the markets of the world. Concluding sequences show the versatile use of the snowmobile during the winter fishing season.

3. Fish Spoilage Control - 1956:

Prepared by: National Film Board for Dept. of Fisheries.

Size: 16 mm.

Time to run: 10 min.

Description: Part in colour and part in black and white, with sound. An animated cartoon illustrating contamination of fish and correct methods of handling

to ensure freshness from boat to dinner table. The spoilage process is portrayed by battalions of little red demons who march in full invading force upon the hapless form of freshly caught fish. They demonstrate most effectively how every act of carelessness in fish handling will increase their numbers but how proper refrigeration and sanitary methods will put them to route.

4. Great Lakes Invader (Sea Lamprey):

Prepared by: U.S. Fish and Wildlife Service.

Size: 16 mm.

Time to run: 20 min.

Description: Colour with sound.
An account of destruction by sea lampreys in Lakes Huron and Michigan, of lamprey biology, and of plans for controlling sea lampreys as of about 1954.

5. Lamprey Barriers 1957-58:

Prepared by: Fish. Res. Bd. Canada, London Biological Station.

Size: 8 mm.

Time to run: 25 min.

Description: Silent - colour.
Views of electrical barriers used on the Canadian side of Lake Superior and activities at them.

6. Chemical Warfare on Lamprey 1961:

Prepared by: Fish. Res. Bd. Canada, London Biological Station.

Size: 16 mm.

Time to run: 25 min.

Description: Colour - silent (needs revising).
Film depicts the activities of the sea lamprey control experiment - working on the various aspects of operation of electrical barriers, survey for distribution of sea lamprey ammocoetes, and chemical treatment of streams.

STAFF LIST ARRANGED TO SHOW ORGANIZATION AND ASSIGNMENTS

(April 1, 1961 to March 31, 1962)

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Director	W. A. Kennedy, Ph.D.
Senior Scientist	A. H. Lawrie, M.A. (Ass't Director)
Administrative Officer 2	R. B. Rush (Executive Assistant)
Administrative Ass't.	R. S. Williams
Clerk 3	K. L. Cuthbert
Clerk 1	Carol A. March
Clerk 1	J. W. Morrison
Clerk 1	Vilma Rikters
Stenographer 3	Emiliana Davis
Stenographer 2	Patricia L. Churchill (from Oct. 23)
Stenographer 2	Enid C. Dolan (to Aug. 31).
Typist 1	Caroline Boam
Maintenance Helper	M. Thomas

SERVICESDrafting & Photography:

Assistant Technician 3	S. T. Zettler
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Library:

Technician 1	Annabelle R. Taylor, B.Sc.
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Punch Cards:

Clerk 2	A. Eleanor Gough
Clerk 2	Lorraine J. Hamilton

Scale Reading:

Assistant Technician 1	J. A. Myatt
Assistant Technician 1	Barbara M. Johnson
Assistant Technician 1	Katie M. Kennedy
Assistant Technician 1	Mary E. Regan
Assistant Technician 1	Irene D. Weir

SERVICES (cont'd)S.C.U.B.A. Diving:

Technician 1

P. J. McPherson

INVESTIGATIONSPopulation Dynamics:Principal Scientist, i/c
Senior ScientistG. F. M. Smith, Ph.D.
G. H. Lawler, Ph.D. (i/c Heming
field station)Technician 1
Assistant Technician 3G. P. McRae
J. G. McCauley (full time from Apr. 17,
half time from Nov. 16)Cook
CookHelen I. McLean (May 4-Sept. 10)
Ella Hedin (Jun. 11-Jun. 19, Oct. 11-Oct. 22)Student Assistant
Student Assistant
Student Assistant
Student AssistantJ. H. Brown (May 16-Sept. 11)
K. A. Palm (May 15-Sept. 11)
R. J. MacLeod (May 30-Sept. 11)
A. G. Wikjord (May 4-Sept. 11)Great Slave Lake:

Associate Scientist, i/c

J. J. Keleher, M.A.

Technician 2

K. G. Roberts (i/c M. V. "Stenodus"
and Hay River field station)

Assistant Technician 3

C. G. Haight

Assistant Technician 3

B. E. Meeker, B.A. (May 15-Mar. 31)

Student Assistant

M. C. Petreman (May 15-Sept. 9)

Student Assistant

D. A. Pringle, B.A. (Jun. 2-Sept. 13)

Student Assistant

J. Solohub (May 1-Sept. 16)

Student Assistant

J. W. Snarr (May 5-Sept. 6)

1 Casual (9-3/4 man-days)

Lake Trout:Senior Scientist, i/c
Assistant ScientistA. H. Lawrie, M.A.
A. Rojo, Ph.D. (to Aug. 31)

Technician 2

R. M. Hanson

Technician 1

W. M. Ransbury (i/c M. V. "Cottus")

Assistant Technician 3

L. R. Golden

Assistant Technician 3

H. B. Chisholm (Apr. 4-Jan. 11)

INVESTIGATIONS (cont'd)Lake Trout - cont'd:

Technician 1	C. C. Parker
Technician 1	A. G. Ryder
Assistant Technician 3	D. V. Browne (from Jan. 1)
Assistant Technician 3	D. V. Carroll (May 8-Jul. 15)
Assistant Technician 3	D. F. Hunt (May 8-Nov. 15)
Assistant Technician 3	J. E. Hurdman (Jul. 31-Dec. 15)
Assistant Technician 3	J. Soga, B.A. (from Aug. 28)
Assistant Technician 3	T. P. Van Dyk (to Sept. 19)

1 Casual (22½ man-days)

Radioisotopes:

Associate Scientist	D. P. Scott, Ph.D.
Technician 1	J. Hoy

Special Advisor:

Principal Scientist	F. E. J. Fry, Ph.D. (Jun. 1-30)
---------------------	---------------------------------

LAMPREY CONTROL EXPERIMENTLamprey Physiology:

Assistant Scientist, i/c	R. W. McCauley, M.A.
Assistant Technician 2	J. A. Sholdice (Apr. 4-Sept. 20)

Ammocoetes:

Assistant Scientist	M. L. H. Thomas, B.Sc. (educational leave from Oct. 17)
---------------------	---

Chemical Treatment:

Associate Scientist, i/c	J. J. Tibbles, Ph.D.
Assistant Scientist	A. Lamsa, B.A. (i/c treatments)
Assistant Scientist	B. G. H. Johnson, M.Sc.
Assistant Scientist	H. Elizabeth LeMaire, M.A.
Assistant Scientist	D. P. Dodge, B.S.A. (from Jun. 1)

LAMPREY CONTROL EXPERIMENT (cont'd)Chemical Treatment (cont'd):

Technician 2	D. L. Holmberg
Technician 2	J. R. Miron (to Jun. 21)
Technician 1	W. Pratt (deceased Jun. 12)
Technician 1	C. M. Tiede
Assistant Technician 3	U. W. Dube
Assistant Technician 3	R. W. Gibbons
Assistant Technician 3	E. G. Golden (from Apr. 24)
Assistant Technician 3	M. J. McCarthy
Assistant Technician 3	C. C. Rivers
Assistant Technician 3	R. D. Somers (from Apr. 24)
Cook	C. Beckett (Apr. 24-Nov. 30)
Cook	J. A. Breckenridge (Apr. 24-Nov. 22)
Cook's Helper	R. G. Breckenridge (Apr. 24-Nov. 22)
Student Assistant	T. J. Buscher (May 1-Sept. 15)
Student Assistant	W. A. Davis (May 1-Sept. 5)
Assistant Technician 2	E. Arnold (Apr. 24-Oct. 6)
Assistant Technician 2	R. P. Bouchard (Oct. 11-Nov. 1)
Assistant Technician 2	G. Arbo (May 30-Jul. 3)
Assistant Technician 2	F. B. Brannigan (Jul. 5-Nov. 15)
Assistant Technician 2	F. Chavy (Apr. 24-Jul. 3)
Assistant Technician 2	A. R. Easton (Jul. 5-Nov. 15)
Assistant Technician 2	A. A. Higo (May 1-Dec. 13)
Assistant Technician 2	M. A. Holland (Jul. 5-Oct. 4)
Assistant Technician 2	M. A. Kay (Apr. 17-Dec. 2)
Assistant Technician 2	D. W. Marshall (Oct. 2-Nov. 23)
Assistant Technician 2	G. R. Moskwa (Jul. 5-Nov. 11)
Assistant Technician 2	W. Paul (Apr. 17-Jul. 4)
Assistant Technician 2	J. R. Pavelko (Apr. 24-Nov. 15)

Bio-assay and Nipigon Barriers:

Assistant Scientist	S. M. Dustin, M.S.
Technician 1	F. R. Green
Assistant Technician 3	P. M. Neveau

LAMPREY CONTROL EXPERIMENT (cont'd)Electrical Barrier Operation:

Technician 4, i/c	A. W. Carter (i/c S. S. Marie field station)
Technician 1	G. E. Smith
Assistant Technician 3	H. G. Fairbairn (from Apr. 4)
Storeman 2	L. King
Assistant Technician 2	L. Lewis (Jun. 16-Nov. 1)
Assistant Technician 2	R. J. Stevenson (May 1-Nov. 15)
Assistant Technician 2	W. Swanson (Jun. 16-Nov. 1)
2 Casual (54 man-days)	

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SPECIES NAMED

The following species of aquatic vertebrates are mentioned in this report and its appendices; synonymy is indicated to assist the reader in identification. In most cases the "common name" is the one recommended by a committee of the American Fisheries Society. "Short names" are alternatives used for brevity or to include more than one species. An asterisk in the "common name" column indicates the designation when identification is not made to species.

<u>Common Name</u>	<u>Scientific Name</u>	<u>Short Name</u>
Sea lamprey	<u>Petromyzon marinus</u>	lamprey
Silver lamprey	<u>Ichthyomyzon unicuspis</u>	lamprey
Michigan brook lamprey	<u>Ichthyomyzon fossor</u>	lamprey
*	<u>Ichthyomyzon spp.</u>	lamprey
American brook lamprey	<u>Entosphenus lamottei</u>	lamprey
Alewife	<u>Alosa pseudoharengus</u>	...
Gizzard shad	<u>Dorosoma cepedianum</u>	...
Lake trout	<u>Cristivomer namaycush</u>	trout
Lake whitefish	<u>Coregonus clupeaformis</u>	whitefish
*	<u>Leucichthys spp.</u>	cisco
American smelt	<u>Osmerus mordax</u>	smelt
White sucker	<u>Catostomus commersoni</u>	sucker
Longnose sucker	<u>Catostomus catostomus</u>	sucker
Longnose dace	<u>Rhinichthys cataractae</u>	dace
Rosyface shiner	<u>Notropis rubellus</u>	minnow
Common shiner	<u>Notropis cornutus</u>	minnow
Spottail shiner	<u>Notropis hudsonius</u>	minnow
Blacknose shiner	<u>Notropis heterolepis</u>	minnow
Fathead minnow	<u>Pimephales promelas</u>	minnow
Carp	<u>Cyprinus carpio</u>	...
Channel catfish	<u>Ictalurus punctatus</u>	catfish
Northern pike	<u>Esox lucius</u>	pike
Trout-perch	<u>Percopsis omiscomaycus</u>	...
Burbot	<u>Lota lota</u>	...
Yellow perch	<u>Perca flavescens</u>	perch
Logperch	<u>Percina caprodes</u>	...
Iowa darter	<u>Etheosoma exile</u>	darther
Johnny darter	<u>Etheosoma nigrum</u>	darther
Rock bass	<u>Ambloplites rupestris</u>	...
White perch	<u>Roccus americanus</u>	...
White bass	<u>Roccus chrysops</u>	...
Miller's thumb	<u>Cottus cognatus</u>	sculpin
Muddler	<u>Cottus bairdi</u>	sculpin
Mud puppy	<u>Necturus maculosus</u>	...

G. H. Lawler
G. F. M. Smith

Appendix 1

TAGGING AND RECAPTURE DATA FOR 1961

The following tag types were used in the studies begun at Heming Lake in 1961:

- Spaghetti Dart Tag - spaghetti streamer of clear plastic with impregnated black serial numbers.
- Swedish Carlin "Smolt" Tag - 50% attached by stainless steel wire; 50% attached by tantalum wire. Tag made of clear plastic with black serial numbers.
- Anchor Tag - Small barb of spring stainless steel for insertion into fish. Clear plastic identifying tags attached to anchor by (1) stainless steel wire, or (2) tantalum wire, or (3) monofilament nylon.

The number of each type of tag released and the number of recaptures are shown in Table I.

Table I. Tagging at Heming Lake in 1961. (Fish marked with yellow tags not included in this table.)

	Number of tags applied	Number of recaptures	% recaptured
Spaghetti Dart Tags	1186	141	12
Carlin Smolt Tags			
Tantalum wire	803	125	15
Stainless steel wire	<u>788</u>	<u>105</u>	<u>13</u>
Total	1591	230	14
Anchor Tags			
Stainless steel streamer	837	95	11
Tantalum streamer	861	80	9
Nylon streamer	<u>465</u>	<u>41</u>	<u>9</u>
Total	2163	216	10

Approximately 12% of all tagged fish were recaptured during the fishing season. Carlin smolt tags showed a slightly higher rate of return than the other types with a recapture rate of 14%. Fewer anchor tags were recaptured than either dart or Carlin tags.

G. H. Lawler
G. F. M. Smith

Appendix 2

SMALL RETURN OF COLOURED TAGS

During the experimental tagging in Heming Lake, 1960, some of the yellow plastic identification discs of streamer tags were recovered from pike stomachs. Most of the tags used in 1961 had clear plastic discs, but as an experiment about one-half of the perch less than 15cm were tagged with clear discs and the other half with yellow discs. The perch were of a size that could be readily eaten by pike. Several methods of attachment were used, as have been noted in Appendix 1. The various types were exposed to essentially the same recovery effort over the same time. The tagging and recovery record is as follows:

Table I. Tagging perch less than 15 cm - 1961.

	Y e l l o w			C l e a r		
	Tagged	Recap- tured	% Recap.	Tagged	Recap- tured	% Recap.
Anchor stainless	76	2	2.6	124	28	23.0
Anchor tantalum	77	5	6.5	99	17	17.0
Anchor nylon	<u>31</u>	<u>1</u>	<u>3.3</u>	<u>44</u>	<u>4</u>	<u>9.0</u>
Anchor total	184	8	4.4	267	49	18.3
Carlin stainless	84	2	2.4	81	2	2.5
Carlin tantalum	<u>79</u>	<u>6</u>	<u>7.6</u>	<u>56</u>	<u>8</u>	<u>14.3</u>
Carlin total	163	8	4.9	137	10	7.2
Total	347	16	4.6	404	59	14.6

The difference between clear and yellow discs is significant at the 1% level, but the differences between anchor and carlin attachment or between tantalum and stainless steel wire are not significant at the 5% level.

It is concluded that at least in this application the use of coloured (yellow) discs would invalidate the use of recapture data for population estimates.

G. H. Lawler
G. F. M. Smith

Appendix 3

COMPARISON OF GILL-NET CATCHES IN 1960 AND 1961

A moderate gill-net fishery was imposed on the Heming Lake fish population in 1961, so that changes in the population could be followed by comparing the catches with previous years. Since 1952 two gangs of nylon gill nets, each composed of three nets of 1-1/2, 2-3/4 and 3-1/2 inch stretched mesh, have been fished in exactly the same localities. One gang has been set in a relatively shallow productive bay and the other set has been made in the deepest region of the lake. In 1961 these nets were set during the early warming period of the lake, when the lake temperature had reached its maximum, and then again when the temperature had begun to decline. For comparative purposes the total catch from the deep and shallow areas have been combined for each of the years and this is shown in the accompanying table.

Table I. Total numbers of each of several species of Heming Lake fish caught in 1960 and 1961 from comparable effort.

Species	1960	1961
Perch	134	329
Sucker	684	490
Whitefish	14	26
Pike	148	158
Burbot	3	8

A marked increase in the catch of perch is noted for 1961. There has been a slight decline in the number of suckers, but the pike population appears to be relatively stable. The numbers of whitefish and burbot taken were too small to evaluate.

G. H. Lawler
G. F. M. Smith

Appendix 4

SPECIES CAPTURED WITH VARIOUS FISHING GEAR IN 1961

Prior to 1961 the fishing effort on Heming Lake was directed towards the reduction of the pike population. Gill nets were used almost exclusively in the latter years of the program. In 1960 live-capture fishing methods, for tagging studies, were introduced and small experimental trap nets were used for the first time. In 1961 live-capture gear was used almost exclusively, except for three periods during which moderate gill-net fishing was imposed. Most of the fish were captured in trap nets and seines. It was intended to supplement these fishing gears with a trammel net, but the net did not arrive till near the close of the 1961 operations, and so we were unable to assess its usefulness in the current study. The amount of fishing effort for each method follows:

- 271 trap nets (one trap net set for 24 hr).
- 174 gill-net sets (one 50-yard gill net set for 24 hr).
- 133 seine hauls (each haul took less than ½ hr).
- 8 trammel sets (each 100-yard set took about ½ hr).

The total catch by species and gear type is shown in Table I.

Table I. Number of each species of Heming Lake fish captured by each type of fishing gear in 1961.

Species	No. Gear	Gill Nets	Seine	Trammel	Trap Nets	Total
Perch	11	520	984	1	979	2495
Sucker	20	556	1771	13	2059	4419
Burbot	2	11	...	...	77	90
Cisco	...	4	...	...	...	4
Whitefish	...	28	...	...	...	28
Pike	3	179	240	4	88	514
Total	36	1298	2995	18	3203	7550

G. H. Lawler
G. F. M. Smith

Appendix 5

PHYSICAL PROGRESS FOR TAGGING STUDIES

In last year's annual report, a description of the fish fences used to prevent movement of marked fish out of Heming Lake was given. Extremely severe weather conditions in the fall of 1960 prohibited installation of the racks in the fence at the main inlet of the lake. Favorable conditions existed in the spring of 1961 and the fence was completed before the lake broke and before the tagging program began.

Trap nets designed for Heming Lake studies were used for the first time in 1961. These nets were simply constructed, yet proved efficient for the task. To carry out tagging studies it is much more efficient to have many small samples rather than a few large ones. These nets averaged about 35 fish per lift, which is just about the number that can be handled safely and conveniently. Specifications on the nets are available at the Station. One-inch mesh was used in the crib and one and one-half inch mesh in the leader.

A 200-yard all-nylon trammel, whose inner mesh was one inch stretched, arrived too late to be tested in the summer. It was used in the late fall (when trammel nets are normally not too efficient) and it was found that a 200-yard nylon net could be handled almost as easily as the 100-yard cotton net used in previous years. Further tests this coming spring will show how many fish a 200-yard net will capture. If it takes too many fish to conveniently tag, the net will be cut into two 100-yard nets.

Other equipment designed to increase the accuracy and speed up measurements included stainless steel rulers marked in 1/2-centimeter intervals and a balance marked in dekagrams.

Sites were chosen for a warehouse and living cabin, the land was cleared and footings for these buildings were poured in 1961.

G. H. Lawler

Appendix 6

INCIDENCE OF TRIAENOPHORUS CRASSUS IN PIKE AND COREGONINES

During the life-history and pike-exploitation studies of Triaenophorus at Heming Lake, all intestines from pike captured between mid-August and mid-September were examined for T. crassus and T. nodulosus parasites. In the current program at Heming Lake it is not possible to examine every pike captured, as live-capture methods of fishing are being used and tagged fish

cannot be sacrificed for examination for parasites. During 1962 gill nets were fished only during three periods of 10 days each. All pike captured in these gill nets were examined for Triaenophorus. Although the sample size was smaller than in previous years, it probably was representative of the population, since pike of all sizes were captured in the various mesh sizes employed. The results of these examinations are shown in Table I. For four years running no T. crassus parasites have been found in pike intestines. Reiterating last year's statement, "there is no doubt now but that the life cycle of T. crassus in this lake has been broken." The decline in Triaenophorus infection has resulted from an actual decline in the numbers of parasites in lake whitefish, coupled with a reduction in the population of larger pike which maintain the life-cycle by eating infected coregonines.

Table I. The percentage of pike infected with T. crassus during the years 1952-61.

Year	Percentage of infected pike with <u>T. crassus</u>	Percentage of all pike containing <u>T. crassus</u>
1952	14.2	9.7
1953	18.7	8.3
1954	14.7	9.7
1955	6.2	5.1
1956	1.2	1.1
1957	0.4	0.4
1958	0.0	0.0
1959	0.0	0.0
1960	0.0	0.0
1961	0.0	0.0

Very few coregonines were captured in 1961, in fact the total catch was composed of 28 whitefish and 4 ciscoes. The paucity of coregonines, however, does not represent a further decline in the population size, because the catch in former years was taken from gill nets (251,000 yard-nights in 1960) while only 9,000 yard-nights of gill net were fished in 1961. Although the small catch of coregonines does not constitute a good sample for determining the incidence of T. crassus, it is worth noting that no parasites were found.

G. H. Lawler

Appendix 7

OCCURRENCE OF "FIN ROT"

Early in June it was noticed that a high percentage of both marked and unmarked fish had diseased or rotting fins. The condition was most apparent in suckers and perch, which formed the greatest percentage of the catch. The rotting appeared most frequently on the caudal fin, but further observations

showed the other fins were also susceptible. Some fish were only slightly affected, but in other fish the disease was so severe that the fins were reduced to mere stubs. Fish exhibiting the latter appearance were removed from the population. An early symptom of the disease was a white line or border on the edge of the fin. The white line gradually moved towards the base of the fin and at the same time the outer margin became frayed, owing to the disintegration of the soft tissue between the fin rays. This process continued occasionally until the entire fin was destroyed.

It was suspected that a bacterial infection was present in the lake, but the causative organism was unknown. As it is imperative in a tagging study that only healthy fish are released after tagging, remedial measures were begun even though the disease and its control measures were unknown. It was assumed that crowding in holding pens would allow easier transmission of the disease, so more holding pens were built and the samples thinned accordingly. The actual handling of fish by the taggers was considered and recommendations for improving the techniques were implemented. Instead of covering the fish with moist burlap (which could act as a vector for transmitting the disease from infected to non-infected fish), the fish were tagged completely submerged under water in pans which were cleaned frequently with a strong germicide. Measuring boards and instruments were dipped in a germicide after a few operations. The holding pens, constructed of fine galvanized mesh, were lined with netting to prevent the fins of anaesthetized fish from becoming torn on the rough wire surface as they recovered. It was felt that even minor abrasions would make the fish more susceptible.

Shortly after these techniques were applied, a marked improvement in the condition was noted and by mid-July it was considered to be on the wane. Whether the decrease resulted from improved handling techniques or from a natural decrease in the incidence of the disease remains unknown, but the experience demonstrated vividly how a program could be seriously disrupted, or perhaps ruined, by an unknown factor in the environment.

G. H. Lawler

Appendix 8

"BLACK SPOT" DISEASE ON HEMING LAKE FISH

In recent years, as part of the routine observation of individual fish, the incidence of some ecto- and endoparasites has been recorded.

Darkly pigmented spots have been observed on the spottail shiner, yellow perch, burbot, darters, sculpins, pike, troutperch and suckers. The parasite has not as yet been identified to species, and in the field has been recorded as "black spot" disease. Eventual identification may reveal that more than one species is present, as the pigmented areas on the flesh of the burbot appear different than those on the other species.

The results of the 1961 examination are shown in the accompanying table.

Table I. Incidence of "black spot" disease and number of fish in each category examined.

Species	Not examined	No spots	5 spots or less	6-15 spots	Over 15 spots
White sucker	428	2796	765	262	168
Yellow perch	140	1255	850	161	89
Pike	18	75	128	114	179
Burbot	3	6	7	19	55
Whitefish	27	...	1	...	...

The disease was most prevalent in pike, approximately 85% were infected, followed by perch with an infection rate of 47% and suckers with a 30% infection rate. The parasites were found in greatest numbers among the smaller individuals in each species. The infection is not known to be harmful to the fish.

G. H. Lawler

Appendix 9

LIMNOLOGICAL DATA COLLECTED IN 1961

Daily water temperatures were recorded with a Negretti-Zambra reversing thermometer at depths of 3, 6, 9, 12, 15 and 18 feet. The minimum temperature was 9.5°C on May 27. The lake warmed rapidly from this point and the temperature was nearly uniform at all depths about June 19. The maximum temperature, 22°C, was reached by July 8 after which time the average temperature declined gradually until nearly the end of July when it began to rise again, and held fairly steady until the latter part of August when it then began to decrease rapidly.

Water levels were read at several stations daily during the early part of the year and then weekly for the balance of the summer. The water level of Heming Lake dropped approximately 1½ feet over the summer period.

Oxygen concentrations were determined weekly and ranged between 6.3 and 7.1 cc/l.

Weather observations were recorded daily.

Air temperature and barometric pressure were continuously measured by recording thermographs and barometers.

G. H. Lawler

G. P. McRae

Appendix 10

AGE AND GROWTH OF HEMING LAKE BURBOT

The data on age and growth in this appendix are based on the examination of 411 specimens collected in 1960. Total length was measured from the tip of the snout to the posterior end of the caudal fin. Otoliths were removed and stored either dry or in 50% glycerin. Ages were determined by counting the number of opaque bands on the otolith.

The specimens collected ranged in age from two to eight plus years. The size range was 7 inches (age class II) to 18 inches (age class VIII). Eighty per cent of the sample is represented by age classes II and III. The older age groups were present in about equal numbers but formed a minor part of the catch. The scarcity of older animals may have resulted from the heavy exploitation of previous years' fishing.

The maximum age reached in Heming Lake is about 8 years. This is less than the maximum age of 11 years reported for Lake Erie and 13 years reported for Lake Simcoe.

The mean lengths for the various age groups are shown in Table I.

Table I. Average length of each age of Heming Lake burbot.

Age	Average Length (inches)	No. of fish
2+	10	17
3+	11	264
4+	13	72
5+	14	22
6+	16	18
7+	17	18
8+	18	1

Burbot in Heming Lake grow slower than in Lake Erie and Lake Simcoe, but faster than river populations in more southern areas.

G. H. Lawler

Appendix 11

NEW MINNOW RECORDS FROM HEMING LAKE

Heming Lake has been under intensive investigation since 1945 and during the early years every effort was made to determine what species of fish the lake contained. All types of habitats were probed with seines and emulsifiable rotenone. It was concluded, and the data published, that Heming Lake contained 13 species of fish. In June of this year in a seine haul of 559 minnows (Notropis hudsonius), one minnow appeared to be different. Subsequent examination proved it to be Notropis heterolepis which had never been observed previously. Following this find the seine hauls, made almost daily, during the summer were watched carefully to determine the frequency of occurrence of N. heterolepis. Another minnow new to Heming Lake, Pimephales promelas, appeared in a seine haul in mid-August. From 40 seine hauls made between June 6 and September 5, the following ratio of minnows was obtained:

4407 N. hudsonius : 32 N. heterolepis : 1 P. promelas.

It is possible that N. heterolepis and P. promelas have always been present in Heming Lake and have not been observed because of their apparent low abundance or, alternatively, they are recent immigrants to the lake. Their frequency of occurrence will be noted in future years. A subsequent increase in abundance would support the theory that they are just moving into the lake.

J. J. Keleher

Appendix 12

COMMERCIAL FISHERY STUDY AT GREAT SLAVE LAKE

The main investigation at Great Slave Lake is that of the commercial fishery. The trend of exploitation of the fish populations is being followed by the indices of average size, age composition and catch per unit of effort (availability). Since availability is largely computed from the fishermen's estimates, some attention lately has been directed to their validity. Indications are that previous estimates of winter availability have been too high owing to an overestimation of the usual number of nets lifted. For the

summer fishery actual examination of the catch from 2,000 nets showed reasonable agreement between the number of fish discarded and the usual estimates of culls. In addition, no extensive amounts of undersized or poor quality whitefish and trout were discarded on the lake.

Although collection of the data on both the summer and winter commercial fisheries has been maintained since 1956, presentation has been further delayed because of the recent conversion to the I.B.M. punched card system. During the past year most of the data for the 1956 to 1960 winter seasons have been punched on cards. The conversion will allow a more critical examination of the results because of the greater ease of manipulation of the data, an improvement in their accuracy and an overall diminution of the time required for the analysis.

J. J. Keleher

Appendix 13

DESCRIPTION OF GREAT SLAVE LAKE FISHING BOATS

The results of an interview survey of the fishing fleet carried out in 1958 have been prepared. Information on 58 fishing boats and 7 skiffs are presented individually and in comparative tables. Considerable variation exists in the dimensions and other features. Photographs and other information have been utilized to describe the fishing boats used in earlier years. This comparison indicates that since 1945 they have increased in dimension, accommodation, accessories and in conformity of design.

J. J. Keleher

Appendix 14

REPORT ON DOMESTIC FISHING AT SNOWDRIFT

The extent of local (domestic) fishing at Great Slave Lake was estimated in 1945 to be one million pounds annually. Owing to changing conditions, a reassessment of this utilization appeared desirable. Since the greatest quantity of fish was considered to be taken in the fall, field work has concentrated on this period. From October 4 to November 16, 1961, the survey was conducted at Snowdrift, having covered previously the settlements of Hay River and Resolution. It will be completed in 1962 when Rae, Yellowknife and Trout Rock will be visited.

Fishing by the Snowdrift residents was carried out in Great Slave and at four other locations. From counts of the fish and samples of their weight, it

was estimated that 43,000 lb of fish were taken. The catch from Great Slave Lake was 19% of this total and consisted of not more than 5,000 lb of trout and whitefish. Data were also collected to establish age composition and catch per unit of effort. A manuscript report containing the details for these and other findings is in preparation.

J. J. Keleher

Appendix 15

STUDY OF GREAT SLAVE LAKE ANGLING

The increased interest in angling at Great Slave Lake has indicated a need for assessment of this utilization of the fish populations. As no information has heretofore been available, plans have been formulated to conduct an intensive investigation for a 3-year period to establish the amount of fish caught, the factors responsible for angling success and the biology of angled and young trout. Tagging will be undertaken to assess the movement in angling areas.

During the 1961 summer season a creel census was conducted at the lodge situated at Taltheilei Narrows. Interviews on 183 angling trips were obtained; angling success was 0.8 trout per rod hour. Angling trips in Great Slave Lake were confined almost exclusively to the region within ten miles of the lodge or to special locations, e.g., Lockhart River. The difficulty of calculating the size of the angler's released fish will be overcome by special angling.

J. J. Keleher
for R. H. D. Harris

Appendix 16

BIOLOGY OF THE LONGNOSE SUCKER IN GREAT SLAVE LAKE

A biological investigation of the longnose sucker, in Great Slave Lake, was carried out in 1950 and 1951. Specimens were obtained by use of gill nets and seines. Suckers taken along the south shore had a faster rate of growth than those in the more northern area. In both areas, males and females grew at the same rate in length and weight. Females lived longer and thereby became heavier. The average annual survival rate was 45%. The growth exponent was 2.88; the length-weight relationship $W = 0.000252 L^{2.88}$. Longnose suckers spawned in Hay River from the ice cover break-up in May to June 15. The water temperature did not exceed 59°F (15°C). The majority of spawning-run fish were 10 to 12 years old.

Although sexually mature at seven years, no suckers younger than nine years of age were found in the spawning run. Females contained from 17,000 to 60,000 eggs, but may not spawn each year. Fingerlings from Hay River were 33 to 80 mm in length, and were in their first summer. They all had scales. Details of the information presented here have appeared as a Journal article.

A. H. Lawrie

Appendix 17

THE COMMERCIAL LAKE TROUT FISHERY OF LAKE SUPERIOR IN 1961

Since 1957 the lake trout populations of Lake Superior have been studied to assess the effects on the trout stock of:

- (a) predation by sea lampreys and the current effort to reduce lamprey numbers, and
- (b) the repeated plantings of fin-clipped, hatchery-reared lake trout into the lake.

Examination of the commercial catches has provided the majority of the data employed. The program of net-run sampling of the commercial catches of lake trout from the Canadian waters of Lake Superior was intensified in 1961 by the addition of two permanent technicians to the field staff. Approximately 75% of the total Canadian catch of lake trout was examined by this staff. Data processing was facilitated by the introduction of machine methods employing I.B.M. punched cards. Not only were 1961 data punched onto cards, but very substantial progress was made in converting earlier (1950-1960) data to this system to permit analysis of the entire series. It is anticipated that the conversion will be complete by mid-April of 1962. The present report is, therefore, preliminary to the extent that it will be subject to later and more comprehensive reviews.

Preliminary estimates from the catch statistics now being tabulated by the States of Michigan, Wisconsin, and Minnesota and the Province of Ontario indicate a further substantial decline in the lake trout production from the waters of both countries. Table I presents the U.S. and Canadian landed catches from 1958 to 1961.

In Canadian waters a good part of this decline was owing to decreased effort. Preliminary statistics, prepared by the Ontario Department of Lands and Forests, suggest that the decline, since 1960, in overall effort will be of the order of 50%, with extremes of 30 and 90% in individual statistical divisions.

Table I. United States and Canadian landings of lake trout from Lake Superior, 1958-1961.

Year	U.S. Landings	Can. Landings
1958	1,059,000	385,000
1959	868,000	238,000
1960	380,000	107,000
1961	297,722*	44,117*

*Provisional estimates only.

However, a substantial part of the decline in catch must be attributed to a reduced return for effort expended since these same data suggest declines, since 1960, in catch per unit effort ranging from 40 to 80% in six of the seven statistical divisions. In general these estimates are confirmed by the less comprehensive, but more detailed, information from sampling carried out by the Fisheries Research Board.

The decline in effort has resulted primarily from the withdrawal of fishermen from the fishery, and secondarily from a reduction of effort on the part of many of those who have remained. It would have been steeper still had it not been for the occurrence of a better than average whitefish fishery in eastern Lake Superior, which sustained and encouraged that segment of the industry. This self-regulation imposed by economic forces may be expected to persist, and probably to intensify, during 1962.

From an assessment point of view, the decline in effort has had the serious effect of reducing sample sizes and hence the precision of indices derived from these samples. Further, the "fishing behaviour" of the industry has become unstable, as individual fishermen have constantly shifted their efforts from fishing ground to fishing ground and from species to species. In consequence, the data which are available are heterogeneous and fragmentary, often not rigorously comparable to those available for earlier years. This applies with particular force to catch per unit effort data, so that even the gross figures cited above should be regarded with caution, especially as measures of relative availability of lake trout in 1960 and 1961. They are as likely to measure the skill and luck of the fishermen in finding fish.

The data presented in this section are restricted to those pertaining to the occurrence of trout with bleeding wounds (fresh scars), since these are clearly related to lamprey predation at the time of the catch. Data on the incidence of trout with scars (healed scars) are available, but have not been critically examined.

Table II. The incidence of lamprey-wounded lake trout in the catches from large-mesh (4 1/2-4 3/4") gill net set in Lake Superior during 1960 and 1961. (Ninety-five per cent confidence limits and sample sizes shown in parentheses.)

Season (months)	Division I		Division IV		Division VII	
	1960	1961	1960	1961	1960	1961
Spring (4, 5, 6)	9.2 (7.3-11.6) (805)	11.9 (8.9-15.4) (410)	7.5 (6.4-8.8) (1841)	5.7 (4.2-7.5) (820)	5.2 (4.0-6.6) (1283)	1.7 (1.1-2.5) (1263)
Summer (7, 8)	...	...	...	...	1.2 (0.4-2.8) (403)	0.6 (0.07-2.1) (365)
Fall (9, 10)	14.1 (11.7-17.0) (803)	8.4 (6.5-10.5) (935)	15.3 (13.7-17.0) (1719)	4.7 (3.9-6.5) (869)	5.9 (4.5-7.5) (1162)	1.8 (0.7-3.0) (682)

Lamprey-wounded lake trout were abundant in the spring catches in both U.S. and Canadian waters. The usual summer decline in the incidence of wounded fish occurred, presumably as a result of fully adult lampreys leaving the lake to spawn, but wounded lake trout were, everywhere in the lake, significantly less abundant this fall than in 1960. Table II presents the data from Canadian waters for those statistical divisions for which an adequate comparison can be made between 1960 and 1961.

Our 1960 report noted a decline in the proportion of wounded lake trout in the 1960 catches from Division VII (eastern Lake Superior) when compared with those from 1959. A further decline from 1960 to 1961 is demonstrated for spring and fall catches and may be reasonably assumed for the summer catches despite the lack of statistical significance.

The spring catches from Divisions I and IV (western Lake Superior) showed no significant change in the proportion of wounded lake trout when compared to those from 1960. Summer catches were virtually nonexistent in these divisions and no comparison is attempted. A significant decline, however, was apparent in the fall catches in both divisions. This is the first indication of such a decline in western Lake Superior. There can, therefore, be little doubt that a real change has occurred throughout the lake. Whether this change is a result of the hoped-for decline in lamprey numbers remains to be demonstrated by the size of the lamprey spawning runs in 1962.

Length data from the 1961 catch are still being processed so that precise comparisons with 1960 cannot be made. Table III presents the mean weights of the marketed portion of the catches from the three divisions for which comparable data exist in both years. No confidence limits can be given for these statistics because of their manner of computation, but care was taken to ensure that the comparisons are as rigorous as possible by utilizing only data from the same gear fished on the same grounds at the same time of year. From these data there is no evidence of a significant change in mean weight of marketable fish from 1960 to 1961.

Table III. Mean weights (in pounds) of marketed lake trout from the catches of large-mesh (4 1/2-4 3/4") gill net set in Lake Superior during 1960 and 1961. (Sample sizes in parentheses.)

Year	Division I	Division IV	Division VII
1960	2.27 (1621)	2.09 (4200)	2.17 (3426)
1961	2.51 (1062)	2.06 (2204)	2.23 (3174)

Determinations of the ages of the trout sampled in Canadian waters in 1961 are not yet complete, but data covering the season to October are available for three divisions and are presented in Table IV.

Table IV. Age determinations of lake trout taken by commercial fishermen and anglers in the Canadian waters of Lake Superior in 1961 to October. Figures given are percentages.

Statistical Division	A g e									Sample size
	2	3	4	5	6	7	8	9	10	
I	...	5.1	11.6	30.5	31.9	17.1	3.1	0.8	...	778
IV	2.3	8.6	12.5	24.4	35.9	15.4	0.8	0.1	0.04	2422
VII	0.7	6.3	8.0	15.0	40.0	25.1	4.4	0.5	...	1183

A. H. Lawrie

Appendix 18

ASSESSMENT OF PLANTED LAKE TROUT IN LAKE SUPERIOR

All lake trout planted into Lake Superior in recent years have been marked by the removal of specific fin combinations, so that when recovered in the fishery they are recognizable as to plant. This year's plantings by all agencies combined totalled 1,290,000 yearling fish, an increase of 240,000 over 1960.

Of the 1,614 fin-clipped lake trout, whose occurrence in Canadian catches was reported, 1,569 have thus far been assigned to a particular planting. Seventy-five per cent of these originated from ten plantings made by the Ontario Department of Lands and Forests between 1953 and 1960. The remaining 25% originated from thirteen plantings made between 1953 and 1960 in U.S. waters by the United States Fish and Wildlife Service and the Wisconsin Conservation Department. Table I lists these recoveries by year class, planting agency, area planted, fin clip and age at planting. Data on mean size are not yet available. Comparisons of the relative success of various plantings have not yet been attempted.

The age distributions of Table IV in Appendix 17 take on added significance when the contribution of hatchery-reared lake trout to them is taken into account. Table II presents, for the same three divisions, the percentage contribution of these fish to each age group. In Divisions IV and VII planted

fish have provided the great majority of the two- and three-year old lake trout captured. The contribution of hatchery-reared fish in Division I is smaller but still significant, and it should be remembered that Divisions IV and VII have been the sites of three successive plantings, whereas Division I has received its share of planted fish solely by immigration.

Table I. The numbers of fin-clipped lake trout recovered from the Canadian waters of Lake Superior in 1961.

Year Class	Planting Agency	Area Planted	Age at Planting	Fin Clip	Number Recovered
1960	ODLF	Pie Is.	Fingerlings	RP & LV	1
	ODLF	Rosspport	Yearlings	BV	11
1959	ODLF	Rosspport	Yearlings	RP	142
	ODLF	Agawa	Yearlings	Ad & LP	6
	WCD	Apostle Is.	Yearlings	LP	2
	FWS	Keweenaw	Yearlings	Ad & LV	1
1958	ODLF	Rosspport	Yearlings	RV	538
	ODLF	Lizzard Is.	Yearlings	LV	145
	FWS	Keweenaw	Yearlings	Ad & LV	4
1957	ODLF	Rosspport	Yearlings	Ad	254
	ODLF	Lizzard Is.	Yearlings	Ad	69
	FWS	Eastern	Yearlings	LP	335
	FWS	Marquette	Yearlings	LV	9
	FWS	Keweenaw	2-yr olds	Ad & LP	1
	WCD	Apostle Is.	Yearlings	RP	13
1956	ODLF	Dog R.	2-yr olds	Ad & RV	1
	FWS	Marquette	3-yr olds	RV	13
1955	WCD	Apostle Is.	Yearlings	RP	13
1954	WCD or FWS	Apostle Is. or Marquette	Yearlings	Ad & LV	5
	WCD or FWS	Apostle Is. or Marquette	Fingerlings	Ad & RV	2
1953	ODLF	Pie Is.	Fingerlings	Ad & LP	2
	FWS	Marquette	Fingerlings	Ad & RV	1
	WCD	Apostle Is.	Fingerlings	LP	1

Table II. The contribution of hatchery-reared fish to each age group of lake trout taken by commercial fishermen and anglers in the Canadian waters of Lake Superior in 1961 to October. Figures given are percentages.

Statistical Division	A g e									No. of planted fish
	2	3	4	5	6	7	8	9	10	
I	0.0	15.0	14.4	0.4	0.0	0.0	0.0	0.0	0.0	20
IV	94.6	86.5	32.0	0.5	0.0	0.0	0.0	0.0	0.0	332
VII	62.5	55.4	25.5	0.6	1.0	1.0	5.8	0.0	0.0	82

Presuming that mortality rates for planted and native trout are similar, these data provide striking evidence of the progressive failure of natural recruitment. Further evidence is provided by the fact that in 1960, only 1% of the total Canadian catch and 13% of the sublegal (less than 1½ pounds dressed weight) portion of the catch were planted fish, while in 1961 these figures had risen to 9 and 33% respectively. It would appear that, within three years, the fishery, if any, will be essentially on a put and take basis!

A. H. Lawrie

Appendix 19

EXPERIMENTAL CATCHES FROM SUPERIOR SHOAL

The program of experimental fishing and tagging being carried out by the Fisheries Research Board on Superior Shoal was continued in 1961. One thousand and twenty-one lake trout were captured in twelve lifts between June 20 and September 22, of which 361 were tagged and released. Only 2% of these fish bore lamprey wounds. Twenty per cent were scarred. Three hundred and fifty-eight of six hundred and seventy-one fish examined were judged mature and seventy-five of them were taken while spawning or immediately after.

RADIOISOTOPES

During 1961, a successful field trial of the radioisotope marking technique was carried out. Ammocoetes were collected from streams on Lake Superior, marked by immersion for 36 hours in Caesium-137 solutions, and released in three streams on St. Joseph's Island near Sault Ste. Marie. The marking was carried out in plastic containers in one of the bio-assay trailers stationed at Sault Ste. Marie.

The Two Tree River received 1,910 marked animals, distributed in varying numbers at seven stations. Richardson's Creek received 400 animals, and Gawas Creek received 110. All three streams were subsequently treated with lampricide, and recoveries made of dead animals. Of the trials, only Richardson's Creek could be termed a success, since collecting conditions on the other two streams were very poor because of weather conditions. However, the Richardson's Creek trial was very successful and showed that, at least for periods up to one month, marking of ammocoetes with radiocaesium provides a useful means of population estimates.

A paper covering both laboratory and field experiments was published in the Journal of the Fisheries Research Board, Volume 18, No. 1. The project was terminated on October 31, 1961.

THERMAL TOLERANCE OF SEA LAMPREY EGGS

The influence of temperature on the development of sea lamprey eggs was studied using two approaches. Data were available from Piavis (1961) which indicated that lamprey eggs would develop over a range of 15°C to 24°C with an optimum in the lower part of this range. It was considered first of all necessary to repeat this experiment in order to confirm or further delimit the range for development. Temperatures chosen were 15°C, 20°C and 25°C, and additional data were obtained in a second experiment at 18°C. These results were reported in the 1960-61 Annual Report.

In the second approach the effect of changing the rearing temperatures at various stages of development was investigated. The temperature regime under which lamprey eggs develop in the stream is not constant, but is subject to both diurnal and seasonal variations (Fig. 1). Such temperature changes occurring at different stages in development may have different effects, depending on the stage at which the change occurs. A more

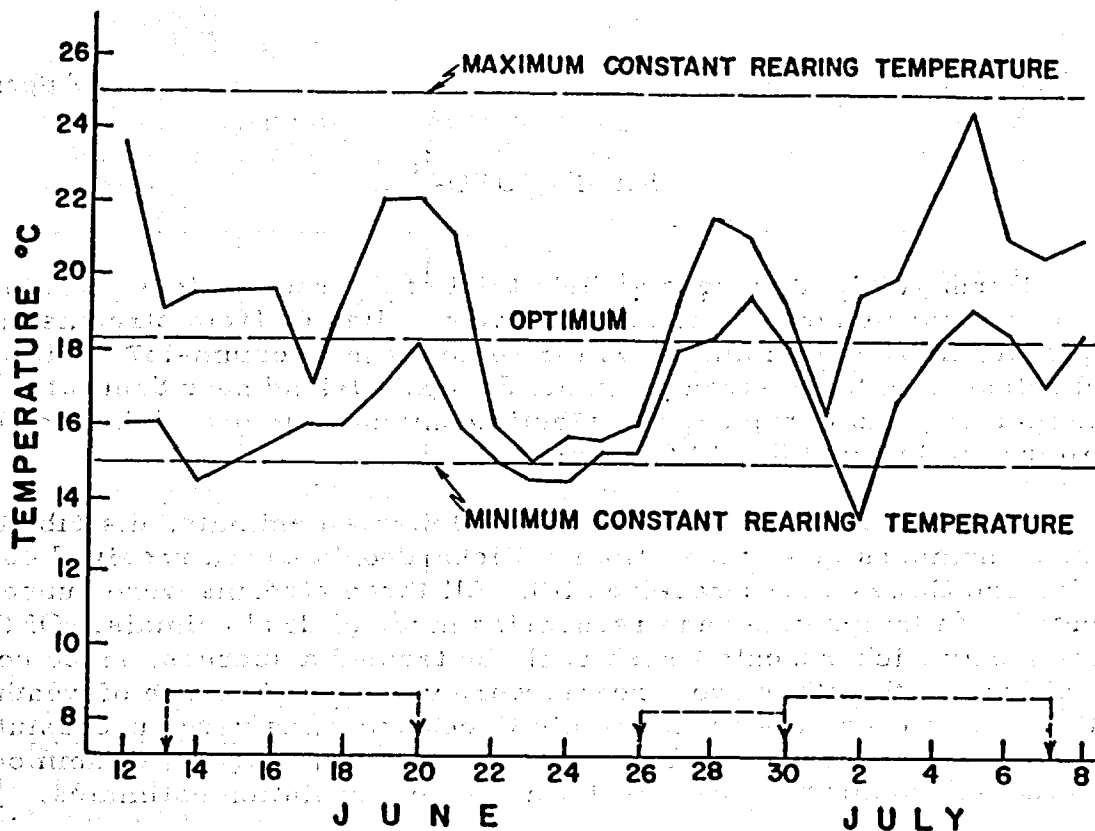


Fig. 1. Daily maximum and minimum temperatures recorded in the Thessalon River during the months of June and July, 1959. Incubation periods of samples of eggs in nests are indicated.

complete description of temperature effects should include then recognition of any stages in development at which the process is particularly sensitive to temperature. A beginning was made on such a study by initially fertilizing and rearing eggs at the optimum temperature of 18°C as determined above. As the eggs developed at this temperature, subsamples of 200 were removed at various stages and transferred to constant temperatures above and below the rearing temperature. They were then allowed to continue their development at these new temperatures and the number of prolarvae which hatched in each subsample was recorded. The temperatures chosen were 12°C , 14°C , 23°C and 26°C . Unfortunately, further experiments which involved changing temperatures could not be carried out because of the lack of a supply of viable, fertilized eggs. The reproductive season of the sea lamprey is only about one month long in Big Creek. It was hoped originally to extend the period over which experiments on developing eggs could be performed by collecting spawning-phase animals early in the season and holding back their sexual maturation by cold temperature. In early May of 1961 lampreys were trapped in the Saugeen River and Big Creek and held at the laboratory in water at 5°C . The animals were subjected to a photoperiod of 12 hours. At convenient intervals during the following four months, lampreys were removed and brought to spawning condition by either holding them in cages immersed in Big and Medway Creeks or transferring them to tanks in the

laboratory maintained at 20°C. By these two methods, it was possible to obtain sexually mature animals as late as September. However, the fertilized eggs arising from these specimens did not develop beyond early cleavage. No reason was found for the lack of viability of these eggs, but when the necessity of using lampreys which were collected off nests became evident the reproductive season had passed.

Table I shows the results of the experiment in which eggs are exposed to sudden changes to new levels of temperature at various stages of their development and allowed to continue their development, if possible, at these new temperatures.

Table I. Percentage hatch in subsamples of 200 eggs reared initially at 18°C and transferred to higher and lower temperatures at various stages of development. Observations on the number of embryos which hatched were made 15 days after fertilization.

Time at which transfer was made	Stage at which transfer was made	Final rearing temperatures °C				
		12	14	18	23	26
24 hours	64 cells	0	0	..	0	0
2 days	full blastula	0	0	..	3	0
3 "	gastrula	0	0	..	8	0
4 "	neural plate	0	1	..	12	0
6 "	head	5	2	..	14	5
8 "	prehatching	29	7	54*	25	23

*54% of the eggs left at the initial rearing temperature hatched.

At 18°C, the optimum temperature for development, 54% of the eggs hatched into prolarvae. In general, the later a subsample was transferred to the final rearing temperature, the greater was the percentage hatch. Excluding the results for 18°C and 23°C, the only temperatures within the range for some successful hatching, no prolarvae hatched from eggs transferred before the neural plate stage.

A SUMMARY OF STUDIES ON THE THERMAL TOLERANCE OF THE SEA LAMPREY

The susceptibility of the sea lamprey in all its life stages to lethal temperatures was investigated. The stages comprise fertilized egg, prolarva, larva, parasitic-phase adult and spawning-phase adult. Of these stages, the eggs have the most exacting thermal requirements. The range of constant temperatures necessary for some successful hatching is narrow, being 15-25°C. This range may be extended to 12-26°C when the eggs are allowed to develop to the neural plate stage at 18° before being exposed to higher and lower temperatures.

The prolarvae, unlike the developing eggs, have presumably a physiological mechanism which adjusts to temperature extremes. Prolarvae reared at 20°C can withstand temperatures as high as 29°C for one week or as low as 1°C for three days. The larvae, given time to acclimate, can live at temperatures ranging from 0°C to 32.5°C. There is evidence, however, that larvae cannot live for prolonged periods at temperatures at the upper part of their biokinetic range. At an acclimation temperature of 30°C, mortality in the holding baths significantly increases.

Metamorphosis for all the physiological and morphological changes it involves does not alter the high thermal tolerance of the species. Although parasitic lampreys are classified as cold living, stenothermal animals on the basis of their distribution in the lake, they have not lost the high thermal tolerance of the larvae. In the later stages of sexual maturity of the spawning-phase animals, the destructive processes of physiological degeneration may be accelerated by high temperature and individuals succumb at high but sub-lethal temperatures.

Lethal temperatures may possibly be encountered by lampreys during their life history at three periods. At the time of embryonic development, lethal temperatures experienced by the eggs likely control the size of the year class of larvae. Temperature may exclude the establishment of larvae from shallow, protected bays in the lake shore which, during spells of warm weather, can attain lethally high temperatures. Finally, large numbers of spawning-phase adults in advanced sexual maturity could be killed by temperatures as low as 25°C. Temperatures exceeding 25°C have been recorded during the month of June in the Bronte and Humber Rivers, Lake Ontario.

R. W. McCauley
for J. A. Sholdice

Appendix 23

SWIMMING SPEEDS OF SEA LAMPREY LARVAE

Swimming speeds of ammocoetes were measured in a rotating annular chamber (described in Appendix 41, 1957-58 Annual Report). Difficulties were encountered in attempting to induce the animals to swim by the techniques which are conventionally used with this apparatus. Behaviour in the ammocoetes which frustrated the experimenter included:

1. Not swimming for more than a few seconds even when prodded with a glass rod.
2. Swimming with the current in the chamber.
3. Persistent attempts to burrow into the bottom of the chamber.
4. Bursts of fast swimming into the current followed by reversals in the direction of swimming.
5. An erratic spiralling-type of swimming from the bottom to the top and from the inner to the outer wall of the chamber.
6. Lack of orientation to some stationary point in the surroundings which may have accounted for irregular gaining or losing of laps during the rotation of the chamber.

Because of the behaviour of the larvae mentioned above, the technique of measuring swimming speeds was modified in the following manner. Instead of introducing the experimental animal into the stationary chamber and slowly increasing the speed of rotation until the animal is no longer able to swim against the current, the chamber was rotated first at a given speed and the animal dropped in. When this procedure was followed, the ammocoetes swam against the current for a period of time which was related to the speed of the swirling water in the chamber. It was found that the faster the ammocoete swam, the shorter the time its swimming speed could be maintained. The relationship between swimming speed, measured in body lengths per second, and the time during which this speed could be maintained is shown in Fig. 1. For comparison, a similar curve based on the mean values for several values of fish is also plotted. In the curve for the hypothetical fish, the speed at which the curve rises vertically is the cruising speed, since the fish can maintain this speed for an indefinitely long period of time. In the curve for the ammocoetes, however, there is no speed above one body length per second, which the animals can maintain indefinitely and they swim for proportionally longer times at low water velocities.

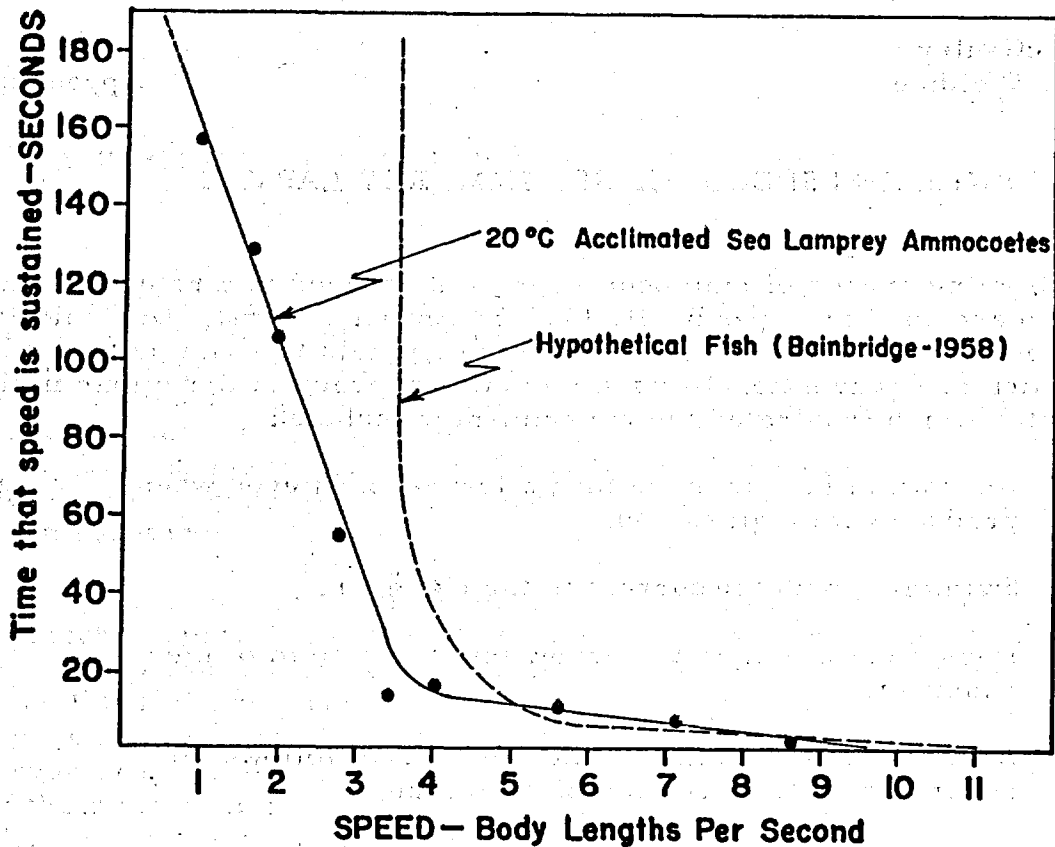


Fig. 1. Swimming speeds of a sample of ten sea lamprey larvae acclimated and tested at 20°C. The lengths of the animals range from 7.6 cm to 9.3 cm.

The differences observed between the swimming speed-duration curves of ammocoetes and fish may either be due to the peculiarities of the measurement of the speed of ammocoetes in the laboratory or it may reflect real differences in the nature of swimming between ammocoetes and fish.

M. L. H. Thomas

Appendix 24

A REVIEW OF THE INVESTIGATIONS ON AMMOCOETES

For several years the Board, as agent for the Great Lakes Fishery Commission, has studied several aspects of ammocoete biology. Since the Commission has terminated its support, it seems appropriate to review accomplishments. Although there still is much remaining to be done, we now have a much more accurate picture of ammocoete biology.

Perhaps the most important knowledge gained is of a very general nature. We now know that we are dealing with a very highly adaptable species and that it is dangerous to draw any conclusions based on only limited observation or research. This adaptability applies to the entire life cycle of the sea lamprey; in the larval stage it is well exemplified by the range of habitat utilized. The ammocoete stage of the lamprey is spent as a filter feeder, which normally lives in a burrow constructed in the bottom of streams. It was, until recently, believed that this mode of life restricted larvae to reasonably soft bottoms. It is certain that ammocoetes cannot burrow into any but rather soft bottoms, but our studies show that where a typical burrow cannot be made the larvae are able to utilize almost any cover. This adaptability is great enough that ammocoetes can survive in almost all naturally occurring habitats within their range.

Early investigations centred on Big Creek, a southwestern Ontario stream tributary to Lake Erie, were concerned mainly with the gross distribution of ammocoetes within stream systems. Larvae were found in soft bottoms downstream of all spawning sites. Extent of distribution downstream appears to be dependent on stream gradient. Such a generalization probably applies to all lamprey-bearing streams.

Early investigations gave some knowledge of migration habits, but more information was needed. The subject was studied in the Big Creek watershed using several methods, for example, two-way check weirs and repeated clearance of several marked areas. It was found that migration was almost completely downstream; upstream migration was uncommon and took place only for short distances in slowly moving water. Migration exhibited a circadian rhythm, being almost entirely nocturnal. It would seem that diurnal migration only takes place when ammocoetes are mechanically scoured from the bottom and swept away. Evidence gained mainly from the recolonization of cleared areas showed that peak migrations occurred at times of high water temperature combined with high flow. It is suggested that downstream migration results from the combination of an active temperature correlated component and a passive flow correlated component. It has been shown that increased temperature results in increased free-swimming activity. It has also been demonstrated that swimming ability in ammocoetes is limited. Thus a larva leaving its burrow would tend to be swept downstream even if attempting to move against the current.

Knowledge of migration activity led to the conclusion that many ammocoetes in typical utilized streams must pass beyond the mouth before metamorphosis. This aspect is of great importance in connection with the use of lampricide in control, since ammocoetes passing into the open lake are beyond the reach of toxicants and serve as a reservoir for reinfection. This aspect of ammocoete biology was investigated off eight lamprey-bearing streams flowing into the Canadian waters of Lake Superior. Sea lamprey ammocoetes were found off six of these rivers, both close to shore and in deep water. Ammocoetes captured in the lake increased in size with increasing distance from the river mouth, indicating that growth continued in these lentic situations. It should be pointed out, however, that where ammocoetes were found the rivers emptied into relatively shallow and sheltered

bays. Growth may not continue where rivers empty directly into the main body of the lake; such rivers, however, are the exception rather than the rule. The most extensive investigations were carried out in Batchawana Bay off the mouths of the rivers Batchawana and Sable. In that location the presence of a large island devoid of lamprey-bearing streams provided an ideal situation to check on ammocoete dispersion within the lake. It was found that sea lamprey ammocoetes extended up to 2-1/8 miles from the mouth of the Batchawana River and up to 1-1/2 miles from the mouth of the Sable River. Thorough investigation showed that close to shore the number of ammocoetes per unit area was little influenced by the shore type. On shores within 2-1/2 miles of the Batchawana River mouth, there was an average of 1.7 sea lamprey ammocoetes per 1000 square yards. Numbers collected in deep water were not sufficient for a reliable population estimate, but did suggest that ammocoetes there may have been as numerous as inshore. Thus the sea lamprey population off the Batchawana River may be in the tens of thousands. It seems probable that comparable populations exist off other rivers and it is quite possible that enough adult sea lampreys can develop from these populations to maintain predation on lake trout at an unacceptably high level. However, since lampreys presumably do not spawn in the lake, these populations can be reduced if rivers are treated with lampricide at frequent enough intervals so that no larvae reach the lake. In rivers such as the Chippewa, where spawning grounds lie within a mile of the lake, evidence on migration rates gained from studies in Big Creek suggest that most ammocoetes reach the lake within a year. In such rivers annual treatment would be required to eliminate the species.

Factors affecting the distribution of ammocoetes within areas where they are resident have been investigated, both in streams and in the open lake. Data collected from one tributary of Big Creek showed that the main controlling factors in that stream were bottom hardness and water velocity. A multiple regression of these factors on population density was highly significant. Age of ammocoetes was correlated, both in streams and in the lake, with distance from the spawning grounds, a consequence of migration habits. The lake bottom environment tends to be uniform over large areas, giving ammocoetes little opportunity for selection. In such areas the adaptability of the species is to its advantage, populations being found in such diverse situations as wave-beaten sandy shores, gravel, stone and boulder beaches and reed beds. Concentrations of ammocoetes were occasionally found along partial barriers such as sand ridges and sunken logs, particularly if these lay at right angles to a lake current.

Information on growth and duration of larval life in ammocoetes has long been needed for organization of control. In rivers such as the Goulais, where the course below spawning sites is so long that ammocoetes rarely reach the mouth, such information could determine the frequency of lampricide re-treatment. So far no method of aging lampreys other than by length-frequency determinations has been discovered. The length-frequency method has proved far from ideal. Large variations in growth rate occur between individuals of the same age, both within streams and from stream to stream. This makes the interpretation of length-frequency polygons very difficult after the third year of life. However, recently some progress has

been made, particularly by a British worker (Hardisty, M. W., J. Anim. Ecol., 30(2): 1961) in this field, who has had access to sea lamprey ammocoetes from the Great Lakes. It has been shown that growth rate is almost linear up to the start of transformation, and this is borne out by recent collections from Big Creek. Thus fairly confident extrapolations can be made provided good growth data for the first three years is available. It is also postulated that variation in average growth rate from stream to stream results not in varying age, but in varying size, at metamorphosis, transformation taking place at the same age, on the average. If this is true, the length of life of sea lamprey ammocoetes in Big Creek is either 5½ or 6½ years. This agrees with an estimate made by Hardisty for Michigan ammocoetes. Fig. 1 illustrates data from a tributary of Big Creek and a second stream in that area.

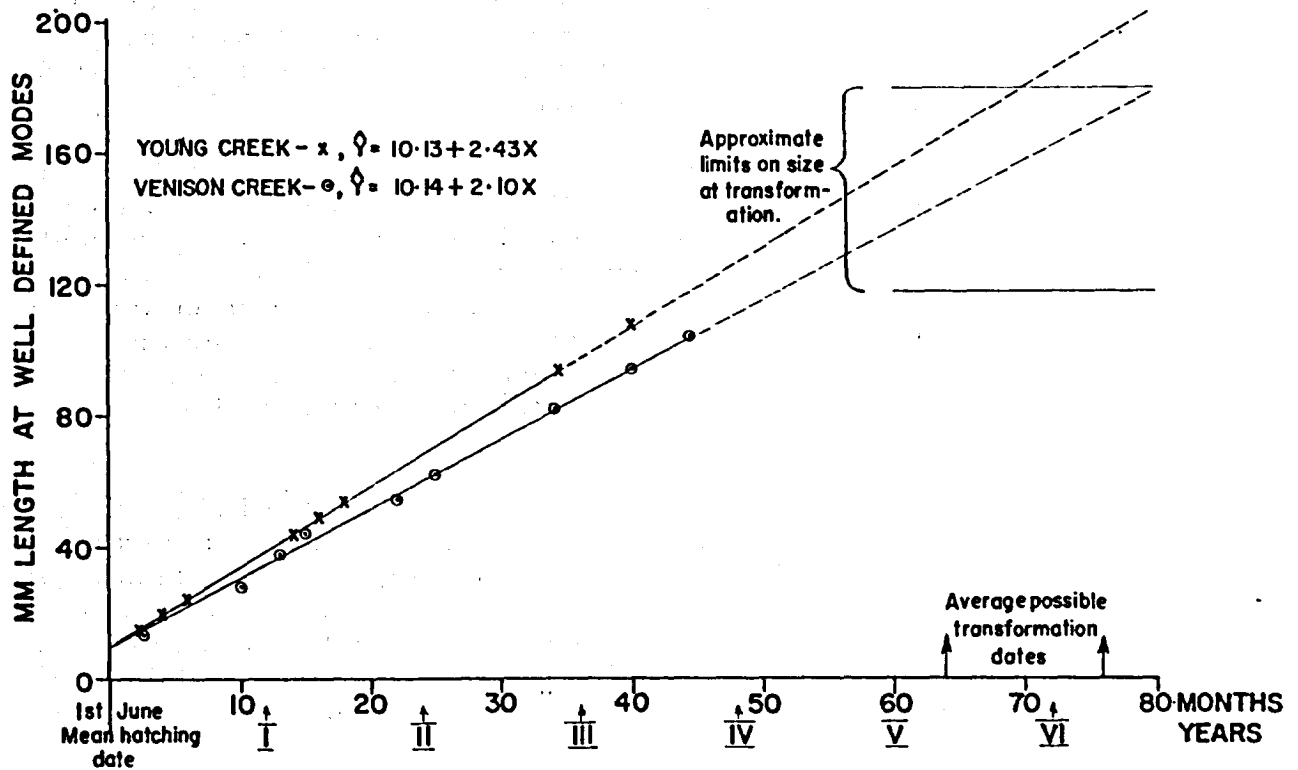


Fig. 1. Growth of sea lamprey ammocoetes in two Ontario streams.

The question of circadian activity rhythms in ammocoetes has been investigated in the laboratory under controlled conditions. It was found that free-swimming activity was entirely nocturnal and showed a maximum just after nightfall. Free swimming activity increased with temperature, but was not exhibited by an individual every day. Activity within the substrate was not confined to darkness, movement and construction of new burrows occurred at all times of day. It is thought that further work in the field of within-burrow activity would be scientifically rewarding and would give results useful to lamprey control management.

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Appendix 25

OPERATION AND MAINTENANCE OF ELECTRICAL BARRIERS, LAKE SUPERIOR, 1961

The L.B.O.U. operations during 1961 were carried out by two groups located at the field headquarters at Sault Ste. Marie, and a field station near Rosspport, Ontario. The Wawa station, which operated in 1960, was eliminated in 1961 as the Michipicoten River barrier (maintained from Wawa) was removed from service after the 1960 season. The Rosspport field station consisted of a mobile house trailer for personnel and a mobile bio-assay laboratory trailer used to perform preliminary bio-assays of tributaries to Lakes Superior and Huron for the Chemical Treatment Unit. After field operations on the electrical barriers were completed, the Rosspport unit divided into two groups; one continued bio-assay work from Sault Ste. Marie and the other assisted with chemical treatment of streams and stream surveys.

The L.B.O.U. operation during 1961 was conducted as in 1960 except that two electrical barriers, namely, the Goulais and Michipicoten Rivers, were eliminated. The eight barriers operated consisted of six in the Sault Ste. Marie area and two in the Rosspport area (Table I). Water conditions during the installation of barriers were near normal spring expectation; thus little difficulty was encountered except with the Batchawana River where damage to the electrodes caused a 48-hour non-operational period. The balance of the season was conducted with little trouble from high water or mechanical failures.

At the termination of the barrier operating season, the L.B.O.U. staff in the Soo area started to dismantle and remove the discontinued electrical barrier installations. The following is the list of 13 barriers which have been discontinued and removed: Little Carp (S-4), Goulais River (S-24), Stokeley Creek (S-36), Agawa River (S-93), Old Woman River (S-138), Michipicoten River (S-167), Hewitson River (S-351), Coldwater River (S-103), Baldhead River (S-105), McLean's Creek (S-363), Cypress River (S-374), McIntyre River (S-570) and Neebing River (S-571).

The total number of adult migrant sea lampreys collected during the years 1955-1961 from the eight Lake Superior barriers, that are presently being maintained and operated for assessment of the effect of the chemical control experiment on the lake population of lampreys, are listed in Table II. This table includes all lampreys collected from each river for the complete operating seasons. Table III indicates the dates of the first and last capture of lampreys at each of the eight barriers. Prior to 1960 the barriers were installed as early in the spring as possible. However, extreme difficulty was encountered in installation due to high water levels and flash flooding prevalent during April.

Table I. Dates of operation, operating hours, operating hours lost to barriers failing, evidence of escapement and use of nets to reduce fish kill for eight rivers, Lake Superior, 1961.

Stream Names	Dates of operation	Operating hours	Hours inoperative			Evidence of escapement	Upstream nets	Downstream nets
			May	June	July			
Big Carp (S-5)	May 5 - July 31	2046	12	...	...	Nil	Nil	One
Harmony (S-39)	May 5 - July 31	2058	...	...	...	Nil	Nil	One
Chippewa (S-48)	May 8 - July 31*	2016	...	...	...	1 adult seen	Nil	One**
Batchawana (S-52)	May 15 - July 31	1800	48	...	...	1 adult seen	Nil	One**
Sable (S-54)	May 5 - July 31	2058	...	...	...	Nil	Nil	One
Pancake (S-56)	May 3 - July 31	2105.8	.2	...	...	Nil	Nil	One
Pays Plat (S-360)	May 19 - July 29	1780	...	...	...	Not examined	Nil	One
Gravel (S-368)	May 19 - July 29	1750	...	30	...	Reported by anglers	Nil	One
	Totals	15,613.8	60.2	30	0			
				90.2				

* Chippewa River - barrier in operation on west side from May 8 to July 31, east side May 11 to July 31.

** Six-foot chain link fence stretched across river, 1960 Annual Report - Appendix 21.

Table II. Adult migrant sea lampreys recovered from eight electrical barriers, Lake Superior, 1955-1961.

	1955	1956	1957	1958	1959	1960	1961
Big Carp R. (S-5)	5	27	28	19	15	20	6
Harmony R. (S-39)	29	29	16	6	8	19	14
Chippewa R. (S-48)	807	839	359	220	296	1051	453
Batchawana R. (S-52)	608	421	427	358	482	629	561
Sable R. (S-54)	43	65	76	47	142	246	100
Pancake R. (S-56)	555	717	1073	809	816	1306	931
Pays Plat R. (S-360)	...	6	3	4	32	10	31
Gravel R. (S-368)	...	5	99	154	541	626	799
Totals	2047	2109	2081	1617	2332	3907	2895

It is apparent in Table III that the lamprey run does not start until about mid-May, presuming that the barriers have been effective in sampling the population during the early spring. As the barriers have not been used during 1960 and 1961 as the means of control, and also as the lamprey run begins later in May, the target date for installation, especially of the larger rivers that are affected by the flooding, during 1960 and 1961 was May 15. Table IV lists the number of lampreys collected at the eight barriers after July 31. Until 1961 the barriers were operated for varying periods late into the fall season. The criterion had been established that barriers would operate until a two-week period had elapsed, in which time no adult lampreys were collected. Until 1960 some barriers operated until September or October. The number of lampreys collected at these barriers after the end of July is insignificant compared to the total number for the individual barriers for each season.

On comparing the total number of lampreys (Table II) and taking into consideration the number of lampreys collected after the end of July (Table IV), it is apparent that the fluctuations in capture could be attributed to normal variations in any population.

Table III. Date of first and last lamprey collected from electrical barriers, Lake Superior, 1956 - 1961.

	1956	1957	1958	1959	1960	1961
Big Carp R. (S-5)	June 7* Aug. 16**	ca. May 25 ca. Aug. 31	May 7 July 9	May 20 June 15	May 18 July 5	May 21 July 14
Harmony R. (S-39)	May 24 Aug. 28	May 16 ca. Aug. 3	June 12 July 16	May 22 Aug. 13	May 18 July 4	June 7 July 14
Chippewa R. (S-48)	May 24 Aug. 25	ca. May 16 ca. Aug. 31	May 5 July 31	May 21 Aug. 21	May 23 Aug. 8	May 13 July 31
Batchawana R. (S-52)	June 12 Sept. 5	ca. May 16 ca. Sept. 14	May 4 July 31	May 14 Sept. 15	May 18 Aug. 5	May 21 July 28
Sable R. (S-54)	May 24 Sept. 2	ca. May 25 ca. Aug. 31	May 12 July 29	May 14 Aug. 18	May 15 Aug. 8	May 9 July 20
Pancake R. (S-56)	May 24 Sept. 13	May 16 Sept. 3	May 5 July 31	May 11 Aug. 19	Apr. 27 Aug. 8	May 19 July 31
Pays Plat R. (S-360)	June 12 July 25	June 13 July 17	May 21 July 24	May 25 Aug. 18	May 25 July 6	May 30 July 16
Big Gravel R. (S-368)	June 11 July 21	June 4 July 22	May 16 July 31	May 26 Aug. 14	May 16 July 20	May 24 July 22
Date last barrier turned off	All off Sept. 9 Sable & Pancake Nov. 14	All off by Sept. 14	All off by Oct. 4	All off by Sept. 25 (Pancake operated all year)	All off by Aug. 9	All off by July 31

* first lamprey collected.

** last lamprey collected.

Table IV. Number of adult sea lampreys collected from electrical barriers, Lake Superior, after July 31, 1956-1961.

	1956	1957	1958	1959	1960	1961
Big Carp R. (S-5)	4	5	0	0	0	Shut off Jul. 31
Harmony R. (S-39)	7	1	0	1	0	"
Chippewa R. (S-48)	13	6	16	6	6	"
Batchawana R. (S-52)	39	19	18	10	3	"
Sable R. (S-54)	7	13	8	3	5	"
Pancake R. (S-56)	58	28	15	10	6	"
Pays Plat R. (S-360)	0	0	0	2	0	"
Big Gravel R. (S-368)	0	0	2	4	0	"
Totals	128	72	59	36	20	

The catches at the Sault Ste. Marie barriers, Big Carp to Pancake R., have remained comparable throughout the years, while there has been a decided increase from year to year at the western end of Lake Superior at the Pays Plat and Gravel Rivers near Nipigon that may indicate that the population in that area has not stabilized.

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Appendix 26

SEA LAMPREY SURVEY - LAKES SUPERIOR AND HURON, 1961

Sea lamprey surveys were conducted with electro-shocking gear, augmented with the lampricide normally used for chemical treatments of streams. The collection of live ammocoetes for bio-assays occasionally contributes survey-type information. Surveys fall into four categories:

1. Preliminary surveys: which are performed periodically, on all rivers, in which it is considered possible for lampreys to spawn but where lamprey populations have not been demonstrated.

2. Distribution surveys: which are carried out to determine the upstream distribution of sea lamprey ammocoetes, in the main river and its tributaries. These surveys are conducted prior to treatment with lampricide and determine the location of "feeder sites" for the application of the toxicant.

3. Pre-treatment surveys: which are performed prior to treatment with lampricide. These surveys may or may not be the distribution surveys, depending on the interval of time intervening between the distribution survey and the time of treatment.

4. Post-treatment surveys: which are generally conducted immediately after the treatment with lampricide to determine the effectiveness and thoroughness of the treatment. Post-treatment surveys performed immediately after treatment, with electro-shocking gear, are not satisfactory owing to the psychological blocks based on the knowledge that the majority of the lampreys, in any watershed, have been killed, especially where the concentration of toxicant has been maintained during treatment at the 99.9% level of kill as indicated in the bio-assay. These surveys are better performed one to two years after treatment. The most effective post-treatment survey is a re-treatment of the watershed with lampricide.

Preliminary stream surveys (Table I) were conducted on St. Ignace and nearby islands and on selected mainland streams in these remote areas of Lake Superior which are accessible only by boat. Many of the streams surveyed have a permanent flow and all the known requirements for lamprey habitation; however, no new lamprey streams were located.

Survey techniques have been refined considerably over the past four years. It has become apparent that more power was required in some rivers and larger portable generators have been acquired. Even these have not been satisfactory on some streams and we have resorted to the use of lampricide, which is applied at high concentrations for short periods of time. This technique was used extensively in 1961 for distribution surveys and has proven faster and more efficient in many cases. The use of TFM for survey is expensive and the chemical loses its property of selective toxicity when applied in this manner. It is imperative that a lethal concentration be attained to activate the animals over the short period of time applied. Without using bio-assay or chemical analyses, the concentrations of TFM in the streams also kill fish. This naturally limits the type of stream and area where this technique may be applied.

The survey crew was moved to Lake Superior late in September, to attempt a survey in the Marathon area, where there are numerous large streams including Big Pic, Little Pic, Steel and Prairie Rivers that have always been suspect streams but have never produced sea lamprey ammocoetes. Unfortunately, the water was turbid and the rivers were in flood after heavy rains early in September. Little was accomplished as this condition existed until late October because of continuous rains, and the survey crew was moved to southern Ontario.

Table I. Preliminary surveys, Lake Superior, 1961.

Stream No.	Stream Name	Number of Ammocoetes Collected			Type of Survey
		P.m.*	Ichth.**	E.l.***	
S-34	Black Cr.	...	1071	...	Bio-assay specimens
S-571	Neebing R.	...	1125	...	" " "
S-305	Big Pic R.	...	...	...	Preliminary
S-306	Duncan Cr.	...	...	...	"
S-315	Mink Cr.	...	...	...	"
S-322	Little Pic R.	...	...	...	"
S-335	Steel R.	...	...	...	"
S-336	Out of Jackfish L.	...	...	...	"
S-379	Jackpine R.	...	...	...	"
S-474		...	...	...	"
S-476		...	...	...	"
S-477		...	...	...	"
<u>Fluor Island</u>					
S-478		...	...	...	"
S-478-1		...	...	...	"
S-479		...	...	...	"
<u>St. Ignace Island</u>					
S-640	Brook R.	...	...	...	"
S-641	Rainbow Lake Cr.	...	...	...	"
S-642	Tedesco Cr.	...	...	...	"
S-643	Otter Lake Cr.	...	...	...	"
S-644	Ruth Cr.	...	...	...	"
S-648		...	...	...	"
S-649		...	...	...	"
S-649A		...	...	...	"
S-651	Shelling Lake Cr.	...	...	...	"
S-652		...	...	...	"
S-652A	Iron Lake Cr.	...	...	...	"

* P.m. = Petromyzon marinus (sea lamprey).

** Ichth. = Ichthyomyzon spp. (silver lamprey and Michigan brook lamprey).

*** E.l. = Entosphenus lamottei (American brook lamprey).

The only pre-treatment survey conducted on Lake Superior, the Wolf River, is listed in Table II, while the pre-treatment surveys for Lake Huron are listed in Table III.

During the 1961 field season the majority of pre-treatment surveys were completed just prior to treatment. At times the chemical crew had to assist with and complete the survey before the lampricide could be applied.

Post-treatment surveys for Lake Superior (Table II) were conducted on all of the streams, treated since 1958, from the Pancake River to Sault Ste. Marie and on the Kaministikwia, Black Sturgeon, Jackfish, Big Gravel, and Pays Plat Rivers in western Lake Superior. Sea lamprey ammocoetes, larger than could be expected by normal growth since the time of the original treatment, were found in the Big Carp, Goulais, Batchawana, Sable, tributaries to the Kaministikwia, and near the mouths of the Harmony and Stokeley Rivers. These findings indicate the advisability of re-treating Big Carp, Goulais and Kaministikwia Rivers during 1962.

Except on the Kaministikwia, where chemical was used on the small tributaries, post-treatment surveys conducted on the streams of western Lake Superior were not conclusive, since the rivers were in flood - some two to four feet above normal. An additional survey is required on these rivers early in 1962.

The finding, in the rivers treated in 1959 and 1960, of sea lampreys larger than could be expected from normal growth, may be explained as follows: (1) Ammocoetes found in the estuarine areas, and upstream as far as the river is affected by seiche action, can in part reasonably be attributed to lake populations and to ammocoetes that escaped the lampricide in the outer estuarine area - owing to the current pattern prevalent at the time of treatment. Ammocoetes can and do migrate from the lake to the river as well as downstream into the estuarine area. (2) Sea lampreys may have been present in lagoons where they remained undiscovered during distribution surveys. Such lagoons would not be treated with lampricide. The most probable areas for recruitment to the main river are from unmapped lagoons, small tributaries and pools which, during low flow, are isolated from the main river. Even though the scale of the maps used is four inches to the mile, small tributaries and lagoons, which are not indicated on the maps, have been found when the rivers have been carefully explored.

Native lampreys, American brook lamprey and Ichthyomyzon spp. (silver lamprey and Michigan brook lamprey combined), were generally more abundant in post-treatment surveys. This was to be expected, as they are more widely distributed in the watersheds and are found upstream from feeder sites. They were also present in lagoons and tributaries which did not support sea lamprey populations. These areas were not treated with lampricide.

Treatment and survey techniques have been refined since the original applications during 1959. Sea lampreys have been located in lagoons and small tributaries that previously may have been regarded as unsuitable habitat. The streams in the Soo area in 1959 were treated as low flow. During

re-treatment of the Sable River in 1961 the river was in flood. Lagoons that had been blocked off in low flow were re-connected to the river. Sea lampreys have been found in isolated pools that are connected to the river when in flood. It is evident that further refinements are required for stream surveys and treatments. A planned major refinement will be a thorough investigation of the complete watershed for small tributaries, lagoons and isolated pools prior to treatment. These are the most probable areas for contamination. The larger streams can be navigated by boat from the feeder site to the mouth; smaller streams will of necessity have to be walked from feeder site to the estuarine area. In some cases this is many miles.

Table II. Pre- and post-treatment surveys, Lake Superior, 1961.

Stream No.	Stream Name	Number of Ammocoetes Collected			Type of Survey
		P.m.*	Ichth.**	E.l.***	
S-2	W. Davignon R.	...	...	231	Post-treatment
S-4	Little Carp R.	2	...	123	" "
S-5	Big Carp R.	4	...	121	" "
S-23	Cranberry R.	...	...	42	" "
S-24	Goulais R.	30	...	430	" "
S-36	Stokeley R.	8	...	1372	" "
S-39	Harmony R.	1	...	132	" "
S-52	Batchawana R.	9	41	147	" "
S-54	Sable R.	37	...	401	" "
S-56	Pancake R.	...	...	1	" "
S-368	Big Gravel R.	...	...	...	" "
S-509	Black Sturgeon R.	...	...	...	" "
S-572	Kaministikwia R.	152	30	...	" "
S-517	Wolf R.	4	15	...	Pre-treatment

* P.m. = Petromyzon marinus (sea lamprey).

** Ichth. = Ichthyomyzon spp. (silver lamprey and Michigan brook lamprey).

*** E.l. = Entosphenus lamottei (American brook lamprey).

Table III. Pre-treatment surveys, Lake Huron, 1961.

Stream No.	Stream Name	Number of Ammocoetes Collected			Type of Survey
		P.m.*	Ichth.**	E.l.***	
H-39	Gawas R.	...	...	...	Pre-treatment
H-50	Two Tree Cr.	145	...	665	" "
H-51	Richardson's Cr.	...	...	...	" "
H-57	Watson's Cr.	...	...	...	" "
H-58	Gordon's Cr.	217	...	268	" "
H-59	Brown's Cr.	6	...	14	" "
H-62	Kaskawong Cr.	137	...	3	" "
H-65		...	...	15	" "
H-68		...	...	52	" "
H-87	MacBeth Cr.	...	...	...	" "
H-88	Thessalon R.	3461	1764	784	" "
H-92	Livingston R.	...	...	...	" "
H-102		...	...	...	" "
H-107	Mississagi R.	183	7	49	" "
H-114		2	...	106	" "
H-116	Serpent R.	63	100	26	" "
H-134	Spanish R.	51	1959	...	" "
H-1354	Lafontaine R.	11	...	...	" "
H-1360	Nottawasaga R.	4374	446	...	" "
H-1492	Saugeen R.	20	...	...	" "
H-1589	Lucknow R.	...	239	...	Bio-assay specimens
H-1681	Bayfield R.	215	78	...	Pre-treatment

* P.M. = Petromyzon marinus (sea lamprey).

** Ichth. = Ichthyomyzon spp. (silver lamprey and Michigan brook lamprey).

*** E.l. = Entosphenus lamottei (American brook lamprey).

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Appendix 27

WELLAND SHIP CANAL INVESTIGATION, 1959 AND 1961

An investigation of the Welland Ship Canal system was initiated during December 1959 and continued during December 1961 to determine the extent, if any, to which sea lamprey adults use the Canal as a channel for migration from Lake Ontario to Lake Erie. The following records of sea lampreys in the Canal system were reported to the local Department of Lands and Forests office:

- | | | |
|---------------|---|---|
| Nov. 27, 1960 | - | One adult lamprey on screen of City of Welland water intake - 25.5 inches long. |
| Dec. 1, 1960 | - | One adult lamprey in minnow dip net, Niagara River, Fort Erie - 21 inches long. |
| Dec. 6, 1960 | - | One adult lamprey snagged in Niagara River, Fort Erie - 14 inches long. |

During the navigation season, extensive investigations of the Ship Canal is impractical. However, drainage of sections of the Canal for annual construction and repairs, instituted during the winter months of the year, affords an opportunity for examining the Canal.

From December 18 to 30, 1961, a crew of three men sampled the fish population of the Welland Canal. The length of the Canal drained was 8.6 miles, commencing at Lock 7 and following in order to Lock 1 on Lake Ontario. Lock 1 was pumped rather than drained, because the bottom of this Lock is below the level of Lake Ontario. Seven points within that part of the system drained, including the recess pools behind the sills of Locks 7, 6, 3 and 2, were shocked with a portable electric generator. Each set of gates of a lock rides on a cement skid and, when closed, the bottoms of the gates come up flush to a cement sill. When each lock is drained, the water is retained in the pools between the cement skids and the sill. These pools, called the recess pools, have a depth of five to six feet, width of eighty feet, and a length of forty feet. The pools thus become a natural basin in which the fish may collect. The large pondage (1/2 acre by 3 feet in depth) above Lock 3 was also shocked. This pondage, when completely filled with water, is 20 feet deep and has a surface area of over 10 acres.

Table I lists some of the features of the Welland Ship Canal system. Tables II and III list the species of fish that were removed from various points of the Canal during 1959 and 1961. The most abundant fishes were gizzard shad, alewife, and smelt. The remaining species occurred sparingly and only one specimen of the white perch was found. The bulk of the fish were less than 1/2 pound; however, some gizzard shad, pike and perch reached one pound in weight.

Table I. Welland Ship Canal System

First placed in operation	1932
Number of lift locks (three of the above are twin flight locks)	7
Length of lift lock	859 feet
Width of lock	80 "
Depth of water <u>on</u> sills	30 "
Depth of water <u>in</u> sills (recess pools)	5.5 "
Average lift of lock	46.5 "
Height of lower lock gates	82 "
Amount of water required for a lockage (Imperial gallons) average	21,000,000 gal
Greatest height of lock wall (between Locks 4 & 5)	130.8 feet
Width of canal at bottom - nominal	200 "
Width of waterline at surface of water - minimum	310 "
Depth of canal prism	27 "
Time to fill one lock	12 to 15 min
Height of Lake Erie above Lake Ontario	365.5 feet
Length of Welland Canal	27.6 miles
Distance Lake Ontario to: Lock 1	1.90 "
Lock 2	3.70 "
Lock 3	6.35 "
Lock 4)	7.66 "
)	
Lock 5) Flight Locks	7.83 "
)	
Lock 6)	8.00 "
Lock 7	8.60 "

Table II. List of fish collected from Locks 4 and 5 of the Welland Ship Canal during December 1959.

Common Name	Scientific Name	Collected from
Alewife	<u>Alosa pseudoharengus</u>	Locks 4, 7
Gizzard shad	<u>Dorosoma cepedianum</u>	Locks 4, 7
American smelt	<u>Osmerus mordax</u>	Locks 4, 7
Northern pike	<u>Esox lucius</u>	Lock 4
White sucker	<u>Catostomus commersoni</u>	Lock 4
Common shiner	<u>Notropis cornutus</u>	Locks 4, 7
Rosyface shiner	<u>Notropis rubellus</u>	Locks 4, 7
Channel catfish	<u>Ictalurus punctatus</u>	Lock 4
White bass	<u>Roccus chrysops</u>	Locks 4, 7
Rock bass	<u>Ambloplites rupestris</u>	Lock 4
Yellow perch	<u>Perca flavescens</u>	Lock 4

Table III. List of fish collected from the Welland Ship Canal during December 1961.

Common Name	Scientific Name	Collected from
Alewife	<u>Alosa pseudoharengus</u>	Locks 1, 2, 3, 6, 7 ...
Gizzard shad	<u>Dorosoma cepedianum</u>	Locks 1, 2, 3, 6, 7 Pondage #3
American smelt	<u>Osmerus mordax</u>	Locks 2, 3, 6, 7 ...
Northern pike	<u>Esox lucius</u>	Locks 1, 3 Pondage #3
White sucker	<u>Catostomus commersoni</u>	... "
Carp	<u>Cyprinus carpio</u>	Locks 1, 7 "
Channel catfish	<u>Ictalurus punctatus</u>	... "
White perch	<u>Roccus americanus*</u>	Lock 7 ...
Rock bass	<u>Ambloplites rupestris</u>	Lock 3 ...
Yellow perch	<u>Perca flavescens</u>	Lock 3 ...

*This is the first record of this species from the Welland Canal system. Furthermore, few specimens have been collected from Lake Erie.

Of the fish examined, only a few pike and carp were of a size on which lampreys would be expected to feed. However, no fish exhibited any wounds or scars, nor were any adult or larval forms of lampreys discovered. These data, however, do not indicate that sea lampreys do not use the Welland Canal. Further investigation is intended before any conclusions can be drawn.

We wish to acknowledge the cooperation shown by Mr. P. P. Ellis and men of the St. Lawrence Seaway Authority employed at the Welland Ship Canal and the Lake Erie District of the Ontario Department of Lands and Forests.

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Appendix 28

SUMMARY OF CHEMICAL TREATMENT OF STREAMS LAKES SUPERIOR AND HURON, 1961

Twenty streams were treated with lampricide on Lake Superior and Huron during 1961. All of the streams were treated at a concentration and for a duration of time which a bio-assay had indicated would produce at least a 99.9% level of mortality to lampreys.

Table I lists the pertinent data concerning the treatments on Lake Superior during 1961, while Table II lists the data for the Lake Huron treatments. Lafontaine Creek, Lake Huron, was treated after sea lamprey ammocoetes were collected from it for the first time in the spring of 1961. In Lake Superior, the Wolf River was experimentally treated and the Batchawana and Sable Rivers were treated ahead of schedule, as sea lamprey ammocoetes were collected from them during the post-treatment surveys. Sea lampreys were found to be relatively abundant during re-treatment of both the Batchawana and Sable Rivers. Possible explanations of the presence of large ammocoetes found is discussed under post-treatment surveys (Appendix 26).

Although summaries of all treatments are included in Appendices 30 and 31, a brief summary is included in this Appendix on the Nottawasaga River treatment, owing to the size and complexities of the watershed, and on the Wolf River because there were two experimental treatments.

Preparations to treat the Nottawasaga River were started on May 23, 1961, when a campsite was set up beside the river. A series of rain storms prevented treatment until June 18. In the intervening period many measurements and tests were performed. These included 25 bio-assays of water from the river and its main tributaries, numerous discharge measurements and dye checks, and the frequent recording of water levels at many stations.

Table I. Streams treated with lampricide for the sea lamprey control experiment, Lake Superior, 1961.

Name	Date treated	Flow in cfs	Concentrations in ppm during Treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Pancake R.</u>	Jul. 9-13/61	37	Feeder 2.3 Mouth 1.5	369	27	988.00	Scarce	15

Gimlet Cr.	Jul. 10-11/61	2	Feeder 3.0	46	61	122.00	Moderate	2

Trib. 12	Jul. 10/61							
Lagoon 11A	Jul. 11/61							
" 9B	"							
" 9A	"							
" 8F	"							
" 8E	"							
" 8D	"							
" 8C	"							
" 8B	"							
" 8A	"							
Trib. 2	"							
				Total tribs.				
				41		100.00		

TOTALS		39		456		watershed 31	1,219.00	17

<u>Chippewa R.</u>	Jul. 12-13/61	174	Feeder 1.5 Mouth 0.7	667	10	1,786.00	Abundant	1.5

Table I. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Batchawana R.</u>	Sept. 7-8/61	154	Feeder 2.3 Mouth 1.0	1,829		4,902.00	Moderate	8
Trib. 53	Sept. 7-8/61							
Lagoon 15-16	Sept. 7/61							
" 12-12A	"							
" 17	Sept. 8/61							
" 6-7	"							
" 11-14	Sept. 9/61							
" 9-10	"							
" G	"							
Booster 5-1	Sept. 10/61			437		1,171.00		
Lagoon 2-3	"							
								Total lagoons
								1.5
Totals		154		3,151	55	8,445.00		9.5
<u>Sable R.</u>	Sept. 16-17/61	70	Feeder 2.0 Mouth 1.5	371		994.00	Moderate	12
Trib. 8A	Sept. 16/61		Feeder 2.0					
" above 8	"	10						Total
" " 8	"	+ other						tribs.
" " 2	Sept. 17/61	(springs, etc.)						2.5
Lagoon 1-2	"							
Totals		100 at mouth		502	13	1,344.00		14.5

Table I. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Wolf R.</u>	Oct. 5-7/61	75	Feeder 4.5 Mouth 3.0	874		2,341.00	Abundant	
Trib. 18-19	Oct. 5/61							
Lagoon 17	"							
" 16	Oct. 6/61							
" 15	"							
Trib. 13	"							
Lagoon 5	"							
" 4-5	"							
" 2	"							
Trib. below 2	"							
Booster 10A-2	Oct. 7/61			137		366.00		
Totals - 1st Treatment		<u>75</u>		<u>1,134</u>	<u>40</u>	<u>3,036.00</u>		<u>8.5</u>
<u>Wolf R.</u>	Oct. 13-14/61	200*	Feeder 3.0 Mouth 2.0	2,348		6,292.00	Nil	
Lagoon 16	Oct. 13/61			18		49.00		
" 4	Oct. 14/61							
Totals - 2nd Treatment		<u>200*</u>		<u>2,366</u>	<u>32</u>	<u>6,341.00</u>		<u>8.5</u>

*Estimate

Table II. Streams treated with lampricide for the sea lamprey control experiment, Lake Huron, 1961.

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Gordon's Cr.</u>	Apr. 29/61	4	Feeder 1.2-8.0 Mouth 1.2-3.5	32	21	85.00	Moderate	1
<u>Gawas Cr.</u>	Apr. 30/61	10	Feeder 5-10+ Mouth 4.3-10+	137	39	366.00	Few	0.5
Lagoon at 1A	"			8		21.00	Nil	
Swamp at 1A	"			5		12.00	Nil	
Small trib at 1A	"			8	42	21.00	Nil	
Small trib at 1	"			2	61	6.00	Nil	
Totals		10		160	43	426.00		0.5
					watershed			
<u>Brown's Cr.</u>	May 1-2/61	7	Feeder 3.5 Mouth 2.0	103	40	276.00	Moderate	1.5
<u>Richardson's Cr.</u>	May 4-6/61	12	Feeder 14.0 Mouth 6.0+	378	84	1,013.00	Abundant	4
Unnamed tribs								
Station 4	May 5/61			14	74	37.00	Nil	
" 5	May 5/61			46	244	122.00	Few	
Totals		12		438	98	1,172.00		4
					watershed			

Table II. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
Two Tree Cr.	May 7-10/61	9	Feeder 14 Mouth 5	642	191	1,719.00	Moderate	9.5
Mill Pond outlet	May 7-9/61	4		205	137	549.00	Moderate	
Harmony School Cr.	May 8/61	5		218	117	585.00	Abundant	4.2
Unnamed tribs.								
Stn. 20	May 7/61			27		73.00	Nil	
14	May 9/61			24		70.00	Nil	
8	May 8/61			27		73.00	Nil	
4E	May 9/61	12		55	12	146.00	Nil	
Boosters 11	May 8/61			27		73.00	...	
4E	May 9/61			27		73.00	...	
4B	May 8-9/61			82		219.00	...	
Totals		30		1,334	Watershed 119	3,580.00		14.5
Lafontaine Cr.	Jun. 11-14/61	5	Feeder 6 Mouth 3	49		165.00	Scarce	10
Boosters 8	Jun. 12/61			26		88.00		
6	Jun. 13/61			33		110.00		
Unnamed tribs. 8	Jun. 12/61			20		66.00	Nil	
3	Jun. 13/61			23		77.00	Nil	
Totals		5		151	101	506.00		10

Table II. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Nottawasaga R.</u>	Jun. 18-25/61	106	Feeder 12 Mouth 8	4,204		11,267.00	Scarce	45
Booster 220	Jun. 22/61			<u>2,907</u>		<u>7,791.00</u>		
Sub Total				7,111	180	19,058.00		
Tributaries								
385	Jun. 19?/61	1*					Nil	0.5+
380	Jun. 19/61	1*					Nil	0.25
372	"	4*					Nil	0.25
364	"	5*					Nil	1.0
110A	Jun. 22/61						Nil	200**
72A	"						Nil	...
51A IV	Jun. 22/61						Few	...
51A III	"						Few	...
51A II	"						Nil	400**
51A I	"						Nil	400**
45A IV	Jun. 23/61	1*					Nil	...
45A III	"						Nil	200**
45A II	"						Nil	...
45A I	"						Nil	...
42B III	Jun. 23/61						Nil	...
(lagoon)42B II	"						Nil	...
42B I	"						Nil	200**
Jacks Lake	"						Nil	0.5
42 B	"						Nil	700**

*Estimate

**Feet

Table II. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Nottawasaga R. Watershed - cont'd</u>								
Lagoon 42 I	Jun. 24/61						Nil	100**
37	"						Nil	100**
37+	"						Nil	400**
1B+	"						Nil	...
Lagoons								
1A1-1A2	Jun. 25/61						Nil	900**
Sub-total				829		2,809.00		
Combined chemical - main stem	118			7,940	185	21,867.00		

Boyne R.	Jun. 18-19/61	25	Feeder 12 Mouth 12	1,092	117	2,927.00	Abundant (only 1 P.m.)	3

Mad R.	Jun. 19-21/61	33	Feeder 15 Mouth 5.1-12.4	1,597		4,280.00	Abundant	50
Boosters								
136C	Jun. 21/61			176		595.00		
136B	"			78		264.00		
130	"			355		951.00		
Tributaries								
188 i	Jun. 20/61	2*					Nil	...
188 ii	"						Nil	0.25
188 iii	"	1*					Nil	...

*Estimate

**Feet

Table II. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Nottawasaga R. Watershed - cont'd</u>								
Tributaries (Mad R.)								
176	Jun. 20/61	1*					Nil	...
178	"						Nil	...
180	"	3*					Nil	1
164 i	"	1*					Nil	0.5
164	"						Few	...
166	"	1*					Nil	...
138	Jun. 21/61	5*					Nil	0.25
131D	"						Nil	...
136	"	1*					Nil	...
132	"						Nil	300**
131G	"						Nil	...
131F	"						Abundant	...
136A	"						Few	300**
136A2	"						Few	...
136A2+	"						Few	...
136A3	"						Abundant	...
136A4	"						Nil	...
125x	Jun. 22/61	1*					Scarce	0.5
125x	Jun. 23/61	1*					Scarce	0.5
Sub-totals:	Feeder			1,597		4,280.00		
	Booster	33		608		1,810.00		
	Tribs	<u>17*</u>		<u>306</u>		<u>1,036.00</u>		
	Total	50		2,511	143	7,126.00		

*Estimate

**Feet

Table II. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
Nottawasaga R. Watershed - cont'd								
Noisy R. (Trib to Mad)	Jun. 19-20/61	18	Feeder 18 Mouth 9	1,775	264	4,756.00	Moderate	12
Tributaries								
203	Jun. 19/61	4*					Nil	...
199	"	1*					Nil	...
201	"	1*					Nil	...
196	"	2*					Nil	...
194	"	...					Nil	...
171	Jun. 20/61	1*				545.00	Nil	...
Totals				1,936		5,301.00		
Totals Mad R. Watershed		90 at mouth		4,447	138	12,427.00		65

Pine R.	Jun. 21-22/61	78	Feeder & mouth 10	3,331	114	8,926.00	Scarce	1

Bear Cr.	Jun. 20-21/61	19	Feeder 9 Mouth 7.5	364	51	976.00	Scarce	3
2nd treatment	Jun. 24/61		Feeder 11	218	31	585.00	Nil	4
Total				582		1,561.00		

Willow R.	Jun. 22-23/61	55	Feeder & mouth 8	1,824	112	6,184.00	Scarce	600**

*Estimate

**Feet

Table II. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Nottawasaga R. Watershed - cont'd</u>								
Phelpston Cr.	Jun. 22/61	10*	Feeder 10-15	102	27	274.00	Nil	2
Lamont Cr.	Jun. 23-25/61	5	Average 15-25	564	302	1,512.00	Moderate	5
GRAND TOTALS		400*		19,883	139	55,680.00		131
					Watershed			
<u>Root River</u>	Jul. 16-24/61	24	Feeder 2.3 Mouth 1.8	218	24	585.00	Abundant	15.5
Lagoon 21-23	Jul. 19/61							
Trib. 22A	"			24		64.00		
Lagoons 22	"							
Trib. 3B	"							
Booster 4	Jul. 20/61			54		146.00		
West Root	Jul. 17-20/61	5	Feeder 0.9 Mouth 1.2	54	29	145.00	Moderate	5.5
Lagoon 28	Jul. 18/61							
" 28A	"							
Pond 29	Jul. 21/61			Total tribs				
Pond 28A	"			41		110.00		
Pond 29	"							

*Estimate

Table II. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Root R. Watershed - cont'd</u>								
W. west Root	Jul. 17/61	2	Feeder 1.4 Mouth 0.8				Moderate	5
Pond 37A	Jul. 18/61							
Pond above 44	Jul. 20/61							
" " 44	Jul. 21/61							
" " 44	Jul. 22/61							
" " 44	Jul. 24/61							
				Total W.W. Root	100	289.00		

Coldwater Cr.	Jul. 18-19/61	9	Feeder 1.7 Mouth 1.4	55	16	146.00	Scarce	
Trib. 19	Jul. 19/61			1		3.00		1.5

Crystal Cr.	Jul. 19/61	19	Feeder 1.3 Mouth 1.2	109	15	293.00	Moderate	6
Trib. 8A	"							
Trib. below 8A	"							
" " 8	"							
" " 5B	"							
Trib. 5	"							
" 3	"							
				Total tribs	20	53.00		

<u>Totals for Root River Watershed:</u>								
Main Root R.		24		296	33	795.00		
West Root R.		5		95	51	255.00		
West West Root R.		2		99	144	289.00		
Coldwater Cr.		9		55	17	149.00		
Crystal Cr.		19		129	18	346.00		
		+ other (springs, etc.)						
GRAND TOTAL		70 at mouth		674	Watershed 26	1,834.00		33.5

Table II. (continued).

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Serpent R.</u>	Aug. 5-6/61	269	Feeder 1.2 Mouth 1.0	1,583		4,244.00	Moderate	8
Trib. 6D	Aug. 5/61							2.5
" 6B	"							
" 6A-6	"							
" 5A	"							
" 4	"							
" 4 up	Aug. 6/61							0.5
" 9-9B	"							
" 9-9A	"							
Lagoon 28A	"							
" 27	"							
" 13	"							
Trib. 9B	Aug. 7/61							
Totals		269		1,735	17	4,652.00		11
<u>H-114</u>	Aug. 7/61	0.5*	Feeder app. 8	14	74	37.00	Nil	0.25
<u>Livingstone Cr.</u>	Aug. 10-11/61	0.5*		43		116.00	Moderate	3
Trib. 2A	Aug. 10/61			2		6.00		
Totals				45	244	122.00		
<u>MacBeth Cr.</u>	Aug. 10/61	0.5*		50	268	134.00	Moderate	0.25

*Estimate

Table II. (continued)

Name	Date treated	Flow in cfs	Concentrations in ppm during treatment	Lbs active ingredient	Cost \$/cfs	Total cost chemical (\$)	Ammocoete abundance	Miles stream treated
<u>Lauzon R.</u>	Aug. 10-11/61	5.0*	Feeder 2.0 Mouth 1.0	21	11	55.00	Moderate	0.5
<u>Mississagi R.</u>	Aug. 16-18/61	1800*	Feeder 1.5 Mouth 1.2	12,258		32,851.00	Abundant	

Bolton R.	Aug. 16/61		Feeder 2.4 Downstream 2.0	164		439.00		
Trib. 126A	"							
" 124	"							
" 119	"							
Lagoon 119	"							
Trib. 116	"							
" 114	"							
" 62	"							
" 61	"							
Lagoon. 51	Aug. 17/61							
" 51.	"							
Mud flat 51A	"							
Trib. 38A	"							
" 38	"							
" 18	"							
" 17A	"							
" 12	"							
" 11	"							

Totals		1800*		12,693	19	34,017.00		15.5

*Estimate

The actual treatment lasted from June 18 to June 25, during which time at least one feeder was in operation at any given moment. In addition to many small tributaries, the following major streams in the Nottawasaga River system were treated: Boyne, Mad, Noisy, Pine, Bear, Willow, Phelpston and Lamont. The main stem of the Nottawasaga was treated at two points, a booster being used about half way between the main feeder and the mouth. Lampricide was applied at 50 locations in all, and a total of 131 miles of stream was treated. We were fortunate in being able to successfully treat a river of such magnitude and complexity of watershed as the Nottawasaga. It is doubtful that the Nottawasaga could be scheduled for treatment at any specific time of year owing to the effect of local climatic conditions on this watershed.

The Wolf River was treated on October 6-7, 1961. Prior to treatment we had only limited evidence of successful sea lamprey spawning in the river. The Wolf was partially surveyed in 1960 and again re-surveyed prior to treatment. Only Ichthyomyzon spp. ammocoetes had been collected.

Sea lamprey nests were observed in 1960 and recently-hatched lampreys were collected from them. Sea lampreys were observed spawning in the Wolf during the spring of 1961.

It was decided to experimentally treat the Wolf River from this evidence of spawning activity. This was the first river treated without the collection of identifiable sea lampreys. Since it was an experimental treatment and the river was in flood, and in order to conserve on chemical, the flow was reduced from over 200 cfs to approximately 75 cfs by means of a control dam a few miles above the feeder site - a falls that constitutes a natural barrier.

Sea lamprey ammocoetes, 20-125 mm in length, as well as Ichthyomyzon spp., were abundant especially in the areas where surveys had been performed.

When flow is reduced, by a control dam, a relatively large proportion of larval habitat along the banks is exposed in mud flats and in sandbars in mid-stream. This had been noted in other rivers where flow had been reduced to low levels to conserve on chemical, as in the Kaministikwia, Black Sturgeon, Michipicoten and Mississagi River treatments. Whether or not ammocoetes escape the toxicant when rivers are treated at an artificially reduced flow has always been a controversial subject. In an effort to determine the extent of escapement, the Wolf River was retreated on October 13-14, 1961 under flood conditions with a controlled flow of over 200 cfs. After extensive searching, no ammocoetes were found in the main river during the second treatment. Two ammocoetes were found in a lagoon near the mouth.

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Appendix 29

MOBILE BIO-ASSAY UNIT, 1961

A mobile bio-assay trailer was located near the Pays Plat River from May to July. This unit was transferred to Sault Ste. Marie for the remainder of the year. Sixty-four bio-assays were performed, in this unit, in an attempt to determine any trend in the seasonal loss of biological activity of the toxicant and to determine the appropriate time for future treatments. This unit was also responsible for the operation of the electrical barriers in the western end of Lake Superior.

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Appendix 30

INDIVIDUAL STREAM TREATMENT REPORTS, LAKE SUPERIOR, 1961

The following is a list of tributaries to Lake Superior that were treated with lampricide during 1961. A brief account of each stream treatment is included.

<u>River Name</u>	<u>Date of Treatment</u>
1. Pancake River (S-56)	July 9-13, 1961
2. Chippewa River (S-48)	July 12-13, 1961
3. Batchawana River (S-52)	Sept. 7-10, 1961
4. Sable River (S-54)	Sept. 16-17, 1961
5. Wolf River (S-517)	Oct. 6-7, 1961
Second treatment of Wolf River	Oct. 13-14, 1961

1. Pancake River (S-56)

Pancake River and its tributary Gimlet Creek, Townships of Herrick and Ryan, District of Algoma, were treated from July 9 to 13, 1961, with a formulation of 3-trifluormethyl-4-nitrophenol (TFM) containing about 40% by weight of the active ingredient, as supplied by the Hoechst Chemicals Company. The lampricide was applied to Pancake River at a point about 15 miles from its mouth, and to Gimlet Creek at a point about 2 miles from its junction with the river. The toxicant was also applied at eleven other points in the watershed by hand or by drip feeder. This was the second treatment of Pancake River, the first having been conducted in 1958.

Pre-treatment examination of the river included discharge measurements, dye checks, and a bio-assay of Pancake River water. Just prior to the treatment, the volumes of flow at the mouth of Pancake River and in Gimlet Creek were 39 and 2 cubic feet per second (cfs) respectively. Results of the bio-assay indicated that for an eighteen-hour treatment, less than 0.8 ppm of TFM would kill at least 99.9% of the lampreys, and 3.2 ppm of TFM would not kill more than 25% of the trout. These doses were the minimum effective and maximum permissible for the treatment.

Lampricide was applied by means of "Proportioneer" dual-piston feeders, beginning at 1200 hours on July 9 in Pancake River and at 0950 hours on July 10 in Gimlet Creek for periods of eighteen hours in both cases. Eighty-one gallons of formulation containing 369 pounds of TFM were applied at the Pancake River feeder, 10 gallons containing 46 pounds were applied at the Gimlet Creek feeder, and 9 gallons containing 41 pounds were applied by hand and by drip feeders at miscellaneous locations. Concentrations of TFM were: below the Pancake River feeder site, between 2.1 and 2.9 ppm for eighteen hours; below the Gimlet Creek feeder site, 2.4 to 9 ppm for eighteen hours; and at the mouth of Pancake River, 1.1 to 2.1 ppm for sixteen hours.

The main feeder sites on both Pancake River and Gimlet Creek in 1961 were at the same locations as those chosen in 1958. Both sites were accessible to four-wheel drive vehicles at the times of the treatments. The volume of flow in Pancake River during the 1961 treatment was approximately equal to that during the 1958 treatment.

Ammocoetes were much less abundant, particularly in the main river, in 1961 than in 1958, as indicated by the numbers of dead specimens collected after the treatments. In Pancake River, of 45 larvae collected, six were sea lampreys; while in Gimlet Creek, of 100 larvae, twenty-four were sea lampreys.

2. Chippewa River (S-48)

Chippewa River, Township of Tilley, District of Algoma, was treated on July 12 and 13, 1961, with the Hoechst 40% formulation of TFM. The lampricide was applied at a point about 1½ miles from the mouth above a falls which is a barrier to upstream migrating sea lampreys. There were no other sites requiring separate treatment.

Although ammocoete surveys have been made periodically since 1953, and in spite of the fact that sea lampreys have been observed spawning in Chippewa River, the first identifiable sea lamprey ammocoete was taken in 1960. Pre-treatment studies in 1961 included discharge measurement, a dye check and a bio-assay of Chippewa River water. Just prior to the treatment, the volume of flow in Chippewa River was 174 cfs. Results of the pre-treatment bio-assay indicated that, for a nine-hour treatment, the minimum effective and maximum permissible concentrations of TFM were less than 0.8 and not more than 1.6 ppm respectively.

Lampricide was applied by means of a "Proportioneer" dual-piston feeder, for a period of eleven hours, forty minutes, beginning at 0600 hours on July 13, 1961. A total of 1465 gallons of formulation, containing 667 pounds of active ingredient, was used in Chippewa River. Concentrations of TFM prevalent during the treatment were: 1.5 ppm for eleven hours below the feeder, and at the highway bridge between 1.0 and 1.5 ppm for more than 9½ hours. Samples of treated water from the river mouth gave readings which were lower than the true values for their TFM content, because lake water which was present in the estuary reduced the background colour of the river. Considering the more than adequate treatment of the river above the estuary, it is assumed that most of the estuary was successfully treated.

Chippewa River has a natural barrier to upstream lamprey migration within 1½ miles of the mouth. Thus, in spite of being one of the larger rivers in the Sault Ste. Marie area, it was treated with a minimum of time and effort. Weather conditions at the time of treatment were ideal and water levels were low, although seasonably normal.

Ammocoetes, though abundant, were predominantly native species. Of almost 1,000 collected during this treatment, only ten were sea lampreys.

3. Batchawana River (S-52)

Batchawana River, Townships of Fisher and Palmer, District of Algoma, was treated between September 7 and 10, 1961 with the Hoechst 40% formulation of TFM. The lampricide was initially applied at a point about eight miles from the mouth of the river, above falls which are a barrier to the upstream migration of sea lampreys. A further application of lampricide to the already treated water was made in an area within one-half mile of the mouth. In addition, nine lagoons and tributaries were treated by manual applications of lampricide.

This was the second lampricide treatment of Batchawana River; the first was in 1959. The decision to retreat the Batchawana this year was reached after surveys with lampricide and electro-shockers revealed the presence of sea lamprey larvae which had survived the previous treatment. Other pre-treatment studies on Batchawana River included discharge measurement, chemical analysis of river water, and a bio-assay. The volume of discharge just prior to the treatment was 154 cfs. Results of the bio-assay indicated that, for an eighteen-hour treatment, the minimum effective and the maximum permissible concentrations of lampricide would be 1.05 and 4.0 ppm respectively.

Lampricide was applied by means of a "Proportioneer" dual-piston feeder for a period of eighteen hours, beginning at 1825 hours on September 7, 1961. A total of 402 gallons of formulation, containing 1,829 pounds of active ingredient, was applied at the main feeder site. An additional 96 gallons, containing 437 pounds of TFM, were poured from a moving boat in the estuary on September 10. This application boosted the concentration of lampricide already in the area by about 1 ppm. A further 195 gallons, containing 885 pounds of TFM, were used in treating tributaries and lagoons.

Concentrations of lampricide prevalent during the treatment were: below the feeder, 1.4 to 2.5 ppm for 17½ hours; in the vicinity of the electric barrier, 1.0 to 2.2 ppm for 18 hours; and at the mouth, 1.0 to 2.2 ppm for about 20 hours.

The principal difference between the two treatments was the increased amount of lampricide used in 1961. Most of this was accounted for by the greater amounts applied to lagoons and tributaries and by the booster application in the second treatment. The same site was chosen for the location of the main feeder in both cases.

The second treatment resulted in a heavy mortality of ammocoetes including 41% sea lampreys, some of which, judging by their size, must have survived the first treatment. Most of these were collected near the mouth and in the vicinity of a lagoon near the barrier and a tributary below the feeder site.

4. Sable River (S-54)

Sable River, Township of Fisher, District of Algoma, was treated on September 16 and 17, 1961 with the 40% Hoechst formulation of TFM. The lampricide was applied to the main river at a point about twelve miles from its mouth, and to a tributary from Carp Lake about one mile from its junction with the river. Two other small tributaries and a lagoon were also treated with lampricide. This was the second treatment of Sable River; the first was in 1959. The decision to retreat at this time resulted from the discovery, during this year's surveys with lampricide and electro-shockers, of sea lamprey larvae which had survived the previous treatment.

Other pre-treatment studies of Sable River included discharge and water level measurements, chemical analysis of the water and three bio-assays. At the time of treatment the volume of flow at the feeder site was 70 cfs, a higher than normal figure resulting from a recent flood. Results of the final bio-assay indicated that for an eighteen-hour treatment the minimum effective and maximum permissible concentrations of TFM would be 0.52 and 2.1 ppm respectively.

At the main feeder site, lampricide was applied by means of a "Proportioneer" feeder for a period of 13-¾ hours, beginning at 1500 hours on September 16. Drip feeders were used on the tributaries and the lagoon was treated manually by pouring the toxicant into the lagoon from a moving boat. A total of 82 gallons of formulation containing 371 pounds of active ingredient was used in the main river, and an additional 29 gallons containing 131 pounds of active ingredient in the lagoon and tributaries.

Concentrations of TFM prevalent in the river during treatment were: below the main feeder, 1.9 to 2.2 ppm for thirteen hours; in the Carp Lake Creek, 1.1 to 2.7 ppm for fourteen hours; and at the mouth of Sable River, 1.5 to 1.8 ppm for twelve hours.

Comparison of the 1959 and 1961 treatments reveals that more lampricide

was used in 1961, due in part to the greater volume of flow and in part to the treatment of two small tributaries and a lagoon not treated in 1959. A booster feeder, employed in 1959 to counteract the effects of dilution and attenuation between the main feeder and the mouth, was not required in 1961.

Ammocoetes collected during the 1961 treatment included, in addition to many specimens of native species, numerous sea lampreys, particularly between the electric barrier and the mouth. Although most of these were of a size that would place them in the post-1959 year classes, a significant number of survivors of the 1959 treatment were also collected. It is probable that these lampreys escaped lethal exposure to lampricide in pools and lagoons temporarily isolated from the river at the low water conditions which existed at the time of treatment.

5. Wolf River (S-517)

Wolf River, Townships of Dorion and Stirling, District of Thunder Bay, was treated on October 6 and 7, 1961, and again on October 13 and 14, 1961, with the 40% Hoechst formulation of TFM. The first treatment was made at low water level and the second at high water. Our ability to control the flow, by means of a dam located above the feeder site, made possible an experiment to test the effectiveness of treatment at low water conditions. The application was made about 8½ miles from the mouth above a falls impassable to the upstream migration of lampreys.

The decision to treat Wolf River was based on reports that sea lampreys have been observed spawning in the river during 1960 and 1961 and the collection of newly-hatched lampreys from these nests during 1960. This was the first river treated without the collection of identifiable sea lamprey larvae prior to the treatment. Other pre-treatment studies included discharge and water level measurements, dye checks, water analysis and bio-assays.

The first treatment was carried out at a stream flow of 75 cfs. The pre-treatment bio-assay indicated that for an eighteen-hour treatment the minimum effective and maximum permissible concentrations of TFM would be 3.5 to 5.0 ppm. A "Proportioneer" feeder applied lampricide for a period of 18½ hours starting at 1525 hours on October 5. One hundred and ninety gallons of formulation, containing 874 pounds of active ingredient, were applied at the main feeder site. An additional 30 gallons, containing 137 pounds of TFM, were introduced near the mouth as a booster application. Three small tributaries and six lagoons were also treated with a total of 27 gallons of formulation containing 123 pounds of TFM.

The first treatment resulted in the following concentrations of TFM in the river water: below the feeder, 4.5 to 6.3 ppm for 18 hours; at the highway, 2.5 to 4.1 ppm for 18 hours; and at the mouth, 2.0 to 4.8 ppm for 17 hours.

Ammocoetes were numerous during this treatment and included *Ichthyomyzon* spp. and sea lampreys in an overall ratio of about 2 to 1, although the latter were more numerous, relatively, in the upstream portions of Wolf River.

The second treatment of Wolf River was made at an estimated flow of 225 cfs, calculated from staff gauge readings of the fluctuating water levels correlated with current readings at lower flow rates. A bio-assay conducted just prior to this treatment indicated that for an 18-hour exposure the minimum effective and maximum permissible concentrations of TFM would be 1.9 and 6.2 ppm respectively.

Application was made from the site used in the first treatment and the same pumping equipment was used to pump chemical for 16 hours, beginning at 0400 hours on October 13. Five hundred and sixteen gallons of formulation, containing 2,348 pounds of active ingredient, were used. An additional 4 gallons containing 18 pounds were applied in two lagoons. Concentrations of TFM in the river during this treatment were as follows: below the feeder, 2.6 to 3.2 ppm for 15 hours; at the highway, 2.4 to 2.7 ppm for 14 hours; and at the mouth, 2.1 to 2.7 ppm for 14 hours. A booster feeder was not required in the second treatment, because the river was in flood and the greater flow decreased the effects of dilution and attenuation.

No lampreys were collected from the Wolf River during the second treatment. Two ammocoetes only were found in a lagoon connected to the river in the estuarine area. The first treatment was apparently successful in this instance in spite of the abnormally low water levels existing at the time.

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Appendix 31

INDIVIDUAL STREAM TREATMENT REPORTS, LAKE HURON, 1961

The following is a list of tributaries to Lake Huron that were treated with lampricide during 1961. A brief account of each stream treatment is included.

<u>River Name</u>	<u>Date of Treatment</u>
1. Gordon's Creek (H-58)	April 29, 1961
2. Gawas Creek (H-39)	April 30, 1961
3. Brown's Creek (H-59)	May 1-2, 1961
4. Richardson's Creek (H-51)	May 4-6, 1961
5. Two Tree River (H-50)	May 7-10, 1961
6. Lafontaine Creek (H-1354)	June 11-14, 1961
7. Nottawasaga River (H-1360)	June 18-25, 1961
8. Root River (H-3)	July 16-22, 1961
9. Serpent River (H-116)	Aug. 5-7, 1961

River NameDate of Treatment

10. Unnamed stream (H-114)	Aug. 7, 1961
11. Livingstone Creek (H-92)	Aug. 10-11, 1961
12. MacBeth Creek (H-87)	Aug. 10, 1961
13. Lauzon River (H-112)	Aug. 10-11, 1961
14. Mississagi River (H-102-107)	Aug. 16-18, 1961

1. Gordon's Creek (H-58)

Gordon's Creek, in Jocelyn Township, St. Joseph's Island, was treated on April 29, 1961, with the 40% Hoechst formulation of TFM. Lampricide was applied at only one point, which was about one mile from the mouth, just below a beaver dam. All ammocoetes collected from the stream below this dam in 1956, 1957 and 1958 were sea lampreys.

Pre-treatment studies included discharge measurements, chemical analysis and a bio-assay. The volume of flow near the mouth was 4.3 cfs at the time of treatment. Results of the bio-assay indicated that for a 12-hour treatment the minimum effective and maximum allowable concentrations of TFM would be 1.2 and 3.1 ppm respectively.

Application by means of a battery-powered electric fuel pump was begun on April 29, at 1030 hours, and continued for 13¼ hours. Concentrations of TFM in the river during treatment were: at the feeder site, between 1.2 and 8.0 ppm for 10¼ hours; half way to the mouth, between 1.2 and 5.9 ppm for 13 hours; and at the mouth, 1.2 to 3.5 ppm for 11 hours. Relatively wide variations in concentrations resulted from difficulty experienced in regulating the output of the pump, because the formulation was viscous and contained solids. A total of 7 gallons, containing 32 pounds of active ingredient, was applied.

Ammocoetes collected during the treatment included almost equal numbers of sea lampreys and native species. Overall abundance of lampreys in Gordon's Creek was only moderate, and relatively few ammocoetes occurred in the upper third of the treated section.

2. Gawas Creek (H-39)

Gawas Creek, in the Township of St. Joseph, St. Joseph's Island, was treated on April 30, 1961 with the 40% Hoechst formulation of TFM. The feeder site was located above barrier falls which were only one-half mile from the mouth of the river. Ammocoete collections in 1956, 1957, 1958 and 1960 indicated that no sea lampreys occurred above this point, and were scarce in general.

This river had been stocked with 110 radioisotope-marked ammocoetes about three weeks prior to the treatment (Appendix 20). It was anticipated that recovery of marked specimens would make possible an accurate estimate of the population density and a measure of migratory activity.

Preliminary discharge measurements were made and a bio-assay of the

water was conducted. At the time of treatment, the volume of flow was about 10 cfs. Results of the bio-assay showed that for a 12-hour treatment minimum effective and maximum permissible concentrations of TFM would be 4.7 and 8.0 ppm respectively.

Application of lampricide by means of an electric fuel pump was begun at 1700 hours on April 30, and continued for 10-3/4 hours. At this site, 30 gallons of formulation containing 137 pounds of active ingredient were used. Two tributaries, a lagoon and a swamp were also treated, by means of drip feeders, and a total of 4.5 gallons of formulation containing 23 pounds of TFM was used.

Concentrations of TFM in the river during treatment were: at the feeder site, between 4.8 and 10 ppm for 10½ hours; and at the mouth, 3.9 to 10 ppm for over 10 hours.

Dead ammocoetes resulting from the treatment of Gawas Creek were very scarce, and in spite of intensive efforts to collect them, only five specimens were found. Two of these were found to be radioactive. Both the population density and the sample size were apparently too low for a successful marking experiment in this stream.

No particular difficulties were experienced during this treatment. Two fairly extensive swampy areas near the creek mouth and two small tributaries required manual applications of lampricide. Inclement weather in the form of snow and hail caused discomfort, but no serious operational difficulties. Access was good to the parts of the river which were undergoing treatment.

3. Brown's Creek (H-59)

Brown's Creek, Hilton Township, on St. Joseph's Island, Algoma District, was treated on May 1 and 2, 1961, with the 40% Hoechst formulation of TFM. The feeder site was located about 1½ miles from the mouth. There were no tributaries requiring treatment. Two beaver ponds were located below the feeder site; however, these did not require separate treatment.

Sea lamprey larvae had been collected from this stream in 1956, 1957 and 1958. The 1961 pre-treatment survey defined the limits of their occurrence upstream. Other pre-treatment studies included measurements of discharge and water level, analysis of water samples and a bio-assay. The volume of flow at the time of treatment was 6.9 cfs. Results of the bio-assay indicated that, for a 16-hour treatment, the minimum effective and maximum permissible concentrations of TFM would be 1.0 and 1.4 ppm respectively.

Lampricide was applied by means of a "Proportioneer" feeder for a period of 24 hours, beginning at 1100 hours on May 1. A total of 22.6 gallons of formulation, containing 103 pounds of active ingredient, was used. During the treatment concentrations of 2.9 to 3.8 ppm of TFM were maintained at the feeder site for 22 hours, and 1.7 to 3.1 ppm at the main road for over 12 hours. The long treatment period for this length of stream was necessary to ensure that the TFM in the beaver ponds was uniform in distribution and of the concentration required in the main river.

Observations made during the treatment indicated that ammocoetes were moderately abundant in Brown's Creek. Of the specimens collected, about 44% were sea lampreys. Fish mortality during the treatment appeared to be almost nil, and only two or three dead suckers were observed.

4. Richardson's Creek (H-51)

Richardson's Creek, in the Townships of Jocelyn and St. Joseph, St. Joseph's Island, was treated on May 4-6, 1961 with the 40% Hoechst formulation of TFM. The lampricide was applied at a "feeder site" about four miles from the mouth of the stream. Two roadside ditches were also treated near their junction with the main stem.

The river had been stocked with 400 radioisotope-marked ammocoetes about three weeks prior to the treatment. It was the second river to be treated of the three that had been chosen for this tagging experiment. From the results of electro-shocker surveys dating back to 1956, Richardson's Creek was known to have a population of sea lamprey larvae comprising 8 to 9% of the total ammocoete population, but confined to the main stem of the stream. Ammocoetes were moderately abundant upstream, but relatively scarce near the mouth.

Other pre-treatment studies included discharge measurements, bio-assays and chemical analysis of the stream water. The volume of flow part way downstream from the feeder was 12.5 cfs. at the time of treatment. The pre-treatment bio-assay indicated that, for an 18-hour treatment, the minimum effective and maximum permissible concentrations of TFM would be 5.45 to 8.5 ppm respectively.

The application of lampricide, by means of a "Proportioneer" feeder, was begun at 1500 hours on May 4 and continued for approximately 18 hours. At the main feeder, 83 gallons of formulation containing 378 pounds of active ingredient were applied. An additional 13 gallons containing 60 pounds of TFM were applied in two ditches by means of drip feeders. Concentrations of TFM in the river during this treatment were: below the feeder, 12 to 22 ppm for 18 hours; and at the furthest downstream point sampled, 6.4 to 13.4 ppm for 13 hours. The relatively high concentration maintained at the feeder was required in order to compensate for dilution downstream due to springs and surface drainage. A fairly heavy mortality of young trout was caused by the high concentration of lampricide for a short distance below the feeder. Below the half way point between the feeder and the mouth, however, fish mortality was negligible.

Special efforts were made to collect as many ammocoetes as possible during this treatment for the purpose of obtaining good returns of marked specimens, as well as for routine population studies. In addition to the normal hand collections, fyke nets were installed at two locations about a mile apart in the mid-section of the treated stretch of river. Most of the ammocoetes, however, were collected by hand in the lower part of the stream. Of the 400 marked ammocoetes which were planted, 63 were recovered among a total collection of 1,329. The ammocoetes were fast-frozen for later

identification of tagged specimens. At that time it was not possible to identify these ammocoetes as to species. A rather considerable mortality of stream fish including dace, darters, sculpins and fingerling brook trout occurred for a short distance below the feeder site. In the major part of the river, fish mortality appeared to be negligible.

5. Two Tree River (H-50)

Two Tree River, in the Township of St. Joseph, St. Joseph's Island, was treated on May 7 to 10, 1961, with 49 cans of the 40% Hoechst formulation of TFM and half a can of a 30% formulation supplied by Maumee Chemical Company of Toledo, Ohio. The main river was treated at a point 9.5 miles from its mouth and two tributaries, Mill Pond Creek and Harmony School Creek, were treated at distances of one mile and four miles respectively from their junction with the river.

This river had been stocked with 1,910 radioisotope-marked ammocoetes about four weeks prior to the treatment. Of the three rivers chosen for this marking experiment, Two Tree was the last to be treated.

Electro-shocker surveys conducted in this watershed from 1957 to 1960 inclusive had indicated that the relative abundance of sea lampreys was low, being less than 5% of the total ammocoete population. Additional pre-treatment surveys in 1961 established the upstream limits of the sea lamprey population. Feeder sites were located above these limits. Other pre-treatment studies included discharge and water level measurements, dye checks, bio-assays and chemical analysis of the river water. A day before the treatment volumes of flow had been: below the feeder site, 9.8 cfs; in the Harmony School branch, 5.0 cfs; and in the Mill Pond branch, 4.4 cfs. Rainfall just before the treatment increased these figures, but by the time that application was started water levels in the upstream sections of the river had dropped to their previous values. Results of the pre-treatment bio-assay indicated that for a 24-hour treatment the minimum effective and maximum permissible concentrations of TFM would be 4.8 and 7.8 ppm respectively.

Application by means of a "Proportioneer" feeder was begun on the main river at 1400 hours on May 7 and continued for nearly 24 hours. Drip feeders were started at 2130 hours on the same day at the Mill Pond outlet and at 0900 hours on May 8 at the Harmony School tributary, and continued for 28 and 24 hours respectively. The following volumes of lampricide formulation and corresponding weights of active ingredient were applied at the above sites: main river, 141 gallons (642 pounds); Mill Pond outlet, 45 gallons (205 pounds) Harmony School Creek, 48 gallons (218 pounds). An additional 60 gallons containing 269 pounds of TFM were used in four small tributaries and in three booster applications.

Concentrations of TFM in the river during the treatment were: below the main feeder, 11.4 to 16.4 ppm for 24 hours; below the Mill Pond feeder, 5.0 to 25 ppm for 17 hours; below the Harmony School Creek feeder, 5.0 to 8.6 ppm for 21 hours; and in the main river above the mouth, 4.5 to 7.7 ppm for 20 hours.

Weather conditions, topographical features and operational complications combined to make the treatment of Two Tree River a difficult one. Rainfall just prior to the application caused fluctuations in discharge and variations in turbidity during treatment. As a result it was difficult to control the concentrations of lampricide in different parts of the watershed. Numerous drains and ditches connected to the river and its tributaries required individual treatment. Special efforts had to be made to collect representative samples of ammocoetes in order to ensure that sufficient numbers of marked individuals would be taken. High turbidity added to the difficulty of collection.

Of the 1,910 isotope-marked ammocoetes planted in Two Tree Creek, 24 were recaptured. These were among a total of 501 individuals collected during the treatment. The specimens were fast-frozen for later identification of radioisotope tags. At this time it was impossible to identify these ammocoetes as to species. The mortality of stream fishes was low, being confined chiefly to the areas immediately below the feeder sites. Darters, dace and sculpins appeared to be the most seriously affected in these localities, however a few fingerling brook trout were also killed.

6. Lafontaine Creek (H-1354)

Lafontaine Creek, Tiny Township, Simcoe County, was treated on June 11 to 14, 1961 with a formulation of the sodium salt of TFM containing 30% of active ingredient, as supplied by the Maumee Chemical Company. Approximately ten miles of stream, including two small tributaries, were treated. The existence of adult spawning sea lampreys in this stream was first reported during the spring of 1961, and several sea lamprey ammocoetes were collected mainly from one area in limited electro-shocker surveys just prior to the treatment.

Other pre-treatment investigations included discharge measurements, dye checks, a bio-assay and chemical analysis of the stream water. The volumes of flow prior to the treatment were: at the feeder site, 1.4 cfs, and near the mouth, 4.5 cfs.

Results of the bio-assay indicated that for a 12-hour treatment the minimum effective and maximum permissible concentrations of TFM would be 3.0 and 5 ppm respectively.

Application by means of a "Proportioneer" feeder was begun at 1915 hours on June 11 and continued for 17-3/4 hours. At the main site 15 gallons of formulation containing 49 pounds of active ingredient were used. An additional 13 gallons containing 43 pounds of TFM were drip fed to treat tributaries and 18 gallons containing 59 pounds were used to increase the concentration of TFM in the main river to the required level. This was necessary as the concentration had dropped, owing to the presence of beaver dams and one man-made dam on the main river. Concentrations of TFM in the river during the treatment were: below the feeder, an average of 6 ppm for 18 hours; about half way downstream, 3.4 to 6.0 ppm for 18 hours; and at the mouth, 2.8 to 4.6 ppm for 12 hours. Somewhat higher concentrations occurred temporarily, for short distances, below the main feeder and the drip feeders.

Ammocoetes collected during the treatment consisted exclusively of sea lampreys, as did the pre-treatment collections, and overall abundance was low. Difficulty was experienced in maintaining steady concentrations of TFM below a large man-made pond about a mile from the feeder site. Dilution and attenuation of the lampricide occurred in this and other portions of the watershed, necessitating additional applications by means of booster feeders. Access was good to those parts of the watershed which required attention. A heavy thunderstorm occurred during the treatment, but rainfall was not of sufficient duration to create a serious dilution problem, although it caused changes in the optical density of the stream water which made colorimetric analysis awkward for a time. The treatment of Lafontaine Creek appeared to be highly successful; concentrations of TFM lethal to lampreys were maintained to the mouth of the river and mortality of fishes was very low.

7. Nottawasaga River (H-1360)

The Nottawasaga River system, in the Townships of Sunnidale, Flos, Vespra, Essa, Tosoronto and Nottawasaga, Simcoe County, was treated from June 18 to June 25, 1961, with the 40% Hoechst formulation of the sodium salt of TFM, and with two Maumee formulations, one containing 30% of the sodium salt and the other 60% of the amine salt of TFM. The following main tributaries were also treated: Boyne River, Mad River, Noisy River, Pine River, Bear Creek, Willow River, Phelpsston Creek and Lamont Creek. About 50 other small tributaries, lagoons and ponds were also treated and four booster applications (one on Nottawasaga River, three on Mad River) were made. The main feeder on Nottawasaga River was located at Nicolston Dam; Boyne River was treated at Alliston, Bear River at Utopia, Pine River at Angus, Mad River at Singhampton, Noisy River near Maple Valley and Lamont Creek at Highway 26. Other tributaries were treated for distances of less than half a mile. A total of 131 miles of stream was treated in the Nottawasaga River drainage.

The start of the treatment was delayed for nearly a month by frequent rains in one part of the watershed or another. A large amount of information was accumulated during this period from numerous discharge measurements and dye checks, frequent chemical analyses of the water and 25 bio-assays. Volumes of flow just prior to the treatment were as follows: in Nottawasaga River at Nicolston Dam, 106 cfs; in Boyne River, 25 cfs; in Mad River at Singhampton, 33 cfs; in Noisy River at Maple Valley, 18 cfs; in Pine River at Angus, 78 cfs; in Bear Creek, 19 cfs; and in Willow Creek, 55 cfs. The volume of flow at the mouth of Nottawasaga River was 504 cfs. Results of the final bio-assays, expressed as minimum effective and maximum permissible concentrations of TFM for 18-hour exposures, were as follows: Nicolston Dam, 8.0 and 16.0 ppm; Boyne River, 8.0 and 16.0 ppm; Mad River, 7.0 and 10.0 ppm; Noisy River, 6.4 and 10.0 ppm; Bear Creek, 7.0 and 7.3 ppm; Willow Creek, 3.1 and 8.5 ppm; and for Nottawasaga River at Wasaga Beach, 5.4 and 9.3 ppm.

The application of lampricide was begun on June 18 at 1615 hours on Boyne River with a "Proportioneer" feeder, and at 2125 hours on Nottawasaga

River (Nicolston Dam) with a "Milton Roy" feeder. The Boyne River application lasted for 18½ hours and used 240 gallons of formulation containing 1,092 pounds of TFM, while the Nicolston Dam application lasted for 17½ hours and used 924 gallons containing 4,204 pounds. Treatments of Mad River and its tributary, Noisy River, were started on June 19 at 1320 and 1415 hours respectively by means of "Proportioneer" feeders. The Mad River application lasted 17½ hours and used 351 gallons of formulation containing 1,597 pounds of TFM, while the Noisy River treatment lasted 20 hours and used 390 gallons containing 1,775 pounds. An additional 250 gallons containing 917 pounds of TFM were used in Mad River, and 49.5 gallons containing 161 pounds of TFM in Noisy River, for booster applications and the treatment of tributaries. Bear Creek was treated initially for 19½ hours, beginning on June 20 at 1145 hours. A second treatment was started at a point further upstream at 1140 hours on June 24, and terminated after 6½ hours. These treatments used respectively 80 gallons of formulation containing 364 pounds of TFM and 48 gallons containing 218 pounds. "Proportioneer" feeders were used for the treatments of Bear Creek. Pine River was treated for 18 hours, beginning on June 21 at 0130 hours, by means of a "Milton Roy" feeder. This application used 732 gallons of formulation containing 3,331 pounds of TFM. Willow Creek was treated by means of a "Proportioneer" feeder for 12 hours, beginning at 0420 on June 22, using 324 gallons of lampricide containing 1,824 pounds of TFM. Phelpsston Creek was treated by means of a fuel pump for a period of 4-¾ hours on June 22, requiring 22¼ gallons of lampricide (102 pounds of TFM). Lamont Creek, because of its extremely slow movement, needed several applications at different points. Its treatment by means of drip feeders lasted about 54 hours through June 23 to 25, and consumed 55 gallons of lampricide (564 pounds of TFM).

Treatment of the main stem of Nottawasaga River was boosted at a point near Angus; further downstream at Jack's Lake chemical was poured into the arms of the lake from outboard motor boats. A number of minor tributaries and lagoons along the main river were treated. These applications required an additional 894 gallons of lampricide containing 3,736 pounds of TFM.

During these treatments, concentrations of TFM at the feeder sites and near the mouths respectively were as follows: Nottawasaga, 8.4 to 16.0 ppm for 17 hours and 8.0 to 11.7 ppm for 10 hours; Boyne River, 10.3 to 17.5 ppm for 18 hours and 8.8 to 12.2 ppm for 16 hours; Mad River, 12.5 to 25.6 ppm for 17-¾ hours and 6.0 to 12.4 ppm for 8 hours; Noisy River, 10.5 to 28 ppm for 20 hours and 6.8 to 10.9 ppm for 17 hours; Pine River (one location), 7.4 to 11.2 ppm for 17½ hours; Bear Creek, 8.4 to 11.7 ppm for 19 hours and 7.0 to 10.0 ppm for 14 hours; Willow Creek (one location), 6.2 to 14.8 ppm for 12½ hours; Lamont Creek, 22.1 to 26 ppm for 9½ hours and 1.2 to 10.0 ppm for 21 hours.

The overall abundance of ammocoetes in the Nottawasaga River system, as revealed by these treatments, was low. Native species were fairly ubiquitous but sea lampreys, though much more restricted in distribution, usually outnumbered the others locally. Sea lampreys were very abundant in Mad River, moderately abundant in Noisy River, scarce in Bear River, and very scarce in the main stem of Nottawasaga River. Except for carp and suckers, fish mortality was very low.

The entire treatment appeared to be extremely successful, in that lethal concentrations of lampricide, sufficient for 99.9% kill of lampreys, were present at all sample stations. Weather and stream conditions were favourable throughout the operation, a situation which would be hard to duplicate by choice again.

8. Root River (H-3)

Root River, including four tributaries, in Tarentorus and Aweres Townships and Garden River Indian Reservation, District of Algoma, was treated from July 16 to 22, 1961. The Hoechst 40% formulation and a small amount of the Maumee 30% formulation of TFM were used in the treatment. The main river was treated at a distance of 15½ miles from the mouth; the West Root, West West Root, Coldwater and Crystal Creeks at distances of 5½, 5, 1½ and 6 miles respectively from their junctions with Root River. Electro-shocker surveys, completed in 1960, had indicated that sea lamprey ammocoetes occurred in Root River and its above-mentioned tributaries, but that their distribution did not exceed the distance treated.

Pre-treatment studies of the Root River watershed included discharge measurements, dye checks, water analyses, and bio-assays. At the time of treatment, the volume of flow at the mouth of Root River was 70 cfs. At the mouth of the following tributaries the volumes of flow were: West Root, 5.2 cfs; in West West Root, 1.6 cfs; in Coldwater, 8.5 cfs; and in Crystal, 19 cfs. Results of the final bio-assay indicated that for exposures of 12 hours, the minimum effective and maximum permissible concentrations would be for Root River 1.2 to 1.7 ppm, for West West Root Creek 0.6 to 1.6 ppm, for West Root Creek 0.5 to 2.0 ppm, for Crystal Creek 0.6 to 1.5 ppm, and for Coldwater Creek 1.2 to 1.5 ppm.

Treatments of West Root and West West Root Creeks were started on July 17, 1961 by means of drip feeders. The movement of water in both of these tributaries was very slow and the lampricide was introduced at several points below the original feeder sites in order to shorten the time for the chemical to reach the creek mouths. In West Root Creek a large beaver flowage and several smaller ponds required manual applications of lampricide. Treatment of this tributary lasted from July 17 to July 21, and required 21 gallons of lampricide (95 pounds of TFM) which were applied at 12 different locations. Treatment of West West Root Creek, begun initially on July 17, had to be repeated at four successive upstream points, because sea lamprey ammocoetes were discovered in the vicinity of the feeder sites. Treatment of this tributary lasted until July 24 and required 25 gallons of lampricide (100 pounds of TFM) which were applied at seven different locations.

Two 18-hour applications were started on July 18, 1961 at 1000 hours in the main Root River and at 1710 hours in Coldwater Creek. "Proportioneer" feeders pumped 48 gallons of lampricide containing 218 pounds of TFM into the main Root River, and 12 gallons containing 55 pounds into Coldwater Creek. An additional 17 gallons (79 pounds of TFM) were applied to Root River and one quart (1 pound of TFM) was applied to Coldwater Creek by means of drip feeders.

Crystal Creek was treated for 18 hours, beginning on July 19 at 1800 hours by means of a "Proportioneer" feeder. This application used 24 gallons of lampricide (109 pounds of TFM). An additional four gallons (20 pounds of TFM) were used in treating tributaries and lagoons.

Concentrations of TFM during these treatments in the main river were: between 1.4 and 2.6 ppm at the feeder; 0.8 and 1.1 ppm at the mouth. In West Root Creek the concentration varied from 1.0 to 3.7 ppm at the main feeder and from 0.5 to 1.7 ppm at the mouth; in West West Root Creek from 0.5 to 1.7 ppm at the main feeder and from 0.5 to 1.0 at the mouth. These concentrations of lampricide were present for periods exceeding 14 hours in all cases. In Coldwater Creek concentrations of lampricide were between 1.2 and 2.3 ppm at the feeder site for 16 hours and between 1.2 and 1.5 ppm at the mouth for the same period. In Crystal Creek concentrations of TFM were between 1.3 and 1.7 ppm for 18 hours at the feeder site and between 1.0 and 1.4 ppm at the mouth for 16 hours.

As indicated previously, this treatment of the Root River system was prolonged and complicated by the existence of numerous beaver ponds and extensive flowages in two of the tributaries. An additional complication was the discovery of sea lampreys above the point believed to be the upper limit of their occurrence in one tributary. Treatment of the stream above this point was hampered by extreme difficulty of access.

A gravel washing plant uses water from West Root Creek and returns it, after passing through several settling ponds, to a point farther downstream near the confluence with Root River. It was observed that highly turbid water issued from these ponds at certain times. This situation occurred during the treatment, causing some difficulty in colorimetric analysis of water samples.

Observations made during this treatment indicated that ammocoetes were abundant in the main Root River, but only moderately plentiful in the tributaries. Of some 1,700 specimens collected, however, almost 75% were native species, although sea lampreys were relatively more numerous in a few upstream localities. Mortality of stream fishes appeared to be low and confined mainly to forage species.

9. Serpent River (H-116)

Serpent River and two tributaries, in Spragge Township, Sudbury District, were treated from August 5 to 7, 1961 with the 40% Hoechst formulation of TFM. The main river was treated at a point just above highway #17, about eight miles from the mouth and an additional three miles of tributary streams were treated.

Sea lampreys were known to occur in Serpent River from collections made in 1957. Pre-treatment surveys made in 1961 with electro-shockers and lampricide established the limits of the ammocoete population. Other pre-treatment studies included discharge measurements, dye check, water analysis and a bio-assay. The volume of flow in the main river at the time of treatment was 269 cfs. Results of the bio-assay indicated that for a 12-hour exposure,

the minimum effective and maximum permissible concentrations would be 1.0 and 1.4 ppm respectively. We used a new fluorescent dye, "Rhodamine B", for the first time, in this river. It did not appear to have any advantage, at this time, over fluorescein but may be superior in water of different colour.

The application of lampricide to the first tributary (Little Serpent Creek) was begun at 1100 hours on August 5 by means of drip feeders. Because of very slow water movement, lampricide was applied at six different locations in amounts totalling 15½ gallons of formulation (70 pounds of TFM). Final application of lampricide in Little Serpent Creek was on August 6.

In the main river, 348 gallons of lampricide (1,583 pounds of TFM) were applied by means of a "Proportioneer" feeder over an 18-hour period, beginning at 2000 hours on August 5. An additional 6 gallons (27 pounds) of lampricide were applied in lagoons along the Serpent River.

A tributary, consisting of a chain of beaver flowages emptying into the south side of Serpent River near the mouth, was treated on August 5, 6 and 7. A total of 12 gallons of lampricide (55 pounds of TFM) was applied at three locations. No sea lampreys had been taken above the lowermost beaver dam during pre-treatment surveys, and when none appeared during these subsequent applications, it was concluded that a complete treatment of this extensive waterway was unnecessary.

Concentrations of TFM in the main river during the treatment were: at the feeder site, 1.0 to 1.4 ppm for 17 hours; and at the mouth, 1.0 to 1.4 ppm for 12 hours. In the Little Serpent concentrations of TFM were between 1.5 and 7.0 ppm for over 30 hours.

Ammocoetes were moderately abundant only in the mid-section of the main Serpent River, as indicated by the number of specimens collected during the treatment. In other parts of the main river and in the tributaries ammocoetes were scarce.

Moderate numbers of suckers, pike and log perch, and large numbers of leeches and mud puppies were killed during the treatment of Serpent River. Mortality of game fish, however, appeared to be negligible.

10. Unnamed Stream (H-114)

The stream known to us as H-114, in Spragge Township, Sudbury District, was treated on August 7, 1961 with the 40% Hoechst formulation of TFM. The site of application was at the top of falls about 30 feet high and one-quarter mile from the mouth. No tributaries enter this stream below this point. Sea lamprey ammocoetes had been collected from this river during surveys conducted in 1957 and 1961.

The volume of flow at the time of treatment was estimated at about 0.5 cfs. No other pre-treatment studies were made. Lampricide was applied for 9¼ hours on August 7, by means of a constant-head drip bottle and three gallons of formulation containing 14 pounds of TFM were used. Concentrations of TFM below the feeder were about 8 ppm throughout the treatment.

The entire treated length of the stream was examined both during and after the treatment. No lampreys or fish, either dead or alive, were observed. It appears likely that any ammocoetes that had been present in H-114 were destroyed by the lampricide used in the stream survey on July 24, 1961.

11. Livingstone Creek (H-92)

Livingstone Creek, Striker Township, Algoma District, was treated on August 10 and 11, 1961 with the 40% Hoechst formulation of TFM. This was applied at several points as far upstream as the railroad bridge about three miles from the mouth. Two small tributaries, one of which was almost dry, were also treated. Sea lampreys had been collected during a stream survey by means of lampricide three days previously.

The volume of flow of Livingstone Creek was estimated to be 0.5 cfs. Other pre-treatment studies were not made. Four and a half gallons of lampricide were applied in the area of the mouth to about one-half mile upstream from a moving boat. An additional 5 gallons were applied manually in the upper area of the main stream and about one-half gallon in the two tributaries, making a total of 10 gallons of formulation containing 46 pounds of active ingredient.

No analysis of the treated water was made, but concentrations of TFM appeared adequate for successful treatment. Two days were required to complete this treatment, because of lack of convenient access and the presence of several beaver ponds. Ammocoetes, including small numbers of sea lampreys, were collected as far upstream as the railroad bridge, but most were within one mile of the mouth.

12. MacBeth Creek (H-87)

MacBeth Creek, Thessalon Township, Algoma District, was treated on August 10, 1961 with the 40% Hoechst formulation of TFM. The toxicant was applied at several points within one-half mile of the mouth. There were no tributaries in this stretch of river. The stream had been surveyed three days before the treatment, but no lampreys were found.

The volume of flow in MacBeth Creek was estimated to be 0.5 cfs. Results of a pre-treatment bio-assay indicated that for a nine-hour treatment the minimum effective and maximum permissible concentrations of TFM would be 4.3 and 2.2 ppm respectively. In spite of this unfavourable range, treatment was considered to be desirable because of the small extent of the area to be treated.

The upstream portion of the creek was treated by means of a drip feeder whose location had to be moved upstream several hundred yards during the application due to the appearance of ammocoetes immediately below the original site. This part of the treatment required six gallons of formulation containing 27 pounds of TFM. In the vicinity of the mouth five gallons of lampricide (23 pounds of TFM) were applied by boat.

13. Lauzon River (H-112)

Lauzon River, Striker Township, Algoma District, was treated on August 10 and 11, 1961 with the 40% Hoechst formulation of TFM. The site of application was the dam at the outlet of Lake Lauzon, about one-half mile from the mouth. There are no tributaries below this point.

The volume of flow of Lauzon River was estimated to be 5 cfs at the time of treatment. Results of a pre-treatment bio-assay indicated that, for a nine-hour treatment, the minimum effective and maximum permissible concentrations of TFM would be 1.8 and 2.7 ppm respectively. Water samples were also analysed.

Initially, treatment was by means of a constant-head drip feeder by which 2½ gallons of formulation (11 pounds of TFM) were applied. Analysis of the treated water indicated that concentrations of TFM below the feeder were between 2.0 and 4.5 ppm for 8½ hours. Concentrations at the mouth of Lauzon River, however, did not exceed 1.7 ppm due to dilution by incoming lake water. A second treatment of the estuarine area was, therefore, made by manual application of lampricide from a moving boat. In the latter case, 2 gallons of formulation (10 pounds of TFM) were used.

The ammocoete population of Lauzon River was sparse, as indicated by collections made during this treatment. Of fourteen specimens collected, thirteen were sea lampreys. There was no evident mortality of stream fishes, with the exception of a few minnows.

14. Mississagi River (H-102-107)

Mississagi River, Mississagi, Thompson, Bright and Gladstone Townships, Algoma District, was treated on August 16 to 18, 1961, with the 40% Hoechst formulation of TFM. One major tributary, Bolton River, was also treated concurrently. The main river was treated at the Red Rock power dam, about 16 miles from the mouth, while Bolton River was treated at the outlet of Bright Lake about three miles from the main river. In addition, 17 other places in the watershed were treated, including small tributaries, lagoons and sand flats. An intensive pre-treatment survey of Mississagi River, completed in the first week of August 1961, indicated that sea lampreys were present but generally scarce.

Other pre-treatment studies included dye checks, the recording of water levels, chemical analysis, and bio-assays of water from Mississagi and Bolton Rivers. Results of the latter tests indicated that for Mississagi River the minimum effective and maximum permissible concentrations of TFM based on an 18-hour treatment would be 1.1 and 2.0 ppm respectively, while for Bolton River the corresponding values would be 1.2 and 2.0 ppm respectively.

The volume of flow in Mississagi River is regulated by the Red Rock power dam and typically varies rather widely in accordance with the operating schedule of the power station as dictated by current loads. Through prior

arrangement with the Great Lakes Power Company, the flow at Red Rock was maintained at a constant level of approximately 1800 cfs during the treatment period of about 42 hours.

In accordance with the results of the dye checks, treatment of Bolton River was started at 0100 hours on August 16, and continued for 12 hours. A total of 36 gallons of lampricide containing 164 pounds of TFM was applied. Treatment of Mississagi River was started at 1000 hours on August 16, continued for 18 hours, and consumed 2694 gallons of lampricide (12,258 pounds of TFM). An additional 60 gallons (271 pounds of TFM) were applied to various small tributaries and lagoons along the river. An unusual feature of the treatment was the application of lampricide to exposed sand bars, left in the river by the receding water. It was believed possible that ammocoetes living in these areas, when covered with water, might remain there when the surface of the sand became dry. Liquid formulation was, therefore, applied to several exposed sand bars by means of portable sprayers. No lampreys were observed to emerge from these areas and it was concluded that the animals, if present, were probably killed in situ.

Concentrations of TFM in Bolton River during the treatment were between 2.2 and 2.7 ppm for 11 hours below the feeder and between 2.0 and 2.7 ppm for 10 hours at the mouth. Concentrations of TFM in Mississagi River were: below the feeder, 1.3 to 1.8 ppm for 18 hours; and from the campsite at Highway 17 to the mouth, 1.0 to 1.4 ppm for about 18 hours.

This treatment proceeded without difficulty. Road access to that part of the river being treated was good, and weather conditions remained favourable throughout the operation. Fish mortality was negligible and was confined mainly to minnows and rough species. A few pickerel in the vicinity of the feeder appeared to be distressed, but only 3 or 4 were found dead. Ammocoetes were abundant in Mississagi River, judging from the numbers that appeared during this treatment. Sea lampreys apparently made up a large proportion of the ammocoete population, comprising 90% of the total collection.
