ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1968

GREAT LAKES FISHERY COMMISSION

MEMBERS — 1968

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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

1968

1451 Green Road
ANN ARBOR, MICHIGAN,
U. S. A.
1969

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 1968.

Respectfully,

L. P. Voigt, *Chairman*

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ANNUAL REPORT FOR 1968

INTRODUCTION

The rapid development of communities around the Great Lakes has placed heavy demands on their resources. Fish populations, to name one, have had to face intensive selective exploitation, entrance of destructive non-indigenous species through man-made waterways, and a rapidly deteriorating aquatic environment. Attempts to maintain the fishery have rested heavily on regulation of commercial fishing, artificial propagation of native and non-native species, and control of undesirable species. Deterioration of the environment, a concern of fishery scientists for many years, has now received public recognition and stronger measures to reduce pollution are now being introduced.

The international nature of the fishery in the Great Lakes was recognized early in its development and surveys of conditions in the fishery were carried out jointly by the United States and Canada from time to time. The need for a continuing review of the problems, coordination of research, and a concerted effort to control sea lamprey led ultimately to ratification of the Convention on Great Lakes Fisheries in 1955 and the organization of the Great Lakes Fishery Commission in the following year.

The Commission was asked to formulate and coordinate research designed to determine the measures needed to provide a maximum sustained yield from the Great Lakes fisheries. It was also instructed to formulate and implement a program to eradicate or minimize sea lamprey populations which had become established in the Upper Great Lakes destroying their lake trout populations, and reducing other important species.

The Commission relies on existing agencies to carry out the research it proposes and to implement the measures it recommends. Technical committees have been established for each lake to develop and coordinate local research and management while central committees advise the Commission on matters affecting the fishery as a whole. Control of the sea lamprey, a direct responsibility of the Commission, is carried out by contracts with federal agencies in each country.

The virtual elimination of the lake trout, the major coldwater predator, initiated a series of changes in prey species, which has, in the opinion of some scientists, left the unwanted alewife in a dominant position. Re-establishment of predator species is regarded as a prerequisite for restoring a stable and productive fishery in four of the five Great Lakes. Since restoration of predatory coldwater species will be difficult and costly if sea lamprey are not reduced, the Great Lakes Fishery Commission has concentrated its efforts on controlling the parasite.

Lamprey have been reduced in Lake Superior and Lake Michigan by treating streams inhabited by the larvae with selectively toxic chemicals applied in a way which minimizes the loss of desirable species. Treatments began on Lake Superior in 1958 and were extended to Lake Michigan and Lake Huron in 1960. The program was discontinued on Lake Huron in 1962 but resumed in 1966 when the first round of treatments was completed on Lake Michigan. In the 3 years since 1966, all but 20 of the 89 lamprey-producing streams on Lake Huron were treated.

Chemical treatments of Lake Superior resulted in a reduction in the number of spawning lamprey taken by barriers on 16 index streams. Since 1962, the residual population has remained between 7 and 23 percent of the pre-control level (1958-1961), reaching its minimum in 1967. The barrier catches in 1968 rose to 16 percent of the pre-control level.

The reduction in the lamprey population in 1962 did not come in time to prevent the failure of lake trout reproduction in inshore waters of Lake Superior where mature fish had been drastically reduced. The survival of lake trout has improved since 1962. Natural reproduction resumed in 1965, but has not yet made a substantial contribution to the population which is still largely dependent on planted fish.

The results of stream treatments in Lake Michigan are not as evident as in Lake Superior. Only 3 barriers were operated for assessment and these were restricted to Green Bay. The catch of spawning lamprey began to decline in 1962 several years before treatments could have significantly reduced the population. The catch, however, continued to decline through 1966 when barrier operations ended. The response of fish populations is also poorly documented although improvements in the production of whitefish and angler catch of rainbow trout indicate that these species have become abundant. The introduced lake trout and Pacific salmon have shown a high survival, probably not possible if sea lampreys were abundant.

Since lake trout populations have been drastically reduced in Lake Superior and virtually eliminated in the other lakes, it has been necessary to plant hatchery fish to bring about their recovery. The planting program, which is coordinated by the Commission, is being carried out by federal, state, and provincial agencies. An assessment of the survival and reproduction of planted fish in the face of continuing attacks from residual lamprey is an important adjunct of this work.

The Commission held an Annual Meeting in Toronto, Ontario, on June 18-20 to consider the progress of lamprey control and fishery research, to review its program for the coming year, and to adopt a program for the following year. An interim meeting was held in Ann Arbor on December 3-4 for further review and revision of programs. The proceedings are summarized in the following sections, while the information presented at the meetings is summarized in appendices.

ANNUAL MEETING

PROCEEDINGS

The Thirteenth Annual Meeting of the Great Lakes Fishery Commission was held in Toronto, Ontario on June 18-20. The Chairman Dr. A. L. Pritchard called the meeting to order and introduced the Honorable Rene Brunelle, Minister of Lands and Forests for the Province of Ontario. Mr. Brunelle welcomed the Commission and its advisors and briefly reviewed some of the major programs of his Department, stressing the importance of those in fisheries being carried out cooperatively with other Great Lakes agencies and the Great Lakes Fishery Commission.

The Chairman introduced the members of the Commission and welcomed Dr. W. Mason Lawrence, Deputy Commissioner for Administration, New York Conservation Department, who had recently been appointed as the fourth United States Commissioner. The introduction of advisors and observers from both countries followed.

The Commission adopted the proposed agenda and the schedule of plenary, executive, and committee sessions suggested by the Chairman. Minutes of the Interim Meeting held in Ann Arbor, Michigan on November 28-29, 1967 were approved.

The Chairman noted in his report that several valuable species had become more abundant and introduced species had shown remarkable survival in lakes where sea lamprey had been reduced. Agencies were increasing their investigations and adding to the information required to manage the recovering fishery. Sea lamprey control continued to be a major concern of the Commission since no substantial improvement in the fisheries of the Great Lakes appeared possible if the parasite was not controlled. Since 1962, however, the Commission had not received all the funds it had requested and was having difficulty extending lamprey control to all of the Great Lakes as required by the Convention. Operations in the upper lakes could not be reduced to extend the program without risking a build-up of their residual lamprey populations. He believed that the sea lamprey would "adapt" in some degree to present measures and these would have to be adjusted and perhaps intensified to maintain an effective control program.

He believed that the Commission must continue to see that research by fishery agencies on the Great Lakes was coordinated and directed at the most pressing problems so that maximum benefits from the fishery would ultimately be realized. A potential annual benefit of $2.1 million had been forecast for the lake trout fishery in Lake Superior. This benefit could only be realized if the sport and commercial fisheries were intensively managed and lamprey tightly controlled.[1] Investigations which would provide reliable estimates of mortalities caused by residual lamprey and the respective fisheries were essential for the intensive management envisaged.

The artificial propagation of salmon and trout in the Great Lakes presented further opportunities for management. The high survival and growth of the planted fish indicated a good supply of prey species. However, it was important now to assess the effects of these introductions so that the re-development of stable fish populations could proceed in an orderly fashion.

Sea lamprey control and research. The Commission accepted the report of the Sea Lamprey Control and Research Committee and the reports of its two agents on their operations.[2]

Mr. Thomas J. Francis, Federal Co-Chairman of the Upper Great Lakes Regional Commission, reported that his organization had contributed funds for the development of salmon rearing facilities in Michigan and was greatly concerned with the delay in establishing lamprey control on Lake Huron. It had, therefore, decided to make $50,000 available for stream treatments on the United States shore as requested by the State of Michigan.

The Commission adopted a revised program for fiscal year 1969 which included a continuation of stream treatments on the United States shore of Lake Huron. The revision was made with the understanding that $1,600,400 would be made available from various sources.

The Commission endorsed a proposed study of sea lamprey and trout interrelations in Cayuga Lake proposed by Dr. Dwight A. Webster of Cornell University and urged that the United States and the State of New York jointly support the study.

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[1] "An Economic Evaluation of Sea Lamprey Control and Lake Trout Restoration" Great Lakes Fishery Commission (mimeo), 1968.

[2] Final reports covering operations in the United States and Canada in 1968 appear as Appendices C and D.

The Commission agreed that the improvement of some streams for the passage of anadromous fish particularly recently introduced Pacific salmon could make lamprey control more difficult. It, therefore, recommended *that agencies considering the removal of dams or the installation of devices to improve fish passage advise the Commission or its agents, at an early stage in the planning so that any problems created for the control of lamprey would be fully understood and steps taken to minimize any undesirable effects.*

The Commission adopted a program and budget of $1,898,100 for fiscal year 1970 with $64,400 to be used for administration and general research and $1,833,700 to be used for the following sea lamprey control and research operations:

Lake Superior - Re-treat 11 streams (9 in the United States and 2 in Canada); survey potential lamprey-producing streams to determine when re-treatment is required; operate barriers on 16 streams in the United States during the lamprey spawning run to assess abundance.

Lake Michigan - Re-treat 23 streams; maintain surveillance of known and potential lamprey streams to determine need for treatment.

Lake Huron - Treat 5 streams in Canada and 3 in the United States for the first time; re-treat 11 streams in the United States; operate 9 assessment barriers in Canada and 1 in the United States to follow changes in lamprey abundance.

Lake Erie and Lake Ontario - Resume surveys of streams in the United States to determine which produce sea lamprey.

Research - Study the action of lampricides on fish and lamprey; screen chemicals to find an irritant for use in surveys; develop better methods for application of lampricide; determine factors that stimulate transformation of larvae; explore new ways to assess lamprey abundance; investigate the pattern of larval re-establishment in Lake Superior and Lake Michigan streams; study larval populations in estuaries; continue study of the growth, transformation, and movements of the 1960 year class of larvae in the Big Garlic River.

Management and research. The Commission accepted the reports of the Management and Research Committee[1] and discussed at some length recent information on pesticide residues (DDT and dieldrin) in Lake Michigan fish and their possible effects on rehabilitation of the fishery. It agreed to urge that all the states bordering Lake Michigan restrict the further use of persistent pesticides in the watershed. It would also bring

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

the situation in Lake Michigan to the attention of agencies engaged in water quality research and control in the other Great Lakes and encourage them to severely restrict the use of these pesticides.

The Commission, while recognizing the constructive steps taken for control of pollution in the Great Lakes Region, believed that some agencies thus engaged did not fully recognize its serious effects on the fisheries. It would, therefore, seek the assistance of the International Joint Commission in urging that control agencies give greater consideration to the welfare of the fisheries.

The Commission indicated its support of the experimental introduction of coho salmon in Lake Erie and stressed the importance of studies to assess the results.

The Commission agreed that the walleye in western Lake Erie must be provided greater protection without delay in view of the report and recommendations presented at the 1967 Interim Meeting. It asked for a report at its Interim Meeting on the measures agencies proposed to take in 1969.

The Commission asked that minimal sampling requirements, uniform data recording, and presentation be adopted by agencies studying Lake Superior lake trout. A greater effort should also be made to obtain the ages of the fish sampled in order to determine age structure and estimate mortality.

The Commission asked its agents to evaluate alternative methods for assessing the effectiveness of lamprey control and to report at the Interim Meeting.

Election of officers. Mr. L. P. Voigt (United States) was elected Chairman and Dr. A. L. Pritchard (Vice-Chairman) for the ensuing two years.

Finance and Administration Committee. The Chairman explained that the appointment of a fourth commissioner from each country would enable the Commission to form its Finance and Administration Committee.[1] The Committee would advise the Commission on budgets, publications, meeting arrangements, and other related financial and administrative matters which the Commission as a whole had not been able to consider in detail.

Award. The Chairman announced that the Commission would, from time to time, publicly recognize those individuals who performed a distinctive service in furthering the welfare

[1]See Revision to Rule of Procedure 17, 1965 Annual Report, page 5.

of the Great Lakes fishery. The first person to be recognized was Mr. Russell Robertson of the Michigan Department of Natural Resources who, prior to the formation of the Commission, established brood stocks of lake trout in the hatchery under his supervision. These stocks were now the major source of eggs for the rehabilitation program. Mr. Robertson was presented a plaque in recognition of this important contribution.

Adjournment. Mr. Voigt expressed the Commission's appreciation to the participants for their advice and assistance during the meeting and to the Minister of Lands and Forests and his staff for their hospitality. After announcing that the Interim Meeting would be held in Ann Arbor on December 10-11, he adjourned the Annual Meeting.

INTERIM MEETING

PROCEEDINGS

The Commission held its Interim Meeting in Ann Arbor on December 3-4, 1968, to consider the progress of sea lamprey control, lake trout restoration, salmon introductions, alewife research, walleye management in western Lake Erie, and pesticide contamination in Great Lakes fishes.

Sea lamprey control and research. The Commission heard preliminary reports on sea lamprey control operations in 1968 submitted by its agents and reviewed the prospects for establishing an effective control program on the Upper Great Lakes in view of the difficulty in obtaining funds. Resumption of lamprey control operations along the United States shore of Lake Huron in 1968, for example, was possible only because $150,000 had been provided by the State of Michigan, the Upper Great Lakes Regional Commission, and the Department of Fisheries of Canada. Michigan officials pointed out that their State had responded to the financial emergency in fiscal year 1969, but could not offer this assistance again. They urged full federal funding of the Commission's program in fiscal year 1970.

The Commission was advised that it should not expect a significant increase in the United States contribution for fiscal year 1970. In this event, it would be necessary to postpone control operations on Lakes Ontario and Erie and confine chemical treatments on Lake Huron to lamprey streams in its northern half. The latter action would jeopardize expenditures made by the State of Michigan and the Province of Ontario on salmon and "splake" plantings. The Commission agreed that no changes would be made in the proposed program for fiscal year 1970 until required by budget restrictions.

Lake trout restoration. The Commission received reports from agencies conducting lake trout assessment studies on Lake Superior and Lake Michigan which indicated further improvements in the abundance of planted trout in both lakes. However, preliminary information from Lake Superior suggested that the survival of the larger and older trout was still low and could limit recovery of the spawning stocks and natural reproduction. The relatively high incidence of lamprey wounds

on the large lake trout in both Lake Superior and Lake Michigan suggested that lamprey predation was the major cause of the high mortality and control operations should not be relaxed on either lake.

Salmon introductions. Michigan representatives reported that the total recovery from 1,732,300 coho salmon planted in Lake Michigan tributaries in 1967 was 19 percent, considerably less than the 32 percent from the 1966 plant, but still spectacular by any standards. Recoveries from the 1967 planting of 465,000 coho in Lake Superior was 2 percent as compared to 16.3 percent from the 1966 planting.

Coho and chinook plantings were continued in Lakes Michigan and Superior and expanded to Lake Huron in 1968.[1] Modest plantings of coho were also made in Lakes Erie and Ontario in 1968. Kokanee plantings were continued in 1968 in the Ontario waters of Lake Huron and Lake Ontario.

The Commission agreed to extend its role of allocation of fin clips to salmon and rainbow trout plantings as requested by several fishery agencies.

Alewife in Lake Michigan. The U. S. Bureau of Commercial Fisheries reported that the alewife which appeared in Lake Michigan in 1949 increased first in the northern part of the lake, then in the south, and reached peak abundance in 1966. The major dieoff which occurred in the spring and summer of 1967 was comprised mainly of the strong 1964 year class. The year class was still dominant (41 percent) in the 1968 population; the 1965 year class represented 32 percent of fish sampled. The death of large numbers of the 1964 year class in 1967 and the relatively poor survival of the 1965 year class reduced alewife abundance in 1968 to about one-third that in 1966.

Walleye management. Management agencies of Ohio, Michigan, and Ontario agreed that additional protection was needed for the walleye in western Lake Erie which had not produced a strong year class since 1965. Ohio reviewed the regulatory action taken in its waters in 1968 and urged that Ontario and Michigan adopt appropriate measures for their waters. Ontario representatives explained that additional data collected on the walleye in 1968 and now being analyzed, would probably provide the information needed for developing regulations.

[1] Distribution of planted salmon is given in Appendix B.

Pesticide contamination. The Commission, after hearing reports on the accumulation of pesticides in Great Lakes fishes, expressed deep concern regarding the potential threat to the fisheries. Analyses by the U. S. Bureau of Commercial Fisheries revealed that concentrations of DDT and dieldrin in fish from Lake Michigan were, on the average, 2 to 7 times higher than in those from the other Great Lakes. Pesticide concentrations differed from species to species and increased with increasing size. Studies by Michigan State University strongly suggest that DDT caused significant mortalities among fry hatched from eggs of Lake Michigan coho. The mortality in coho fry attributed to DDT was estimated at 11 percent collectively in Michigan hatcheries in the winter of 1968.

Coordination of research. The Executive Secretary submitted proposals for improving and increasing the flow of information required by the Commission. After discussing these, the Commission asked its Scientific Advisory Committee to review the "Prospectus of Investigations on the Great Lakes" issued in 1964 and on the basis of recent developments describe the investigations it believed necessary to produce the information needed by the Commission to discharge its responsibilities more effectively.

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 fisheries is summarized for each lake as follows:

Lake Superior

Commercial landings in Lake Superior dropped from 10.5 million pounds in 1967 to 9.9 million pounds in 1968. Ontario produced 34 percent of the catch, Michigan 31 percent, Wisconsin 18 percent, and Minnesota 17 percent. Lake herring accounted for most of the Canadian catch and lake herring, smelt, chubs, and whitefish were the dominant species in the United States catch.

Commercial fishing for lake trout was restricted for the seventh consecutive year to encourage the recovery of the trout. Some fishing, however, was again permitted under catch quotas to provide information on the recovery of the population and to evaluate plantings. The total allowable catch of lake trout in 1968 was increased from 404,000 to 606,000 pounds to allow additional information to be collected. Quotas were as follows:

	1967	1968
Ontario	170,000	188,000
Michigan	146,000	330,000
Wisconsin	75,000	75,000
Minnesota	13,000	13,000
Total	404,000	606,000

Although catch quotas have generally proven effective in protecting lake trout, there has been a high incidental catch of trout in gillnets fished for whitefish in Michigan and Wisconsin waters. In 1968, these states introduced a permit system limiting gillnet operations but despite these additional restrictions an estimated 16,500 lake trout were taken incidentally in Michigan waters. An estimate of the incidental catch in Wisconsin

is not available, but checks of the whitefish fishery indicated that the catch of lake trout in gillnets was either equal to or exceeded the catch of whitefish for most of the fishing season. Further regulation changes to offer planted lake trout additional protection are under consideration for 1969.

Sea lamprey control measures have been successful in reducing the adult lamprey population to about 15 percent of their former level of abundance (Appendix C), and improving the survival of planted fish. Lake trout abundance has increased more than twofold as indicated in the following table.

Numbers of marketable lake trout caught per 10,000 feet of large mesh gillnet lifted during the spring, Lake Superior, 1962-1968.

Year	Michigan	Wisconsin	Minnesota	Ontario
1962	39	77	43	34
1963	46	81	58	32
1964	43	111	68	56
1965	55	134	50	59
1966	75	150	22	99
1967	116	181	46	111
1968	245	-	32	76

In 1968, the catches of lake trout per 10,000 feet of large mesh gillnet continued to increase over those in 1967 by 111 percent in Michigan waters, but fell below the 1967 values in both Minnesota and Ontario waters by 30 and 32 percent, respectively. Data on relative abundance in Wisconsin waters were not collected in the spring of 1968, but data for the preceding years show that lake trout have been more abundant in these waters than in any others since 1962. Significant spawning of lake trout has occurred in Wisconsin waters since 1964 and further increases in the average age and relative abundance of the spawning stock were observed in 1968. Native trout now comprise a significant part of the juvenile population in some Wisconsin waters. Spawning in other areas of Lake Superior has been very limited and there is no evidence of any recent year classes of native trout.

Preliminary studies suggest that the survival of lake trout planted prior to 1961 in Michigan waters was too low to allow significant numbers to reach maturity, on the other hand, survival in Wisconsin waters was apparently high enough to allow increases in spawning stocks beginning in 1964. Mortality of the older trout in Wisconsin appears to be relatively high and natural reproduction may be less than adequate for complete

rehabilitation. There is a trend, however, toward lower mortality for trout planted since 1961, particularly in Michigan waters which, if it continues through the older ages, will improve the prospects for lake trout re-establishment. Since the sea lamprey attacks are the likely source of the high mortality among mature trout the recent increase in the barrier catch of lamprey is a matter of considerable concern.

Annual plantings of salmonid species following lamprey control are being made to speed the rehabilitation of the fishery. In 1968, plantings in Lake Superior totalled nearly 3.5 million lake trout yearlings, 373,500 coho yearlings, and 50,000 chinook fingerlings.[1] Other plantings included 193,000 rainbow trout (steelhead), 61,000 brook trout, and 6,000 brown trout.

The 2.2 percent recovery from Michigan's planting of 467,000 coho in the Big Huron River in 1967 was well below the 16.3 percent recovery from the 1966 plant of 192,400 fish. Anglers caught an estimated 7,000 coho of which 4,500 were taken in Wisconsin and Minnesota waters and 2,500 in Michigan waters. The incidental catch in commercial gear was estimated at 500 fish and the spawning escapement at 2,500 fish. Straying of coho to other Lake Superior streams was extensive. Adults returning to the Big Huron River averaged 21.1 inches and 3.6 pounds.

The condition of lake herring stocks in United States waters continues to be of considerable concern to fishery agencies. United States commercial landings in 1968 fell to an all-time low of 3.6 million pounds with 2.3 million pounds from Michigan waters, 0.6 million pounds from Wisconsin waters, and 0.6 million pounds from Minnesota waters. In contrast, some improvement was noted in the lake herring catch in Canada. The 2.6 million pounds taken in 1968 surpassed the 1967 catch (1.8 million pounds) by 42 percent and fell only 7 percent short of the peak catch (2.8 million pounds) in 1962. The reasons for the higher catch in Canadian waters are not clear, but increases in abundance, new methods of processing, and better markets are suspected. The decline in United States catch has been characterized by an increasing average size and age and a decreasing rate of recruitment. Studies by the University of Minnesota on the early life history of lake herring and their interrelationships with other species have been undertaken to identify the factors responsible for this decline.

[1] A summary of previous plantings and details of 1968 plantings of lake trout and salmon in the Great Lakes appear in Appendix B.

Lake Michigan

Commercial landings in Lake Michigan dropped from 58.7 million pounds in 1967 to 43.7 million pounds in 1968. The decline (26 percent) was due entirely to a drop in the production of alewife which still accounted for 62 percent of the catch. Wisconsin produced 63 percent of the total 1968 catch, Michigan 35 percent, Illinois 1 percent, and Indiana less than 1 percent. Dominant species in 1968 were alewives, chubs, smelt, and whitefish in Michigan waters; alewives, chubs, and carp in Wisconsin; chubs in Illinois, and yellow perch in Indiana.

Although commercial fishing for salmonid species is not permitted in Lake Michigan, there was a high incidental catch of planted lake trout in gillnets fished for whitefish in the northern part of the lake. Special gillnet permits employed by Michigan and Wisconsin failed to provide the desired protection and an estimated 87,000 planted trout were taken incidentally in the whitefish gillnet fishery in Michigan waters. An estimate of the total number taken in Wisconsin waters was not available, but periodic samples obtained during 1966 showed incidental catch rates ranging from 5 to 15 trout per 1,000 feet of net lifted. More stringent restrictions on the large gillnet fishery in both Michigan and Wisconsin waters are planned for 1969.

Rehabilitation of major fish stocks is far less advanced in Lake Michigan than in Lake Superior, but the rapid growth and high survival of planted salmon and lake trout and the increasing abundance of the whitefish, rainbow trout, and burbot populations suggest that lamprey control and restocking programs have been responsible for the improvement.

A total planting of 1.7 million coho salmon in four Lake Michigan streams in 1967 produced a combined catch and spawning escapement of 19 percent in 1968 as compared to 32 percent in 1967 from the 1966 planting of 659,400 coho smolts. Anglers caught an estimated 91,200 coho from Lake Michigan and tributary streams in nearly 0.5 million days of fishing. Fishing success in the lake was 0.2 coho per angler day in 1968 in contrast to 0.4 in 1967. In addition to the sport catch, 1.9 million pounds of coho were sold from the river weirs. Adult coho returns in 1968 averaged 29.0 inches and 9.0 pounds, approximately the same total length but one pound less than 1967 returns. The local economic impact of the coho fishery was shown in retail sales tax collections which indicated that the salmon fishery in 1967 generated an estimated $7.4 million in retail sales in the 11 northwest counties bordering the fishing grounds.

Planted lake trout show excellent growth averaging from 3.9 to 6.4 inches each year for the first 3 years of life. Planted trout disperse gradually from planting sites along preferred depth contours of 20 to 40 fathoms. The majority remain within the general area of planting for about 3 years, but a few have been taken as far as 300 miles from the planting site. Newly planted trout fed on invertebrates and sculpins, but after 9 months they begin to feed largely on alewife.

Test fishing on former lake trout spawning grounds in northern Lake Michigan was conducted in the fall of 1968 to detect any natural reproduction of planted trout. Nearly 2,000 trout were caught and examined but only a few males and no females were mature. Egg development in some females from the 1965 planting suggested that a few might spawn in 1969.

Rainbow trout (steelhead) which were severely depleted by the lamprey have recovered and impressive runs have developed in several Michigan streams. Little Manistee River in 1968 produced spring-run steelhead which averaged 11 pounds and fall-run steelhead which averaged 7.3 pounds. Fall-run steelhead in the Platte River averaged 4.8 pounds. Planted rainbow, brook, and brown trout have also exhibited phenomenal growth and are beginning to contribute to the angler catch. Rainbow trout have reached 25 inches in length and brook and brown trout 23 inches after 2 years in the lake.

Whitefish production in Lake Michigan, which fell to an all-time low of 25,000 pounds in 1957, increased sharply in 1964, reached 1.4 million pounds in 1966, and remained at just over 0.8 million pounds in 1967 and 1968. Recent studies reveal marked differences in the age composition of exploited and unexploited whitefish populations in Lake Michigan. Whitefish examined from waters closed to commercial fishing range from 2 to 10 years of age and five age groups (III to VII) comprise 93 percent of the sample. In contrast the age of whitefish from waters open to commercial fishing range from 2 to 6 years with age groups III and IV representing 91 percent of the sample in waters moderately fished; in heavily fished stocks age groups II and III represent 83 percent of the sample. Whitefish in the intensively fished populations grow faster and mature earlier than those in the less heavily fished populations. In the intensive fisheries, most female whitefish are taken before they spawn for the first time and regulations to protect immature fish are being considered.

The abundance of alewives in Lake Michigan in 1968 remained near the 1967 level and considerably below the 1966

level. The 1968 year class was rated as very strong and, depending upon subsequent survival, could substantially increase the adult stock in 1971.

Since there are no electrical barriers on Lake Michigan, changes in the abundance of sea lamprey are currently being assessed by the incidence of lamprey wounds on planted lake trout. In 1968, wounding rates on lake trout in the northern part of the lake ranged on the average from 12 to 22 percent depending on size. These wounding rates reflected a relatively high level of lamprey predation when compared with those from Lake Superior and there is reason to believe that the first round of treatments has not reduced the lamprey sufficiently in Lake Michigan to allow re-establishment of spawning stocks.

Salmonid plantings in Lake Michigan totalled 4,217,500 fish in 1968. Lake trout plantings amounted to 1,875,900 of which 855,500 were planted in Michigan waters, 816,750 in Wisconsin waters, 103,650 in Illinois waters, and 100,000 in Indiana waters. Salmon plantings in 1968 consisted of 1,176,900 coho and 686,700 chinook. Coho were planted in 10 Michigan streams and 1 Wisconsin stream, and the chinook in 2 Michigan streams. Plantings of other salmonids included 213,100 rainbow trout, 23,950 brook trout in Michigan waters; and 75,300 rainbow trout, 25,500 brook trout, and 140,150 brown trout in Wisconsin waters.

The recently detected accumulation of pesticide residues in fish constitute a threat to the rehabilitation of the Lake Michigan fishery. Pesticide analyses conducted over the past 3 years by the U. S. Bureau of Commercial Fisheries reveal that concentrations of DDT and dieldrin are 2 to 7 times higher in Lake Michigan fish than those from the other Great Lakes. Levels differ from species to species and increase with an increase in fish size. Studies by Michigan State University strongly suggest that DDT was the most likely cause of the high mortality of fry hatched from eggs of Lake Michigan coho. A mortality syndrome (loss of equilibrium, erratic swimming, and prolonged convulsions), which appeared abruptly during the last stage of yolk-sac absorption was observed in all Lake Michigan groups. DDT concentrations in Lake Michigan coho salmon eggs were 3 to 5 times higher than those from Lake Superior, and approximately 60 times higher than in eggs from Oregon. Overall DDT induced mortality in coho fry was estimated at 11 percent, collectively in Michigan hatcheries. In the laboratory, mortalities of coho fry from individual Lake Michigan coho ranged from 15 to 73 percent, while mortalities in progeny from Lake Superior and Oregon coho ranged from 1 to 5 percent.

Lake Huron

The commercial catch in Lake Huron fell to an all-time low of 5.1 million pounds in 1968. The 1968 catches of 2.4 million pounds in Ontario waters and 2.7 million pounds in Michigan waters were 65 and 77 percent below respective normal levels. Carp and yellow perch comprised over 70 percent of the United States catch. Whitefish, chubs, and walleye were the dominant species in the Canadian catch.

Monitoring of fish populations in South Bay, Ontario indicated that alewife, yellow perch, and white sucker populations continued to decline from peak abundance in the early 1960's. The abundance of lake herring continued to rise from previous low levels. No trend has been apparent in the abundance of whitefish for the past 3 years. In the Blind River area of the North Channel, whitefish production is expected to improve in 1969 with the entry of the strong 1966 year class into the fishery. In the Clapperton Island area of the North Channel, fishing intensity on whitefish increased so sharply that the fishery has become dependent on a single age group. Whitefish production in southern Georgian Bay has declined, but the 1964 year class made an impressive contribution to the fishery.

Whitefish studies in Ontario waters have been devoted to determining factors affecting year class strength by examining the life history of young-of-the-year whitefish. Estimates of relative year class strength of young-of-the-year whitefish in South Bay from trawl catches have been substantiated by pound net catches of yearlings the following spring. Considerable information on the movements and growth of young whitefish in their first year of life has been collected. Annual fishing and natural mortality rates are being obtained for whitefish in the Burnt Island area and in South Bay which should prove useful in measuring improvements arising from sea lamprey control.

Measures to restore desirable salmonid species in Ontario waters of Lake Huron include the planting of kokanee and splake. Selective breeding of the latter, a brook x lake trout hybrid, has been underway for 10 years. The first substantial planting of highly selected stock will be made in 1969. Kokanee plantings were first made in 1964 and early 1965. Survivors spawned in the fall of 1967 and fry were collected during their downstream migration in the spring of 1968. Returns to spawning sites in 1968 from the second plantings were considerably below those of the first planting. The fourth planting in 1968 consisted of 185,000 fry and 59,000 fingerlings. The fry were placed in the Manitou, Sauble, and Saugeen Rivers, and the

fingerlings in southern Georgian Bay and South Bay. Coho salmon plantings were made by the State of Michigan in Lake Huron in the fall of 1967 when 3,500 adult coho were transferred from Lake Michigan streams to the Ocqueoc, Carp, and AuGres Rivers. These adults spawned and produced young fish which survived well in some of the streams. In 1968, a total of 400,000 coho were planted in the Carp, Thunder Bay, Tawas and AuSable Rivers, and 265,000 chinook were planted in the Ocqueoc and Thunder Bay Rivers. Coho "jacks" from the 1968 planting returned to the Tawas and AuSable Rivers during October and November where anglers caught about 900. Their average size was 17 inches in total length and 2-1/2 pounds in weight. Coho "jacks" were also observed in Thunder Bay River from early September until late November, and anglers caught an estimated 300 fish. There was no apparent return to the Carp River, but coho were observed in many small streams from Rogers City to the AuGres River. Most of the coho reported from Ontario waters were taken incidentally in pound nets near Point Edward at the extreme southern end of Lake Huron during the late summer and fall and off the southwestern end of Manitoulin Island. The total catch was estimated at just under 1,000 pounds.

Lake Erie

Commercial landings in Lake Erie totalled 51.3 million pounds in 1968 as compared to 49.4 million in 1967. Of this total, Ontario produced 77 percent, Ohio 20 percent, Michigan 1.5 percent, Pennsylvania and New York each less than 1.0 percent. Yellow perch and smelt were the dominant species in the Ontario catch; yellow perch, freshwater drum, and carp in the Ohio catch; carp and yellow perch in the Michigan catch; yellow perch in the Pennsylvania catch, and walleye and yellow perch in the New York catch.

Yellow perch catches in 1968 were dominated by fish of the 1965 year class. The relatively weak 1966 and 1967 year classes are not expected to make significant contributions to the fishery and the 1968 year class appears to be even weaker than the one produced in 1967. Smelt catches were confined entirely to Canadian waters and were composed almost equally of the 1965, 1966, and 1967 year classes. The 2-year cycle in the year class dominance of smelt has shifted from strong year classes in even years (1962 and 1964) to odd years (1965 and 1967). The incidence of the microsporidian parasite *(Glugea hertwigi)* in smelt increased from less than 1 percent in 1960

to 60 percent in 1968. Walleye catches in the western basin have depended largely on the strong 1965 year class in the last 3 years. By the fall of 1968, the 1965 year class appeared to be fully exploited and the weak 1966 and 1967 year classes are not expected to sustain the fishery at its current level. The walleye catch in the western basin is, therefore, expected to fall to an all-time low in 1969. Walleye in the eastern basin appear more stable than those in the western basin as 6 to 8 classes were represented in the 1968 catch. Freshwater drum (sheepshead) appear to be undergoing a general population increase similar to that of yellow perch during the 1960's. The drum is presently one of the most abundant species in the lake and capable of providing much greater production to both the sport and commercial fishery. Channel catfish catches in 1968, mainly from Ohio waters, were composed almost entirely of fish of the 1964 year class (42 percent), the 1963 year class (27 percent), and the 1962 year class (20 percent).

Although several measures have been taken to reduce fishing pressure on critically depressed walleye stocks in Ohio and Ontario waters, it is apparent that further restrictions are needed if adequate numbers are to reach maturity.

Experimental plantings of 119,600 coho salmon smolt in Lake Erie were made by Ohio, Pennsylvania, and New York in 1968. More than 1,200 coho were reported taken in Lake Erie in 1968 and "jacks" were observed in most of the planted streams during the fall. The recovery of significant numbers of unmarked coho in Lake Erie suggest a considerable influx from Lake Huron.

Lake Ontario

Commercial landings in Lake Ontario totalled 2.4 million pounds in 1968 as compared to 2.1 million pounds in 1967. Of the 1968 total, Ontario produced 89 percent and New York 11 percent. Most of the commercial production continued to come from the shallow waters in the eastern end of the lake while the relatively large expanse of deep water remained unproductive. The whitefish catch increased 57 percent over 1967 but remained well below catches made in the early 1960's. There was no evidence of the Bay of Quinte population which contributed substantially to the Canadian fishery 15 years ago. American eel catches, which declined over the past 3 years, increased slightly in 1968.

Exploratory fishing was carried out in 1968 in Canadian waters to determine the feasibility of a trawl fishery for smelt and alewives. Echo sounding located fish along the entire lake mainly within the 30 fathom contour, but only 5 percent of the bottom within these depths was suitable for trawling. One area in the eastern end of the lake and another off Hamilton in the western end showed a potential for commercial production. Trials with midwater trawls encountered operational difficulties and were inconclusive.

The current low level of fish production in Lake Ontario is a challenge to agencies attempting to develop it as a major fish producer. Attempts to re-establish lake trout through hatchery plantings have failed as few survived to spawn. Since high losses to lamprey are suspected, planting of less vulnerable species such as coho and kokanee salmon are being tried. Kokanee plantings since 1965 have met with poor results in contrast to those in Lake Huron, apparently because of low survival on reaching the lake. A planting of 25,000 coho smolt was made by New York in the spring of 1968. About 50 "jacks" returned to the planted stream in the fall of 1968.

Information on the sport fishery was collected in several areas of the lake and the St. Lawrence River. The most intensive creel census was made in the Thousand Island area where over 15,000 anglers were interviewed - most of their catch consisted of smallmouth bass and northern pike.

Investigations in Ontario included monitoring of the whitefish fishery and rearing of whitefish past the fry stage; the potential of two species of Japanese salmon[1] for introduction in the Great Lakes; the effects of eutrophication processes on fish fauna; and general studies of the American eel, smelt, and kokanee. Investigations in New York were largely confined to the distribution and spawning of smallmouth bass in streams and in the lake in its extreme eastern end. Studies have also begun on the sturgeon.

[1] *Oncorhynchus masou*
Oncorhynchus rhodurus

APPENDIX B

SUMMARY OF TROUT AND SALMON PLANTINGS

Intensive annual plantings of hatchery-reared salmonids have been the principal method employed by cooperating government agencies to speed the rehabilitation of the Great Lakes fisheries. Lake trout have been planted annually in Lake Superior since 1958 and in Lake Michigan since 1965, kokanee salmon in Lake Huron and Lake Ontario since 1965, coho salmon in Lake Superior and Lake Michigan since 1966, and chinook salmon in Lake Superior and Lake Michigan since 1967. Initial plantings of salmon in 1968 included coho and chinook in Lake Huron and coho in Lake Erie and Lake Ontario.

Lake trout plantings have been carried out cooperatively by the United States Bureau of Sport Fisheries and Wildlife; the States of Michigan, Wisconsin, and Minnesota, and the Province of Ontario. Lake trout eggs are produced by brood fish maintained in hatcheries or inland lakes and virtually all the lake trout are reared to yearlings and planted during the spring and summer. Tables 1 and 2 summarize annual plantings of lake trout in Lake Superior and Lake Michigan and Tables 3 and 4 detail the 1968 plantings in Lake Superior and Lake Michigan, respectively.

Kokanee plantings in Lake Huron and Lake Ontario have been carried out by the Ontario Department of Lands and Forests. They have been planted as eyed eggs, swim-up fry and fingerlings, but eyed-egg plantings were discontinued in Lake Ontario after 1965 and in Lake Huron after 1966. Table 5 summarizes the annual plantings of kokanee in Lakes Huron and Ontario and Table 6 presents in detail the 1968 plantings in these lakes.

Coho plantings in Lakes Superior, Michigan, and Huron have been made mainly by the State of Michigan. The State of Wisconsin introduced coho in their waters of Lake Michigan in 1968. Coho plantings were initiated in Lake Erie in 1965 by the States of Ohio, Pennsylvania, and New York. Coho eggs have been obtained from Alaska, Oregon, Washington, and Lake Michigan parents and chinook eggs from Washington parents. Coho have been planted during the spring as 15-16 month reared yearlings and the chinook during the spring as 4-5 month reared

fingerlings. Table 7 summarizes the annual coho plantings for each lake and Table 8 the chinook plantings.

Table 1. Plantings (in thousands) of lake trout in Lake Superior, 1958-1968.

Year	Michigan	Wisconsin	Minnesota	Ontario	Total
1958	298	184	-	505	987
1959	44	151	-	473	668
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	2,631
1965	827	448	251	468	1,994
1966	2,218	377	257	450	3,302
1967	2,059	244	228	500	3,031
1968	2,260	344	377	500	3,481
Total	11,810	3,820	1,585	5,353	22,568

Table 2. Plantings (in thousands) of lake trout in Lake Michigan, 1965-1968.

Year	Michigan	Wisconsin	Illinois	Indiana	Total
1965	1,059	205	-	-	1,264
1966	956	761	-	-	1,717
1967	1,118	1,129	90	87	2,424
1968	855	817	104	100	1,876
Total	3,988	2,912	194	187	7,281

Table 3. Plantings of lake trout in Lake Superior, 1968.

Location	Numbers	Fin clip
Michigan		
Silver City	105,240	Adipose
Black River Harbor	148,920	"
Eagle Harbor	107,500	"
Huron Bay	159,165	"
Pequaming	108,945	"
Big Traverse Bay	152,215	"
Betsy River	104,145	"
Bette Grise	105,200	"
Big Bay	257,160	"
Loma Farms	200,220	"
Shelter Bay	96,730	"
Grand Island (Munising)	197,065	"
Grand Marais	252,265	"
Pendills Bay	54,995	"
Whitefish Bay	121,530	"
Whitefish Point	89,080	"
Sub-total	2,260,375	
Wisconsin		
Apostle Islands	239,075	Adipose & right pectoral
Apostle Islands (west)	105,290	Left pectoral & left ventral
Sub-total	344,365	
Minnesota		
Knife River to Hovland	223,130	Dorsal & right ventral
" " " "	153,700	Left pectoral & left ventral
Sub-total	376,830	
Ontario		
Cobinosh Isl. to Swede Isl.	236,420	Adipose & left ventral
Shesheeb Bay	13,320	" " " "
Sawpit to Michipicoten Bays	250,000	Adipose & left pectoral
Sub-total	499,740	
Total	3,481,310	

Table 4. Plantings of lake trout in Lake Michigan, 1968.

Location	Numbers	Fin clip
Michigan		
Naubinway	107,410	right ventral
Petoskey	100,300	"
Charlevoix	50,000	"
Leland	58,920	dorsal & right pectoral
Ludington	61,990	"
Frankfort	57,910	"
Grand Traverse (Acme)	90,250	dorsal & left pectoral
" (Bowers Harb.)	87,170	"
Port Sheldon	141,240	adipose
New Buffalo	100,300	"
Sub-total	855,490	
Wisconsin		
Gills Rock	184,250	adipose & both ventrals
Algoma	201,160	left ventral
Kewaunee	238,040	"
Green Bay	193,310	left pectoral & right ventral
Sub-total	816,760	
Indiana		
Bethlehem Steel Pier	100,000	adipose
Illinois		
Great Lakes Naval Dock	103,650	adipose
Total	1,875,900	

Table 5. Plantings (in thousands) of kokanee salmon in Lake Huron and Lake Ontario, 1965-1968

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
Total	1,728	2,680	755	5,163
Lake Ontario				
1965	323	772	2	1,097
1966	-	1,389	-	1,389
1967	-	1,412	-	1,412
1968	-	228	-	228
Total	323	3,801	2	4,126

Table 6. Plantings (in thousands) of kokanee, 1968.

Location	fry	fingerlings
Lake Huron		
Manitou River	35	-
Sauble River	60	-
Saugeen River	90	-
Colpoy Creek	-	7 [1]
Fairs Rock (South Bay)	-	52
Total	185	59
Lake Ontario		
Shelter Valley Creek	228	-

[1] Progeny of Colpoy Creek parents (1967 brood year).

Table 7. Plantings (in thousands) of coho salmon in the Great Lakes, 1966-1968.

Location	1966	1967	1968
Lake Michigan			
Platte River	265	503	308
Bear Creek	395	750	52
Little Manistee River	-	433	148
Thompson Creek	-	46	25
Manistee River	-	-	74
Muskegon River	-	-	220
Pere Marquette River	-	-	98
Brewery Creek	-	-	101
Whitefish River	-	-	100
Porter Creek	-	-	50
Total	660	1,732	1,176
Lake Huron			
Tawas River	-	-	177
Thunder Bay River	-	-	100
AuSable River	-	-	75
Carp River	-	-	50
Total	0	0	402
Lake Superior			
Big Huron River	192	467	-
Presque Isle River	-	-	32
Anna River	-	-	175
Sucker River	-	-	40
Falls Creek	-	-	52
Ontonogan River	-	-	50
Cherry Creek	-	-	25
Total	192	467	373
Lake Erie			
Chagrin River	-	-	30
Pennsylvania (5 small streams)	-	-	86
Cattaragus Creek	-	-	5
Total	0	0	121
Lake Ontario			
Salmon River, New York (spring)	-	-	25
Salmon River, New York (fall)	-	-	15
Total	0	0	40

Table 8. Plantings (in thousands) of chinook salmon in the Great Lakes, 1967-1968.

Location	1967	1968
Lake Michigan		
Little Manistee River	591	322
Muskegon River	211	365
Total	802	687
Lake Superior		
Big Huron River	33	-
Cherry Creek	-	50
Total	33	50
Lake Huron		
Ocqueoc River	-	200
Thunder Bay River	-	65
Total	-	265

APPENDIX C

LAMPREY CONTROL IN THE UNITED STATES

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Bureau of Commercial Fisheries
U. S. Fish and Wildlife Service

Budget restrictions in fiscal year 1968 severely hampered the sea lamprey control program in the first half of 1968. Personnel from the Marquette chemical staff were assigned to barrier operation. The Ludington staff, with assistance from supervisory personnel, was able to complete treatment of 1 large Lake Michigan tributary. The full treatment schedule was resumed in early August and favorable weather late in the fall permitted good progress. Sixteen streams were treated; 2 tributary to Lake Superior, 10 to Lake Michigan, and 4 to Lake Huron (Table 1).

Table 1. Summary of chemical treatments in United States waters of the Great Lakes in 1968.

	Number of streams	Discharge at mouth (cfs)	Stream miles treated	TFM used (pounds)	Bayer 73 used (pounds)
Superior	2	331	97	7,594	6
Michigan	10	3,562	628	64,706	171
Huron	4	401	186	12,118	32
Total	16	4,294	911	84,418	209

The numbers of spawning-run sea lampreys taken at 16 barriers on the U. S. streams of Lake Superior increased considerably. The final count of 7,936 adult sea lampreys at the 16 electric barriers was 4,574 more than in 1967 and was only 633 below the average for the past 6 years (1962-67). The total still is 88% below the peak of 66,701 captured in 1961.

Lake Superior surveys

Forty-three previously treated streams were surveyed in 1968 and sea lamprey ammocetes were found in 25. Populations were relatively large in the Traverse and Bad Rivers; both streams were treated with lampricide. Ammocetes in 22 streams were too few or too small to require immediate treatment. In Harlow Lake, 80 sea lampreys (19-153 mm) were found on the delta at the mouth of Bismark Creek. The delta and adjacent shoreline areas were treated with Bayer 73 granules while TFM was being applied to the lower 100 yards of Bismark Creek. A total of 608 sea lampreys was collected, of which about 15% were 120 mm or longer. No larvae were found in 18 of the streams but surveys of 6 are incomplete. Resurveys of 6 "negative" streams showed no change of status.

Sea lamprey nests were found in 7 of 9 Lake Superior streams examined for spawning in 1968. The number of nests in the Bad River increased to 107 this year compared with 51 in 1967, 38 in 1966, 44 in 1965, and 189 in 1964. Fish Creek in Wisconsin, and the Sucker, Knife, Gooseberry, Split Rock, and Arrowhead Rivers in Minnesota, all contained sea lamprey nests.

Lake Superior chemical treatments

Only 2 of the 4 streams scheduled were treated in 1968. The 2 streams, Bad and Traverse Rivers, were treated for the fourth time at a combined flow of 331 cfs (Table 2). The 2 streams not treated were rescheduled for the fall of 1969. One, the Potato River, is being used for re-establishment studies and treatment was postponed until evidence of metamorphosis is observed. The Big Garlic River will be treated when time permits as part of a study of the age and growth of larvae in this river.

The Bad River was treated on August 29 at approximately half its average discharge. A saving of more than 1,500 pounds of chemical was realized in spite of attenuation of the chemical caused by low water and longer time to death caused by low stream temperatures. The re-established ammocete population was large and many transforming sea lampreys were collected. The fish kill was negligible. Powdered Bayer 73 was applied to oxbow ponds, small tributaries, and other disconnected sections of the Bad River before the main treatment. More than 1,100 larvae were collected from these areas.

Table 2. Details on the application of lampricides to tributaries of Lake Superior in 1968

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm) Minimum effective	Concentration (ppm) Maximum allowable	TFM (pounds)	Bayer 73 (pounds)
Bad River	Aug. 29	300	2.5	6.0	7,335	. . .
Traverse R.	Sept. 25	31	1.5	3.5	259	6
Total	. . .	331	. . .	. . .	7,594	6

The Traverse River was treated on September 25 under nearly ideal conditions. The re-established sea lamprey population was large and 10 transforming sea lampreys were collected. Granular Bayer 73 was applied to a section of the estuary that contained sufficient stored volume to dilute the chemical bank below minimum lethal concentration. Small numbers of 6- to 8-inch white suckers were killed in the estuary.

Lake Superior electric barrier operations

Electric barriers were operated in 1968 on 16 streams tributary to the south shore of Lake Superior from early April to July 13. Conditions for trapping of lampreys and fish were generally good.

The number of spawning migrants increased substantially in 1968; 7,936 lampreys were captured in 1968 compared to 3,362 in 1967 and 4,761 in 1966. The total was still 58,765 below the catch of 1961 before control measures became effective (Table 3). The lamprey migration developed slowly and stabilized between 3 and 5% of the total run per 5-day period during May. The peak of the run came June 5-9 when 24% of the total catch was made. The run again stabilized between 5 and 8% of the total catch per 5-day period until the last week of operation when numbers sharply declined.

The number of sea lampreys captured in weirs east of the Keweenaw Peninsula increased 83% and the number in western streams increased 370% from the catch in 1967. The greatest contributors were the Brule River (33%), Two Hearted River (27%), and the Silver River (13%). Only the catches from the Iron and Amnicon Rivers declined. (The weir in the Ocqueoc River, Lake Huron, captured 3,418 adult sea lampreys compared with 674 in 1967 and 3,272 in 1966.)

The average size of sexually mature sea lampreys collected from 10 index barriers decreased in 1968. The average length

Table 3. Catches of adult sea lampreys for comparable periods from 16 Lake Superior streams, 1957-68.

Stream	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
Betsy River	768	1,061	999	696	1,366	316	444	272	187	65	57	78
Two Hearted River	7,570	3,388	3,950	4,290	7,498	1,757	2,447	1,425	1,265	878	796	2,132
Sucker River	3,496	1,613	2,436	4,683	3,209	474	698	386	532	223	166	658
Miners River	417	94	127	399	220	64	107	74	23	85	75	158
Furnace Creek	246	38	350	2,012	1,012	132	142	93	199	118	119	126
Rock River	2,510	1,403	1,170	2,598	3,660	399	353	229	237	158	439	498
Chocolay River	8,088	6,133	3,486	4,173	4,201	423	358	445	563	260	65	122
Iron River	708	391	250	317	2,430	1,161	110	178	283	491	643	82
Huron River	2,809	3,447	1,408	1,237	4,825	70	201	363	637	8	2	14
Silver River	2,748	2,000	753	1,271	5,052	267	760	593	847	1,010	339	1,032
Sturgeon River	31	28	539	161	427	397	1,445	375	135	259	43	132
Misery River	758	830	2,433	696	962	80	24	12	3	10	26	52
Firesteel River	1,003	1,532	2,044	250	1,118	70	178	327	11	15	9	25
Brule River	[1] 18,453	22,637	19,156	9,539	22,478	2,026	3,418	6,718	6,163	226	364	2,657
Middle River	4,273	4,829	3,598	2,815	3,502	311	48	45	52	17	19	22
Amnicon River	11,024	7,622	968	1,094	4,741	879	131	232	700	938	200	148
Total	50,418	57,046	43,667	36,430	66,701	8,826	10,864	11,767	11,837	4,761	3,362	7,936
Percentage of the 1957-61 mean	99	112	86	72	131	17	21	23	23	9	7	16

[1] Estimate (1958-61 mean).

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Percentage of the 1957-61 mean	99	112	86	72	131	17	21	23	23	9	7	16

[1]Estimate (1958-61 mean).

and weight of the sea lampreys were 16.3 inches and 5.5 ounces in 1968 compared with 16.5 inches and 5.9 ounces in 1967. The 1968 catch contained 32.7% males, the same as 1967.

The number of white suckers handled in 9 representative streams of Lake Superior increased significantly, whereas the number of longnose suckers and large rainbow trout declined. These numbers have fluctuated without trend since the beginning of barrier operation. Sea lamprey wounds were found on 3.2% of the large rainbow trout entering 9 selected Lake Superior tributaries (Table 4). This figure is an increase over 1967, but is still 48% less than the wounding rate in 1961.

Lake Michigan surveys

Surveys were completed on 26 Lake Michigan tributaries scheduled for chemical treatments in 1968 and 1969. Large populations of ammocetes were present in 7 streams; the Whitefish, Boyne, Jordan, Big Manistee, Pere Marquette, White, and Muskegon Rivers. Ammocetes were present in small to moderate numbers in 14 streams and absent from 5. Twenty previously non-productive streams were re-surveyed, and 13 sea lampreys (57-131 mm) including 1 metamorphosing larva were found in Rogers Creek, Van Buren County. A re-survey of the Crow River in Mackinac County confirmed the continued presence of a small population of sea lampreys. The stream has never been treated because of the very small population and the attitude of the landowner.

Surveys of 37 streams treated from 1961 to 1967 showed no re-established sea lampreys in 12 and small to moderate numbers in 22. The Ford, Big Cedar, and Platte Rivers supported sizeable re-established populations.

Lake Michigan chemical treatments

Chemical treatment of Lake Michigan rivers began with the Pere Marquette River on May 12 and continued until October 4. Ten streams with a combined discharge of 3,563 cfs were treated (Table 5). Sea lamprey ammocetes were numerous in all streams except the Little Fishdam River, Valentine Creek, and the Pentwater River. The scarcity of ammocetes in Valentine Creek is attributed to the unsuspected success of a "rained-out" treatment in the fall of 1967. Frequent heavy rains during treatment of the Whitefish River increased the total time of the operation from 2 to 7 weeks. Poor access

Table 4. Percentage of sea lamprey scarring on rainbow trout[1] from tributary streams of Lake Superior, 1961-1968.

[The figures in parentheses indicate the number of rainbow trout examined.]

Stream	1961	1962	1963	1964	1965	1966	1967	1968
Two Hearted River	2.8 (178)	4.6 (217)	1.6 (256)	1.6 (62)	1.4 (279)	0.4 (242)	1.2 (496)	4.3 (369)
Sucker River	2.4 (166)	4.2 (257)	5.6 (179)	3.0 (231)	1.3 (312)	1.4 (290)	1.9 (158)	0.9 (223)
Miners River	18.0 (100)	3.5 (201)	3.3 (90)	5.2 (77)	5.8 (120)	3.0 (164)	1.3 (224)	3.3 (61)
Furnace Creek	13.6 (22)	0.0 (8)	25.0 (4)	12.5 (8)	0.0 (13)	0.0 (14)	2.6 (38)	0.0 (22)
Huron River	11.5 (233)	2.3 (398)	3.4 (291)	2.2 (180)	5.6 (270)	3.8 (421)	2.3 (399)	3.9 (356)
Silver River	4.2 (72)	2.8 (71)	1.8 (56)	9.1 (55)	4.0 (50)	0.0 (42)	6.3 (16)	4.8 (42)
Misery River	3.2 (31)	0.0 (9)	0.0 (13)	0.0 (5)	. . . (0)	0.0 (11)	0.0 (9)	0.0 (5)
Firesteel River	0.0 (114)	0.0 (43)	0.0 (47)	0.0 (18)	0.0 (29)	0.0 (29)	0.0 (17)	0.9 (11)
Brule River	1.2 (82)	2.1 (140)	0.9 (227)	3.4 (177)	4.3 (255)	0.9 (414)	0.0 (271)	2.4 (296)
All streams	6.2 (998)	3.1 (1344)	2.7 (1163)	3.4 (813)	3.2 (1328)	1.8 (1627)	1.4 (1628)	3.2 (1385)

[1]Over 12 inches, total length.

and many beaver dams required the application of such heavy chemical concentrations in 3 tributaries that substantial brook trout mortality resulted. Some mortality to brown trout and rainbow trout occurred during the treatment of the Pere Marquette River. The remnants of a planting of 100,000 coho salmon smolts were in the river, but no mortality of these fish was observed. Fish mortality was low in all other streams.

The Manistee River from Tippy Dam to Manistee Lake was treated with a TFM-0.5B formulation which gave about a 20%

Table 5. Details on the application of lampricides to tributaries of Lake Michigan in 1968.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		TFM (pounds)	Bayer 73 (pounds)
			Minimum effective	Maximum allowable		
Pere Marquette River	May 12	620	5.0	14.0	16,542	. . .
Pentwater River	July 10	72	6.0	16.0	1,764	. . .
Whitefish River	July 31	278	5.0	9.0	13,428	1
Manistee River	Aug. 8	2,215	6.0	14.0	25,909	170
Mile Creek	Aug. 8	3	3.5	5.0	36	. . .
Valentine Creek	Sept. 11	11	2.0	4.0	239	. . .
Little Fishdam River	Sept. 13	14	2.5	6.0	279	. . .
Fishdam River	Sept. 16	49	3.0	6.0	858	. . .
Black River	Oct. 1	30	4.5	9.0	738	. . .
Millecoquin River	Oct. 4	270	4.5	9.0	4,913	. . .
Total	. . .	3,562	. . .	. . .	64,706	171

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Manistee River	Aug. 8	2,215	6.0	14.0	25,909	170
Mile Creek	Aug. 8	3	3.5	5.0	36	...
Valentine Creek	Sept. 11	11	2.0	4.0	239	...
Little Fishdam River	Sept. 13	14	2.5	6.0	279	...
Fishdam River	Sept. 16	49	3.0	6.0	858	...
Black River	Oct. 1	30	4.5	9.0	738	...
Millecoquin River	Oct. 4	270	4.5	9.0	4,913	...
Total	...	3,562	...	...	64,706	171

reduction of chemical cost. Bear Creek, a large tributary, was treated with TFM alone. Numbers of sea lamprey in the main stream were low, but were high in Bear Creek. The treatment of the Millecoquins River included the river below Millecoquins Lake which had not been treated since 1961. Since no re-established sea lampreys were found during pretreatment survey of the lower river in 1964, it was not treated in 1965. A survey in 1968 indicated a sizeable sea lamprey population in tributaries of the lower river. Subsequent treatment collections contained many ammocetes and transforming sea lampreys. Ammocetes in the river above Millecoquins Lake were not as abundant as in previous treatments.

Sampling for newly metamorphosed sea lampreys at the industrial water intake screen on Pere Marquette Lake continued through the year. The catch from July through June for the last 6 years is given below.

Migration period	Total	Migration period	Total
1962-1963	7,936	1965-1966	69
1963-1964	19,800	1966-1967	37
1964-1965	75	1967-1968	120

The Pere Marquette River was treated in May 1964 and again in May 1968. Since the last treatment, only 6 metamorphosed individuals have been captured.

Lake Huron surveys

Surveys of Lake Huron tributaries did not begin until late July. Pretreatment examination was completed on 6 rivers. Four have been treated and 2 are scheduled for 1969. Very large populations of sea lampreys were present in the Ocqueoc, East Au Gres, and Rifle Rivers, a moderate number in the Devils River, and very few in the Black River, Alcona County. Re-establishment surveys of the Pigeon, Sturgeon, and Pine Rivers in the Lower Peninsula of Michigan and the Carp River and Beavertail Creek in the Upper Peninsula disclosed sea lampreys well established again in all but Beavertail Creek.

Lake Huron chemical treatments

Four Lake Huron rivers with a total discharge of 401 cfs were treated in September and October (Table 6). All were initial treatments.

Table 6. Details on the application of lampricides to tributaries of Lake Huron in 1968.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm) Minimum effective	Concentration (ppm) Maximum allowable	TFM (pounds)	Bayer 73 (pounds)
Devils River	Sept. 29	73	7.0	14.0	1,774	...
Black River	Oct. 9	50	11.0	20.0	1,311	...
Ocqueoc R.	Oct. 18	226	5.0	12.0	5,206	32
Au Gres R.	Oct. 31	52	10.0	19.0	3,827	...
Total	...	401	...	...	12,118	32

Sea lampreys were very abundant in the Ocqueoc River from Ocqueoc Lake upstream to Ocqueoc Falls. Only a few large ammocetes and transforming individuals were collected above the falls. Granular Bayer 73 was distributed on the alluvial fan in Ocqueoc Lake. Larval and metamorphosing sea lampreys were so abundant in this delta area that it seems probable that a considerable number of lampreys in Ocqueoc Lake were not affected by the chemical. Fyke nets are being fished below the lake to determine the contribution of this residual population.

Moderate numbers of sea lampreys were present in the Au Gres River and about 60% were transforming. Some brown trout in spawning condition were killed in two tributaries of the upper river. Fish mortality was substantial in the lower half of the river because of the presence of large populations of warmwater species and variable water temperatures.

Re-establishment in treated streams

Re-established populations of sea lampreys were present in 32 streams of Lake Superior in 1968. The 1963 year class was present in 2 streams, the 1964 year class in 4, the 1965 year class in 6, the 1966 year class in 10, the 1967 year class in 24, and the 1968 year class in 13 (surveys for the 1968 year class are incomplete).

The growth rate of re-established sea lamprey larvae is being monitored in 3 Lake Superior streams where age groups

are distinct due to rapid growth or the absence of some year classes. Considerable variation in growth of larvae exists among the 3 streams. The mean length (104 mm) and range of lengths (85-165 mm) of the V-group ammocetes in the Mosquito River were similar to the V-group ammocetes of known age in the Big Garlic River. Although some of the ammocetes were in the length range at which metamorphosis takes place, no metamorphosed sea lampreys were found. The III-group ammocetes collected in the Waiska River had a mean length of 95 mm (range, 73-140 mm). Ammocetes in the Potato River, a small stream (summer flow, 4 cfs) in Ontonagon County, grew at one of the fastest rates observed in Lake Superior tributaries. The mean length of the III-group larvae in August was 139 mm (range, 113-166 mm). TFM and granular Bayer 73 were used in the estuary and electric shockers in the main stream to recover ammocetes. Although the ammocetes were unusually long, no metamorphosing lampreys were captured.

Collections of larvae from the Sturgeon River, Baraga County, indicate that sea lampreys may metamorphose within 2 years. To provide more accurate information on the length of larval life in the Sturgeon River, 897 sea lampreys (range, 41-88 mm long) of the 1967 year class were captured, marked and released in the river. A section of the river is scheduled for chemical treatment in 1969 to determine whether some of the marked larvae will metamorphose at age II. Eight fyke nets fished at 4 locations for 20 days in October and November in the Sturgeon River caught 1 metamorphosed sea lamprey. Last year, no transformed sea lampreys were collected in the fyke nets.

Nearly all of the sea lampreys collected above Ocqueoc Falls during the chemical treatment of the Ocqueoc River were over 100 mm long, indicating no recruitment to this area for several years. The sex of ammocetes and recently metamorphosed sea lampreys above Ocqueoc Falls was predominately female. The percentage of females was 76 for the larvae and 82 for recently metamorphosed lampreys. Downstream from the falls where all lengths of ammocetes were collected, the sexes of larvae and recently metamorphosed sea lampreys were more equally represented; females composed 55% of the larvae and 48% of the transformed sea lampreys. This information suggests that male sea lampreys may metamorphose at a younger age than females or that differential mortality exists between the sexes.

A total of 154 recently metamorphosed sea lampreys was recovered in the chemical treatment of the Bad River. Data

from re-establishment surveys and chemical treatments indicate that probably a substantial number of the metamorphosed lampreys were age-group III. Most of the young parasitic-phase lampreys fell within the range of lengths of the age-III larvae.

Age and growth of sea lampreys

The known-age sea lampreys established in the Big Garlic River in 1960 metamorphosed for the fourth consecutive year. The all-season trap captured 370 metamorphosed lampreys in 1968; of these, 8 were taken in the spring compared with 2 in 1967. The trap captured 223 young adults in 1967, 44 in 1966, and 4 in 1965. The parasitic lampreys ranged from 123 to 174 mm long and averaged 145 mm long. The females average 145 mm and the males 142 mm long. The percentage of males was 31% in 1968 compared with 40% in 1967 and 51% in 1966. Movement of ammocetes to the trap increased substantially over the previous high of 1966. The trap captured 11,168 larvae in 1968 and 7,925 in 1966.

A total of 560 ammocetes and 3 metamorphosed lampreys was collected with an electric shocker in October for annual growth studies (Table 7). The ammocetes averaged 112 mm long (range, 72-158 mm); the mean length decreased 1 mm from 1967.

Table 7. Growth of 1960 year class of ammocetes in the Big Garlic River to October 1968.

Year	Mean length (mm)	Length range (mm)	Length increment (mm)
1960	13	10- 19	13
1961	39	25- 54	26
1962	63	37-107	24
1963	80	52-134	17
1964	92	43-159	12
1965	107	65-176	15
1966	111	67-179	4
1967	113	72-165	2
1968	112	72-158	-1

A total of 551 larvae ranging from 127 to 170 mm long (average, 138 mm) was marked this year bringing the total number of marked animals returned to the study area to 10,557. The large ammocetes were marked to determine the percentage transformation of this group. Of the 551 marked larvae released in the spring, 101 (18%) metamorphosed and comprised 28% of the transformed lampreys captured on the trap.

Adult sea lampreys bypassed the downstream trap in 1967 through a channel opened by flood water. Upstream migration of these lampreys was limited by a natural barrier to the lower 1-1/2 miles of the 5-mile study area. The mean length of the ammocetes established in 1967 is 33 mm (range, 22-42 mm). The ammocetes established in 1960 in the same area had a mean length of 34 mm as age-group I (range, 28-41 mm). The length of the longest larva (42 mm) of the 1967 year class is separated from the length of the smallest ammocete (72 mm) of the 1960 year class by 30 mm.

A fyke net was installed above the incline trap in the Big Garlic River on October 29, 1968, and fished until November 20, 1968. A total of 144 recently metamorphosed lampreys captured on the downstream trap was fin clipped and released 1-1/2 miles upstream to determine the efficiency of the fyke net. The fyke net captured 20 (30%) of the 67 marked lampreys migrating downstream.

Lamprey population assessments

Assessment surveys were completed on 27 of the 30 index streams tributary to Lakes Superior, Michigan, and Huron. High water and lack of time prevented surveys on 3 streams.

Sea lamprey abundance in 1968, as indicated by the number of larvae recovered per hour of shocking, increased in 21 streams, decreased in 5, and remained the same in 1. Although the higher recovery rates undoubtedly reflect the growth of re-established populations in most streams, the use of a more effective shocking unit may have significantly increased the catch on some streams. Two of the 5 streams that showed a decline in the catch per unit of effort had been treated shortly after the 1967 surveys. Poor survey conditions and inexperienced personnel may have contributed to the decline on the other 3. The 1 stream (Sucker River) that showed no change in recovery rates has been treated every other year.

Research and development of control methods

The search for new and more efficient lampricides continued on a limited basis during 1968; approximately 100 compounds were screened. Most of these were related to compounds tested previously and none demonstrated any real promise as replacements or supplements to the materials presently used in sea lamprey control.

The search for an irritant to cause emergence of larval lampreys for use in surveys also has continued. The only materials evaluated to date have been chemicals tested previously as potential larvicides; none have shown promise as irritants. The test procedure is being altered somewhat so that selected chemicals can be evaluated with greater definition as potential irritants.

Bioassays with rubber pellets impregnated with Bayer 73 were conducted in 1968. The high application rates required to kill lamprey larvae indicated that this material, in its present form, would not be practical as either an irritant or as a bottom-type lampricide.

Comparative bioassays with Pro-noxfish (synergized rotenone) and Bayer 73 were made on young-of-the-year carp and larval sea lampreys. This study was designed to provide toxicity data for possible future use in the sea lamprey control program and particularly for treatments that might be coordinated with state-planned projects for rough fish removal. The bioassays showed that stream treatments with Bayer 73 should eliminate carp and larval sea lampreys but that treatments with Pro-noxfish, designed specifically for the control of carp, would have little effect on larval lampreys.

Flowing-water raceway tests were conducted to obtain toxicity indices on chinook salmon "jacks" and full-term coho salmon. Both species were captured during their upstream migration in the Little Manistee River in October 1968. The fish were exposed to a series of concentrations of TFM and a synergistic mixture containing 99% TFM and 1% Bayer 73 (TFM-1B). The salmon proved to be more tolerant of TFM-1B than of TFM alone, but chemical treatments with either toxicant should not coincide with runs of jack chinook salmon. Adult coho salmon were generally tolerant of TFM and of the synergistic mixture; no serious mortality of mature coho salmon should be expected from stream treatments.

Fingerling chinook salmon tested in standard bioassays in three representative waters were relatively tolerant of TFM and several synergistic mixtures. Their response was similar to that of fingerling rainbow trout and coho salmon tested earlier.

Lamprey biology

Physiology. Investigation of factors which may trigger or influence metamorphosis of sea lampreys has continued. Other investigations have showed that tadpoles exposed to L-thyroxine

at low temperatures begin metamorphosis when the temperature is raised. A similar study was initiated with sea lamprey larvae.

Fifteen groups of 10 animals each were exposed to low concentrations of L-thyroxine and subjected to a temperature change from 41° F to 68° F. None of the larvae have exhibited any external signs of metamorphosis. Electrophoretic separations of hemoglobins of the exposed animals are being compared with those of control animals at 10-day intervals to detect changes which may reflect the onset of metamorphosis.

Physiological effects of larvicides. To understand better the physiological effects of TFM and Bayer 73, experiments were conducted to measure their effect on oxygen consumption rates of larval and metamorphosed sea lampreys and rainbow trout. Measurements of oxygen uptake were made with a galvanic oxygen analyzer in a specially constructed sealed reaction chamber. The test animals were exposed to concentrations of TFM and Bayer 73 known to be nontoxic in oxygen-saturated water. These lampricides, when introduced into the reaction chamber, caused an increase in oxygen uptake by lampreys but not by rainbow trout. This preliminary information suggests a differential influence of the chemicals on the metabolic processes of the two species. The data also indicate that less lampricide is required in stream treatments where dissolved oxygen levels are below those in the standard pretreatment bioassays.

Downstream migration of lampreys in the Ocqueoc River.--Fyke nets fished continuously in the Ocqueoc River for the past 6 years have provided specimens for use in the laboratory and have yielded information on the characteristics and magnitude of the downstream migration of recently metamorphosed sea lampreys. The nets have also provided preliminary information on the effectiveness of the chemical treatment of the river on October 19, 1968.

The characteristics of the 1968 spring and fall migrations were similar to those observed in previous years: Catches were relatively small during winter and were largest in March and April at periods of high water levels and water temperatures between 33° F and 50° F. The catches were low in summer but again increased during November and December when water temperatures dropped below 44° F and water levels increased.

Although the biological characteristics of sea lampreys in the fall run in 1968 were similar to those of lampreys in fall runs of previous years, the size of the run was considerably

smaller due to the chemical treatment of the stream in October. In a single index net fished continuously in the same location since 1963-64, the catch in this index net was 3,373 in 1963-64; 1,174 in 1964-65 (the net was lost during extremely high water in the spring); 3,913 in 1965-66; 3,248 in 1966-67; 3,363 in 1967-68; and 379 for the first half of 1968-69. On the basis of earlier catches it appears that the treatment was somewhat less than 90% effective.

Population estimates, based on mark-recapture studies, were 42,005 in 1963-64; 56,958 in 1965-66; 80,396 in 1966-67; and 70,651 in 1967-68. During 1963-68, 32 groups of marked lampreys were released. The percentage recaptured from these groups varied from 1 to 12% (due primarily to changing water levels) and averaged 5.6%. In 1968, one group of transforming sea lampreys was marked and released after the stream treatment about 2 miles above Ocqueoc Lake. By December 31, 6% of the marked animals had been recaptured and the estimate of the downstream migration had reached 6,317.

To attempt to determine the source of the metamorphosing sea lampreys in 1968, fyke nets were placed in the river about 100 yards upstream from Ocqueoc Lake from October 29 to December 12 (when the river froze over) and in Orchard Creek (a small tributary of Ocqueoc Lake) from December 3 to December 13. No unmarked lampreys were captured at either location. The capture in the nets in the Ocqueoc River above the lake of 8% of the ammocetes marked in the fall, indicates that the nets were fishing efficiently.

On the basis of these tests, most, if not all, of the transforming sea lampreys captured below the lake must have been in the lake before the treatment, or escaped to the lake before they received a lethal dose during the treatment. It appears that the treatment of the river above the lake was possibly 100% effective. If so, data from one more year should indicate if metamorphosis is taking place in the lake.

Feeding study of parasitic lampreys. Size at metamorphosis has no apparent effect on the feeding ability, growth, or mortality of aquarium-held adult sea lampreys. The averages and ranges of lengths and weights of the survivors in three size groups (125-130 mm; 150-155 mm; and 175-180 mm at transformation) feeding on longnose suckers are now nearly identical. Mortality has ranged from 53.3% in the 125-130 mm group to 70% in the 150-155 mm group.

The feeding efficiency (grams of fish killed per gram of lamprey growth) was highest for the small lampreys. Feeding efficiency steadily decreased with the increase in size of the lampreys.

The growth, mortality, and feeding ability and efficiency of lampreys (150-155 mm) feeding on white suckers were nearly identical to those feeding on longnose suckers. The cause of the total mortality of lampreys (150-155 mm) feeding on rainbow trout has yet to be determined.

APPENDIX D

LAMPREY CONTROL IN CANADA

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This review summarizes the report of activities of the Sea Lamprey Control Station at Sault Ste. Marie, Ontario, for the period April 1, 1968 to March 31, 1969, while acting as agent for the Great Lakes Fishery Commission.

Electrical barrier operations

The numbers of sea lampreys which have been caught at Lake Huron assessment barriers each year during comparable periods of operation are shown in Table 1. Catches are grouped by the natural divisions of Lake Huron; the North Channel (3 barriers), Georgian Bay (3 barriers), and the main basin (4 barriers). Of the 10 barriers that are now in operation, only 1, on the Ocqueoc River in the United States, was in existence prior to 1965 - 3 were operated in 1965, 7 in 1966, and 10 in 1967 and 1968. For the North Channel prior to 1966 and for Georgian Bay prior to 1965 there are no data with which to compare recent barrier catches.

Two of the three North Channel barriers have taken decreasing numbers of sea lampreys in their first 3 years of operation. The contributions of the Kaskawong, although greater in 1968 than in 1967, did not mask the downward trend in the North Channel as a whole. Two Georgian Bay barriers on the Still and Naiscoot-Harris have on the other hand caught increasing numbers of sea lampreys in each succeeding year. The contributions from the Mad River have been relatively constant, and small in comparison with those of the other two barriers. In the main basin of Lake Huron, the barrier on the Ocqueoc River, which is operated by the U. S. Bureau of Commercial Fisheries, has shown no trend in catch during the last 4 years. Of interest are the changes at the Bayfield barrier which are

Table 1. Numbers of sea lampreys taken at Lake Huron electrical assessment barriers from 1965 to 1968 for comparable periods.

Streams	Count for the season			
	1965	1966	1967	1968
North Channel Area				
Echo		526	458	195
Two Tree		20	22	6
Kaskawong			82	239
Totals		546	562	440
Georgian Bay Area				
Still	344	1,820	1,839	6,154
Naiscoot-Harris	593	968	1,635	1,336
Mad		324	333	413
Totals	937	3,112	3,807	7,903
Lake Huron Area				
Manitou			637	597
Blue Jay			957	1,807
Bayfield		443	789	191
Ocqueoc[1]	1,390	3,272	674	3,418
Totals	1,390	3,715	3,057	6,013
GRAND TOTALS	2,327	7,373	7,426	14,356

[1]U. S. assessment barrier.

in the opposite direction to those at the Ocqueoc barrier. Although the barriers on the Manitou and Blue Jay have only been in operation for 2 full seasons, their combined catch in 1968 was greater than in 1967, as was that of the Ocqueoc. The barrier catches in the main basin suggest that the sea lamprey using the 3 northern streams and those using the single southern stream represent partially independent populations. Several more years of comparable data collections are necessary to substantiate this hypothesis.

Surveys

No sea lampreys were found in re-establishment surveys conducted on 8 Lake Superior streams previously treated. Surveys for evidence of sea lamprey transformation were performed on 3 rivers known to have re-established populations

of larvae--the Nipigon, Jackfish, and Kaministikwia--with negative results. No lampreys were found in routine surveys of 10 streams in which sea lampreys have never been found.

On Lake Huron, surveys were confined to Georgian Bay with the exception of the Echo River near Sault Ste. Marie. Twenty-seven rivers in Georgian Bay were surveyed and sea lampreys found for the first time in the Wanapitei and Muskoka Rivers, both having relatively large discharges.

Lamprey attacks on fish occur in Lake Nipissing, one of the largest lakes in Ontario aside from the Great Lakes. Adult silver lampreys have been collected, but rumors of predation by sea lampreys have not been substantiated to date by specimens.

Lampricide treatments

Since 1958, 106 stream treatments with lampricide have been performed on 38 tributaries on the Canadian side of Lake Superior. Of the 38 original sea lamprey streams, only 20, with an aggregate flow of 4,425 cfs, require, at the present, treatment on a regular schedule. Six streams, with a total flow of 8,200 cfs, having large complex watersheds and low lamprey populations, will be treated following collection of newly metamorphosed sea lampreys. Six streams, with a total flow of 555 cfs, in which lampreys were scarce in the original treatment and apparently have not become re-established, and 6 streams with a total flow of 430 cfs, in which sea lampreys were not found during the last application of lampricide, will probably never require additional treatments. Of the 10 streams scheduled for treatment during 1968, only 7 were completed. Three streams--the Kaministikwia, Jackfish and Pigeon--were not treated because of adverse conditions in the Jackfish, lack of ammocetes in the Pigeon and lack of newly metamorphosed animals in the Kaministikwia.

The estuaries of the Batchawana, Chippewa and Sable Rivers and adjacent areas of Batchawana Bay were treated with granular Bayer 73, while the main sections of these streams were treated with TFM. The small size of ammocetes found in the Bay suggests that migration of larvae from the streams occurs early in life and that these rivers will require treatment each year.

In a continuing effort to reduce ammocete populations in Batchawana Bay, 16 small streams were treated in October using TFM and granular Bayer 73. Five streams were found to harbor limited populations of sea lamprey ammocetes. The

program was extended to Goulais Bay and the peninsula between Goulais and Batchawana Bays, where 7 streams were treated for the first time with negative results.

All 11 streams scheduled for treatment in Lake Huron were completed, except for some remote sections of the Echo River. Solar Lake, in the upper Echo River system, was found to contain an abundant population of lampreys around its shoreline and will be treated with granular Bayer 73 applied by aircraft.

Use of Bayluscide

Bayluscide (Bayer 73) was first introduced into the lamprey control program in Canada in 1963 when it was used to synergize the lampricide TFM in the White, Big Pic, and Michipicoten River treatments. Since that time, it has been used in most treatments on the Canadian side of Lake Superior at a rate of 2 percent by weight of the TFM, and has generally reduced the amount of TFM required by 50 percent.

The heavy-granule formulation of Bayluscide (granular Bayer 73) has been tested and is particularly effective as a survey tool, especially in streams which are deep, turbid, or have a low electrical conductivity. It has been used extensively in treating estuarine and lacustrine areas and has proven more effective than the TFM which dissipates rapidly in the lake. The heavy granule quickly reaches the bottom as revealed by subsequent lamprey movement. In deeper water, some of these lampreys swim to the surface where they can be collected. Use of the granular material has also overcome the effect of thermal stratification in both river and estuarine areas by sinking through the thermal barrier to the sediments where some larvae are located. These larvae are not exposed to the TFM dissolved in the overlying warmer stream water. There have been fish kills with the granular material in the shallow water because of the high concentrations developed; other fish kills have been caused by drifting chemical in the form of a dust. The latter problem may be overcome by better quality control during manufacture.

Trawling for adult sea lampreys

Trawling for adult sea lampreys in the St. Marys River has been carried on each fall since 1963. Data on lamprey catch per hour of trawling are available for 1966, 1967, and 1968. Two aluminum-hulled cruisers, each approximately 18 feet long, and powered with twin 33 h. p. outboard motors,

towed modified beam trawls made of one-half inch square mesh netting hung on a pipe frame having an 8 ft. by 4 ft. opening. The cod ends were made of knitted nylon with quarter inch openings. The nets were towed at the surface in the propeller wash about 10 to 12 feet behind the transoms. The area fished was usually in front of the Edison Sault Electric Company plant at Sault Ste. Marie, Michigan, about one mile below the American locks.

The average catch per hour of trawling in 1968 (Figure 1) was 47 percent of that in 1967 and 23 percent of the 1966 figure. The possibility that this apparent reduction in the numbers of sea lampreys in the St. Marys River resulted from a relocation of the center of abundance was investigated in 1967 and 1968 by trawling in areas other than at the Edison Electric Company plant. Catches in these areas were either nil or very small. Apparently the decrease in catch per hour in the past 2 years reflects a decrease in the number of sea lamprey which enter the area in the fall. This decrease is, in turn, probably due to sea lamprey control measures carried out since 1966 in the North Channel.

The catch per hour during 1968, while much lower than that in 1966 or 1967, displayed comparable seasonal trends (Figure 1). The maxima reached in late October to early November in all years coincided with rapidly declining water temperatures in the interval between 50° and 45° F. After mid-November, the catch per hour has decreased.

Of the 278 sea lampreys tagged and released in 1968, 22 were recaptured in trawls and released again in the St. Marys River. To date, 8 have been recaptured in commercial fishing gear, one in Lake Superior and 7 in Lake Huron. In 1967, 689 sea lampreys were tagged and released, 315 were recaptured and again released in the St. Marys River. Sixteen were caught elsewhere, 4 in Lake Superior and 12 in Lake Huron. In 1966, 785 sea lampreys tagged by Canadian and United States crews were released in St. Marys River. Thirty-three were subsequently recaptured, 14 in the river itself, 18 in Lake Huron, and 1 in Lake Superior.

This local and temporary accumulation of sea lampreys in the St. Marys River and their eventual dispersal appears to be a consistent part of a migratory pattern. The nearby spawning streams of Lakes Superior and Huron are probably the ultimate destinations of most of these lampreys since tagged individuals have been taken at electrical barriers on the Echo and Kaskawong Rivers and by commercial fishermen in Whitefish Bay, North Channel, and the waters around Manitoulin Island.

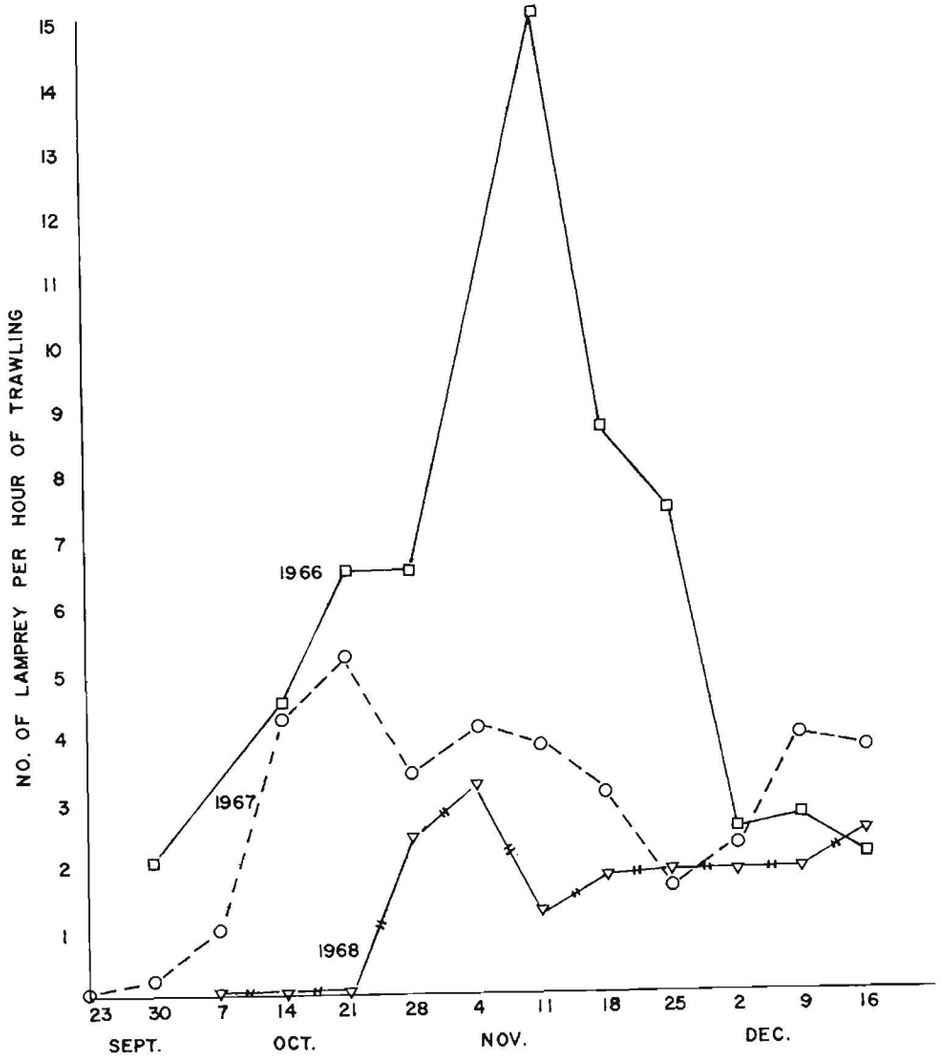

Figure 1. Catch of sea lamprey per hour by trawling in the St. Marys River, 1966-68.

The origin of the St. Marys River sea lampreys is probably in the same areas. Their abundance in St. Marys River should, therefore, be related to the numbers of predatory sea lampreys present in these same areas during the summer and early fall months, and to the numbers of spawning adults in the following spring.

As suggested by the returns of tagged specimens, sea lampreys in St. Marys River below the locks can and do move into Lake Superior, as well as into Lake Huron. The numbers of tag returns do not, however, permit an estimate of the relative numbers in the population that move in these directions. The period during which most of these tagged lampreys are at large (October to June) coincides with the period when commercial fishing effort is at a minimum and, therefore, the chance of recapture is low. It is doubtful, therefore, that the continued release of tagged sea lampreys can yield any more information than is now available.

In the past 3 years, the St. Marys River sea lamprey populations have declined about 75 percent. If the trend continues, fewer lampreys will be available for tagging in 1969. It is our belief that a continuation of the tagging program would be not only unproductive of information, but contrary to wise practice in sea lamprey control. It is, therefore, planned to stop releasing tagged lampreys in the St. Marys River and use the animals taken by trawling for biological studies. The trawling project will be continued, possibly on a reduced schedule, in order to maintain surveillance of the St. Marys River sea lamprey population.

Adult sea lampreys collected from commercial fishermen

Adult sea lampreys are often caught by commercial fishermen in the Great Lakes, either attached to fish or entangled in the nets. In order to take advantage of this potential source of data, the Sea Lamprey Control Station offered a reward, starting in July 1967, to commercial fishermen, for adult sea lampreys caught in commercial fishing gear together with information as to their place, date, and method of capture. It was expected that information collected over a period of years would be useful in planning sea lamprey control measures for maximum effectiveness and would aid in interpreting evidence of changes in lamprey abundance. Some preliminary observations on the characteristics of the population of sea lampreys associated with the commercial fishery can be made at this time.

In something less than 2 full fishing seasons commercial fishermen on the Canadian side of the Great Lakes have sent in nearly 5,500 sea lampreys, together with useful catch records. Most of the specimens in both years came from Lake Huron, and of these, the majority were caught in the main basin. Lesser numbers were taken from the North Channel and from Georgian Bay. These sea lampreys were taken with whitefish caught in pound nets and large mesh gillnets over 3-1/2", or with chubs caught in small mesh gillnets. Fairly large numbers of sea lampreys were also sent by fishermen from Lake Ontario. These specimens were from a mixed fishery, mainly for coarse species, in the open lake south of Prince Edward County. Relatively small numbers of sea lampreys came from Lake Superior in both years. Upon arrival at the laboratory, the formalin-preserved specimens were weighed, measured, and the sex, maturity, and condition of the stomachs were determined. Information on fishing effort was obtained from the Ontario Department of Lands and Forests.

Figure 2 shows the numbers of sea lampreys caught per 1,000 yards of gillnet for each month of the fishery season in the main basin of Lake Huron, the North Channel, Georgian Bay, and Lake Ontario. Typically the catch per unit of effort (CPE) has risen in the fall and fallen again in early winter. In both Lake Huron proper and the North Channel, the catch per unit of effort was higher in 1967 than 1968. The annual averages for Lake Huron proper were 0.9 and 0.4 lampreys per 1,000 yards respectively, and for North Channel 0.4 and 0.1 respectively. Pound net catches of sea lampreys per lift, were also higher during 1967 than in 1968 for Lake Huron proper.

In Georgian Bay, on the other hand, the sea lamprey catch per 1,000 yards of gillnet was higher in 1968 than 1967. The Lake Ontario fishery took an average of 0.5 sea lampreys per hour in 1968.

There is reason to believe that the lower CPE in the North Channel compared to that in the main basin of Lake Huron in both 1967 and 1968 reflects a real difference in the abundance of sea lampreys in these areas. The lamprey producing streams flowing into the North Channel were treated with lampricide in 1966 and 1967, while none of the streams flowing into the main basin have yet been treated.

Trends in sex ratios, averaged at monthly intervals, for sea lampreys caught in Lake Huron proper, North Channel, Georgian Bay, and Lake Ontario showed general similarities.

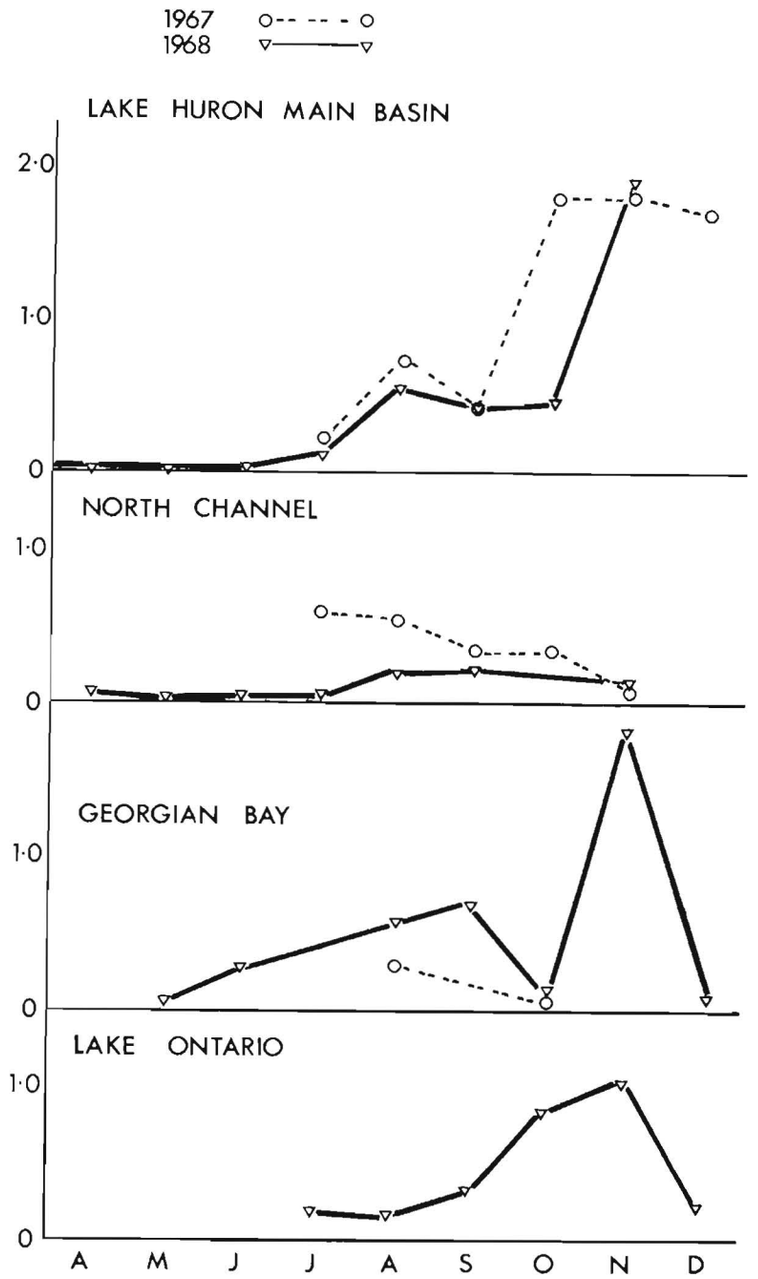

Figure 2. Catch of sea lamprey per 1,000 yards of gillnet.

By October, in both years, male sea lampreys had virtually disappeared from all of the commercial fisheries sampled. Eight hundred specimens collected by the Fisheries Research Board of Canada from Lake Superior in the years from 1957 to 1967, inclusive, also showed a predominance of females among sea lampreys caught by commercial fishing gear in the fall of each year. This apparently widespread and consistent sex segregation of sea lampreys, in the second half of the parasitic phase, cannot be fully explained; but, it is notable that, of the few male sea lampreys encountered in the fall, most came from inshore sets of fishing gear.

Segregation of the sexes may occur to a lesser degree at other times of the year than the fall and the actual sex ratio of the parasitic populations may be very difficult to determine. Any estimate of sea lamprey abundance based on their capture by the commercial fishery should be weighted in order to compensate for sex segregation. This weighting is complicated by the fact the sex ratio of spawning sea lamprey taken by electrical barriers is variable. In Lake Huron, in 1967, there were 90 males per 100 females while in 1968 there were 60 males per 100 females.

Sea lamprey associated with chubs, although smaller than those associated with whitefish at any particular time, showed the same growth rates throughout the season. There is no evidence of a change of host suggesting that size of sea lamprey is largely based on a lasting association with a host species established early in the parent stage.

Lampreys collected in the Humber River

Approximately 1,200 spawning-phase sea lampreys were collected from the Humber River of Lake Ontario. The lampreys were caught by hand or in a dip net by an individual under contract. Apparently lampreys have not had spawning success in the Humber River since only one sea lamprey ammocete has been found in it.

APPENDIX E

ADMINISTRATIVE REPORT FOR 1968

Meetings. The Commission held its 1968 Annual Meeting in Toronto, Ontario, June 18-20, and its Interim Meeting in Ann Arbor, December 3-4. Meetings of committees held prior to the Annual Meeting were as follows:

Lake Erie Committee, Erie, Pennsylvania, March 5-6
Lake Huron Committee, Milwaukee, Wisconsin, March 19.
Lake Superior Committee, Milwaukee, Wisconsin, March 20.
Lake Michigan Committee, Milwaukee, Wisconsin, March 21.
Lake Ontario Committee, Glenora, Ontario, March 26-27.
Sea Lamprey Control and Research Committee, Ann Arbor, April 2.

Officers and staff. At the close of the 1968 Annual Meeting, the Commission elected Mr. L. P. Voigt, Chairman and Dr. A. L. Pritchard, Vice-Chairman.

At the Interim Meeting, the Commission approved the assignment of its members to various committees as follows:

Sea Lamprey Control and Research Committee

C. H. D. Clarke, Chairman
W. M. Lawrence

Management and Research Committee

E. W. Burridge, Chairman
Claude Ver Duin

Scientific Advisory Committee

C. F. Pautzke, Chairman
A. L. Pritchard

Finance and Administration Committee

L. P. Voigt, Chairman
A. O. Blackhurst

The Commission also called for a review and re-statement of committee functions by the Chairman and Executive Secretary.

There were no changes in staff during 1968.

Staff activities. The staff spent considerable time arranging meetings of the Commission and its various committees, drafting agendas, requesting presentation of information, and preparing and distributing records of the proceedings.

Although the two professional members of the Commission staff share administrative duties, there is a division of program responsibilities. The Executive Secretary is concerned primarily with the sea lamprey program and fishery programs in the two lower lakes. The Assistant Executive Secretary is mainly concerned with the lake trout restoration and fishery programs in the Upper Great Lakes.

Much of the Executive Secretary's time in 1968 was spent in drafting and revising sea lamprey programs with the agents' assistance, preparing justifications, and providing briefing material for budget hearings. In the latter connection, he attended a meeting of Fishery Commission Directors held by the U. S. Department of State in May, 1968. Budget officials present at the meeting made general suggestions for improving justifications and gave their assessment of the "budget climate" for fiscal year 1969.

The Executive Secretary was also called on to resolve some editorial problems with a report on the ecology and management of the walleye in western Lake Erie, the outcome of a study sponsored by the Commission. The re-organization of the report and the revision of several sections took the better part of a month.

In 1969, the Executive Secretary was asked to serve as Secretary of the recently formed International Association for Great Lakes Research, an interdisciplinary organization formed to promote Great Lakes Research through regular annual conferences and publication of proceedings.

The Assistant Executive Secretary spent considerable time promoting and expediting cooperation among fishery agencies carrying out management and research programs on the Great Lakes. This work was accomplished mainly through correspondence, meetings, and personal visits with scientists and administrators of the agencies concerned. As a result of these activities a systematic cooperative sampling program was developed for Lake Michigan which was accepted by state and federal agencies.

The Assistant Executive Secretary continued to coordinate the lake rehabilitation programs which involve large plantings of salmonid species by state, provincial, and federal agencies. Plans were prepared in cooperation with federal, state, and provincial agencies for the maintenance of brood stocks and the distribution of lake trout eggs and fry for rearing. Lake trout planting rates and locations were determined in cooperation with biologists studying the fishery to assure that the fish were placed in areas where they would have the best opportunities for survival and reproduction. Fin clips were assigned to fishery agencies to evaluate experimental plantings of lake trout, coho, and chinook salmon and rainbow, brook, and brown trout.

The Assistant Executive Secretary served as chairman of a subcommittee established by the Great Lakes Basin Commission to analyze fishery programs on the Great Lakes and review current plans for their management. He also participated in several conferences and meetings with State officials, local citizen groups, Great Lakes Basin Commission, Great Lakes Commission, and the Michigan Fish Producers Association.

Accounts and audit. The Commission's accounts for the fiscal year ending June 30, 1968 were audited by Icerman, Johnson, and Hoffman of Ann Arbor. The firm's report is appended.

Contributions in fiscal year 1968. At its 1966 Annual Meeting, the Commission adopted a sea lamprey control and research program for fiscal year 1968 estimated to cost $1,785,000 and an administrative and general research budget of $56,300. Several revisions were required to remain within budget limits set by the United States contribution (see 1967 Annual Report), which led ultimately to suspension of stream treatments on the United States shore of Lake Huron.

Requests for funds, contributions, and credits for fiscal year 1968 were as follows:

	United States	*Canada*	*Total*
Sea Lamprey Control and Research			
Commission request	$1,231,950	$553,450	$1,785,400
Appropriation	973,650	437,450	1,411,100
Credits from fiscal year 1966	2,616	1,177	3,793
	$ 971,034	$436,273	$1,407,207
Administration and General Research			
Commission request	$ 28,150	$ 28,150	$ 56,300
Appropriation	28,150	$ 28,149	$ 56,299

Expenditures in fiscal year 1968. Lamprey control and research in fiscal year 1968 was carried out under agreements with the U. S. Bureau of Commercial Fisheries ($759,400) and the Department of Fisheries of Canada ($434,444).[1] In January, 1968, the Commission increased the amount paid to the Bureau to $793,400 enabling it to meet unexpected increases in salaries and other costs.

The Bureau treated 10 of the 13 Lake Superior streams specified in the Memorandum of Agreement and 2 other streams which were found to contain young lamprey approaching transformation. The 3 streams which were not treated were found not to contain sea lamprey larvae. Survey crews re-examined 36 Lake Superior streams. Assessment barriers were operated on 16 lamprey streams on Lake Superior and 1 on Lake Huron during the 1968 spawning runs.

On Lake Michigan, 8 of the 11 streams specified in the Agreement were treated and 1 stream which was not specified was also treated. Two small streams on Green Bay did not contain larvae and were not treated as first proposed. The Manistee River treatment was postponed until the first half of fiscal year 1969 because of high water.

Laboratory research at Hammond Bay was carried out as proposed in the Agreement. The 3 field studies on lamprey population assessment, re-establishment of larvae, and age and growth of larvae were continued.

After a final accounting had been made, the Bureau returned $12,268 in unexpended funds to the Commission.[2]

In Canada, the Department of Fisheries treated 6 of the streams mentioned in the Agreement omitting 2 which did not contain larvae. The lower sections and estuaries of 3 other streams were treated with granular Bayer 73. Nineteen streams were re-surveyed and the estuaries of 2 streams checked with granular Bayer 73. Lamprey assessment barriers were operated during the 1967 lamprey spawning run on 8 Lake Superior streams.

On Lake Huron, the 12 lamprey streams scheduled were treated except for sections of the Echo River which required special treatment with granular Bayer 73. One stream on the north shore of Manitoulin Island, not mentioned in the Agreement, was treated thereby completing the work on the North Channel. Surveys were carried out on the Nottawasaga, Saugeen, and Bayfield Rivers. Assessment barriers were operated on 9 Canadian streams during the 1967 spawning run as mentioned

[1] $469,200 Canadian funds.

[2] $8,084 in January, 1969 and $4,184 in August, 1969.

in the Agreement. At the end of fiscal year 1968, the Department refunded $31,520 which was used to purchase lampricide.

The Commission purchased 86,749 lbs. of TFM @ $2.55 per pound from subsidiaries of Farbewerke Hoechst which submitted the low bid of the two received. The American Hoechst Corporation supplied 56,166 pounds for use in the United States and Hoechst Chemicals 30,583 for use in Canada. The Haviland Chemical Company, agent for the Chemagro Corporation, provided 497 pounds of Bayer 73 in the powder form to synergize TFM in Canadian treatments.

Expenditures for administration and general research exceeded income by $674 and this amount was carried forward into fiscal year 1969. Printing and reproduction costs were higher than anticipated because of the large volume of committee reports reproduced during the year. Other contractual services were higher than anticipated because of charges in connection with the Lake Erie walleye study and the economic evaluation of sea lamprey control and lake trout restoration in Lake Superior.

Program and budget for fiscal year 1969. At the 1967 Annual Meeting, the Commission adopted a program for sea lamprey control and research in fiscal year 1968 and a budget of $1,814,100. A budget of $65,000 was approved for administration and general research. As a result of a limitation on the United States contribution, the sea lamprey program was reduced to $1,450,400 mainly by again postponing treatment of streams on the west shore of Lake Huron. The administration and general research budget was reduced to $60,000. Chemical operations on the west shore of Lake Huron were resumed when the State of Michigan agreed to provide up to $150,000. Subsequently, the State obtained $50,000 in federal funds through the Upper Great Lakes Regional Commission which was matched, according to the 69:31 formula, by the Government of Canada which provided $22,464. The remaining $77,536 was supplied by the State of Michigan.

The status of funds for fiscal year 1969 is as follows:

	United States	*Canada*	*Total*
Sea Lamprey Control and Research			
Commission request	$1,251,700	$562,400	$1,814,100
Contribution	1,000,800	449,600	1,450,400
Additional (Upper Great Lakes R.C.)	50,000	-	50,000
" (Canadian Dept. of Fish.)	-	22,464	22,464
" (State of Michigan)	77,536	-	77,536
	$1,128,336	$472,064	$1,600,400
Administration and General Research			
Commission request	$ 32,250	$ 32,250	$ 65,000
Contribution	30,000	30,000	60,000

The revised program for fiscal year 1969 provided for the following activities:

Lake Superior - Re-treat 14 streams; routinely examine lamprey and potential lamprey streams to determine if and when re-treatment is required; operate lamprey assessment barriers on 16 streams.

Lake Michigan - Re-treat 13 streams; examine lamprey streams and potential lamprey streams to determine time for re-treatment.

Lake Huron - Treat 25 streams (15 in the United States and 10 in Canada); survey potential lamprey producing streams; operate 10 assessment barriers.

Research - Study mode of action of lampricides, and ammocete physiology, develop an irritant for surveys, explore other methods of assessing lamprey abundance, follow re-establishment of larvae, changes in growth, and time to transformation.

Agreements to carry out the program in fiscal year 1969 were made with the U. S. Bureau of Commercial Fisheries ($887,000), and the Department of Fisheries of Canada ($404,700).[1] The Commission ordered 110,000 pounds of TFM ($280,500); 25,000 pounds of granular Bayer 73 ($16,250), and 1,500 pounds of powdered Bayer 73 ($9,375) for its agents.

The Commission reviewed the administration and general research budget for fiscal year 1969 and authorized a transfer of funds within the budget reducing amount provided for supplies and increasing the amount for printing and reproduction to cover publication of the report on Lake Erie walleye.

[1] $436,600 in Canadian funds.

It approved the payment in fiscal year 1969 of up to $700.00 to improve the pension benefits for employees as recommended by the International Fisheries Commission Pension Society. The improvement was made by taking the salaries in effect on October 1, 1960, as applicable to all service since October 1, 1957, and purchasing the additional benefits. The adjustment was made immediately for one employee close to retirement.

Program and budget for fiscal year 1970. The Commission adopted a program for lamprey control and research in fiscal year 1970 estimated to cost $1,833,700 and a budget of $64,400 for administration and general research.

Reports and publications. In 1968 the Commission published its Annual Report for 1967, and the following:

"Population characteristics and physical condition of alewives, *Alosa pseudoharengus* in a massive dieoff in Lake Michigan, 1967," by Edward H. Brown, Jr., Great Lakes Fishery Commission, Tech. Rep. 13, 20 p.

"An economic evaluation of sea lamprey control and lake trout restoration," by Ayers Brinser, Lloyd L. Smith, Jr., H. C. Frick, and F. E. J. Fry, Great Lakes Fishery Commission, Mimeo, 49 p. + Appendices I-V.

The results of investigations supported by the Commission were published in various journals as follows:

"Water quality of streams tributary to Lakes Superior and Michigan," by Jerome W. Zimmerman, U. S. Fish Wildl. Serv., Spec. Sci. Rep. 559, 41 p.

"Sea lamprey in the Great Lakes," by Norman S. Baldwin, Limnos Magazine, Great Lakes Foundation, I (3): 20-27.

"Effects of lamprey larvicides on aquatic invertebrates in streams," Richard L. Torblaa, U. S. Fish Wildl. Serv., Spec. Sci. Rep. 572, 13 p.

"An electric beam trawl for the capture of larval lampreys," Alberton L. McLain and Frederick H. Dahl, Trans. Amer. Fish. Soc. 97 (3): 289-293.

"Production of sea lamprey larvae from nests in two Lake Superior streams," Patrick J. Manion, Trans. Amer. Fish. Soc., 97 (4): 485-486.

"A unique method of capturing parasitic-phase sea lampreys," Frederick H. Dahl, Prog. Fish, Cult., 30 (3): 183-184.

"Comparative embryological development of five species of lampreys of the Upper Great Lakes," Allen J. Smith, John H. Howell, and George W. Piavis, Copeia, No. 3, August: 461-469.

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 19, 1968

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

We have examined the statements of receipts and expenditures of the Great Lakes Fishery Commission Administration and General Research Fund, and Lamprey Control Operation Fund for the year ended June 30, 1968. 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 present fairly the cash balances of the designated funds of the Great Lakes Fishery Commission at June 30, 1968, 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, 1968

		Actual	*Budget*
Receipts			
Canadian Government		$28,149	$28,150
United States Government		28,150	28,150
Total		$56,299	$56,300
Expenditures			
Salaries (including tax and pension)		$47,293	$47,400
Travel		3,658	3,400
Communication		1,293	1,000
Rents and utilities		754	700
Printing and reproduction		1,946	1,300
Other contractual services		1,028	400
Supplies		1,044	1,900
Equipment		(43)	200
Total		$56,973	$56,300
Excess of expenditures over receipts		$ 674	
Cash balance, July 1, 1967	$1,150		
Transfer to Lamprey Control Operation Fund	1,150	-0-	
Cash deficit		$ 674	

Great Lakes Fishery Commission

Lamprey Control Operation Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1968

		Actual	*Budget*
Receipts			
Canadian Government		$ 436,273	$ 437,450
United States Government		971,034	973,650
Refund from Canadian Dept. of Fisheries		31,520	-0-
Total		$1,438,827	$1,411,100
Expenditures			
Canadian Department of Fisheries		$ 434,444	$ 436,300
United States Fish and Wildlife Service		793,400	732,900
Lampricide purchases		215,236	241,900
Total		$1,443,080	$1,411,100
Excess of expenditures over receipts		$ (4,253)	
Obligated for Lampricide purchases, July 1, 1967		(65,608)	
Obligated for Lampricide purchases, June 30, 1968		46,518	
Cash balance, July 1, 1967	$70,664		
Transfer from Administration and General Research Fund	1,150	71,814	
Cash balance, June 30, 1968		$ 48,471	

SUMMARIES OF EXPENDITURES BY AGENTS IN FISCAL YEAR 1968

Bureau of Commercial Fisheries

Activity	Funds programmed	Salaries	Other expenses	Total	Unobligated balance
Program costs					
Ann Arbor (Laboratory)					
Chemical operations	392,000	296,535	87,277	383,812	8,188
Barrier operations	131,000	90,142	39,622	129,764	1,236
Research	181,200	142,319	36,083	178,402	2,798
Washington D.C.	25,100	10,988	14,112	25,100	-
Executive direction (Ann Arbor)	25,100	24,900	154	25,054	46
General administration (Ann Arbor)	39,000	39,000	-	39,000	-
	793,400	603,884	177,248	781,132	12,268

Department of Fisheries of Canada

Administration	$106,638 (Canadian funds)
Chemical control	218,041
Operation of assessment barriers	97,995
Superannuation (6.5% of 192.066)	12,484
Subtotal	$435,158
Funds provided by Commission	$469,200
Refund	$ 34,042
	$ 31,520 (U. S. funds)

Table 3. Catches of adult sea lampreys for comparable periods from 16 Lake Superior streams, 1957-68.

Stream	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
Betsy River	768	1,061	999	696	1,366	316	444	272	187	65	57	78
Two Hearted River	7,570	3,388	3,950	4,290	7,498	1,757	2,447	1,425	1,265	878	796	2,132
Sucker River	3,496	1,613	2,436	4,683	3,209	474	698	386	532	223	166	658
Miners River	417	94	127	399	220	64	107	74	23	85	75	158
Furnace Creek	246	38	350	2,012	1,012	132	142	93	199	118	119	126
Rock River	2,510	1,403	1,170	2,598	3,660	399	353	229	237	158	439	498
Chocolay River	8,088	6,133	3,486	4,173	4,201	423	358	445	563	260	65	122
Iron River	708	391	250	317	2,430	1,161	110	178	283	491	643	82
Huron River	2,809	3,447	1,408	1,237	4,825	70	201	363	637	8	2	14
Silver River	2,748	2,000	753	1,271	5,052	267	760	593	847	1,010	339	1,032
Sturgeon River	31	28	539	161	427	397	1,445	375	135	259	43	132
Misery River	758	830	2,433	696	962	80	24	12	3	10	26	52
Firesteel River	1,003	1,532	2,044	250	1,118	70	178	327	11	15	9	25
Brule River	[1] 18,453	22,637	19,156	9,539	22,478	2,026	3,418	6,718	6,163	226	364	2,657
Middle River	4,273	4,829	3,598	2,815	3,502	311	48	45	52	17	19	22
Amnicon River	11,024	7,622	968	1,094	4,741	879	131	232	700	938	200	148
Total	50,418	57,046	43,667	36,430	66,701	8,826	10,864	11,767	11,837	4,761	3,362	7,936
Percentage of the 1957-61 mean	99	112	86	72	131	17	21	23	23	9	7	16

[1]Estimate (1958-61 mean).

COMMITTEE MEMBERS - 1968

[Commissioners in Italics]

SCIENTIFIC ADVISORY COMMITTEE

CANADA	UNITED STATES
A. L. Pritchard, Chm.	*C. F. Pautzke*
F. E. J. Fry	C. A. Dambach
Lionel Johnson	L. L. Smith
K. H. Loftus	S. H. Smith

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
A. O. Blackhurst	*Claude Ver Duin, Chm.*
G. C. Armstrong	W. G. Bentley
M. J. Brubacher	W. F. Carbine
R. M. Christie	W. R. Crowe
K. C. Lucas	C. D. Harris
D. R. Wilson	W. J. Harth
	C. N. Lloyd
	W. H. Tody

LAKE COMMITTEES

LAKE HURON

C. D. Harris, Chm.
M. J. Brubacher

LAKE ONTARIO

W. G. Bentley, Chm.
D. R. Wilson

LAKE MICHIGAN

W. H. Tody, Chm.
Woodrow Fleming
W. J. Harth
C. N. Lloyd

LAKE SUPERIOR

G. C. Armstrong, Chm.
D. J. Curry
C. N. Lloyd
H. O. Swenson

LAKE ERIE

W. R. Crowe, Chm.
D. C. Armbruster
W. G. Bentley
R. M. Christie
G. L. Trembley