ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1969

GREAT LAKES FISHERY COMMISSION

MEMBERS — 1969

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GREAT LAKES FISHERY COMMISSION

Established by Convention between Canada and the United States for the Conservation of Great Lakes Fishery Resources.

ANNUAL REPORT

FOR THE YEAR

1969

1451 Green Road

ANN ARBOR, MICHIGAN,

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LETTER OF TRANSMITTAL

In accordance with Article IX of the Convention on Great Lakes Fisheries, I take pleasure in submitting to the Contracting Parties an Annual Report of the activities of the Great Lakes Fishery Commission in 1969.

Respectfully,

L. P. Voigt, *Chairman*

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ANNUAL REPORT FOR 1969

INTRODUCTION

The Great Lakes Fishery Commission was established by the Convention on Great Lakes Fisheries ratified by the United States and Canada in 1955. The Commission is required to formulate and coordinate research, recommend measures to improve the productivity of fish stocks of common concern, and eradicate or minimize sea lamprey populations in the Great Lakes. The Commission maintains a small staff or secretariat and relies heavily on the cooperation of federal, state, and provincial fishery agencies for information on which to base its recommendations. It contracts with federal agencies in each country to carry out the sea lamprey control program.

Technical committees have been established for each of the lakes which are composed of senior officials from agencies administering the fishery with scientific advisors from agencies carrying out research. The lake committees meet each spring to consider the status of fish stocks, review the progress and coordination of research and management, and develop recommendations for submission to the Commission. The recommendations are first referred to a central committee, composed of the chairmen and vice-chairmen of the five lake committees, which must consider the welfare of the Great Lakes fishery as a whole before forwarding the recommendations to the Commission. Two other committees are specifically concerned with (1) the sea lamprey control program and (2) the administrative affairs of the Commission. A committee of 6 scientists advises the Commission on matters relating to lamprey control and fishery research.

Sea lamprey control operations by federal, state, and provincial agencies were underway when the Commission was formed. Barriers were being used at the time to block lamprey from their spawning grounds in streams. Research on chemical methods to destroy the larvae in streams was well advanced. Chemical treatment techniques were considered satisfactory for full scale use in 1957 and treatment of lamprey streams began in 1958 in Lake Superior.

Since 1958, the Commission's agents have systematically treated lamprey streams in Lake Superior and Lake Michigan reducing their production of parasites substantially. The first round of treatments was completed in Lake Superior in 1961 and in Lake Michigan in 1966. Treatments on Lake Huron streams are to be completed in 1970. The initial treatments reduce the lamprey population by about 80 percent. Lamprey larvae become re-established in most streams after treatment and these must be re-treated in time to destroy the larvae before they move to the lake to begin their parasitic life. In a few streams the interval between treatments is 2 years, but for the majority it is 4 years or more. At the current level of intensity, chemical operations in Lake Superior are holding the abundance of adult lamprey at about 15 percent of precontrol abundance.

Although virtually all fish are attacked by lamprey, lake trout are the most vulnerable and were eliminated in Lake Michigan and Lake Huron. Lake trout populations in Lake Superior and Lake Michigan have responded favorably to the reduction in sea lamprey. Whitefish have also benefited from lamprey control with production in northern Lake Michigan averaging about a million pounds in the last 5 years after dropping to 25,000 in 1957 when lamprey were abundant. Runs of steelhead, particularly in Lake Michigan, have shown a phenomenal increase and planted Pacific salmon have yielded a high return probably not possible if lamprey were abundant.

Large scale restocking with salmonid species following reductions in lamprey is an important step in rehabilitating the fishery and restoring ecological balance. The Commission is directly responsible for coordinating the planting of approximately 5 million lake trout each year, most of which are produced in federal hatcheries with eggs coming from brood stocks maintained by the Michigan Department of Natural Resources. The Commission, through its lake committees, also works closely with the States and the Province of Ontario in developing coordinated planting programs for other salmonids such as Pacific salmon and brown trout.

Recovery of fish stocks and expansion of fisheries has not been accompanied by a comparable increase in research, particularly stock assessment. For example, lack of information on mortality makes it difficult to determine if lamprey control measures are providing sufficient protection particularly for the vulnerable lake trout. The Commission has stressed the critical nature of this information. A second basic concern of the Commission is the continuing degradation of the water quality of the Great Lakes. This threat to the increasing benefits from the fish resource has been drawn to the attention of the two governments.

The Commission held its Annual Meeting in Niagara Falls, New York, June 17-19, 1969 and an interim meeting in Ann Arbor, December 2-3, 1969. The proceedings are summarized in the following sections while the information presented at the meetings is summarized in appendices. An administrative report is also appended.

ANNUAL MEETING

PROCEEDINGS

The Fourteenth Annual Meeting of the Great Lakes Fishery Commission was held in Niagara Falls, New York on June 17-19. Chairman L. P. Voigt called the meeting to order and drew attention to the death of Commissioner A. O. Blackhurst on January 27, 1969, and the resignation of Commissioner Clarence F. Pautzke from the United States Section. Dr. Blackhurst, a member of the Canadian Section since the formation of the Commission, had worked enthusiastically to improve the Great Lakes fisheries despite poor health in recent years. Mr. Pautzke's ability to develop support and cooperation among the commercial fishermen, anglers, and public agencies had also stood the Commission in good stead.

The Chairman noted in his report the continuing need for research programs on the Great Lakes which would fully utilize the capabilities of the fishery agencies. These agencies were increasing their investigations and it was essential that their efforts be guided and coordinated by the lake committees to assure that the information required for orderly redevelopment of the sport and commercial fisheries was collected.

Sea lamprey control remained a major concern of the Commission since it was clear that rehabilitation of the fishery resource depended on maintaining the parasite at low levels. The growing disparity between funds allocated for lamprey control and funds required to carry out an effective program was of particular concern to the Commission. The continuation of the lamprey program in Lake Huron in 1969 was only made possible by supplemental funds provided by the State of Michigan, the Upper Great Lakes Regional Commission, and the Department of Fisheries and Forestry of Canada, and by reducing lamprey research and surveys on Lakes Superior and Michigan.

The Chairman also expressed concern with the current pesticide contamination of fish which was particularly severe in Lake Michigan. The States bordering Lake Michigan had actively campaigned against the use of DDT and their efforts had mustered sufficient public support so that restrictions on the use of DDT appeared likely. It was important now to determine if levels of DDT in Great Lakes fish would seriously affect their reproduction or render them unfit for human consumption.

Management and research. The Commission accepted the reports on management and research[1] submitted by the Lake Committees. The Commission supported the recommendation of its Lake Superior Committee to stabilize lake trout plantings[2] in United States waters of Lake Superior at the following annual rate:

Minnesota waters	200,000
Wisconsin waters	250,000
Michigan waters	2,000,000 through 1971
	1,400,000 thereafter

This planting rate would be continued until native fish represented approximately 25 percent of the juvenile population (< 17 inches) and then adjusted.

Although the Commission accepted the contention of its Lake Michigan Committee that the high incidence of wounded lake trout in the northern waters of the lake indicated a need to intensify lamprey control in that area, it believed that appropriate action was provided for in the lamprey control program planned for fiscal year 1971.

The Commission expressed pleasure with the response to its earlier recommendation that lamprey control problems be considered in the early planning stages of stream improvement projects to allow passage of anadromous fishes. A recommendation of the Lake Michigan Committee that weirs, dams, and fish passage facilities be designed to block sea lampreys wherever applicable was endorsed for all the Great Lakes. The Commission agreed to arrange for engineering and biological advice during the design stage of such multipurpose devices.

The Commission also agreed to refer a recommendation dealing with the greater utilization of freshwater drum *Aplodinotus grunniens* by the sport and commercial fishery in Lake Erie to the appropriate United States agencies.

The Commission accepted the recommendations of its Scientific Advisory Committee regarding the information most urgently needed for redevelopment of the sport and commercial fisheries and instructed its staff to: (1) convene a meeting of representatives of various agencies concerned with the collection of fishing statistics to discuss the type, assemblage, and analyses of data required; (2) explore the possibilities of engaging a consultant to assist in the development of a satisfactory program; and (3) examine the possibilities of securing a scientist to devote full attention for an analysis of changes likely to occur in the lamprey population as a result of control.

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[1]General reports on the status of fish populations and the fishery, and progress of research and management appear in Appendix A.

[2]Yearling fish.

Sea lamprey control and research. The Commission accepted the reports of its two agents on their lamprey control operations in 1969.[1]

The Commission adopted a revised lamprey control program for fiscal year 1970 having an estimated cost of $1,494,100 rather than the $1,833,700 originally requested. The reduction was made on advice that the United States Government had recommended that its contribution be $234,400 less than the amount requested by the Commission. If the United States contribution was approved, the proposed Canadian contribution would be reduced by $105,200 to maintain the sharing formula. The reduced budget ($1,494,100) would necessitate deferrment of: (1) surveys and construction of assessment barriers on Lake Ontario, (2) chemical treatments of southern Lake Huron streams, and (3) reactivation of several research projects. It would also necessitate heavy withdrawal of lampricide from reserves to carry out scheduled treatments on Lake Superior and Lake Michigan. Recognizing its responsibility to minimize sea lamprey in the Great Lakes, the Commission adopted a program for fiscal year 1971 which called for an expenditure of $2,472,400. The expanded program was in accord with the recommendations of the lake committees for intensification of control measures in the upper lakes and extension of the control program to the lower lakes. The proposed program would entail the following operations:

Lake Superior – Retreat 14 streams (5 in the United States and 9 in Canada); treat larval populations in lakes and estuaries; survey potential lamprey-producing streams to determine when retreatment is required; operate electrical barriers on 16 United States streams to assess changes in abundance of lamprey spawning populations.

Lake Michigan – Intensify surveys on known and potential lamprey-producing streams to determine need for treatment; retreat 25 lamprey streams.

Lake Huron – Intensify surveys on known and potential lamprey-producing streams to determine need for treatment particularly larval populations in lakes and estuaries; treat 9 streams in the United States and 2 in Canada for the first time; retreat 9 streams in United States and 10 in Canada; operate 9 electrical barriers in Canadian streams to assess changes in abundance of spawning populations.

Lake Erie and Lake Ontario – Resume surveys of streams in the United States to determine which produce lamprey; construct electrical barriers on 5 Lake Ontario streams in Canada to assess changes in abundance of lamprey spawning populations.

Lamprey research – Study the mode of action of lampricides on fish and lamprey; screen chemicals to develop new compounds with potential as lampricides and to find an irritant for use in surveys; explore new ways to assess lamprey abundance; study the mechanisms of larval transformation and determine the factors which stimulate it; study the parasitic relationships between lamprey and fish; continue study of the growth, transformation, and movements of the 1960 year class of lamprey in the Big Garlic River.

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[1]Final reports covering sea lamprey control and research in the United States and Canada in 1969 appear as Appendices C and D.

Finance and Administration. A new format for the Sea Lamprey Control and Research budget designed by the Finance and Administration Committee was adopted by the Commission. A budget of $68,100 for Administration and General Research for fiscal year 1971 was approved including an item of $5,000 to provide partial support for an International Symposium on Salmonid Communities in Oligotrophic Lakes to be held in the Great Lakes area in 1971.

Adjournment. After agreement to hold the 1969 Interim Meeting in Ann Arbor on December 2-3, the Chairman expressed the Commission's appreciation to the participants for their advice, the New York Conservation Department for meeting facilities, and the Garcia Corporation for their hospitality. The meeting was adjourned at 1:00 a.m. on June 19.

INTERIM MEETING

PROCEEDINGS

The Commission held an Interim Meeting in Ann Arbor, December 2-3, 1969 to consider preliminary reports on the status of certain fish stocks, pesticide contamination, progress of lamprey control, salmonid plantings, and collection of statistics from the commercial and sport fisheries.

Status of fish stocks. A report on recent changes in fish stocks and fishing based on preliminary information supplied by fishery agencies was presented by Commission staff. The Bureau of Commercial Fisheries reported its progress in obtaining estimates of lamprey mortality. Attention was drawn to the magnitude of the sport catch of lake trout and the importance of considering this source of mortality and incidental commercial catch in any analysis.

Pesticide contamination. The recommendations of the Great Lakes Governors' Conference on pesticide pollution in the Great Lakes were reviewed. Bureau of Commercial Fisheries representatives presented the following conclusions from the work done by the Ann Arbor Laboratory on pesticides in Lake Michigan. The DDT level[1] appeared to have increased in chubs since 1965 and with rare exceptions chubs of commercial size now contained DDT in excess of 5 ppm (FDA interim tolerance level) but did not exceed the tolerance level for dieldrin. DDT concentrations were higher in chubs from the southern basin than from the northern basin. Coho caught before July contained less than 5 ppm DDT. DDT content increased with size exceeding 5 ppm after fish passed 550 mm (20.2 inches). Levels in coho were directly related to oil content. No excessive mortality in hatching coho eggs occurred in 1969. Lake trout under 250 mm (10 inches) contained less than 5 ppm DDT while those over 500 mm (20 inchees) contained more than 5 ppm. Alewives showed no trend in DDT levels between 1965 and 1969; the average DDT concentration in adults was 4-5 ppm.

Progress of lamprey control. Reports on the progress of lamprey control operations in 1969 were presented by the Commission's agents. The results of surveys carried out by the State of New York to locate lamprey streams on the south shore of Lake Ontario were also submitted.

[1]Analysis of whole fish.

It was pointed out that an additional $200,000 had been recommended in the United States to expedite lamprey control on Lake Huron. If these funds and matching funds from Canada were provided it would be possible to complete the first round of treatments on Lake Huron by the end of calendar year 1970. The Commission's agents and staff were asked to prepare alternatives to allow selection of a program when the contributions were approved and the budget for fiscal years 1970 and 1971 finally determined.

The Commission considered the possible effects of dam removal and fishways on the lamprey control program and asked its staff to work closely with the state agencies in their fish passage planning in order to minimize problems for lamprey control in the future.

Salmonid plantings. Salmon and trout plantings during 1969 were summarized by the staff.[1] Preliminary information on the suitability of two species of Japanese salmon for introduction to the Great Lakes was presented by representatives from the Province of Ontario.

Collection of catch statistics. Commission staff described the current system for the collection and analysis of catch statistics in the Great Lakes and some of the deficiencies seen by the agencies responsible. The diffuse nature of the fisheries made the collection of biological information on the catch difficult and yet there was a critical need for expanding this activity.

Pollution. The Scientific Advisory Committee reported that it had examined the problem of taconite disposal in Lake Superior and found it difficult to assess the effects from the information supplied. It believed that the Commission should maintain surveillance of the problem and urge agencies investigating it to continue their assessment.

[1]A summary of salmonid plantings appears in Appendix B.

APPENDIX A

SUMMARY OF MANAGEMENT AND RESEARCH

Information assembled by the lake committees on fish production, status of major species, progress and results of investigations, and measures taken to improve the Great Lakes fisheries is summarized for each lake as follows:

Lake Superior

Commercial landings in Lake Superior dropped from 9.9 million pounds in 1968 to 8.2 million pounds in 1969. Ontario produced 36 percent of the catch, Michigan 35 percent, Minnesota 15 percent, and Wisconsin 14 percent. Lake herring accounted for most of the Canadian catch; and lake herring, chubs, smelt, and whitefish were the dominant species in the United States catch.

Commercial fishing for lake trout has been restricted in Lake Superior since 1962 to encourage the recovery of the stocks. Some test fishing has been permitted, however, to estimate the stage of recovery, evaluate the effects of plantings, and to measure the response of certain offshore lake trout populations to changes in fishing intensity. The total allowable catch (pounds) of lake trout for various jurisdictions in 1969 was as follows:

Ontario	188,000
Michigan	245,000
Wisconsin	60,000
Minnesota	13,000
	486,000

Sea lamprey control has successfully reduced the adult lamprey population in Lake Superior to about 15 percent of their former level of abundance (Appendix C), and has improved conditions for the survival of planted lake trout. Intensive annual plantings of lake trout totalling 25.4 million fish have been made since 1958,[1] and as the lamprey began yielding to control in 1962 the abundance of lake trout has increased nearly three-fold as shown in the following table:

[1]A summary of previous plantings and details of 1969 plantings of lake trout and salmon in the Great Lakes appear in Appendix B.

Numbers of marketable lake trout caught per 10,000 feet of large-mesh gillnet lifted during the spring, Lake Superior, 1962-1969.

Year	Michigan	Wisconsin	Minnesota	Ontario	Average (unweighted)
1962	39	77	43	34	48
1963	46	81	58	32	54
1964	43	111	68	56	70
1965	55	134	50	59	75
1966	75	150	22	99	87
1967	116	181	46	111	113
1968	245	–	32	76	114
1969	249	187	34	90	140

In 1969, abundance increased nearly 23 percent on a lake-wide average. The levelling off of lake trout abundance in Ontario waters is largely due to the wider dispersion of hatchery plantings in these waters since 1963. Abundance of lake trout in Minnesota waters is expected to increase within the next few years as a result of the more intense plantings of hatchery trout carried out in these waters since 1964.

Preliminary information on plantings in Michigan waters suggests that when trout from the earlier plantings in 1959 and 1960 reached age V their annual total mortality rates averaged about 70 percent between age V-IX and were closely correlated with lamprey wounding rates. Recent studies, however, suggest a favorable trend toward lower mortality at these ages for each successive year class planted.

In most areas of Lake Superior, spawning of lake trout virtually ceased during 1959-1962 because of the loss of mature trout to lamprey. Since then there has been a steady but slow increase in the abundance of mature trout throughout the lake. Although spawning activity is not extensive in inshore waters, it is most evident in the Wisconsin area. Here the average size and abundance of the spawning stock has increased significantly since 1963. Naturally produced trout have been observed in Wisconsin waters since 1965, but they are still scarce elsewhere in the lake. In Ontario waters, it appears that spawning populations have developed only where plantings have been made. It is possible that trebling or quadrupling the supply of hatchery fish for Ontario waters will have to be considered.

The greater availability of lake trout has been responsible for rapid development of sport fishing in Lake Superior. Postcard surveys indicated an angler catch in Michigan waters of 172,000 lake trout. The majority of the fish were caught in Keweenaw, Munising, and Whitefish Bays in the first 6 months of 1969, but as the season progressed the catch became more widely distributed. The angler catch of 13,000 trout in Wisconsin waters, estimated by creel census, was fairly well distributed but the majority were caught off Bayfield and Cornucopia. In contrast, the light angling for lake trout in Ontario waters declined. Few lake trout are taken along the shores of Minnesota, but new marinas now under development should provide the access sites needed to encourage an open-water fishery.

Plantings of coho salmon in Lake Superior have met with erratic success. The estimated total survival rates of the 1966 plant (192,400 smolt), the 1967 plant (467,000 smolt), and the 1968 plant (382,000 smolt) by Michigan were 12, 2, and 24 percent, respectively. The 1966 planting provided excellent fishing in the spring of 1967 all along the Michigan shore; a mid-summer lull was followed by a good fall fishery off the mouth of the Huron River. The 1967 plant, however, provided only scattered fishing throughout the entire 1968 season. The 1968 planting provided an estimated angler catch of 60,000 fish during the 1969 season mainly in the Keweenaw Bay and Munising area.

Pink salmon, which have been observed in Lake Superior in very small numbers on the odd-numbered years following their release in Ontario in 1956, appeared to increase sharply in abundance in 1969. During the fall, an estimated 700 pinks were observed in Ontario waters, 50 were seen in Minnesota waters and a similar number in Michigan waters.

Lake herring stocks have declined in United States waters over the past decade. Commercial production, which has varied about an annual mean of 10.9 million pounds, dropped sharply in the 1960's from 11.5 million pounds in 1961 to an all-time low of 2.3 million pounds in 1969. During the decline, the herring have shown increasing growth rates, increasing average length and age, and poor recruitment. In contrast, the smaller herring fishery in Ontario waters has improved in recent years. Commercial production (2.6 million pounds) in 1968 reached a near record high for the post-1940 period, but declined slightly in 1969 (2.4 million pounds) mainly because of a 60-percent decrease in fishing effort. The herring fishery in Michigan waters was conducted during the late fall until the collapse of the lake trout fishery in the early 1960's. After the loss of lake trout, commercial fishermen diverted their operations to other species and fishing effort on herring extended over a longer season. The increase in fishing effort has been associated with a decline in catch-per-effort. On the other hand, a study of the decline of lake herring in western Lake Superior (Minnesota-Wisconsin waters) carried out cooperatively by the University of Minnesota, Minnesota Conservation Department, and the U.S. Bureau of Commercial Fisheries revealed no significant relationship between fishing intensity and abundance of the herring stocks. The high fishing intensity in several critical years, however, could have had some effect on abundance. Food similarities of herring, bloaters, smelt, and highly significant negative correlations and linear trends between herring-bloater abundance and herring-smelt abundance suggest that competition for food during larval stages had a strong influence on the decline. Smelt were probably more influential than bloaters. Predation on eggs was common, but not intense enough to be a serious influence on herring abundance. Although there were several other differing biological characteristics noted between the two herring populations in the western area, the study strongly suggests that the increase in smelt and bloaters have been the major influence in the decline of herring abundance in western waters.

Whitefish stocks have shown some improvements throughout the lake. The 1969 landings of 532,000 pounds represented the highest catch in Michigan waters since 1954. Ontario landings declined from 212,000 pounds in 1968 to 202,000 in 1969, but still were significantly higher than the average catch of the past 10 years. Whitefish production in Wisconsin waters has remained low since the late 1950's, but improvements in the population have been noted by increases in their age and size distribution and in catch-per-effort in the pound net fishery. Commercial fishing for whitefish has not been permitted in Minnesota waters since 1962, but test fishing in recent years indicates that their abundance is relatively high in the Grand Portage area.

Lake Michigan

Commercial landings in Lake Michigan rose from 43.7 million pounds in 1968 to 47.5 million pounds in 1969. The increase was due primarily to alewife production which accounted for nearly 62 percent of the total catch. Wisconsin produced 66 percent of the 1969 catch, Michigan 32 percent, Illinois 2 percent, and Indiana less than 1 percent. Dominant species were alewives, chub, and carp in Wisconsin waters; alewives, chubs, smelt, whitefish, and coho in Michigan waters; and chubs and yellow perch in Illinois and Indiana waters.

Commercial fishing for salmonid species is not permitted in Lake Michigan, but a high incidental catch of planted lake trout in gillnets fished for whitefish in the northern part of the lake has hampered the rehabilitation of the species over the past 3 years. Despite stringent regulations imposed on the commercial fishery in 1969 to provide the desired protection for planted trout an estimated 75,000 and 4,300 trout were incidentally caught in Michigan and Wisconsin waters, respectively. More stringent restrictions on the large-mesh gillnet fishery in Michigan waters are planned for 1970.

The absence of lamprey assessment barriers in Lake Michigan streams requires the use of indirect measures such as wounding rates on lake trout to assess changes in lamprey abundance. At this stage attempts to analyze changes in wounding rates and their significance for lake trout and other species has been limited in Lake Michigan because planted fish have only recently surpassed 21 inches which is the minimum size of full vulnerability to lamprey. Fresh wounding rates on the larger lake trout, which averaged about 9.5 percent over the entire season in 1968 and 1969, indicate that the residual lamprey population will continue to inflict damage on vulnerable salmonids.

Lake trout plantings in Lake Michigan have totalled 9.3 million fish since 1965, coho plantings 7.4 million since 1966, and chinook plantings 2.2 million since 1967.[1]

Planted lake trout have shown excellent growth averaging from 4.0 to 6.4 inches each year for the first 4 years in the lake. In 1969, the average length (inches) of trout from the various plants was:

1965	26.2
1966	22.7
1967	18.7
1968	15.9

The trout disperse gradually from the planting sites along preferred depth contours of 20 to 40 fathoms and the majority remain within the general rea of planting. Newly planted trout feed on invertebrates and small sculpins, but after nine months in the lake they begin to feed largely on alewives. Since it was suspected that some fish from the 1965 plant might spawn in 1969, spawning reefs known to be used by lake trout in pre-lamprey days were fished during the fall. A total of 4,120 lake trout (40 percent females) were caught of which 25 percent were mature. Fish either ripe or spent represented 1.2 percent of the total catch. Several thousand eggs were collected and their survival to hatching was extremely variable (0-70 percent), which is not unusual for first spawners.

Growth and survival of planted coho in Lake Michigan continues to be excellent. Adult returns in 1967, 1968, and 1969 have averaged 29 inches in length and 9.5 pounds in weight. Total survival (catch plus spawning escapement) of the various plantings has been 32 percent for the 1966 plant of 660,000 smolt, 19 percent of the 1967 plant of 1,732,000 smolt, and 25 percent of the 1968 plant of 1,176,000 smolt.

Rainbow trout (steelhead), which were severely depleted by the lamprey, have recovered and impressive runs have developed in several Lake Michigan streams. Numbers of spawning steelhead have tripled in the Little Manistee River and doubled in the Platte River since 1967. Spawning fish in 1969 averaged 7.7 pounds in the Little Manistee and 6.6 pounds in the Platte River run. Planted rainbow, brook, and brown trout are beginning to make significant contributions to the angler catch.

Salmon, lake trout, and migratory trout combined to provide an attractive sport fishery in 1969. Postcard and creel census surveys indicate that anglers caught an estimated 270,000 coho, 108,000 chinook, 112,000 lake trout, and 173,000 steehead. In addition an estimated 7,000 brown trout and 4,700 brook trout were taken in Wisconsin waters. Significant numbers

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[1] A summary of previous plantings and details of 1969 plantings of lake trout and salmon in the Great Lakes appear in Appendix B.

of brook and brown trout were caught in Grand Traverse Bay of Michigan, but reliable catch records were not available. The majority of the coho and chinook were caught from August 15 to October 15 from Muskegon to Platte Bay in Michigan waters and along the Door Peninsula in Wisconsin waters. Lake trout angling was more evenly distributed through the year with the majority being caught in Grand Traverse Bay, but good catches were also made in Little Traverse Bay, the area adjacent to Charlevoix, and to a lesser extent along the entire Michigan shoreline. Lake trout in Wisconsin waters were caught mainly along the northern part of the Door Peninsula. The commercial sale from Michigan production weirs in 1969 totalled 295,000 pounds of coho and 329,000 pounds of chinook. In addition, 32,000 coho weighing 288,000 pounds went into a free public distribution program.

Whitefish production in Lake Michigan is confined almost entirely to its northern end. The commercial catch, which is predominately in Michigan waters, fell to an all-time low of 25,000 pounds in 1957 and then increased sharply in 1965 as the first round of chemical treatments of lamprey streams neared completion. Production has averaged 1.14 million pounds between 1966-1969.

Adult alewife abundance in 1969 increased slightly from the 1968 level with an unusually heavy recruitment of age I fish. Age III fish, which usually dominate the adult stock, were replaced in 1969 by age IV fish of the 1965 year class. Over 50 percent of the adult stock in 1969 was composed of age IV and older fish. Relatively strong year classes of alewives were produced in 1968 and 1969. Dieoffs of alewives occurred lake-wide in 1969, but did not reach serious proportions.

The abundance of adult bloaters in southern Lake Michigan continued to decrease as shown by a 32-percent decline in average CPE from 1968 to 1969. The average age of bloaters has increased sharply from 3.6 years in 1965 to 6.0 years in 1969. The changing age structure, which is partly a result of low recruitment, and the increased growth in the 1960's combined to produce nearly a 3-inch gain in the average length of bloaters. The substantial increase in size explains in part why commercial production (pounds) has remained high despite the decline in abundance. Females continued to dominate the bloater stock and young-of-the-year continued to show a slight upward trend in abundance.

Test fishing indicated that yellow perch remained scarce throughout most of northern Lake Michigan.

Lake Huron

The commercial catch in Lake Huron increased slightly from an all-time low of 5.1 million pounds in 1968 to 5.2 million pounds in 1969. The 1969 catches of 2.3 million pounds in Ontario and 2.9 million pounds in Michigan were 66 and 75 percent below respective normal production levels. Whitefish, walleye and chubs were the main species in the Canadian catch; and carp, yellow perch and whitefish comprised nearly 83 percent of the United States catch.

Collection of information on fish populations in Ontario waters was continued by the South Bay Research Station in conjunction with studies of particular species. The Ontario program is supplemented by investigations carried out by the Department of Lands and Forests district biologists and university graduate students. In Michigan, fisheries research has been increased since 1968 with immediate attention devoted to sampling major species to provide information on relative abundance, distribution, food habits, growth, and mortality rates. The U.S. Bureau of Commercial Fisheries also initiated a limited investigation in northern Lake Huron in 1969 to obtain information on major species and to establish a base from which future changes in their relative abundance could be measured.

Monitoring of fish populations in South Bay has documented the invasion of alewife, its meteoric rise to peak abundance in 1964 and its subsequent decline. Alewife abundance showed some increase in 1969 and a further increase is expected as a result of an exceptional spawning in 1969 and the unusual large numbers of young-of-the-year alewives observed subsequently. Whitefish in South Bay have shown less fluctuation in abundance than any other common species, yet major trends have been obvious. The large whitefish catches in the late 1940's rapidly fell to a low in 1955. Subsequently, the abundant 1958 year class produced another peak catch in 1960 and during the last four years hatches have tended to compensate one another to produce the most stable level within the fisheries history. Lake herring in South Bay, which declined to a low level during 1962-1967 has shown some resurgence in 1968 and 1969. Yellow perch abundance was low during 1947 through 1951 and then increased to a peak in 1961. Since then abundance has declined at a rate of 35 percent per year. Abundance indices of yellow perch in 1969 were the lowest on record.

Sampling of the commercial catch was continued in the Blind River and Clapperton Island areas of the North Channel, Burnt Island in northern Lake Huron, Killarney area in northern Georgian Bay, and from Meaford to the Christian Islands in southern Georgian Bay. The 1969 whitefish catch of 72,500 pounds in the Blind River area was double that of 1968, primarily because of greater effort and a slight increase in abundance. Whitefish make their major contribution to the Blind River fishery at age III and the fishery, therefore, has become dependent on a single year class. Information collected has been used with some success for several years to forecast whitefish catches. A weak 1967 year class suggests a drastic reduction will occur in the 1970 whitefish catch. The 1970 fishery is expected to be largely dependent on age IV fish of the 1966 year class.

The incidence of lamprey wounds on the blind River whitefish has declined from 31 percent during the 1958-1959 period to 0.5 percent during 1968-1969. The very low wounding rate shows the effectiveness of lamprey control and indicate that lamprey predation is no longer an important source of mortality in the Blind River population.

A major increase in fishing effort in the Clapperton Island area has been accompanied by a sharp reduction in whitefish abundance as indicated by a decline in CPE values from 58.4 in 1966 to 30.4 in 1969. This fishery has also become dependent upon a single year class (age III) and an absence of age II fish in 1969 catch suggests that the 1970 production will drop sharply.

In the Burnt Island area on the south shore of Manitoulin Island, Lake Huron, whitefish have been tagged to provide estimates of fishing and natural mortality rates. Recoveries indicate that fishing mortality first appears at age III and thereafter contributes increasingly to whitefish mortality. Natural causes are by far the most important component of total mortality for ages II-V. Most of the annual mortality among III and IV-year-olds occurs during August and September. Lamprey-induced mortality is probably the most important single factor in reduction of whitefish numbers between age II and virtual extinction of the year class at the onset of age V.

Measures to restore salmonid species in Ontario waters of Lake Huron include plantings of kokanee and splake (brook trout–lake trout hybrids). Kokanee plantings have been made in Ontario waters of Lake Huron since the winter of 1964-65 and have consisted of eyed eggs, fry, and fingerlings for a combined total of 5.48 million. Eyed egg plants, which comprised from 24 to 44 percent of the plantings during the first three years, have been discontinued. The 1969 spawning run of kokanee was larger than 1968, but considerably below that observed in 1967. Evidence shows conclusively that river-spawning stocks, when introduced to Lake Huron, spawn both in rivers and on lake shores. Some shore spawning has occurred indicating that kokanee have a high degree of flexibility in adapting to a new environment. Splake research in Ontario has involved several years of breeding and culture of highly selected brood stocks, 7 experimental plantings of F_1 splake in northern Lake Huron prior to the current lamprey control program, and planting of 30,000 highly selected yearling splake in Georgian Bay near Meaford in 1969. This plant marked the beginning of efforts to establish a self-sustaining population of splake in Lake Huron.

Nearly 17,000 highly selected splake brood fish are now available in United States and Canadian hatcheries. Their ages range from 1 to 5 years and their degree of selection from F_3 to F_5.

Studies of the 1966 planting of 49,000 yearling F_1 splake in the Burnt Island area of northern Lake Huron indicated that the majority of the planted fish remained near the planting site, but a few travelled up to 200 miles. Growth was more rapid than either native or planted lake trout, and commercial size of 2 pounds was attained by the fall of their second year in the lake. Yearlings fed mainly on invertebrates while 2 to 4-year-olds fed almost entirely on fish. The onset of sexual maturity occurred at age II and by age III, 86 percent of the males and 58 percent of the females were mature. Ripe 3-year-olds were captured over former lake trout spawning grounds. A total of 8.4 percent of the planted hybrids were reported taken by sport and commercial fishermen over a 3-year period. Although survival to age IV was low, a substantial number attained sexual maturity. Lamprey wounding was not detected on fish less than 12 inches but wounding rates increased from 5.4 percent on 12 to 16-inch fish to 11.6 percent on fish larger than 16 inches.

Preliminary information on the 30,000 highly selected yearlings planted in southern Georgian Bay indicates that the planted fish were vulnerable to the sport fishery during their first year in the lake. Growth appeared good as the fish grew about 5 inches in 6 months. The depth distribution of splake indicated a moderately deep-water preference one of the characteristics sought in the selection of brood fish.

Michigan has concentrated its rehabilitation efforts on the plantings of hatchery-reared Pacific salmon. Plantings totalled 400,000 coho and 250,000 chinook in 1968 and 633,000 coho and 250,000 chinook in 1969.

Coho from the 1968 planting were first recovered in March by the Ontario commercial fishery in southern Lake Huron. The coho were taken in significant numbers during April and May, particularly in the trapnet fishery located between Sarnia and Grand Bend. Few coho were taken during the summer months, but from September to November an estimated 10,000 pounds were taken in various areas of Lake Huron proper. The total estimated coho catch in Ontario waters in 1969 was about 82,000 pounds or approximately 35,000 fish (8.8 percent of the total plant). In Michigan waters, coho were apparently abundant in inshore waters during April and May from Port Huron to Port Austin; and a few were reported as far north as Tawas City. Following a mid-summer lull, coho again became abundant as they concentrated near the planted Michigan streams. A sport fishery in Michigan waters existed through the openwater season and postcard surveys indicate an angler catch in 1969 of approximately 34,000 coho (8.6 percent of total plant). The majority of the catch was reported during the last 6 months of the year. Growth of coho in Lake Huron was comparable to Lake Michigan as mature fish on their spawning run averaged 9.1 pounds. Lamprey predation, however, was very high averaging nearly 73 percent on mature coho entering the streams in contrast to less than 4 percent observed on coho of similar size and age in Lake Michigan.

Lake Erie

Commercial landings in Lake Erie totalled 59.1 million pounds as compared to 51.3 million pounds in 1968. The 1969 production was the highest since 1962 with yellow perch and smelt making the major contributions, 33 million and 15 million pounds, respectively. Ontario produced 81 percent of the total catch; Ohio nearly 16 percent; and Michigan, Pennsylvania, and New York each about 1 percent. Yellow perch and smelt were the dominant species in the Ontario catch; yellow perch, carp, sheepshead, white bass, and catfish in the Ohio catch; carp and yellow perch in the Michigan catch; and yellow perch in the Pennsylvania and New York catch.

Walleye production dropped to a record low of 472,000 pounds in 1969. The low catch was partly attributed to more restrictive regulations on commercial fishing for walleye in the Western Basin as recommended by the

Commission. The 1965 year class of walleye, the last of three strong year classes to appear in the fishery in the western basin since 1956, contributed substantially to the 1969 spring fishery in the United States while the Canadian fishery was supported mainly by the weak 1967 and 1968 year classes. The 1965 year class is not expected to make any significant contribution in 1970. Surveys by the Bureau of Commercial Fisheries showed that the strength of the 1969 year class in the Western Basin was slightly less than half that noted for the 1965 year class. The 1968 and 1967 year classes were weak and the 1966 year class was rated extremely poor. As the burden of production in 1970 will fall largely on these poor or weak year classes, the walleye catch for 1970 is not expected to exceed 350,000 pounds. Walleye at the eastern end of Lake Erie produced about one-quarter of the 1969 landings for the lake and appear to be a much healthier population. Their production has remained rather stable because of the limited commercial and sport fishery.

The record catch of yellow perch in 1969 was attributed to the continued abundance and large size of individuals of the 1965 year class. Good markets for large perch and increased fishing effort undoubtedly contributed to the exceptional catch. The success of hatches of young perch has fluctuated considerably in the past decade with strong year classes produced in 1959, 1962, and 1965. Since 1965, however, the hatches have been weak and the 1969 year class, although showing some improvement over 1968 was considered fair at best. The production of yellow perch in 1970 is expected to decline with the passing of the 1965 year class from the fishery.

Although lake-wide production of freshwater drum in 1969 was reported to be only 2.4 million pounds, it is one of the most abundant fish in Lake Erie and is presently the dominant species in the Western Basin. It leads the list in numbers of young-of-the-year taken in experimental trawls and has shown no major fluctuations in year class strength. Some freshwater drum are landed when other more desirable species are not available and the species is gaining greater acceptance by the fishing industry on the southern shore. Substantial numbers taken in the seine fishery are being transported alive to fee-fishery ponds in southern Ohio and Kentucky. It is believed that if markets were developed and effort increased, landings of drum and other low-value species could be increased 5-fold.

Index fishing for smelt by Ontario showed that the population in 1969 consisted mainly of young-of-the-year and adults. The 2-year cycle of year class dominance is apparently being maintained. The commercial catch in 1969 was dominated by the 1967 year class. The incidence of the internal parasite *Glugea hertwigi* continued to increase in 1969 reaching 74 percent in the Central Basin. Ninety percent of the young-of-the-year smelt were infested and a dieoff last fall was attributed to this condition. An unusually heavy dieoff of adults in the spring of 1969 may also have been due to the parasite.

Channel catfish continue to show stability with the United States fishery in 1969 supported by four year classes, none exceptionally strong. The white bass fishery on the other hand continues to be dependent on a single

year class with their relative strength reflected in the fluctuating annual catch.

Modest experimental plantings of coho salmon in 1968 and 1969 were made by Ohio, Pennsylvania, and New York in an effort to determine the feasibility of establishing a salmon sport fishery in Lake Erie. Plantings totalled 121,000 yearlings in 1968 and 238,000 in 1969. Recoveries of the 1968 planting indicated that after entering the lake, smolts moved in a clockwise direction returning to the southern shore in the winter. Concentrations were found near warmwater discharges at Cleveland and Lorain during January and February of 1969. The heaviest concentrations of coho occurred in September and October of 1969 in or near the tributaries where they had been released. An estimate of the total survival of the 1968 planting was complicated by the appearance of a significant proportion (21 percent) of unmarked fish among those examined. These may have been fish which had escaped marking, regenerated their fins, or had entered from Lake Huron. Assuming the latter to be unimportant, 10.7 percent of the 1968 planting was recovered. It is believed that a significant number of coho which entered south shore streams was undetected and the total return was, therefore, higher than indicated. Spawning coho from the 1968 plant averaged 4.3 pounds.

Angling success for coho was very poor in Lake Erie, but when the fish entered the rivers on their spawning run the fishery became more productive but limited. It is hoped that the larger plantings in 1969 and those planned for subsequent years will encourage greater interest and participation of anglers.

Lake Ontario

Commercial landings in Lake Ontario totalled 2.6 million pounds in 1969 as compared to 2.4 million pounds in 1968. Ontario produced 89 percent of the catch and New York 11 percent. Most of the commercial production came from the shallow eastern end of the lake while the relatively large expanse of deepwater remained unproductive.

Fish populations in Lake Ontario have changed drastically in the last few decades. Most valuable species have been virtually eliminated or severely reduced attributal to a combination of factors such as sea lamprey predation, enrichment, and alewife dominance. Despite an apparent potential to produce fish, the current low level of production in Lake Ontario constitutes a major challenge to fishery agencies.

The whitefish catch in Canadian waters increased 66 percent over 1968 indicating some recovery of the whitefish stocks from the very low levels of abundance in the late 1960's. Commercial production of bullheads, carp, and yellow perch also showed some increase in 1969. The production of lake herring changed little and slight declines occurred in the catches of walleye and American eels. Experimental fishing at Hay Bay within the Bay of Quinte has provided information on changes in relative abundance of important species between 1958-1969. The alewife has shown erratic fluctuations

Table 1. Plantings (in thousands) of lake trout in Lake Superior, 1958-1969

Year	Michigan	Wisconsin	Minnesota	Ontario	Total
1958	298	184	-	505	987
1959	44	151	-	473	667
1960	393	211	-	446	1,050
1961	392	314	-	554	1,260
1962	775	493	77	508	1,853
1963	1,348	311	175	477	2,311
1964	1,196	743	220	472	2,632
1965	827	448	251	468	1,993
1966	2,218	377	257	450	3,302
1967	2,059	244	228	500	3,031
1968	2,260	344	377	500	3,481
1969	1,860	251	216	500	2,828
Total	13,670	4,071	1,801	5,853	25,395

Table 2. Plantings (in thousands) of lake trout in Lake Michigan, 1965-1969.

Year	Michigan	Wisconsin	Illinois	Indiana	Total
1965	1,069	205	-	-	1,274
1966	956	761	-	-	1,717
1967	1,118	1,129	90	87	2,424
1968	855	817	104	100	1,876
1969	877	884	121	119	2,000
Total	4,875	3,796	315	306	9,292

Table 3. Plantings of lake trout in Lake Superior, 1969

Location	*Numbers*	*Fin clip*
Michigan waters		
Black River Harbor	90,290	right ventral
Eagle Harbor	140,350	right ventral
Ontonogan	270,480	right ventral
Big Traverse Bay (onshore)	101,300	left ventral
Big Traverse Bay (offshore)	99,840	dorsal & left ventral
Marquette (onshore)	101,400	both ventrals
Marquette (offshore)	101,200	dorsal & both ventrals
Baraga	88,700	right ventral
Pequaming	100,350	right ventral
Huron Bay	91,390	right ventral
Big Bay	87,680	right ventral
AuTrain (Laughing Whitefish Pt.)	90,190	right ventral
Shelter Bay	90,440	right ventral
Munising	90,190	right ventral
Grand Marais	93,840	right ventral
Whitefish Bay	213,040	right ventral
Munising	9,335	dorsal & left pectoral
subtotal	1,860,000	
Wisconsin waters		
Apostle Islands	78,263	both pectorals
Bark Bay	72,161	both pectorals
Apostle Islands	53,260	adipose & right ventral
Apostle Islands	47,800	adipose & right ventral
subtotal	251,480	
Minnesota waters		
Palmers	57,160	dorsal & left pectoral
Two Harbors	19,540	dorsal & left pectoral
Split Rock	19,989	dorsal & left pectoral
Little Marais	16,640	dorsal & left pectoral
Grand Marais	38,700	dorsal & left pectoral
Hovland	64,588	dorsal & left pectoral
subtotal	216,380	
Ontario waters		
Pie Island to Cloud Bay	124,880	dorsal
Terrace Bay to Wilson Channel	124,900	left pectoral
Montreal R. to Gargantua R.	125,000	right pectoral-left ventral
So. shore of Michipicoten Island	125,000	left pectoral-right ventral
subtotal	499,800	
Total	2,827,700	

Table 4. Plantings of lake trout in Lake Michigan, 1969

Location	*Numbers*	*Fin clip*	
Wisconsin waters			
Green Bay	100,165	dorsal-left ventral	
Sturgeon Bay	200,520	dorsal-left ventral	
Kewaunee	193,280	right pectoral	
Manitowoc	200,750	right pectoral	
Milwaukee Reef	189,430	dorsal-right ventral	
subtotal	884,145		
Michigan waters			
Ford River	99,530	dorsal-both ventrals	
Manistique	90,430	dorsal-both ventrals	
Petoskey	100,745	right pectoral-left ventral	
Charlevoix	83,390	right pectoral-left ventral	
Grand Traverse Bay (East Bay)	34,910	right pectoral-left ventral	
Grand Traverse Bay (West Bay)	33,870	right pectoral-left ventral	
Arcadia	100,100	left pectoral	
Pentwater	100,320	left pectoral	
Montague	69,340	left pectoral	
Port Sheldon	63,730	left pectoral	
New Buffalo	100,280	left pectoral	
subtotal	876,645		
Indiana waters			
Bethlehem Steel Dock	118,650	both ventrals	freeze brand right side
Illinois waters			
Great Lakes Naval Dock	120,565	both ventrals	freeze brand left side
Total	2,000,000		

Table 5. Plantings (in thousands) of kokanee salmon in Lake Huron and Lake Ontario, 1965-1969.

Year	Eggs	Fry	Fingerlings	Total
Lake Huron				
1965	805	825	288	1,918
1966	923	644	261	1,828
1967	-	1,026	147	1,173
1968	-	185	59	244
1969	-	321	43	364
Total	1,728	3,001	798	5,527
Lake Ontario				
1965	323	772	2	1,097
1966	-	1,389	-	1,389
1967	-	1,412	-	1,412
1968	-	228	-	228
1969		334	20	354
Total	323	4,135	22	4,480

Table 6. Plantings (in thousands) of kokanee in Lake Huron and Lake Ontario, 1969.

Location	Fry	Fingerlings
Lake Huron		
South Bay	83	-
South Bay (Fair's Rock)	60	43
Nottawasaga River	178	-
Total	321	43
Lake Ontario		
Shelter Valley Creek	334	20

Table 7. Plantings (in thousands) of coho salmon in the Great Lakes, 1966-1969.

Location	1966	1967	1968	1969
Lake Michigan (Michigan waters)				
Platte River	265	503	308	1,092
Bear Creek	395	750	-	-
Bear River	-	-	52	300
Little Manistee River	-	433	148	700
Thompson Creek	-	46	25	27
Manistee River	-	-	74	100
Muskegon River	-	-	220	11
Pere Marquette River	-	-	98	100
Brewery Creek	-	-	101	100
Whitefish River	-	-	100	162
Porter Creek	-	-	50	50
Big Cedar River	-	-	-	62
Grand River	-	-	-	100
Kalamazoo River	-	-	-	100
St. Joseph River	-	-	-	100
Manistique River	-	-	-	50
Wisconsin waters				
Ahnapee River	-	-	25	45
Kewaunee River	-	-	-	40
Sheboygan River	-	-	-	46
Little Manitowoc River	-	-	-	46
Little River	-	-	-	40
Illinois waters				
Chicago	-	-	-	10
Total	660	1,732	1,201	3,281
Lake Huron (Michigan waters)				
Carp River	-	-	50	100
Thunder Bay River	-	-	100	150
AuSable River	-	-	75	217
Tawas River	-	-	177	200
Total	0	0	402	667

Table 7 (continued)

Location	1966	1967	1968	1969
Lake Superior (Michigan waters)				
Big Huron River	192	467	–	–
Presque Isle River	–	–	32	50
Anna River	–	–	175	226
Sucker River	–	–	40	50
Falls River	–	–	60	50
Ontonagan River	–	–	50	75
Cherry Creek	–	–	25	–
Sturgeon River	–	–	–	75
Minnesota waters				
French River	–	–	–	110
Ontario waters				
Jackpine River	–	–	–	10
Gravel River	–	–	–	10
Total	192	467	382	656
Lake Erie				
Ohio	–	–	30	92
Pennsylvania	–	–	86	133
New York	–	–	5	10
Total	0	0	121	235
Lake Ontario (New York waters)				
Salmon River	–	–	41	–
Oak Orchard	–	–	–	20
Little Salmon River	–	–	–	89
Ontario waters				
Credit River	–	–	–	90
Humber River	–	–	–	20
Bronte Creek	–	–	–	20
Total	0	0	41	239

Table 8. Plantings (in thousands) of chinook salmon in the Great Lakes, 1967-1969.

Location	1967	1968	1969
Lake Michigan (Michigan waters)			
Little Manistee River	591	322	300
Muskegon River	211	365	352
Wisconsin waters			
Strawberry Creek	-	-	66
Total	802	687	718
Lake Superior (Michigan waters)			
Big Huron	33	-	-
Cherry Creek	-	50	-
Anna River	-	-	50
Total	33	50	50
Lake Huron (Michigan waters)			
Ocqueoc River	-	200	200
Thunder Bay River	-	74	45
Mill Creek	-	-	5
Total	0	274	250
Lake Ontario (New York waters)			
Little Salmon River	-	-	65
Total	0	0	65

APPENDIX C

LAMPREY CONTROL IN THE UNITED STATES

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Chemical control of sea lampreys in the upper Great Lakes was continued in 1969 with the treatment of 34 streams. Crews from Ludington and Marquette were combined into a single unit for the first half of the season (April-June) to treat 6 large streams–3 tributaries of Lake Michigan and 3 of Lake Huron (including the Rifle River, which is the most complex stream system yet treated and probably the largest sea lamprey-producing tributary of Lake Huron).

The numbers of spawning-run sea lampreys taken at 16 index barriers in Lake Superior increased for the second successive year. The final count of 9,324 is 845 above the average for the past 7 years (1962-68) and 1,388 above the total in 1968, and is 18 percent of the average catch in the precontrol period (1958-61).

Lake Superior surveys

Sea lamprey populations were generally light to moderate in 13 streams surveyed before treatment, although heavy concentrations were found in limited areas of 5 of them–Furnace and Harlow Creeks and the Sucker, Big Garlic, and Brule Rivers. Twenty-nine other streams that produced sea lampreys in the past were examined to assess current larval populations; ammocetes were found in 16. Significant numbers of larvae had survived earlier treatment in 3 tributaries of the Bad River (treated in 1968) and 1 tributary of the Ontonagon River (treated in 1967). The size and number of ammocetes in the other 14 streams indicated that no changes in the tentative future treatment dates were necessary.

Fourteen streams with no history of lamprey production were resurveyed. Only 1 sea lamprey was found (at the mouth of the Black River, Gogebic County, Michigan).

Surveys of lamprey spawning were limited to the Bad River, where 61 nests were found. In previous surveys, 107 nests were counted in 1968, 51 in 1967, 38 in 1966, 44 in 1965, and 189 in 1964.

Lake Superior chemical treatments

During the period July to October, 19 Lake Superior streams were treated (Table 1). Four of these had not been included in the original schedule, but were added after surveys indicated the need for immediate treatment. All treatments scheduled for Lake Superior for fiscal year 1970 were completed by the end of calendar year 1969.

Table 1. Details on the application of lampricides to tributaries of Lake Superior in 1969.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm) Minimum effective	Concentration (ppm) Maximum allowable	TFM (pounds)	Bayer 73 (pounds)
Brule River	July 15	158	2.5	5.0	1,846	-
Arrowhead River	July 15	130	1.0	2.0	444	-
Harlow Creek	July 24	21	2.5	6.0	241	7.5
Furnace Creek	July 29	13	4.0	8.5	221	5.0
Big Garlic River	July 31	37	2.0	5.0	315	15.0
Waiska River	Aug. 7	30	3.0	7.0	968	-
Au Train River	Aug. 7	233	4.0	9.0	3,448	60.0
Pendills Creek	Aug. 11	27	2.0	4.0	132	-
Mosquito River	Aug. 11	8	5.0	10.0	130	-
Beaver Lake Outlet	Aug. 11	2	3.0	7.0	19	22.5
Sturgeon River	Aug. 21	565	2.5	6.0	3,731	20.0
Silver River	Aug. 23	14	2.5	6.0	189	30.0
Huron River	Aug. 24	12	2.0	4.5	265	12.5
Ontonagon River[1]	Sept. 4	2	4.0	9.0	38	-
Potato River	Sept. 4	1	4.0	9.0	359	4.5
Misery River	Sept. 8	20	5.0	11.0	454	-
Sucker River	Sept. 16	70	3.0	7.0	662	62.5
Bad River[2]	Oct. 19	350	2.0	5.0	3,217	5.0
Sand River	Oct. 29	50	1.5	3.5	672	-
Total	-	1,743	—	-	17,351	244.5

[1]Treated 1 tributary (Mill Creek).
[2]Treated 3 tributaries (Potato, Brunsweiler, and Marengo Rivers).

In the Sturgeon River below Otter Lake, which was treated for the first time since 1963, many large sea lamprey ammocetes and recently transformed adults were found between the outlet of the lake and highway U.S. 41, a distance of 8 miles. None were seen between U.S. 41 and the mouth (2 miles). The Au Train River below Au Train Lake was treated for the first time since 1962; the distribution of lampreys was similar to that in the Sturgeon River.

Sea lamprey ammocetes were discovered in Harlow Lake in 1968 on the delta of Bismark Creek. The delta was subsequently treated 3 times with granular Bayer 73 synergized with TFM; 612 ammocetes were taken in June 1968, 409 in July 1969, and 18 in September 1969. The reduction in the number of ammocetes collected during each treatment indicates that treatments are effective but that successive applications are required to control populations in stream deltas.

Unscheduled treatments included the Sucker River, Beaver Lake Outlet, 3 tributaries of the Bad River, and 1 tributary of the Ontonagon River. The first 2 streams were treated with TFM and their deltas with granular Bayer 73. Sea lampreys were abundant on the Sucker River delta in East Bay.

The Bad River treatment was confined to 3 tributaries (the Potato, Brunsweiler, and Marengo) where many ammocetes had survived the 1968 treatment. Several factors contributed to their survival: (1) low water levels did not permit lethal concentrations to reach ammocetes in backwater and oxbow areas, (2) rain increased flow by 60 percent during treatment of the Potato, and (3) a 11° F. drop in water temperature during treatment of the lower Brunsweiler reduced the effectiveness of the lampricide (at the lower temperature, the chemical was below its minimum effective concentration). The tributaries were re-treated at flows about 10 times greater than those present during the 1968 treatment. Treatment on the Ontonagon River was confined to Mill Creek, where sea lampreys had survived the 1967 treatment.

Ammocetes collected during treatments of Lake Superior streams indicated that substantial numbers of larvae had become established since the last treatment.

No serious fish mortality occurred during treatments in 1969.

Lake Michigan surveys

Pretreatment surveys were completed on 21 streams. Eight of the streams were subsequently treated and 13 are scheduled for 1970 and 1971. Sixty previously treated streams were surveyed; reestablished sea lampreys were found in 39. The relative abundance of ammocetes was high in 8 streams, moderate in 7, and low in 24. Residual lampreys, including 9 that had recently metamorphosed, were numerous in areas of the Whitefish River where treatments are complicated by springs, beaver dams, and ponds. Sea lamprey larvae were collected for the first time since 1956 from the Manistique River below the dam at Manistique. Resurveys were made on 85 streams in which sea lampreys had not previously been found; ammocetes were collected in 5—Elk Lake Outlet, Gurney Creek, Menominee River, Little River, and an unnamed stream (Door #23).

Lake Michigan chemical treatments

Twelve streams were treated on Lake Michigan in 1969 (Table 2). Sea lamprey larvae were generally abundant in all of them.

Table 2. Details on the application of lampricides to tributaries of Lake Michigan in 1969.

River	Date	Discharge at mouth (cfs)	Concentration (ppm) Minimum effective	Maximum allowable	TFM (pounds)	Bayer 73 (pounds)
Boyne	April 24	130	5	10	1,777	5.0
Jordan	April 29	322	6	16	7,250	25.0
White	May 13	724	5	14	14,022	55.0
Kalamazoo[1]	July 12	58	6	14	1,052	-
Muskegon	July 30	1,421	4	8	12,618	89.5
Brevort	Aug. 22	24	4	10	352	5.0
Paquin	Aug. 25	11	5	12	319	-
Boardman[1]	Sept. 4	10	8	17	317	-
Lincoln	Sept. 10	40	6	13	1,078	-
Black	Sept. 19	52	5	14	1,273	-
Ogontz	Oct. 1	5	5	10	221	50.0
St. Joseph[1]	Oct. 2	50	12	24	1,976	-
Total		2,847	-	-	42,255	229.5

[1]Tributaries only.

Substantial fish mortality occurred during treatment of the White and Muskegon Rivers. Many spawning redhorse and white suckers and a few large northern pike were killed in the White River and large numbers of white suckers and walleyes in the Muskegon River (in a section recently made accessible to the sea lamprey by modification of the Newaygo Dam). The probable cause of fish mortality in the Muskegon was a rapid (8° F.) rise in water temperature, which added to the normal stress of treatment.

Routine sampling of the industrial water intake screen located on Pere Marquette Lake continued during 1969. The number of transforming sea lampreys captured (29) was less than the number captured (37-120) in years following the first treatment in May 1964.

Lake Huron surveys

Pretreatment surveys were completed on 7 Lake Huron tributaries in 1969: Canoe Lake Outlet; Hessel, Martineau, Nuns, and Silver Creeks; and the Rifle and Pine Rivers. The Pine River was the only stream treated previously. Sea lampreys were found in 10 of 12 previously treated streams. Ammocete populations were generally light to moderate, except in the Carp River where heavy concentrations were encountered. Few of the larvae were longer than 100 mm. Six untreated streams that produced sea lampreys in the past were resurveyed; ammocetes were found in only 2–a tributary of the Saginaw River and Rock Falls Creek.

Lake Huron chemical treatments

Program funding limited treatment of Lake Huron tributaries to the first half of the season, and to 3 streams–Silver Creek and the Rifle and East Au Gres Rivers (Table 3). All were first treatments; sea lamprey larvae and upstream migrating adults were abundant. Sea lamprey numbers in the Rifle River indicated that this stream was the major lamprey-producing stream along the Michigan shore of Lake Huron. The Rifle River is the most complex system that has yet been treated by the Bureau of Commercial Fisheries; it was treated in sections because the number of people required to treat it as a unit exceeded the number in the combined crew. As a result the treatment was costly and time consuming.

Table 3. Details on the application of lampricides to tributaries of Lake Huron in 1969.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm) Minimum effective	Maximum allowable	TFM (pounds)	Bayer 73 (pounds)
Silver Creek	May 23	75	3	8	1,300	23.5
Rifle River	May 26	472	6	14	12,225	86.5
East Au Gres River	June 5	150	4	10	4,081	39.5
Total	-	697	-	-	17,606	149.5

Lake Ontario surveys

The Bureau of Commercial Fisheries assisted the New York Conservation Department in initiating a survey of Lake Ontario tributaries to locate lamprey-producing streams. A total of 135 streams were surveyed (of which 63 were dry when checked); sea lamprey larvae were found in 18–all east of Rochester, New York. Sea lamprey larvae have also been found in the Oswego River in the past (this stream was not surveyed in 1969).

Surveys of estuarine areas

The survey and treatment of lakes, estuaries, and the lower sections of many rivers were usually impractical until granular Bayer 73 became available. Granular Bayer 73 was used in 1969 off the mouths and in the lower sections of 66 tributaries of Lakes Superior and Michigan. The granules were frequently applied in conjunction with TFM treatments of streams.

Sea lamprey larvae were found in 20 of the deep-water areas surveyed off 35 Lake Superior streams (Table 4). Eight areas contained comparatively large numbers of larvae. Sea lamprey ammocetes were collected from 12 of

Table 4. Number and length range of sea lampreys collected in estuarine areas[1]

Stream	Area examined[1]	Size of sample plot (acres)	Water depth in plot (feet)	Number captured	Length range (mm)
		Lake Superior			
Galloway Creek	Lower river	<0.1	1-5	1	67
Tahquamenon River	Lower river	<0.1	1-5	178	16-70
Sucker River	East Bay*	9.0	1-48	521	25-168
Little Bills Creek	Little Beaver Lake	1.0	1-8	6	100-146
Little Beaver Creek	Little Beaver Lake	1.0	1-6	59	78-145
Arsenault Creek	Little Beaver Lake	1.0	1-4	4	108-159
Deer Lake Creek	Lower river	<0.1	1-4	6	31-178
Au Train River	Au Train Lake	3.0	1-10	4	100-147
Buck Bay Creek	Au Train Lake	1.5	1-5	48	24-105
Bismark Creek	Harlow Lake*	1.0	1-8	427	24-175
Big Garlic River	Saux Head Lake*	1.0	1-14	417	28-175
Ravine River	Huron Bay*	3.6	1-7	24	105-168
Slate River	Huron Bay	2.5	1-8	3	38-44
Silver River	Huron Bay*	6.0	1-6	826	25-164
Sturgeon River	Lower river	0.4	1-5	5	40-68
Sturgeon River	Otter Lake	1.6	1-15	20	46-160
Traverse River	Lower river	<0.1	2	18	96-175
East Sleeping River	Lower river	0.4	2	63	44-75
Cranberry River	Lower river	0.1	4	19	21-122
Black River	Lower river	0.1	1-6	1	78
		Lake Michigan			
Little Brevort River	Brevort Lake	1.1	1-4	3	61-153
Silver Creek	Brevort Lake	1.1	1-3	66	29-148
Manistique River	Lower river	0.1	1-6	115	14-157
Ogontz River	Ogontz Bay	7.0	1-15	290	56-168
Menominee River	Lower river	0.2	1-7	41	29-170
Horton Creek	Lake Charlevoix*	1.1	4-25	332	22-161
Boyne River	Lake Charlevoix	1.5	29-35	13	55-99
Porter Creek	Lake Charlevoix	0.8	3-50	94	57-151
Jordan River	Lake Charlevoix	5.5	10-11	50	73-186
Elk Lake Outlet	Grand Traverse Bay	0.5	5	39	27-141
Boardman River	Grand Traverse Bay	1.7	11-49	5	114-171
Platte River	Loon Lake	0.3	10-43	28	60-181

[1]Asterisks indicate areas where young adult lampreys were collected.

the 31 estuaries of Lake Michigan streams examined. Substantial numbers were collected in 7 areas and smaller numbers in the other 5.

Adult sea lampreys in Lake Superior

The 16 electric assessment barriers along the south shore of Lake Superior, which were operated from April 1 to July 13, 1969, caught 9,324 adult sea lampreys (Table 5). The count was 1,388 more than in 1968, and equal to 18 percent of the precontrol (1958-61) average. The lamprey spawning run began in mid-April and reached a peak May 26-30. It stabilized for 30 days, then declined slightly. The run was increasing when the barriers were deactivated.

Streams in western Lake Superior produced most of the catch. The Brule River with 3,374 lampreys and the Amnicon with 1,576 accounted for 53 percent of the total. The major producers in the eastern end of the lake were the Two Hearted River (1,104) and the Silver River (1,147). These 4 barriers produced 77 percent of the total catch. Nine of the 16 barriers caught more lampreys than in 1968; the number captured in 1969 decreased 15 percent in weirs east of the Keweenaw Peninsula and increased 74 percent in western streams.

The average size of sea lampreys caught at the barriers increased slightly, from 16.3 inches and 5.5 ounces in 1968 to 16.4 inches and 5.7 ounces in 1969. The number of males in the catch decreased from 32.7 percent in 1968 to 26.7 percent in 1969. The percentage of large rainbow trout with lamprey wounds or scars taken at the barriers declined from 3.2 percent in 1968 to 2.8 percent in 1969.

Beginning in August 1969, a reward of $1 was paid to commercial and sport fishermen for each adult parasitic lamprey collected. Sixty-nine were received by the end of the year, including 4 which had only recently transformed. Thirty-two sea lampreys were collected in the Apostle Island region, 23 east of the Keweenaw Peninsula, 11 along the north shore of Minnesota, and 3 near Isle Royale. Average weights and lengths of lampreys in these collections increased by 99 g and 92 mm between August and December. Females, which dominated the sample (68 percent), grew more rapidly than males during this period.

Lamprey passage through fish ladders

A cooperative project with the Michigan Department of Natural Resources was undertaken to determine the effectiveness of a Denil fish ladder in passing rainbow trout while blocking sea lampreys. The ladder was installed in the Rock River dam on May 9 and was removed on July 7. Marked sea lampreys and rainbow trout were released in a box at the lower end of the ladder to test their ability to negotiate it. From a total of 171 sea lampreys released, 54 died in the box, 3 were assumed to have negotiated the ladder (since they were captured at a weir above it), and the others escaped during periods of flood. Of 12 rainbow trout released in the box, 2

Table 5. Catches of adult sea lampreys for comparable periods from 16 Lake Superior streams, 1958-69[1]

Stream	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Betsy River	1,071	1,000	686	1,366	316	444	272	187	65	57	78	120
Two Hearted River	3,418	3,990	4,222	7,498	1,757	2,447	1,425	1,265	878	796	2,132	1,104
Sucker River	1,727	2,457	4,670	3,209	474	698	386	532	223	166	658	494
Miners River	94	132	395	220	64	107	74	23	85	75	158	57
Furnace Creek	38	493	2,204	1,012	132	142	93	199	118	119	126	178
Rock River	1,425	1,181	2,589	3,660	399	353	229	237	158	439	498	138
Chocolay River	6,168	3,490	4,167	4,201	423	358	445	563	260	65	122	142
Iron River	401	257	310	2,430	1,161	110	178	283	491	643	82	556
Huron River	3,435	1,433	1,225	4,825	70	201	363	637	8	2	14	280
Silver River	2,111	773	1,261	5,052	267	760	593	847	1,010	339	1,032	1,147
Sturgeon River	28	544	161	427	397	1,445	375	135	259	43	132	46
Misery River	808	2,465	692	962	80	24	12	3	10	26	52	90
Firesteel River	1,528	2,061	243	1,118	70	178	327	11	15	9	25	14
Brule River	22,593	19,225	9,523	22,478	2,026	3,418	6,718	6,163	226	364	2,657	3,374
Middle River	4,819	3,624	2,814	3,502	311	48	45	52	17	19	22	8
Amnicon River	7,584	980	1,081	4,741	879	131	232	700	938	200	148	1,576
Total	57,248	44,105	36,243	66,701	8,826	10,864	11,767	11,837	4,761	3,362	7,936	9,324
Percentage of the 1958-61 mean	112	86	71	131	17	21	23	23	9	6	16	18

[1]Includes corrections of previously published figures.

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[1]Includes corrections of previously published figures.

died in the box within 2 days, and 10 passed up the ladder within 4 days. It is believed that the fishway as installed in the Rock River could be negotiated by some sea lampreys.

Reestablishment of larvae in treated streams

Surveys in 1969 indicated that the number of Lake Superior streams reinfested with larvae in the preceding year increased substantially. Ammocetes of the 1968 year class were recovered in 47 streams, compared with 29 and 34 streams for the 1966 and 1967 year classes, respectively.

Ammocetes usually grow faster in large streams or streams with impounded water than in small streams; however, larvae in the Potato River, which has summer flows of less than 1 cfs, have one of the fastest growth rates discovered in Lake Superior. The mean length of age-IV larvae was 157 mm (range, 129-178 mm) and the modal lengths for age-groups I and II were 47 and 89 mm, respectively. Of the 552 age-IV lampreys collected, 196 (35.5 percent) were transformed. The mean length of the transformed lampreys was 156 mm (range, 139-180 mm). Males composed 21.1 percent of the larvae but 31.6 percent of the metamorphosed lampreys, indicating that males tended to transform at an earlier age than females. Populations from other streams also show this tendency.

Average lengths and percentage females for recently metamorphosed sea lampreys collected during successive treatments of the Huron River (Lake Superior) were as follows:

Year of treatment	Average length (mm)	Percentage female
1958	138	36
1961	163	52
1965	177	84

Apparently ammocetes that survive chemical treatment and are collected in subsequent treatments as transformed lampreys are predominantly female. Populations of sea lampreys isolated for a number of years above falls or dams are also predominantly female. Recently metamorphosed sea lampreys above the falls in the Ocqueoc River (Lake Huron) had a mean length of 161 mm and were 82 percent females, but those below the falls, in an area subject to annual recruitment, had a mean length of 135 mm and were only 48 percent females.

The high percentage of females among lampreys surviving chemical treatments and in populations where no recruitment has occurred for a number of years was observed in 5 tributaries of Lake Superior and 3 tributaries of Lake Huron. Recently reestablished populations in tributaries of Lake Superior also show a high percentage of females in the larval and metamorphosed stages. The high percentage of female lampreys in both reestablished and residual populations undoubtedly contributes to the high proportion of adult females captured at the barriers.

Age and growth of larvae in Big Garlic River

Sea lamprey larvae established in 1960 in the Big Garlic River have metamorphosed each year since 1965. The downstream trap has captured the following numbers of larvae and transformed lampreys in the 4 migratory periods:

Period	Larvae	Transformed
1965-66	7,684	4
1966-67	11,440	46
1967-68	10,728	229
1968-69	13,207	398

The length of transformed lampreys captured in the fall of 1969 ranged from 122 to 173 mm and averaged 142 mm. The length of the larvae ranged from 76 to 160 mm and averaged 114 mm, an increase of only 2 mm from 1968.

A total of 348 ammocetes, 125 to 162 mm long, were marked and released in the Big Garlic River in June 1969 to determine the percentage transformation among these large individuals.

Research and development of control methods

A total of 166 new compounds were screened during the year at the Hammond Bay Laboratory in the search for more effective larvicides. Compounds belonging to the nitrosalicylanilide group generally displayed high toxicity to larval lampreys and rainbow trout. Several were selectively toxic to larval lampreys below 0.1 ppm but none displayed the differential of 3-trifluoromethyl-4-nitrophenol (TFM) for larval lampreys and rainbow trout. Some of these compounds, however, will be evaluated further as possible irritants for use in survey work or as potential synergists.

In the search for an irritant, selected mixtures of TFM and 2′,5-dichloro-4′-nitrosalicylanilide (Bayluscide) were tested in 15 gallon tanks to measure the emergence time of exposed larvae and to obtain toxicity data on trout exposed simultaneously. In Ocqueoc River water at 65° F, a concentration of 10.0 ppm TFM plus 0.05 ppm Bayluscide caused complete emergence of larval lampreys in 4 hours but had no effect on rainbow trout. Standard bioassays indicated, however, that application rates for mixtures containing high percentages of Bayluscide must be rigidly controlled to minimize fish kills.

To provide information on the possible fate of lampreys that escape into untreated water when lampricides are applied to streams, data on the relation between contact time and recovery were obtained in a series of aquarium experiments. Granular Bayluscide was tested at three application rates and at three temperatures in Lake Huron water. After exposure to the toxicant, larvae emerging from the substrate were immediately removed from the test containers (15-gallon aquariums) and placed in fresh water. Mortality was determined after the specimens had been in fresh water overnight. Larvae emerged most rapidly at the highest water temperature and application rate. Mortality of exposed larvae was complete at an application rate of 150 pounds per acre at 65° F, and decreased progressively at successively lower application rates or temperatures. Similar tests were conducted with TFM and two synergistic mixtures containing TFM and wettable powder of Bayluscide. Three concentrations (2.0, 3.0, and 4.0 ppm) were used at the same test temperatures, and emerging larvae were handled in the same manner as in the previous experiments. Mortality was less than 30 percent in all tests. The most rapid emergence occurred at the highest test temperature (65° F) but mortality was no greater than 8 percent for any of the test chemicals or concentrations at this temperature. This finding strongly suggests that larval lampreys that reach fresh water (i.e., certain inland lakes or estuaries) shortly after emerging during larvicide treatments have an excellent chance of surviving. The results from these tests indicate the desirability of applying granular Bayluscide to estuarine areas as a standard practice during stream treatments, to minimize escapement.

Studies of the synergism of TFM and the wettable powder of Bayluscide were continued during the year to aid the field crews in selecting the proper mixtures and concentrations for pretreatment bioassays. Time-to-death data on larval sea lampreys and fingerling rainbow trout were obtained from bioassays in three test waters. TFM, Bayluscide, and four mixtures of the two were used in each test. The toxicity data obtained will also be used to define the synergistic interaction of TFM and Bayluscide in streams with different water chemistry.

Quality control bioassays were run on samples of 33 production batches of TFM during the year.

Biology of sea lampreys

Sea lamprey culture. Attempts to culture sea lampreys artificially at the Hammond Bay Biological Station have been only partly successful. Young larval sea lampreys hatched from eggs fertilized in the laboratory did not thrive in holding tanks supplied with a continuous flow of Ocqueoc River water. Of an original population of 17,500 larvae, only 306 (1.7 percent) survived to late fall. Their average length at that time was 14.7 mm. There appeared to be no correlation between population density, growth, and survival among the larvae in the three tanks. In contrast, the survival and growth of larvae held in the laboratory were good. Laboratory reared sea lamprey larvae held in running water from Lake Huron to which yeast was added showed good but variable growth. The maximum survival at the end of 5 months in one of 3 groups tested was 36 percent.

Physiology. Ten groups of 10 sea lamprey larvae were exposed to 0.44 ppm of L-thyroxine in an effort to determine if this hormone affects metamorphosis. This concentration is 100 times stronger than that required to produce metamorphosis in tadpoles. None of the exposed lampreys exhibited any signs of metamorphosis.

Considerable knowledge of lamprey hemoglobins was obtained. The larval and adult sea lamprey each possess at least three major hemoglobins which differ from one another in their amino acid sequence. Evidence was found that sea lamprey hemoglobins function as a single polypeptide chain having a molecular weight of 17,500. Repeated freezing and thawing of red cell homogenates, however, causes aggregation of the single polypeptide chains. It remains to be determined whether aggregation takes place between like or unlike chains. The total amino acid composition and amino acid sequences of all six sea lamprey hemoglobins will be determined with the cooperation of Dr. Ben Pollara of the Albany College of Medicine.

Ocqueoc River lamprey population. The index fyke net in the Ocqueoc River below Ocqueoc Lake captured 259 recently metamorphosed sea lampreys during the migratory season in 1969-70, as compared with 677 taken at the same net location during the season of 1968-69. Nets fished above Ocqueoc Lake failed to capture metamorphosed lampreys in either season, indicating that metamorphosis is taking place in Ocqueoc Lake.

Ocqueoc Lake was examined to determine the distribution of the larval lamprey population. *Ichthyomyzon* spp. and sea lampreys, including metamorphosing individuals, were found during electrosurveys in shallow water areas in the lake. Larval lampreys were most numerous off the inlet of the Ocqueoc River. Small numbers were found at several locations around the edge of the lake. Surveys conducted in deep water with granular Bayluscide failed to produce lampreys. Electrosurveys in the upper river indicate that an upstream movement of ammocetes from the lake had occurred since treatment of the river in the fall of 1968.

Water temperatures taken in late summer at numerous locations throughout the lake showed that it was highly stratified, and subsequent investigations indicated that much of the lake bottom was deficient in dissolved oxygen and unfit for lampreys. The concentration of dissolved oxygen was 0.8 ppm at the 16-foot contour and less than 0.2 ppm at 24 and 30 feet. When caged ammocetes were placed on the bottom at 4-, 12-, 18-, 24-, and 30-foot depths, mortality was complete in all cages at the 18-foot contour and below in less than 24 hours. Almost half of Ocqueoc Lake is over 16 feet deep, and therefore could not support lamprey populations in the summer. In these and similar circumstances lake treatments could safely be confined to shallow water.

Lamprey predation on chinook salmon. A run of chinook salmon "jacks" (precocious males) in the Ocqueoc River was sampled periodically by seine during the fall of 1969, mainly to obtain information on sea lamprey predation. During the early part of the run many fish were seen in the river with lampreys attached, and numerous dead fish, undoubtedly killed by lampreys (since all were wounded), were found in the river. In a sample of 401 salmon captured from a run estimated at 3,500 fish, 251 (62.6 percent) bore a total of 440 fresh lamprey wounds or scars.

APPENDIX D

LAMPREY CONTROL IN CANADA

J. J. Tibbles, A. K. Lamsa, and B. G. H. Johnson

Resource Development Branch
Department of Fisheries and Forestry of Canada

This report summarizes activities during the period April 1, 1969 to March 31, 1970 in compliance with a "Memorandum of Agreement" between the Department of Fisheries and Forestry of Canada and the Great Lakes Fishery Commission. The Department acts as the Canadian agent for the Great Lakes Fishery Commission in carrying out sea lamprey control on the Canadian side of the Great Lakes. The work is carried out by the Resource Development Branch from its Sea Lamprey Control Station at Sault Ste. Marie, Ontario.

Again in 1969 the Ontario Department of Lands and Forests have kindly assisted and cooperated with sea lamprey control, especially by making departmental aircraft available to ferry men and equipment into otherwise inaccessible areas.

Electrical barrier operations

Nine Canadian assessment barriers were operated on Lake Huron in 1969.[1] Table 1 lists the lamprey catches from 1965 to 1969. By the conclusion of the barrier operating season, 5,126 sea lamprey had been caught. This is a decrease of nearly 6,000 from the total catch at the same barriers in 1968 but almost 1,000 more than the catch from the same barriers in 1967. The greatest decrease in both absolute and relative terms occurred at the Georgian Bay tributaries, where 2,448 sea lamprey were caught compared with 7,903 in 1968. In Lake Huron proper, the barriers caught 1,856 sea lamprey, a decrease from 1968. But at the North Channel barriers there was an increase in the numbers of sea lamprey taken from 440 in 1968 to 822 in 1969. There is no obvious explanation for the fluctuations in numbers within the 3 subdivisions of Lake Huron. With the first round of treatments of North Channel streams essentially completed in 1967, a drop in

[1] A barrier at the mouth of the Ocqueoc River in the United States has been reactivated but has not trapped lamprey effectively in recent years because of high lake levels.

Table 1. Numbers of sea lampreys taken at Lake Huron electrical assessment barriers from 1965 to 1969.

	Count for the season				
Streams	1965	1966	1967	1968	1969
North Channel area					
Echo		526	458	195	337
Two Tree		20	22	6	7
Kaskawong			82	239	478
Total		546	562	440	822
Georgian Bay area					
Still	344	1,820	1,839	6,154	1,621
Naiscoot-Harris	593	968	1,635	1,336	785
Mad		324	333	413	42
Total	937	3,112	3,807	7,903	2,448
Lake Huron area					
Manitou			637	597	144
Blue Jay			957	1,807	1,130
Bayfield		443	789	191	582
Total		443	2,383	2,595	1,856
GRAND TOTAL	937	4,101	4,369	10,938	5,126

lamprey populations in that area would be expected by 1969. However, the 3 North Channel electrical barriers, which are all located at the lower end of the St. Marys River may not take a representative sample of the North Channel sea lamprey population, and may not truly reflect changes in abundance.

Stream surveys

In Lake Superior, 129 streams were surveyed during 1969. Sea lamprey were collected in the Sand, Michipicoten, Steel, Wolf, Pearl, Nipigon, Pancake, Kaministikwia, Jackfish, and Cloud Rivers. Sea lamprey were found for the first time in the Cloud River and because of the presence of metamorphosing lamprey it was immediately treated with lampricide.

Surveys were carried out on 143 Lake Huron tributaries during 1969. Lamprey were found for the first time in the Sauble River, a tributary to the main basin of Lake Huron near the base of the Bruce Peninsula. Sea lamprey had become re-established in the Root, Garden, Gawas, Watsons, Browns, Kaskawong, and Silver Creek in the North Channel, and Chikanishing, Sturgeon, Nottawasaga, and Silver Rivers in Georgian Bay. Ammocetes were scarce in the Muskoka, Bayfield, and Saugeen Rivers. The latter three are scheduled for treatment in 1970. No lamprey were collected during surveys with granular Bayer 73 in the estuaries of the Mississagi, Serpent, Magnetawan and Naiscoot Rivers, however, they were found near the mouth of the Still River.

During 1968 sea lamprey were located for the first time in the Wanapitei, a large river in the lower section of the French River watershed. Because of the possibility of lamprey migrating into Lake Nipissing, the French River system was extensively surveyed in 1969. However, sea lamprey were not located other than in the Wanapitei River and this river was subsequently treated with lampricide. There were two possible routes for lamprey migration from the Pickerel River (a main channel of the lower French River) into the upper French system. Horseshoe Falls on one of these connecting channels was made a barrier to lamprey migration by blasting out a 6-foot vertical drop. The work was performed under contract through the Department of Public Works of Canada and incorporated in its flow-improvement project for the French River watershed.

Lampricide treatments

Since 1958, 111 stream treatments with lampricide have been performed on 38 tributaries to the Canadian side of Lake Superior. Of the 38 original sea lamprey streams only 20 with an aggregate flow of 4,425 cfs currently require treatment on a regular schedule. Six streams (8,200 cfs) having large complex watersheds and low lamprey populations, will be treated following collection of newly metamorphosed sea lamprey. In addition, 6 streams (555 cfs) in which lamprey were scarce at the time of the first treatment now show no evidence of re-established populations and will probably not require treatments again. Six streams (430 cfs) in which sea lamprey were not found during the last application of lampricide will probably never require additional treatments.

On Lake Superior 4 streams were originally scheduled for treatment, but only the Pancake, Jackfish, and Kaministikwia Rivers were treated (Table 2). The Nipigon River was not treated because surveys indicated that it could be deferred and the Sand and Cloud Rivers were added to the schedule after lamprey were found during surveys.

In Batchawana Bay (Lake Superior) selected small sections in or near the estuaries of the Batchawana, Chippewa and Sable Rivers were treated with granular Bayer 73. These treatments were to delineate areas in which lamprey larval were concentrated and should be considered mainly experimental. In a continuing effort to reduce ammocete populations in Batchawana and Pancake Bays of Lake Superior, 15 small streams were treated during the autumn using TFM and granular Bayer 73. For the first time since 1967 when this project was initiated no sea lamprey ammocetes were collected.

Table 2. Summary of streams treated with lampricide on the Canadian side of Lake Superior, 1969.

Stream	Date	Flow cfs	Stream miles and/or area (sq. ft) treated	TFM (lb)[1]	Bayer 73 (lb)[1]	Granular Bayer 73 (lb)	Sea lamprey abundance
Pancake	June 11 June 18	90	8.5 (59,300)	331	-	195	Moderate
Sand	July 17	100	(158,160)	-	-	460	Scarce
Kaministikwia	Aug. 6 Sept. 13	945	29.3 (219,200)	6,559	112.4	964	Moderate
Jackfish	Sept. 18	45	7.5 (70,400)	520	9.4	481	Abundant
Cloud	Sept. 26	4	3.0	199	4.3	12	Abundant
Totals		1,184	48.3 (507,060)	7,609	126.1	2,112	

[1]Active ingredient.

Stream treatments were carried out on Lake Huron in 1960 and 1961, but discontinued when extra effort was required on Lake Superior and the lamprey control program was extended to Lake Michigan. Treatments were again initiated in 1966 and practically all of the streams, with the exception of those tributary to the lower section of the main basin of Lake Huron, have now been treated. Of the six rivers scheduled for treatment in 1969, only one, the Muskoka River in lower Georgian Bay, was deferred because of the small number of ammocetes collected during surveys. In addition, a portion of Solar Lake located in the headwaters of the Echo River was treated with granular Bayer 73 from a crop-dusting aircraft. Treatments on the 4 Lake Huron streams are summarized in Table 3.

Use of Bayer 73

Bayer 73 was first introduced into the lamprey control program in Canada in 1963 to synergize the lampricide TFM as it was applied to the White, Big Pic and Michipicoten Rivers. Since that time, it has been used in most treatments on Lake Superior at a rate of 2 percent of the TFM and has generally reduced the amount of TFM required for treatment by 50 percent.

The heavy-granule formulation of Bayluscide or granular Bayer 73 is particularly effective as a survey tool, especially in streams which are deep, turbid, or have low electrical conductivity. It has been used extensively in

Table 3. Summary of streams treated with lampricide on the Canadian side of Lake Huron, 1969.

Name	Date	Flow (cfs)	Stream miles treated	TFM (lb)[1]	Bayer 73 (lb)[1]	Granular Bayer 73 (lb)	Sea lamprey abundance
Kaboni	May 13	25	6	671	5.8	12	Moderate
Mindemoya	May 29	42	6	384	3.9	9	Moderate
Blue Jay	June 1	25	8	501	4.1	15	Abundant
Manitou	June 6	84	10	1,702	14.4	12	Abundant
Wanapitei	Aug. 11	535	6	2,847	29.4	50	Moderate
Totals		711	36	6,105	57.6	98	

[1]Active ingredient.

treating estuarine and lacustrine areas and has proven more effective than the TFM which dissipates rapidly in these situations. The heavy granules quickly reach the bottom as revealed by subsequent lamprey emergence. In deeper water, a percentage of these lamprey surface where they can be collected. The granular material has also been efficient in overcoming the effect of thermal stratification in both river and estuarine areas by sinking through the thermal barrier to the sediments where the lamprey are located. These lamprey are protected by a layer of cold water which is overridden by the warmer stream water containing TFM. There have been a number of fish-kills with the granular material because of the high concentration of dissolved Bayer 73 in the shallow water areas treated. Other fish-kills have been caused by drifting chemical in the form of a dust, however, this may be overcome by improved methods of quality control during manufacture.

Experiments were performed in test plots to compare granular Bayer 73 and electric shockers as survey "tools." The effectiveness of granular Bayer 73 was apparent when lamprey were recovered by using the toxicant after they could no longer be collected with the electrical devices, however, each method, dependent on stream characteristics, has its limitations and advantages, and, in general, each supplements the other.

Solar Lake (78 acres in area), an inaccessible lake in the headwaters of the Echo River, was partially treated with granular Bayer 73 using a crop-dusting aircraft. Unfortunately, because of excessive air turbulence, spraying was postponed and after a severe storm with a 3-inch rainfall and subsequent flooding, the treatment was cancelled. In the area treated sea lamprey were only found in the periphery of the lake, and northern pike, the predominate game fish, were only slightly affected. There was a significant fish mortality in the Echo River immediately below Solar Lake caused by a downstream drift of the toxicant. It was apparent, however, that this method of applying granular Bayer 73 is quite feasible.

Lamprey from the commercial fishery

Feeding-phase sea lamprey (2,755) were again purchased from the commercial fishery of the Great Lakes. The lamprey were collected mainly from Lakes Huron and Ontario, with a few from Lake Superior. For the first time in 1969, a relatively large sample of lamprey was collected from a trawl fishery in Lake Erie. The average size of lamprey again was related to the type of gear fished. Female lamprey predominate in the fall catch as they did in 1967 and 1968. Male lamprey virtually disappeared from the offshore commercial fishery in all lakes after July 1969. A fishery in Lake Ontario provided additional evidence that male lamprey move inshore during the summer.

Lamprey from the Humber River, Lake Ontario

In 1969, 1,464 lamprey were collected from the Humber River compared with 1,191 in 1968. The lamprey were caught by hand or dipnet by an individual under contract. The sex ratio, males to females (1.03) was constant throughout the season and only slightly higher than the ratio (0.96) in 1968. The average weight was also slightly higher in 1969 and approached that of lamprey collected at the Lake Huron barriers.

Trawling for lamprey

Populations of sea lamprey in the St. Marys River were again fished by surface trawling at night. The effort expended was reduced from that of previous years and the lamprey were retained for study rather than tagged and released as had been the former practice. The catch of 2.0 lamprey per hour may not be comparable to figures for the preceding years because of motor changes.

Lamprey tagging at Burnt Island

A cooperative program between the Ontario Department of Lands and Forests and the Department of Fisheries and Forestry was initiated at Burnt Island. Lamprey collected in the commercial fishery were tagged and released. From August to November 496 sea lamprey were tagged and to the end of November 94 specimens were recaptured—all but 3 in the vicinity of Burnt Island.

Other investigations

A simplified method for arithmetic calculations used in the bioassay was developed and experiments with chelating agents, as a possible additive for reducing the amount of TFM required to kill lamprey, were performed.

The latter experiments indicated that the use of chelating agents would not be practical for lamprey control.

A program of monitoring water chemistry of selected Great Lakes tributaries was started with the assistance of the Department of Energy, Mines and Resources. Many water constituents were measured by the Department and bioassays were performed at Sault Ste. Marie. It was not possible to correlate activity in the bioassay with any single constituent.

A Pour-Portioner drum meter was tested and has proven to be a simple, efficient and reliable means of applying small volumes of lampricide into streams.

APPENDIX E

ADMINISTRATIVE REPORT FOR 1969

Meetings. The Commission's committees held meetings during the year as follows:

Lake Ontario Committee, Niagara Falls, March 3-4.
Lake Erie Committee, Niagara Falls, March 4-5.
Lake Michigan Committee, Milwaukee, Wisconsin, March 25.
Lake Superior Committee, Milwaukee, Wisconsin, March 26.
Lake Huron Committee, Milwaukee, Wisconsin, March 27.
Sea Lamprey Control and Research Committee, Milwaukee, Wisconsin, March 28.
Finance and Administration Committee, Ann Arbor, Michigan, May 8.

A meeting of agency representatives was held in Ann Arbor, November 13, to discuss the collection of fishery statistics.

Officers and staff. There were no changes in officers during 1969. There were, however, several changes in Commission members. F. E. J. Fry, University of Toronto, was appointed to replace the late A. O. Blackhurst, and C. H. Meacham, Commissioner, U.S. Fish and Wildlife Service, was appointed to replace C. F. Pautzke who resigned from the Commission in January.

Early in the year Mrs. Edith McPherson, who had served as secretary on the Commission staff since 1956, retired and her duties were assumed by Mrs. Trudy Woods. A graduate librarian was employed for two months to assist with the compliation of accessions to the Great Lakes Bibliography.

Staff activities. A major responsibility of the Commission staff is to assist committees established by the Commission to obtain information and coordinate fishery programs. Considerable time was spent by the staff in planning meetings, arranging for the presentation of reports on various subjects, and preparation of minutes. Several subcommittees or work groups established to deal with special problems such as the interpretation of lamprey scar data, development of a systematic fish sampling program, assessment of salmon plants, and improvement of fishery statistics, were assisted by the staff.

The Commission depends heavily on existing agencies in the Great Lakes for information on which to base its recommendations and guide its sea lamprey control program. In the next several years these requirements will increase and greater demands will probably be made on agencies, particularly for information on fish mortality caused by sea lamprey. The Commission staff has repeatedly urged agencies to develop their capabilities in this area. Considerable impetus was given these studies in 1969 by the addition of an experienced biometrician and a statistician to the staff of the Great Lakes Fishery Laboratory of the U.S. Bureau of Commercial Fisheries.

The introduction of coho in the Great Lakes and their extensive movements has required the use of various fin clips to identify plantings. The assignment of fin clips to avoid duplication is made by the Assistant Executive Secretary. The limited number of fin-clip combinations available for both lake trout and salmon led him to investigate cryogenic branding techniques now being tested on the West Coast. As a result, two experimental lots of lake trout with identifying clips have been branded and planted in Lake Michigan. The technique has also been used on smaller plantings of coho in Lake Michigan and Lake Erie. If it proves satisfactory, the identification and evaluation of plantings will be greatly simplified.

The Commission is encountering increasing difficulty obtaining funds for effective control of lamprey in the Great Lakes and considerable effort is spent preparing program justifications and revising these when new budget levels are established. Uncertainty regarding appropriations for fiscal year 1970 made planning and budgeting particularly difficult for the Commission staff and its agents.

In addition to their regular duties, Commission staff participated in several related activities in 1969. The Executive Secretary continued to serve as Secretary of the International Association for Great Lakes Research. He also organized a special session for the annual meeting of the American Fisheries Society on "Introductions of Exotics–the Great Lakes a Case History." The Assistant Executive Secretary completed an analysis of fishery programs and a review of current plans for the management of fishery resources of the Great Lakes which was published in April by the Great Lakes Basin Commission.

Accounts and audit. The Commission's accounts for the fiscal year ending June 30, 1969 were audited by Icerman, Johnson, and Hoffman of Ann Arbor. The firm's report is appended.

Contributions in fiscal year 1969. At its 1968 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research of $1,814,100. A budget of $65,000 was approved for administration and general research. A limit of $1,030,000 placed on the United States contribution and a corresponding adjustment in the Canadian contribution to maintain the sharing formula reduced the budget for lamprey control and research to $1,450,400, and the budget for administration and research to $60,000. Stream treatments on the United States shore of Lake Huron were discontinued in order to remain within the budget but resumed when the State of Michigan agreed to provide $150,000 to continue these operations. Subsequently the State obtained $50,000 in federal funds from the Upper Great Lakes Regional Commission which was matched by a supplemental contribution of $22,464 from the Canadian Department of Fisheries and Forestry in accordance with the sharing formula. The remaining $77,536 was provided by the State of Michigan.

Requests for funds and contributions in fiscal year 1969 were as follows:

	United States	*Canada*	*Total*
Sea Lamprey Control and Research			
Commission request	$1,251,700	$562,400	$1,814,100
Appropriation	999,390	449,600	1,448,990
Credit from fiscal year 1967	1,410	-	1,410
Contributions (regular)	$1,000,800	$449,600	$1,450,400
Contributions (supplementary)			
Upper Great Lakes Regional Commission	50,000		50,000
Department of Fisheries and Forestry		22,500	22,500
State of Michigan	77,536		77,536
	$1,128,336	$472,064	$1,600,436
Administration and General Research			
Commission request	$32,500	$32,500	$65,000
Appropriation	$30,000	$30,000	$60,000

Expenditures in fiscal year 1969. Lamprey control in the United States in fiscal year 1969 was carried out under two agreements with the U.S. Bureau of Commercial Fisheries. The first for $789,000 covered operations on Lakes Superior and Michigan and lamprey research, the second for $150,000 covered operations on Lake Huron made possible by supplemental contributions.

The Bureau treated the Bad and Traverse Rivers on Lake Superior as specified in the Agreement, but were forced to postpone treatment of the Big Garlic until the early part of fiscal year 1970. Sixteen assessment barriers were operated to take spawning lamprey in Lake Superior as specified. On Lake Michigan the Bureau treated 9 of the 13 streams proposed in the Memorandum of Agreement. Low water in 3 streams forced postponement of treatments on Hibbards, Sugar, and Cedar Rivers in Green Bay, while high flow in the Muskegon forced postponement of that treatment until early in fiscal year 1970. The Manistee, originally scheduled for treatment in fiscal year 1968, was treated early in fiscal year 1969.

The Bureau continued its screening of chemicals to find other selective lamprey toxicants for stream treatments and irritants which could be used in surveys. The physiological effects of larvicides to determine their mode of action was investigated and some evidence obtained that metabolic processes were affected.

Field investigations to explore the feasibility of using larval survey data to assess lamprey abundance were discontinued early in the year when it

became clear that the prospects of obtaining useful information for a moderate expenditure of effort were poor. More emphasis was placed on studies of larval re-establishment and age and growth.

Two Agreements were executed to cover operations on Lake Huron—one between the State of Michigan and the U.S. Section of the Commission and one between the U.S. Section and the Bureau for $150,000. Seven of the 14 streams proposed in the Agreement, considered to be major lamprey producers, were treated on Lake Huron. Larvae disappeared from 3 small tributaries in southern Lake Huron and these were not treated but will be kept under surveillance. Time did not permit treatment of the remaining 4 small streams specified in the Agreement and these were re-scheduled for fiscal year 1970. At the end of fiscal year 1969 the Bureau returned $13,870 which was used for the purchase of lampricide.

The Canadian Department of Fisheries and Forestry treated 7 of the 10 streams on Lake Superior specified in the Agreement. Streams not treated were the Pigeon and Kaministikwia which did not contain larvae when re-surveyed, and the Jackfish which could not be treated effectively because of flooding. Eleven lamprey streams on Lake Huron were all treated as scheduled. Assessment barriers were operated on 9 Lake Huron streams to take spawning lamprey. At the end of the year, the Department refunded $1,260 in unexpended funds.

The Commission purchased 110,041 lbs. of lampricide (TFM) from the North American subsidiaries of Farbewerke Hoechst Ag., Germany, which offered the material at $2.55 per pound, the lowest bid of the two received. (Maumee Chemicals, Toledo, quoted a price of $3.00 per pound plus 5% royalty on material used in the United States.) The American Hoechst Corporation delivered 90,041 lbs. to the Bureau of Commercial Fisheries and Hoechst Chemicals of Canada delivered 20,000 pounds to the Department of Fisheries and Forestry.

The Commission also purchased 1,500 pounds of Bayer 73 powder to synergize TFM in certain treatments and 29,250 pounds of Bayer granules for surveys and treatment of estuaries. The Bayer powder was supplied by the Haviland Chemical Company and the Bayer granules by the Chemagro Corporation.

In Commission headquarters operations, expenditures for personal services were less than budget estimates because of the reduced staff. However, printing costs were higher than estimates due to the publication of Technical Report No. 15 entitled "The Ecology and Management of the Walleye in Western Lake Erie" and the microfilming and reproduction of 3 copies of the Great Lakes Bibliography at a cost of $1,705. These copies were distributed to the offices of the Corps of Engineers, Detroit, the Canada Centre for Inland Waters, Burlington, and the Research Branch of the Ontario Department of Lands and Forests, Sault Ste. Marie. The Commission was reimbursed $568 by the Corps of Engineers in fiscal year 1969 and by the Canada Centre for Inland Waters in fiscal year 1970. At the end of fiscal year 1969 expenditures for administration and general research exceeded the budget of $60,000 by $552. This deficit was carried forward into fiscal year 1970.

Program and Budget for Fiscal Year 1970. At the 1968 Annual Meeting in June the Commission adopted a program and budget for sea lamprey control and research of $1,833,700. A budget of $64,400 was approved for administration and general research. The Commission was advised in January, 1969 that the contribution recommended by the United States was $234,400 less than requested. Accordingly the proposed program was reduced to remain within an anticipated budget of $1,494,100. Proposed surveys and the construction of assessment barriers on the lower lakes were dropped, stream treatments in southern Lake Huron discontinued, and several field investigations were not re-activated.

At its Annual Meeting the Commission decided to proceed with the following program for sea lamprey control and research based on a budget of $1,494,100:

Lake Superior – Re-treat 19 streams (15 in the United States and 4 in Canada) which have larval populations approaching transformation; and routinely examine other streams to determine time for re-treatment; operate assessment barriers on the lamprey spawning streams.

Lake Michigan – Treat 17 streams and continue routine surveys to determine when treatments on other lamprey-producing streams are required to prevent escapement of young lamprey to the lake.

Lake Huron – Treat 9 streams on northern Lake Huron and Georgian Bay; continue surveys, and operate 10 electrical barriers to assess changes in lamprey abundance.

Research – Continue screening of chemicals at Hammond Bay Laboratory for an irritant to use in surveys; study the mode of action of TFM and synergists; determine requirements for larval transformation; investigate the extent of larval re-establishment and changes in the growth, movements, and time for transformation in these re-established populations.

Agreements to carry out the program were made with the U.S. Bureau of Commercial Fisheries ($846,900) and the Canadian Department of Fisheries and Forestry (435,200). Orders were placed with Farbewerke Hoechst Ag., Germany for 75,000 pounds of the lampricide TFM at $2.75 per pound—the lowest of two bids received.

The Commission reviewed its Administration and General Research Budget for fiscal year 1970 and agreed to include within the budget of $64,400 the amount of $5,000 to support the organization of a symposium on salmonid communities in oligotrophic lakes to be held in the Great Lakes region in 1971. The Commission also approved the purchase of additional pension benefits for its staff so that these would be based on salaries paid during the last six years of service.

In November the Commission learned that Congress had approved an "add-on" of $200,000 to the United States contribution to expedite completion of the first round of treatments on Lake Huron. At its interim meeting, the Commission agreed to proceed with operations on Lake Huron as originally planned if the proposed increase from the United States and matching funds from Canada were provided.

The current and proposed funding for fiscal year 1970 is as follows:[1]

	U.S.	*Canada*	*Total*
Commission request			
Sea Lamprey Control & Research	$1,265,250	$568,450	$1,833,700
Administration & General Research	32,200	32,200	64,400
	$1,297,450	$600,650	$1,898,100
Contributed funds (confirmed)			
Sea Lamprey Control & Research	$1,030,900	$463,200	$1,494,100
Administration & General Research	32,200	32,200	64,400
	$1,063,100	$495,400	$1,558,500
Contributed funds (with add-on)[2]			
Sea Lamprey Control & Research	$1,229,700	$552,500	$1,782,200
Administration & General Research	33,300	33,300	66,600
	$1,263,000	$585,800	$1,848,800

Program and Budget for Fiscal Year 1971. At the 1969 Annual Meeting, the Commission adopted a program for sea lamprey control and research in fiscal year 1971 estimated to cost $2,472,400 for extension of lamprey control to the Lower Great Lakes and intensification of the program on the Upper Great Lakes. A budget of $68,100 was adopted for administration and general research.

Reports and publications. The Commission published an Annual Report for 1968 and the following technical reports.

"Limnological survey of Lake Ontario, 1964" (5 papers) by Herbert F. Allen, Jerry F. Reinwand, Roann E. Ogawa, Jarl K. Hiltunen, and LaRue Wells. Great Lakes Fishery Commission, Tech. Rep. 14, 59 p.

"The ecology and management of the walleye in western Lake Erie" by Henry A. Regier, Vernon C. Applegate, and Richard A. Ryder. Great Lakes Fishery Commission, Tech. Rep. 15, 101 p.

The results of an investigation supported by the Commission appeared in the following report.

"Evaluation of lamprey larvicides in the Big Garlic River and Saux Head Lake" by Patrick J. Manion. J. Fish. Res. Bd. Canada, 26(11): 3077-3082.

[1]Does not include supplementary contributions totalling $98,820 made at the end of fiscal year 1970 to partially cover cost-of-living increases to employees of the Commission's agents.

[2]Additional United States contribution confirmed January 27, 1970; additional Canadian contribution confirmed February 27, 1970.

ICERMAN, JOHNSON & HOFFMAN
Certified Public Accountants

R. L. Johnson, C.P.A.
C. A. Hoffman, C.P.A.
J. S. Burtt, C.P.A.
C. J. Morehouse, C.P.A.
D. B. Booth, Jr., C.P.A.
J. R. Suits, C.P.A.
D. L. Bredernitz, C.P.A.

OFFICES

Ann Arbor, Michigan
Howell, Michigan

September 30, 1969

Great Lakes Fishery Commission
1451 Green Road
P. O. Box 640
Ann Arbor, Michigan

We have examined the statements of receipts and expenditures and analysis of fund balance of the Great Lakes Fishery Commission Administration and General Research Fund and Lamprey Control Operation Fund for the year ended June 30, 1969. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying statements of receipts and expenditures and analysis of fund balance present fairly the cash balances of the designated funds of the Great Lakes Fishery Commission at June 30, 1969, arising from cash transactions, and the receipts collected and expenditures made by it for the year then ended, on a basis consistent with that of the preceding year.

(signed)

Icerman, Johnson & Hoffman

Great Lakes Fishery Commission
Administration and General Research Fund
Statement of Receipts and Expenditures
Year Ended June 30, 1969
(in United States Dollars)

	Actual	*Budget*
Receipts		
Canadian Government	$30,000	$30,000
United States Government	30,000	30,000
Total receipts	$60,000	$60,000
Expenditures		
Salaries	$43,405	$45,780
Fringe benefits (Note A)	3,855	4,320
Travel	3,651	3,200
Communication	1,220	1,000
Rents and utilities	305	700
Printing and reproduction	5,394	3,250
Other contractual services	893	450
Supplies	1,155	1,100
Equipment	-0-	200
Totals	$59,878	$60,000
Accounts payable, June 30, 1969	436	
Total expenditures	$59,442	
Excess of receipts over expenditures	$ 558	
Cash deficit, July 1, 1968	674	
Cash deficit, June 30, 1969	$ 116	

Analysis of Fund Balance

Cash deficit, June 30, 1969	$ 116
Less accounts payable, June 30, 1969 (Note A)	436
Fund deficit, June 30, 1969	$ 552

Note A – Fringe benefits and accounts payable do not include an increase in pensions for the Executive and Assistant Executive Secretary due to the change in their salary base, since the increased cost is not known at this time.

Great Lakes Fishery Commission

Lamprey Control Operation Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1969

(in United States Dollars)

	Actual	*Budget*
Receipts		
Canadian Government (Note A)	$ 472,100	$ 472,064
United States Government:		
Department of State	1,000,800	1,000,800
Upper Great Lakes Regional Commission	50,000	50,000
Refund from Canadian Department of Fisheries	1,260	-0-
Refund from United States Fish and Wildlife Service	25,267	
State of Michigan and local government units	77,536	77,536
Totals	$1,626,963	$1,600,400
Accounts receivable, June 30, 1969	(18,579)	
Total cash receipts	$1,608,384	
Expenditures		
Canadian Department of Fisheries (Note A)	$ 405,050	$ 404,700
United States Fish and Wildlife Service	889,000	887,000
Lampricide purchases	329,710	308,700
Totals	$1,623,760	$1,600,400
Accounts and obligations payable, June 30, 1968	46,518	
Accounts and obligations payable, June 30, 1969	(89,498	
Total cash expenditures	$1,580,780	
Excess of receipts over expenditures	$ 27,604	
Cash balance, July 1, 1968	48,471	
Cash balance, June 30, 1969	$ 76,075	

Analysis of Fund Balance

Cash balance, June 30, 1969		$ 76,075
Plus accounts receivable, June 30, 1969:		
Refund from Canadian Department of Fisheries	$ 1,260	
Refund from United States Fish and Wildlife Service	17,184	
Other	135	18,579
		$ 94,654
Less accounts payable and obligations payable: June 30, 1969		89,498
Fund balance, June 30, 1969		$ 5,156

Note A – $405,050 was retained by the Canadian Government for use by the Department of Fisheries. The balance of $67,050 was received by the Great Lakes Fishery Commission for the purchase of lampricide.

U.S. BUREAU OF COMMERCIAL FISHERIES

Report of Expenditures for Sea Lamprey Control and Research

July 1, 1968 – June 30, 1969

	Funds programmed	Salaries	Expenses	Total	Unobligated balance
Ann Arbor					
Chemical operations	-	$368,221	$123,527	$491,748	-
Barrier operations	-	85,871	34,991	120,862	-
Research	-	150,271	25,572	175,843	-
	$789,200	$604,363	$184,090	$788,453	747
Executive direction and general administration	65,100	64,701	276	64,977	133
Washington					
Supervision	25,700	23,558	2,142	25,700	-0-
	$880,000	$692,622	$186,508	$579,130	870

U.S. BUREAU OF COMMERCIAL FISHERIES

Report of Expenditures for Sea Lamprey
Control and Research

July 1, 1968 – June 30, 1969

	Funds programmed	Salaries	Expenses	Total	Unobligated balance
Ann Arbor					
Chemical operations	-	$368,221	$123,527	$491,748	-
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Research	-	150,271	25,572	175,843	-
	$789,200	$604,363	$184,090	$788,453	747
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Washington					
Supervision	25,700	23,558	2,142	25,700	-0-
	$880,000	$692,622	$186,508	$579,130	870

DEPARTMENT OF FISHERIES AND FORESTRY OF CANADA

Report of Expenditures for Sea Lamprey
Control and Research

April 1, 1968 – March 31, 1969

Administration	$ 80,299	
Building and Grounds	17,535	
Library and Information	2,304	
Photography and Drafting	5,521	
subtotal		$105,689
Operation of Barriers (Huron)	$ 74,723	
" " (Superior)	53	
Assessment Trawling (St. Marys River)	3,556	
subtotal		$ 78,332
Chemical Control (Superior)	$114,825	
" " (Huron)	122,759	
subtotal		$237,584
Superannuation (6.5% of $209,758)		$ 13,634
Total expenditures		$435,239
Payment under 1968-69 contract	$436,600	
Cost applicable to 1968-1969	435,239	
Unexpended balance	$1,360 (Canadian Funds) $1,260 (U.S. Funds)	

COMMITTEE MEMBERS - 1969

[Commissioners in Italics]

SCIENTIFIC ADVISORY COMMITTEE

CANADA	UNITED STATES
A. L. Pritchard, Chm.	*C. H. Meacham*
Lionel Johnson	L. L. Smith
K. H. Loftus	S. H. Smith
H. A. Regier	D. A. Webster

SEA LAMPREY CONTROL AND RESEARCH COMMITTEE

CANADA	UNITED STATES
C. H. D. Clarke	*L. P. Voigt, Chm.*
J. J. Tibbles	G. Y. Harry

MANAGEMENT AND RESEARCH COMMITTEE

CANADA	UNITED STATES
E. W. Burridge	*Claude Ver Duin, Chm.*
G. C. Armstrong	W. G. Bentley
M. J. Brubacher	W. F. Carbine
J. W. Giles	W. R. Crowe
D. J. Johnston	C. D. Harris
K. C. Lucas	W. J. Harth
	C. N. Lloyd
	W. H. Tody

LAKE COMMITTEES

LAKE HURON	LAKE ONTARIO
C. D. Harris, Chm.	W. G. Bentley, Chm.
M. J. Brubacher	J. W. Giles

LAKE MICHIGAN	LAKE SUPERIOR	LAKE ERIE
W. H. Tody, Chm.	G. C. Armstrong, Chm.	W. R. Crowe, Chm.
Woodrow Fleming	D. J. Curry	D. C. Armbruster
W. J. Harth	C. N. Lloyd	W. G. Bentley
C. N. Lloyd	H. O. Swenson	D. J. Johnston
		G. L. Trembley