ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1970

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MEMBERS — 1970

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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

1970

1451 Green Road
ANN ARBOR, MICHIGAN,
U. S. A.
1972

LETTER OF TRANSMITTAL

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

Respectfully,

E. W. Burridge, *Chairman*

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ANNUAL REPORT FOR 1970

INTRODUCTION

The Great Lakes and their fishery resources are shared by the United States and Canada; only Lake Michigan lies entirely within the United States and it is broadly linked with Lake Huron. Connecting rivers and canals allow fish to migrate from one lake to another. Political boundaries divide the Great Lakes into areas administered by eight states and one province, but these divisions are no obstacle to fish movements. The presence of political subdivisions has emphasized the need for close national and international cooperation in solving common fishery problems. When the sea lamprey infested the Great Lakes, the once-abundant lake trout disappeared and the whitefish declined in Lakes Michigan and Huron. Both the United States and Canada realized the urgency of controlling this parasite in the upper Great Lakes and the need to work together to revitalize the fishery in all the lakes. In 1955 the two nations established the Great Lakes Fishery Commission to formulate and coordinate research programs, to advise governments on measures to improve the fishery, and to implement a program to control the sea lamprey. The Commission's objective is to eradicate or minimize sea lamprey in the Great Lakes, and to improve the quality, abundance, and productivity of the fishery resources of the Great Lakes for sport and commercial use. The Commission maintains a small staff for administrative and coordinating functions and relies on the cooperation of federal, state, and provincial fishery agencies for information required for developing measures to improve the fishery. It contracts with federal agencies in each country to carry out the sea lamprey control program.

Each lake has a technical committee of senior officials from agencies administering the fishery, assisted by advisors from agencies engaged in research. The lake committees advise the Commission on the status of fish stocks, progress of research, and measures to improve the fishery. Their recommendations are reviewed by a Management and Research Committee, which considers the welfare of all the lakes before forwarding the recommendations to the Commission. Two other committees are specifically concerned with (1) the sea lamprey control program, and (2) the financial and administrative affairs of the Commission. In addition to the above, a committee of six scientists advises the Commission on matters related to sea lamprey control and research and fishery research.

The Commission has developed a program of periodic treatment of lamprey-infested tributaries of Lakes Superior, Michigan, and Huron with a chemical that selectively destroys sea lamprey larvae. These treatments have

reduced sea lamprey populations in Lake Superior and Lake Michigan to about 15 percent of pre-control abundance, and a similar reduction is expected in Lake Huron. The Commission plans to extend lamprey control to Lake Ontario in 1971. Sea lampreys are not abundant in Lake Erie and the desirability of extending control to this lake has not yet been determined.

An early indication of the effectiveness of the program was the reduction in lamprey wounding of lake trout, rainbow (steelhead) trout, and whitefish. These species have become more abundant and with the recently introduced Pacific salmon are the basis for an expanding fishery in Lakes Superior and Michigan. Before the ravages of the sea lamprey, lake trout had helped maintain a population balance among the fishes of the upper Great Lakes and played a stabilizing role in supporting the commercial fishery. The commission considers it imperative to reestablish this valuable species.

By the early 1960's, lake trout spawning had ceased along the shores of Lake Superior because of the scarcity of mature fish. Fortunately a planting program was underway which offset to some extent the failure of natural reproduction. Trout planted by federal, state, and provincial agencies in Lake Superior and Lake Michigan are showing excellent growth and survival, and in some areas of Lake Superior trout are now as abundant as in prelamprey days. The final stage, now underway, is the development of spawning populations which will support the lake trout fishery in these two lakes.

The large scale restocking of the lakes with salmonid species following reductions in lamprey abundance has been an important step in rehabilitating the fishery. The Commission is directly responsible for coordinating the planting each year of approximately 5 million lake trout yearlings, which are produced with eggs from brood stocks maintained in hatcheries. The Commission, through its lake committees, also works closely with the States and the Province of Ontario in developing coordinated planting programs for other salmonids such as Pacific salmon, rainbow, brook, and brown trout.

On another front, rapid deterioration of water quality threatens the value and productivity of the Great Lakes fishery resources. If not checked, the degradation of the lakes will nullify fishery rehabilitation programs. The Commission has urged both countries to adopt water quality standards designed to protect the fish stocks in the Great Lakes.

The Commission held its Annual Meeting in St. Paul, Minnesota on June 16-18, 1970, and an Interim Meeting in Ann Arbor, Michigan on December 1-2, 1970. The proceedings are summarized in the following sections while the information presented at the meetings is summarized in appendices. An administrative report is also appended.

ANNUAL MEETING

PROCEEDINGS

The Fifteenth Annual Meeting of the Great Lakes Fishery Commission was held in St. Paul, Minnesota on June 16-18, 1970. The Chairman, Mr. L. P. Voigt called the meeting to order and introduced Mr. C. B. Buchman, Deputy Commissioner of the Minnesota Conservation Department. Mr. Buchman welcomed the Commission and its advisors and stressed that the Commission had enabled the United States and Canada to coordinate their efforts to preserve the valuable resources of the Great Lakes. The Commission adopted the proposed agenda and approved the Minutes of the 1969 Interim Meeting.

The Chairman noted that sea lamprey control remained a major concern of the Commission; it was clear that rehabilitation of the fishery resource of four of the five Great Lakes depended on reducing the abundance of the parasite to a low level. Control measures have reduced the sea lamprey population in Lake Superior and Lake Michigan to about 15 percent of precontrol abundance and a similar reduction is expected in Lake Huron. As a result, planted trout and Pacific salmon have survived and grown exceptionally well. Furthermore, rainbow trout (steelhead) have made a sharp recovery. The combined populations of salmon and trout in the upper lakes have led to the development of the most successful and popular sport fishery in the history of the Great Lakes. Despite these successes the Commission remains concerned with the disparity between funds allocated for lamprey control and funds required to carry out a fully effective program. Limited funds have prevented the Commission from extending lamprey control to Lake Ontario where the people of New York and southern Ontario have waited patiently to share the benefits of lamprey control now enjoyed in the upper lakes.

The Chairman also stressed the continuing need for research programs on the Great Lakes and urged that these efforts be guided and coordinated by the lake committees to assure that the information required for orderly redevelopment of the sport and commercial fishery was collected. In the past, the commercial fisheries were the main source of information on fish stocks; now the sport fishery has become an important source of such information, but it is not readily obtainable. Research leading to the development of methods for collecting reliable catch data from the sport fishery was essential. The presence of DDT and mercury residues in Great Lakes fish has brought new dimensions to the overall research program that need increased attention. This problem forcefully calls attention to the fact that fish are a

part of the total environment and, therefore, of concern to those agencies that deal with water quality and public health.

Management and research. The Commission accepted the reports on management and research[1] submitted by the lake committees. High priority was placed on a lake-wide sampling program to provide information on fish populations basic to the assessment of lamprey control and efficient management of the fishery resource of Lake Michigan. The Commission recommended that the States of Michigan, Wisconsin, Indiana, and Illinois provide the financial support required to develop the program.

Trout and salmon plantings scheduled for the Great Lakes in 1970 were reviewed.[2] The Commission accepted the recommendation of its Lake Michigan Committee that the objective of lake trout plantings continue to be the reestablishment of self-sustaining populations, but that in bays and near-shore areas where lake trout were sought by sportsmen emphasis should be placed on plantings to encourage the catch of lake trout and to maintain high levels of abundance, should this prove necessary. Recognizing that fish production facilities in the United States would require expansion to meet this need, the Commission recommended that the United States Government take the appropriate steps.

The Commission indicated that it would continue to stress sea lamprey control on Lake Superior and Lake Michigan, but emphasized that fishery agencies must intensify and refine efforts to evaluate the effects of lamprey control. The agencies concerned were asked to provide at the 1970 Interim Meeting total mortality estimates on lake trout and assessment of lamprey attack rates derived from data collected to 1969.

The Commission also agreed to refer a recommendation to the International Joint Commission that water quality standards be established for the protection of the fishery resource of the Great Lakes. The recommendation urged that upon establishment of appropriate standards, the Governments of the United States and Canada should require industries and municipalities to provide evidence that their effluents will meet the standards, or in the case of new wastes for which standards are not yet adopted, industries and municipalities should be required to show evidence, before such wastes are discharged or production facilities established, that the wastes will not damage water quality for the production of fish or fish food organisms.

Sea lamprey control and research. The Commission accepted the reports of its two agents on their sea lamprey control operations in 1970.[3]

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

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

[3]Final reports covering sea lamprey control and research in the United States and Canada in 1970 appear as Appendices C and D.

The Commission adopted a revised sea lamprey control and research program for fiscal year 1971 having an estimated cost of $1,910,100 rather than the $2,472,400 originally requested. The reduction was made on advice by the United States Government, that its contribution would be $388,000 less than the amount requested by the Commission. If the United States contribution was approved, the proposed Canadian contribution would be reduced by $208,300 to maintain the cost-sharing formula (69:31). The reduced budget ($1,910,100) would necessitate deferrment of (1) intensification of chemical operations on Lakes Superior, Michigan, and Huron, and (2) surveys to locate sea lamprey populations in tributaries of Lakes Erie and Ontario. It would also require heavy withdrawal of lampricide from reserves to carry out scheduled treatments on Lakes Superior, Michigan, and Huron.

The Commission also adopted a sea lamprey control and research program for fiscal year 1972 which called for an expenditure of $2,536,000. The expanded program was required for the Commission to fulfill its responsibility to minimize sea lamprey in the Great Lakes, and it was in accord with the recommendations of the lake committees for intensification of control measures in the upper lakes and extension of the control program to the lower lakes. The proposed program would entail the following operations:

Lake Superior–Retreat 18 streams (13 in the United States and 5 in Canada); survey and treat larval populations in lakes and estuaries; survey known and potential lamprey-producing streams to determine when retreatment is required; operate electrical barriers on 16 United States streams to assess changes in abundance of spawning lamprey.

Lake Michigan–Retreat 10 streams; this relatively light schedule would permit the assignment of experienced personnel to Lake Ontario operations. Intensify survey operations and assign special crews to the treatment of problem areas.

Lake Huron–Retreat 17 streams, 8 in the United States and 9 in Canada; again the relatively light treatment schedule would permit some expansion of survey activities, particularly on the U.S. shore. Operate 10 assessment barriers (one U.S. and nine Canadian) to follow changes in the population of adult sea lampreys.

Lake Ontario–Treat all known lamprey-producing streams, except the Oswego River which has not been surveyed.

Research–At Hammond Bay continue investigations designed to facilitate field operations, especially the development and testing of irritants for surveys, and techniques and materials for treatment of estuarine or deepwater habitats. Intensify studies of lamprey biology, particularly the transformation process and other life history attributes that may suggest new approaches to control. Initiate investigations aimed toward the feasibility of biological control, including the use of sterile males, parasites, and pathogens. The Ann Arbor and Hammond Bay Laboratories will continue their investigations on the degradation of lampricides in the environment and living organisms.

Finance and Administration. The Finance and Administration Committee approved a budget for $70,000 and $77,900 for Administration and General Research in fiscal years 1971 and 1972, respectively.

Election of Officers. Mr. E. W. Burridge (Canada) was elected Chairman and Dr. W. M. Lawrence (United States) Vice-Chairman for the ensuing two years.

Adjournment. Following agreement to hold the 1970 Interim Meeting in Ann Arbor on December 1-2, the Chairman expressed the Commission's appreciation to the participants for their advice and for the hospitalities and assistance given by the Minnesota Conservation Department. The meeting was adjourned at 11:30 a.m. on June 19.

INTERIM MEETING

PROCEEDINGS

The Commission held its Interim Meeting in Ann Arbor on December 1-2, 1970 to consider changes in United States federal responsibilities in the Great Lakes, the progress and problems of sea lamprey control including extension of lampricide (TFM) registration, lake trout restoration, and collection of statistics from the commercial and sport fisheries.

Changes in United States federal responsibilities in the Great Lakes. The Commission was advised that President Nixon's Reorganization Plan No. 4 had become effective on October 3, 1970. The plan as related to fisheries established the National Oceanographic and Atmospheric Administration (NOAA) in the Department of Commerce. The Bureau of Commercial Fisheries was abolished and virtually all its activities were transferred to the National Marine Fisheries Service (NMFS) along with the Marine Game Fish Activities of the Bureau of Sport Fisheries and Wildlife. The National Marine Fisheries Service is a major line component of NOAA. The Great Lakes Fishery Laboratory in Ann Arbor and those functions of the Bureau dealing with the Commission including sea lamprey control and research were now the responsibility of the Bureau of Sport Fisheries and Wildlife in the Department of the Interior.

Sea lamprey control and research. The Commission heard reports on the progress of the sea lamprey control operations in 1970 submitted by its agents. A preliminary report, prepared by the Bureau of Sport Fisheries and Wildlife, dealing with investigations on the feasibility of biological control of sea lamprey also was discussed; consequently attention was devoted to those research projects most critical to the chemical control program which should be given priority if emphasis on research were shifted to biological control.

Agencies studying lake trout in Lake Superior provided information on wounding rates observed on 21-24.9 inch lake trout during the fall as an indicator of changes in lamprey activity. The index generally suggested that lamprey abundance increased slightly in Lake Superior in 1970, particularly in the northwestern sector of the lake. Time has not permitted the accumulation of sufficient lamprey wounding data on lake trout in Lake Michigan to establish a reliable index of changes in lamprey activity, but present information showing that fall wounding rates on trout in northern Lake Michigan had dropped from 6.6 percent in 1969 to 2.0 percent in 1970 was encouraging. Additionally, wounding rates observed on steelhead trout taken during the spring in the Little Manistee River weir (Lake Michigan) had dropped from 29.0 percent in 1967 to 1.8 percent in 1970.

The Commission was also advised that the Pesticide Regulation Division of the U.S. Department of Agriculture had notified the Fish and Wildlife Service that registration of the lampricide (TFM) would be cancelled on December 31, 1970. A petition for extension of the registration had been filed in September and approval appeared to hinge on the Commission's ability to carry out research that would yield data needed to establish residue and tolerance limits for TFM in water, fish, and food or food stuffs. The cost of such registration-oriented research on TFM was not available, but based on experience of registering other fish control toxicants the consensus was that the price would be high. The Commission received the results of studies conducted by Dr. L. L. Kempe et al. (University of Michigan) on the biodegradability of TFM in lakes and streams. The information obtained indicates that TFM is degraded by microbiological activity in natural mud-water systems. TFM also appears to be absorbed by mud. The Commission considered Dr. Kempe's studies to be extremely pertinent to the registration problem and urged that the results be published at an early date.

The Commission was also advised that it should not expect a significant increase in the United States contribution for sea lamprey control in fiscal year 1972. Since this proposed limitation in funds coupled with the immediate need to carry out a wide range of toxicology and residue chemistry tests on TFM posed serious problems in carrying out an efficient sea lamprey control program, the Commission instructed its agents to meet with the Commission staff on January 14, 1971 to consider what revisions could be made in fiscal year 1972 to incorporate in sea lamprey control programs the registration-oriented research on TFM and remain within the budget limitations set by the proposed U.S. contribution.

Lake trout restoration. The Commission received reports from agencies conducting lake trout assessment in Lake Superior and Lake Michigan which indicated further improvement in the abundance of planted trout in both lakes. Preliminary information obtained from lake trout mortality studies in Lake Superior suggests however that the residual lamprey population is still capable of inflicting heavy losses on the larger and older trout thus hindering the recovery of spawning stocks and natural reproduction of lake trout.

Collection of catch statistics. The Commission received reports from agencies responsible for the collection and analysis of sport and commercial catch statistics which described generally the modifications and expansions being made to improve these activities.

The Commission expressed pleasure with the progress being made and the agencies' desire to overcome remaining deficiencies. Although the diffuse nature of a sport fishery makes the collection of biological information on the catch difficult, a critical need for developing methods to produce reliable catch-effort data on this rapidly growing fishery remains.

APPENDIX A

SUMMARY OF MANAGEMENT AND RESEARCH

Since the entry of sea lamprey into the upper Great Lakes in the 1930's, and the tremendous population explosion by alewives in the 1950's, the most noticeable feature of the Great Lakes fisheries is their instability and rapid change. During the last 30 years, lake trout virtually disappeared except in Lake Superior where remnant populations remained. Stocks of whitefish were severely damaged. Several species of large deep water ciscoes have become virtually extinct. Lake herring and whitefish have almost vanished from Lake Erie, and herring populations in Lakes Michigan and Huron no longer contribute significantly to the commercial catch. The lake herring population in Lake Superior faces imminent collapse. The situation with chubs is comparable. The blue pike has, for all practical purposes, disappeared. Walleye populations in Lakes Michigan and Huron have declined to only an incidental part of the commercial fishery. Catfish harvests have declined and rates of exploitation are high. Only the less valuable species such as carp, freshwater drum, and alewives are abundant.

Long-term environmental deterioration in the Great Lakes has included biological factors such as disruptions brought about by the sea lamprey, the alewife, and an intense and selective fishery. Physical deterioration has been accelerated by domestic, agricultural, and industrial pollution, all of which have contributed to lowered water quality, especially in the inshore areas. In addition, contaminants such as pesticides and heavy metals (mercury) have, and will continue to have, deleterious effects on the fishery resource. The effects of these contaminants will increase unless or until society acts to protect the Great Lakes resource, including the quality of the water and the fish therein.

Despite the obvious deterioration of the resource over the past two or three decades, much cause for optimism remains. The lamprey control program has demonstrated its worth. Restoration efforts with the lake trout, Pacific salmon, and other salmonids have been outstandingly successful to date. The establishment and expansion of the sport fishery on the Great Lakes is of tremendous importance. Environmental deterioration is not so severe at present to preclude the recovery of stocks. The resiliency of the resource, as shown by the frequent appearance of strong year classes of most species in various parts of the basin, suggests that with wise management the present fishery resource can be enhanced and maintained for future users.

Information assembled by the lake committees on status of fish stocks, fish production, progress and results of investigations, and measures taken to improve and maintain the fisheries resource is summarized hereafter.

The Fisheries Resource

Sea lamprey

The sea lamprey control program utilizing the selective lampricide TFM became operational on Lake Superior in 1958. The program was expanded to include Lake Michigan in 1960, Lake Huron was added in 1966, and it is expected that Lake Ontario will be included in 1971.

The program has been effective. Lamprey abundance has been reduced and evidence of lamprey activity has declined. In Lake Superior, annual counts of adult lampreys taken at assessment barriers indicate that lamprey abundance has been reduced by 80-90 percent. In Lakes Michigan and Huron effectiveness of the lamprey control program must be judged by indirect means, such as lamprey wounding rates and the response of fish stocks. Survival and growth of planted salmonids has been excellent. Stocks of whitefish and steelhead (rainbow) trout have shown marked recovery.

Despite encouraging results to date, many difficult obstacles must be surmounted. The residual lamprey population has apparently prevented the rapid development of a self-sustaining population of lake trout. The larger and older lake trout, i.e., the potential spawners, apparently suffer a disproportionate mortality rate because of their prolonged exposure to attack by lampreys. The percentage of juvenile, unmarked (wild) lake trout in the sample catches has increased, but remains very low except in a few areas. Numbers of large trout, in the 24- to 30-inch class, have increased but they are not yet abundant. Furthermore, the lampreys themselves have exhibited some biological response to the control program–faster growth, higher survival, higher percentage of females in the spawning run, and in certain streams metamorphosis seems to have accelerated. Close scrutiny of these biological changes is imperative to prevent the escapement of maturing sea lampreys before scheduled treatments. Present information suggests strongly that lamprey abundance must be reduced further if self-sustaining populations of lake trout are to be reestablished within the near future. Further reduction of lampreys will require intensification of surveillance and stream and estuary treatments, and the development of other control methods such as permanent barriers to spawning run lampreys and biological controls.

Lake trout

The lake trout restoration program became operational in 1958. Plantings were initiated in Lake Superior and extended to Lake Michigan in 1965. Through 1970, nearly 40 million fin-clipped yearling lake trout have been planted: Lake Superior, 28.3 million; and Lake Michigan 11.3 million.

In Lake Superior, where systematic sampling of the population has been employed over a period of years, lake trout abundance has increased steadily since 1962 when effects of lamprey control first became clearly evident (Table 1). In Lake Michigan, measurements of increasing lake trout abundance are less precise, but survival and growth of yearlings planted since 1965 have been excellent and the planted lake trout have contributed to an

Table 1. Numbers of marketable lake trout caught per 10,000 feet of large-mesh gillnet lifted during the spring, Lake Superior, 1962-1970.

Year	Michigan	Wisconsin	Minnesota	Ontario	Average (unweighted)
1962	39	77	43	34	48
1963	46	81	58	32	54
1964	43	111	68	56	70
1965	55	134	50	59	75
1966	75	150	22	99	87
1967	116	181	46	111	113
1968	245	–	32	76	114
1969	249	187	34	90	140
1970	354	368	78	105	226

intense and expanding recreational fishery. The estimated catch (combined for both lakes) by anglers in 1970 exceeded 0.5 million lake trout.

As a consequence of lamprey control, an intensive planting program, and reduced and/or carefully limited commercial exploitation, lake trout are now abundant in Lakes Superior and Michigan. Optimism over this increasing abundance must be tempered by the progressively higher mortality rates for older and larger lake trout, the minimal recruitment from limited natural spawning in the lakes, and mortality attributable to an intense and expanding sport fishery. In short, the present lake trout population is directly dependent upon the planting program.

Careful analysis of lake trout mortality over the past two years in Lake Superior reveals increasing mortality beyond Age V and a length of 20 inches with size rather than age being the main consideration. From evidence at hand, it must be inferred that sea lampreys contribute significantly to the mortality of the larger, older lake trout. The present sea lamprey population has some effect upon overall abundance of lake trout, but acts primarily to reduce the abundance of large spawners, and thereby inhibits recruitment from natural reproduction. The only inshore area where spawning stocks have increased sufficiently to contribute significant numbers of juveniles to the population is in the Apostle Island area of Wisconsin where wounding rates are low.

Certain discrete populations of lake trout on offshore grounds in Lake Superior exhibit different characteristics. Examination of offshore stocks in Michigan waters around Caribou Island revealed that catch per unit of effort in 1970 improved by 17 percent over 1969. The bulk of the catch was made up of "humper" trout[1] (75 percent by number and 57 percent by weight). The results indicate that abundance of humpers continued to increase and that present rate of exploitation is conservative. Fat trout (siscowets) did not

[1]The name "humper" has been used for many years for lake trout that congregate on or near certain offshore reefs in Lake Superior. These lake trout mature at a small size, 13 to 16 inches, seldom exceed 25 inches, usually spawn in late September, and the flesh is usually red or pink. Appearance is sufficiently distinctive to permit their separation from siscowets or typical lake trout.

appear to be on the increase. The descrease in the percentage of lean trout in the catch appeared to be a reflection of sampling effort rather than reduced availability. Also, planted trout seemed to be less numerous than in previous years in the areas sampled. To test the validity of the apparent increase in abundance of humper trout, Michigan proposed to double the harvest quota for 1970 to 120,000 pounds. The quota would be apportioned over the Caribou Islands and Big Flats grounds.

In summary, the lake trout rehabilitation program has, in the main, been very successful. Lake trout are now more abundant in Lakes Superior and Michigan than they have been for a decade or more, but the successful establishment of a self-sustaining population of lake trout remains to be demonstrated.

Lake whitefish

Since the demise of the lake trout, the whitefish has been the highest per-unit-value commercial species in the Great Lakes. Although whitefish stocks, particularly in Lakes Michigan and Huron, declined drastically with the coming of the sea lamprey, they were never reduced to the same degree as lake trout.

Commercial fishing for whitefish is prosecuted vigorously; consequently commercial catch statistics when combined with biological sampling of the catches provide a fairly reliable index to the status of stocks. In the period 1961-1970 the commercial catch of whitefish for the Great Lakes averaged 2.7 million pounds annually (range 1.9 to 3.6) compared to a "normal" (1928-1943) catch of 9.8 million pounds annually.

Although differing characteristics among various discrete stocks in the upper Great Lakes makes generalization difficult, it is apparent that the whitefish stocks have stabilized at levels far below those of pre-lamprey days. The intensive commercial fishery in the upper lakes are probably harvesting whitefish at or beyond the sustainable level. Modest recoveries of some stocks appears attributable to lamprey control.

In Lake Erie, whitefish stocks have dropped to a level where they scarcely contribute to the fishery, probably mainly as a results of environmental deterioration. In Lake Ontario, the commercial catch of whitefish has declined noticeably over the past 10 years.

Lake herring

The lake herring, which often contributed the greatest poundage to the commercial catch, has declined drastically throughout the Great Lakes. Only in Lake Superior have herring continued to support a significant commercial fishery and here the catch has declined steadily from 13.6 million pounds in 1961 to only 4.2 million pounds in 1970. Fully 98 percent of the entire catch of herring came from Lake Superior during this period. Herring in Lake Superior exhibit all the classic symptoms of biological stress--increased growth rates, early maturity, and abnormal sex ratios.

Reasons for the drastic decline of herring stocks throughout the Great Lakes basin are undetermined. Environmental deterioration accompanied by severe biological stress imposed by the unstable species complex have no doubt been major contributing factors.

Chubs and ciscoes

Following the virtual exclusion of lake trout from the commercial fishery and the drastic decline of lake herring, chubs assumed an important position in the fishery. Average annual production in 1961-1970 was 12.6 million pounds, 11.4 from U.S. waters and 1.2 from Canadian waters. Most of the U.S. catch came from Lakes Michigan and Superior, and the major portion of the Canadian catch from Lake Huron. Since the turn of the century, and particularly over the past 20 years, the large deep-water ciscoes have virtually disappeared, and the entire (99 percent) chub catch is made up of the bloater *(C. hoyi)*.

Chub populations throughout the Great Lakes have exhibited symptoms of stress, such as increased growth rates, abnormal sex ratios, and maturity at an early age.

Alewives

Alewives remain very abundant in Lakes Michigan, Huron, and Ontario where they make up a major segment of the fish population. In these lakes, however, the fish population is far below what it once was. In Lake Michigan, a substantial commercial fishery for alewives has continued since about 1958, but no such fishery has developed in the other lakes. Overall abundance of alewives in Lake Michigan declined from its peak following the massive dieoff in 1967, but has increased gradually since that time. The status of alewives in the other lakes has been less carefully evaluated.

Yellow perch

Yellow perch now make up the most valuable segment of the commercial catch in the Great Lakes. Over the decade, 1961-1970, average production has been 28.1 million pounds with 23.9 (85 percent) million pounds taken from Lake Erie. In Lakes Michigan and Huron, perch populations have declined. Competition from alewives and exploitation by the fishery are likely contributing factors. Perch stocks in Lake Erie show signs of instability and the fishery has come to depend upon one or two strong year classes. For a number of years the sport fishery for perch, from piers and breakwaters along the eastern shore of Lake Michigan, has been insignificant but some recovery was noted in 1970.

Smelt

Annual commercial production over the decade, 1961-1970, has averaged 16.4 million pounds with about 80 percent of the catch coming

from Lake Erie. Smelt stocks have not exhibited drastic fluctuations in recent years. In Lake Erie, the heavy infestation of smelt by the microsporidian parasite *Glugea hertwigi* has been associated with some smelt dieoffs and is cause for concern.

Coho salmon

Some 3.3 million coho salmon were planted in waters tributary to Lake Michigan in 1969–all but 227,000 by the State of Michigan. The return of these fish in 1970 was excellent, approximating 25 percent at weirs and by anglers. The estimated sport catch in 1970 was 269,000 coho. Returning adults averaged 8.2 pounds and 27.5 inches at the Platte River and 8.0 pounds and 26.7 inches at the Little Manistee River. Average size of returning adults (Columbia River strain) has declined since the first run in 1967. Alaskan strain coho averaged 23.8 inches and 4.9 pounds. In Wisconsin waters of Lake Michigan anglers caught about 20,000 coho in 1970. In Lake Superior coho mature at a much smaller size and in 1970 averaged 20.1 inches and 2.9 pounds. Adult coho from Lake Huron averaged 25.8 inches and 7.5 pounds in 1970, considerably smaller than the 1969 average of 29.1 inches and 10.3 pounds. In Lake Huron, coho suffer appreciable damage from lamprey attack with 58 percent of the coho showing scars and/or fresh wounds. In Lake Michigan and Lake Superior, coho show little evidence of lamprey attack. Coho in Lake Erie and Lake Ontario have not been so successful as in the upper lakes, but results to date indicate that their potential for sport fishing is promising.

Chinnook salmon

In 1967-1969, some 2.9 million chinook salmon were planted in the Great Lakes, mainly in the Michigan waters of Lake Michigan (2.1 million), and Lake Huron (0.5 million). Through 1970 the total return (catch plus escapement) in Lake Michigan from the 1966 year class was close to 20 percent. In 1970, chinook of the 1966 year class averaged 38.8 inches and 23 pounds; those of the 1967 year class averaged 34.7 inches and 16.6 pounds. A 42-pound specimen was caught by an angler. Chinook remain in the lake for 2-5 years and are, therefore, exposed to lamprey attack over a longer period of time than coho–in 1970, 8.3 percent of the 4-year-old chinook bore wounds and/or scars. In Lake Huron, the sport fishery for chinook was less spectacular than in Lake Michigan (estimated catch in 1970–172,000 fish), but the estimated catch rose from 1,000 fish in 1969 to 19,000 in 1970. Growth rates were similar, but somewhat slower than in Lake Michigan with 2-year-olds averaging 24.6 inches and 6.9 pounds, and 3-year-olds 33.5 inches and 15.5 pounds. In Lake Huron, chinook showed considerable evidence of lamprey activity; more than 50 percent of the specimens bore wounds and/or scars with 22.7 percent carrying fresh wounds. In Lake Superior, the estimated sport catch dropped from 7,000 in 1969 to 3,000 in 1970. In Lake Superior, 3-year-old chinook averaged 26.3 inches, and 8.2 pounds. Chinook in Lake Superior were also vulnerable to lamprey attack with 16.5 percent of the 3-year-olds bearing fresh wounds. Results from small plantings of chinook by other states are not conclusive.

Splake

In Lake Huron, rehabilitation with highly selected splake (brook trout-lake trout hybrids) was initiated in 1969 with the planting of 30,000 yearlings in the Meaford area in Georgian Bay and 5,140 in South Bay. In 1970, a substantial plant of 247,332 yearlings was made in Ontario waters of Lake Huron. Also in 1970, the State of Michigan planted 43,000 yearlings in the Cheboygan area. Initial investigations in 1970 of selected splake in Lake Huron indicate that: (1) Habitats formerly occupied by lake trout were selected. (2) Growth has been excellent–some specimens from the 1969 plant reached lengths of 16 inches and weights of nearly 3 pounds. (3) Sexual maturity was reached at an early age–of 52 Age 1+ females collected on shoals in the fall of 1970, 6 (11 percent) were mature. The number of mature females captured in 1970 suggests that substantial egg deposition could take place as early as 1971. (4) Food of Age I splake consisted mainly of fish and small quantities of invertebrates; Age II splake consumed fish; mainly smelt, alewives, trout-perch, and sticklebacks.

Kokanee

In 1965-1969, some 10 million kokanee were planted in the Ontario waters of Lake Huron (5.5 million) and Lake Ontario (4.5 million). Plantings have consisted of eggs (2.0 million), fry (7.1 million) and fingerlings (0.8 million). To date, kokanee returns in Lake Ontario have been insignificant; in Lake Huron spawning runs of kokanee have developed in Blue Jay Creek and Manitou River in Manitoulin Island. Some shore spawning has also taken place. Lake Huron kokanee averaged 14.5 inches; those from South Bay 12.5 inches. Lamprey predation on kokanee has been insignificant.

Steelhead (rainbow) and brown trout

Lamprey control complemented by substantial plants of hatchery reared trout has permitted substantial recovery of these stocks. Steelhead (rainbow) trout and brown trout are now providing outstanding sport fishing in inshore areas of the Great Lakes and their tributary streams.

Commercial Fisheries

The commercial fishery on the Great Lakes has encountered many serious problems over the past two decades, and, consequently, is in jeopardy biologically and economically. The sea lamprey virtually destroyed the lake trout and severely damaged stocks of whitefish. The fishery was already exploiting these species at or beyond a sustainable leve. During the

same period, lake herring stocks in Lake Michigan and Lake Huron have almost disappeared and have dropped to a low level in Lake Superior. Other large coregonids (black fins, long jaws, etc.) have either become extinct or extremely rare. Chubs have almost vanished from Lake Huron, and show serious signs of stress in Lake Michigan and Lake Superior. Instability of fish stocks was further accelerated by the increasing abundance of the alewife. Recently, various contaminants including pesticides, PCB's, mercury, and probably others, have added to the problems. In Lake Erie, the major producer, the fishery shows all the symptoms of instability, such as sudden shifts in the composition of the catch. In summary, environmental deterioration, and intensive commercial fishery, biological disasters (sea lamprey, alewives), and the continued addition of contaminants to the lakes have combined to seriously endanger the resource base. The continued existence of a viable commercial fishery will depend upon rehabilitation of the resource and rational regulation.

Commercial fish landings declined by about 10 percent from 123.5 million pounds in 1969 to 110.6 million pounds in 1970. Of the catch, 70.4 million pounds (64 percent) were landed in the United States and 40.2 million pounds (36 percent) in Ontario.

The total catch (1,000's of pounds) for the different lakes in 1969 and 1970 is shown in Table 2. Despite the decline, the 1970 catch was very close to the 20-year average (1950-1969) of 111 million pounds. The drop was most apparent in Lake Erie where the Canadian catches of perch and smelt dropped by 9.2 and 5.4 million pounds, respectively. Complete statistics since 1914 are available; in all years except 1967 and 1970 Lake Erie ranked first in landings. For the 20-year period 1950-1069, Lake Erie produced, on the average, 47 percent (range 36-56) of the commercial catch from the Great Lakes. Since about 1958, the commercial catch of alewives in Lake Michigan has increased greatly, rising from 2.2 million pounds in 1958 to a maximum of nearly 42 million pounds in 1967. In 1966-1970, alewives contributed considerably more than half of the total catch from Lake Michigan. Commercial fishing for alewives in Lake Michigan (mainly in Wisconsin waters) explains Lake Erie's occasional failure to hold "first" place.

Table 2. Commercial catch, 1000's of pounds, United States and Canadian waters, Great Lakes, 1969-1970.

Lake	1969	1970
Superior	8,190	8,391
Michigan	47,489	53,091
Huron	5,226	4,536
St. Clair	920	87
Erie	59,077	41,302
Ontario	2,566	3,238
Total	123,468	110,645

Twelve species contributed more than one million pounds to the catch and contributed almost the entire dollar value (Tables 3 and 4). These same species have contributed more than 90 percent of the catch for many years; the notable omission is the lake trout which contributed several million pounds each year until about 1960. Since then the lake trout fishery has been either closed or limited to the amount required for biological sampling.

Table 3. Commercial catch (1,000's of pounds) Great Lakes, 1969-1970.

Species	1969	1970
Yellow perch	35,325	25,512
Alewife	29,248	33,461
Smelt	18,840	13,126
Chubs	10,407	11,161
Carp	7,341	7,144
Lake herring	4,744	4,221
Whitefish	3,465	3,585
Sheepshead	2,504	1,060
White bass	2,103	1,318
Suckers	1,437	1,535
Salmon	1,144	2,243
Catfish	1,005	–
subtotal	117,563 (95 percent)	104,366 (94 percent)
Other species	5,937[1]	6,234
Total	123,500	110,600

[1]Includes species sold as animal food.

Table 4. Commercial catch (1,000's of dollars) Great Lakes, 1969-1970.

Species	1969	1970
Yellow perch	5,793	4,180
Alewife	322	381
Smelt	772	533
Chubs	1,821	1,957
Carp	396	385
Lake herring	451	402
Whitefish	1,895	1,960
Sheepshead	125	53
White bass	517	324
Suckers	47	51
Salmon	160	315
Catfish	412	338
subtotal	12,227 (93 percent)	10,879 (93 percent)
Other species	807	850[1]
Total	13,102	11,729

[1]Includes species sold for animal food.

The bulk of the commercial catch in Lake Superior is made up of chubs, herring, smelt, and whitefish. Lake Michigan contributed alewives, chubs, whitefish, carp, salmon, and smelt. The commercial fishery in Lake Huron, particularly in U.S. waters, has virtually collapsed–carp now contribute the greatest poundage. Yellow perch from Saginaw Bay and whitefish from Ontario waters make up most of the remainder. Lake Erie contributes most of the perch, smelt, sheepshead, white bass, and catfish to the total commercial catch from the Great Lakes. The commercial catch from Lake Ontario is relatively small and no species contributes as much as a million pounds. Carp, yellow perch, and white perch make up most of the catch.

Sport Fishing

Sport fishing on the Great Lakes has been important for many years. Generally speaking, the activity has been confined to bays, estuaries, and around islands. A few examples will suffice: the walleye fishery in northern Green Bay (Bay de Noc), Wisconsin's Door Peninsula, the perch fishery from piers and breakwaters along the eastern shore of Lake Michigan, the fishery for small-mouth bass, perch, and walleyes around the islands in the western basin of Lake Erie. In addition, many tributary rivers annually attract substantial spawning runs of steelhead (rainbow) trout and walleyes. Until about 1965, the recreational fishery on the Great Lakes was of secondary importance in the planning of agencies having jurisdictional responsibility for the fishery resource. To a considerable degree the commercial fishery was of paramount concern. About 1965, there occurred an important policy shift, particularly in U. S. waters, and the recreational fishery assumed a major role in agency planning and programs.

The return of the first coho "jacks" in the fall of 1966 and the first adults in 1967 provided a tremendous stimulus to the sport fishery, although the sport fishery for lake trout in Lake Superior had begun to expand 2 or 3 years earlier.

Information on salmonid angling summarized in Table 5 is indicative of the magnitude of the sport fishery in Michigan waters of the Great Lakes. Not included in the table is an estimated catch of 14.3 million non-game (perch, suckers, smelt, etc.) and 1.1 million other game fish (bass, walleyes, and pike).

About 1967, the State of Michigan began to develop and test methods for obtaining economic data and yield statistics for the Great Lakes sport fishery. Initial efforts were concentrated on the salmon and lake trout fishery in Lakes Michigan, Superior, and Huron, and their tributaries. In 1970, the effort was expanded to cover the entire sport fishery on Michigan's Great Lakes waters. Postcard surveys have been the primary means of obtaining the estimates. Concurrently, other states and Ontario, initiated efforts to obtain quantitative data on the Great Lakes sport fisheries.

Table 5. Angling effort and catch (in thousands) Michigan waters of Lakes Michigan, Superior, and Huron, 1969 and 1970.

1969	Michigan	Superior	Huron	Total
Angler days	1,217	352	221	1,790
Catch				
Lake trout	93	172	1	266
Steelhead	167	37	20	224
Coho	269	60	34	363
Chinook	109	7	1	117
Total	638	276	56	970
1970				
Angler days	2,275	432	1,091	2,798
Catch				
Lake trout	245	172	1	418
Steelhead	231	29	33	293
Coho	542	41	83	666
Chinook	172	3	19	194
Total	1,190	245	136	1,571

Lamprey control and a greatly expanded salmonid planting program have encouraged the development of a valuable and expanding sport fishery, especially in Lakes Michigan and Superior where lamprey control and resource rehabilitation are most advanced. The sport fishery is now, and will continue to have major influence in planning for management of the fishery resource. It is, therefore, imperative that biological and statistical data be obtained for rational management.

APPENDIX B

SUMMARY OF LAKE TROUT AND SALMON PLANTINGS

Intensive annual plantings of hatchery-reared salmonids continue to be the principal method employed to rehabilitate the Great Lakes fisheries.

Lake trout have been planted annually in Lake Superior since 1958 and in Lake Michigan since 1965. The 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 and nearly all 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, respectively.

Kokanee plantings have been made in Lake Huron and Lake Ontario since 1965 by the Ontario Department of Lands and Forests. Plantings have consisted of 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 1969 plantings in these lakes.

Coho salmon have been planted annually in Lakes Superior and Michigan since 1966, and in Lakes Huron, Erie, and Ontario since 1968. Annual plantings of chinook salmon have been made in Lakes Superior and Michigan since 1967, in Lake Huron since 1968, and in Lake Ontario since 1969. Coho have been planted during the spring as yearlings and the chinook during the spring as fingerlings. Table 7 summarizes the annual coho plantings for each lake, and Table 8 the chinook plantings.

Plantings of highly selected yearling splake (brook trout-lake trout hybrids) in Lake Huron were initiated in Ontario waters in 1969 and in Michigan waters in 1970 (Table 9). These plans marked the beginning of efforts to establish a self-sustaining population of splake in Lake Huron.

Table 1. Plantings (in thousands) of lake trout in Lake Superior, 1958-1970.

Year	Michigan	Wisconsin	Minnesota	Ontario	Total
1958	298	184	–	505	987
1959	44	151	–	473	667
1960	393	211	–	446	1,050
1961	392	314	–	554	1,260
1962	775	493	77	508	1,853
1963	1,348	311	175	477	2,311
1964	1,196	743	220	472	2,632
1965	827	448	251	468	1,993
1966	2,218	377	257	450	3,302
1967	2,059	244	228	500	3,031
1968	2,260	344	377	500	3,481
1969	1,860	251	216	500	2,828
1970	1,944	204	226	500	2,874
Total	15,614	4,275	2,027	6,353	28,269

Table 2. Plantings (in thousands) of lake trout in Lake Michigan, 1965-1970.

Year	Michigan	Wisconsin	Illinois	Indiana	Total
1965	1,069	205	–	–	1,274
1966	956	761	–	–	1,717
1967	1,118	1,129	90	87	2,424
1968	855	817	104	100	1,876
1969	877	884	121	119	2,000
1970	875	900	100	85	1,960
Total	5,750	4,696	415	391	11,252

Table 3. Plantings of lake trout in Lake Superior, 1970.

Location		Numbers	Fin clip
Michigan waters			
Porcupine Mountains		279,420	adipose-left ventral
Little Traverse Bay		283,700	"
Baraga		104,960	"
Pequaming		106,640	"
Huron Bay		155,100	"
Big Bay		100,000	"
Loma Farms		264,600	"
Marquette		178,000	"
Laughing Whitefish Pt.		200,000	"
Grand Marais		106,570	"
Pendills Bay		77,600	"
Whitefish Bay		87,800	"
	subtotal	1,944,390	
Wisconsin waters			
Bayfield		103,490	adipose-both ventrals
Apostle Islands		100,070	"
	subtotal	203,560	
Minnesota waters			
Grand Marais		49,810	adipose
Little Marais		17,670	"
Split Rock		18,540	"
Two Harbors		19,210	"
Palmers		70,960	"
Hovland		50,000	"
	subtotal	226,190	
Ontario waters			
Old Woman River-Gargantua R.		125,000	adipose-right pectoral
Dog River to Pukashaw		125,000	"
Craigs Pt. to Ashburton Bay		125,000	right pectoral-left ventral
Schreiber to Rossport		125,000	"
	subtotal	500,000	
	Total	2,874,140	

Table 4. Plantings of lake trout in Lake Michigan, 1970.

Location		Numbers	Fin clip
Wisconsin waters			
Algoma to Kewaunee		300,000	adipose-right ventral
Manitowoc		100,000	"
Sheboygan		100,000	"
Sturgeon Bay		200,000	"
Milwaukee Reef		200,000	"
	subtotal	900,000	
Michigan waters			
Escanaba		90,000	adipose-right ventral
Seul Choix Pt.		100,000	"
Petoskey		100,000	"
Charlevoix		50,000	"
Grand Traverse Bay (East Bay)		50,000	"
Grand Traverse Bay (West Bay)		100,000	"
Frankfort		50,000	"
Big Sable Pt.		100,000	"
Pentwater		100,000	"
Port Sheldon		135,000	"
	subtotal	875,000	
Indiana waters			
Bethlehem Steel Dock		85,000	adipose-right ventral
Illinois waters			
Great Lakes Naval Dock		100,000	adipose-right ventral
	Total	1,960,000	

Table 5. Plantings (in thousands) of kokanee salmon in Lake Huron and Lake Ontario, 1965-1970.

Year	Eggs	Fry	Fingerlings	Total
Lake Huron				
1965	805	825	288	1,918
1966	923	644	261	1,828
1967	–	1,026	147	1,173
1968	–	185	59	244
1969	–	321	43	364
1970	–	3,400	–	3,400
Total	1,728	6,401	798	8,927
Lake Ontario				
1965	323	772	2	1,097
1966	–	1,389	–	1,389
1967	–	1,412	–	1,412
1968	–	228	–	228
1969	–	334	20	354
1970	–	806	45	851
Total	323	4,941	67	5,331

Table 6. Plantings (in thousands) of kokanee salmon in Lake Huron and Lake Ontario, 1970.

Location	Fry	Fingerlings	Total
Lake Huron			
Saugeen River	400		
Willow Creek	150		
Sauble River	240		
South Bay		50	
Sydenham River	175		
Indian Creek	80		
Pottawatomi River	160		
Isthmus Bay	250		
Colpoy Creek	175		
Oxenden Creek	175		
Mallory Beach	150		
Nottawasaga River	293		
Nameless Creek	98		
Sturgeon River	195		
Magnetawan River	581		
Kagawong Creek	80		
Elizabeth Bay	135		
Total	3,337	50	3,387
Lake Ontario			
Shelter Valley Creek	806	45	851

Table 7. Plantings (in thousands) of coho salmon in the Great Lakes, 1966-1970.

Location	1966	1967	1968	1969	1970
Lake Michigan					
Michigan waters					
St. Joseph River				100	100
Kalamazoo River				100	100
Grand River				100	200
Muskegon River			220	11	202
Pere Marquette River			98	100	–
Little Manistee River		433	148	700	550
Manistee River			74	100	100
Bear Creek	395	750			
Big Sable River					200
Platte River	265	503	308	1,092	778
Brewery Creek			101	100	200
Porter Creek			50	50	75
Bear River			52	300	277
Black River					50
Manistique River				50	50
Thompson Creek		46	25	27	73
Whitefish River			100	162	75
Hay Meadow Creek					25
Big Cedar River				62	50
Menominee River					50
Subtotal	660	1,732	1,176	3,054	3,155
Wisconsin waters					
Little River				40	50
Ahnapee River			25	45	57
Kewaunee River				40	50
Two Rivers					25
Oak Creek					50
Manitowoc River				46	50
Sheboygan River				46	58
Subtotal			25	217	340
Indiana waters					
Little Calumet River					10
Trail Creek					38
Subtotal					48
Illinois waters					
Chicago				10	
Waukegan					10
Subtotal				10	10
Total	660	1,732	1,201	3,281	3,553

Table 7. (continued)

Location	1966	1967	1968	1969	1970
Lake Huron					
Michigan waters					
Carp River			50	100	100
Thunder Bay River			100	150	100
AuSable River			75	217	236
Tawas River			177	200	60
Diamond Creek					25
Elk Creek					25
Lakeport Creek					25
Total			402	667	571
Lake Superior					
Michigan waters					
Sucker River			40	50	50
Anna River			175	226	150
Cherry Creek			25		
Dead River					75
Big Huron River	192	467			
Falls River			60	50	82
Sturgeon River				75	100
Ontonogan River			50	75	
Presque Isle River			32	50	50
Subtotal	192	467	382	526	507
Minnesota waters					
French River				110	31
Beaver River					11
Grand Portage Creek					25
Subtotal				110	67
Ontario waters					
Jackpine River				11	31
Gravel River				9	
Subtotal				20	31
Total	192	467	382	656	605

Table 7. (continued)

Location	1966	1967	1968	1969	1970
Lake Erie					
Ohio waters					
Huron River				28	95
Chagrin River			30	31	40
Conneaut River				28	74
Kelly Island					10
South Bass Island				5	35
Subtotal			30	92	254
Pennsylvania waters					
Trout Creek			34	30	43
Godfrey Run			20	60	75
Grimshaw Run			15	19	10
Elk Creek			7		32
Walnut (Bear) Creek				21	25
Orchard Beach Creek				2	4
Six Mile Creek				2	8
Unnamed Creek			10		
Subtotal			86	133	198
New York waters					
Dunkirk Harbor					20
Eighteen Mile Creek					24
Cattaraugus Creek			5	10	20
Subtotal			5	10	64
Total			121	235	516
Lake Ontario					
New York waters					
Pulaski Pond			41		250
Oak Orchard Creek				20	
Little Salmon River				89	
Sterling Creek					50
Subtotal			41	109	300
Ontario waters					
Credit River				90	100
Humber River				20	25
Bronte Creek				20	20
Subtotal				130	145
Total			41	239	445

Table 8. Plantings (in thousands) of chinook salmon in the Great Lakes, 1967-1970.

Location	1967	1968	1969	1970
Lake Michigan				
Michigan waters				
Little Manistee River	591	322	300	309
Muskegon River	211	365	352	500
Grand River	–	–	–	466
Big	–	–	–	100
Bear River	–	–	–	200
Menominee River	–	–	–	100
Subtotal	802	687	652	1,675
Wisconsin waters				
Strawberry Creek	–	–	66	119
Illinois waters				
Chicago	–	–	–	10
Indiana waters				
Little Calumet River	–	–	–	50
Trail Creek	–	–	–	50
Subtotal	–	–	–	100
Total	802	687	718	1,904
Lake Superior				
Michigan waters				
Big Huron River	33	–	–	–
Cherry Creek	–	50	–	–
Anna River	–	–	50	–
Dead River	–	–	–	50
Sturgeon River	–	–	–	100
Total	33	50	50	150
Lake Huron				
Michigan waters				
Ocqueoc River	–	200	200	–
Thunder Bay River	–	74	45	100
Mill Creek	–	–	5	40
AuSable River	–	–	5	503
Total	–	274	255	643

Table 8. (continued)

Location	1967	1968	1969	1970
Lake Erie				
Ohio waters				
Chagrin River	–	–	–	65
Huron River	–	–	–	65
Kelley Island	–	–	–	20
Total	–	–	–	150
Lake Ontario				
New York waters				
Little Salmon River	–	–	65	–
Salmon River	–	–	–	141
Total	–	–	65	141

Table 9. Plantings (in thousands) of splake in Lake Huron, 1969-1970.

Location	1969	1970	Total
Ontario waters			
Meaford	30		30
South Bay	5	61	66
Vail Point		94	94
Douglas Point		49	49
Howdenvale		43	43
Subtotal	35	247	282
Michigan waters			
Cheboygan		43	43
Total	35	290	325

APPENDIX C

LAMPREY CONTROL IN THE UNITED STATES

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U.S. Fish and Wildlife Service

The number of spawning-run sea lampreys taken at the 16 barriers on the U.S. streams of Lake Superior declined in 1970. The final count of 5,690 was 3,643 (39%) less than in 1969 and the third-lowest count since the beginning of chemical control in 1958; it was 91% below the peak of 66,701 in 1961. The average size of sea lampreys caught at the barriers was slightly larger than in 1969, and the number of males in the catch increased from 27.2 to 35.2%.

Stream treatments continued on schedule; a total of 61 streams were treated in the upper 3 Great Lakes. Treatments of 6 streams originally scheduled for fiscal year 1970, of which 3 are major producers of sea lamprey ammocetes, were deferred until calendar year 1971.

Surveys and chemical treatments

Lake Superior surveys. Budget restrictions delayed survey of Lake Superior tributaries until July; however, surveys were completed on 16 streams scheduled to be treated during the 1970 and 1971 field seasons. The assessment of ammocete populations was de-emphasized to allow more time for selecting chemical application sites and determining the status of tributaries in which no ammocetes were found before 1970. Significant numbers of larvae were present in the Two Hearted River, which was later treated, and in the Rock, Traverse, and Ontonagon Rivers, which are scheduled for treatment in 1971. Populations in the remaining 12 streams appeared to be small to moderate. Surveys conducted on 21 streams that had produced relatively small numbers of sea lamprey larvae in the past, to determine whether lampreys had become reestablished, yielded no lampreys in 14 streams and small to moderate numbers in 7. Three untreated streams where very few larvae were taken in previous surveys were rechecked. No sea lampreys were found in the Cranberry River (Bayfield County) or the Hurricane River. Two larvae (41 and 103 mm long) were taken from the Gooseberry River. Twenty-nine streams with no record of sea lamprey production were reexamined but no new populations were discovered. Included in this work was a recheck of the main channel of the St. Louis River, where granular Bayer 73 was applied to 47,500 square feet of habitat at 17 stations.

Spawning surveys were confined to the Bad River. Forty-four nests were found, as compared with 61 in 1969, 107 in 1968, 51 in 1967, 38 in 1966, 44 in 1965, and 189 in 1964. Visibility was good in the stream, but the index areas were visited only once (June 23), because the time that could be spared for the work was limited. In 1964-69, the areas were checked several times during the spawning period to obtain a more reliable count of total nests constructed.

Lake Superior chemical treatments. Chemical treatment did not begin until June 30 because the treatment schedule for fiscal year 1970 had been completed during the fall of 1969. Ten streams with a combined flow of 1,113 cfs were treated during the last 6 months of 1970 (Table 1). The treatment of 8 streams by July 1, 1971, will complete the treatment schedule for fiscal year 1971.

Two of the 10 treatments had not been scheduled—one on the Falls River and the other on the Bismark Creek delta of Harlow Lake. The Falls River was suspected of harboring a population of sea lamprey ammocetes on its delta, where standard survey techniques were not effective. The treatment revealed a small population of sea lamprey ammocetes and 1 transforming young adult. The Bismark Creek delta treatment was part of a continuing study of lamprey orientation in lakes. Although Harlow Lake was a refuge for sea lamprey ammocetes during past treatments, applications of Bayer 73 granules synergized with TFM had eliminated the population in the Bismark Creek delta. To test the orientation of sea lamprey ammocetes to stream mouths or deltas in a lake environment, 476 marked ammocetes were introduced into the center of 75-acre Harlow Lake on July 21, 1970. A treat-

Table 1. Details on the application of lampricides to tributaries of Lake Superior in 1970.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm) Minimum effective	Concentration (ppm) Maximum allowable	TFM (pounds)	Bayer 73 (pounds)
Little Garlic River	June 30	6	2.0	5.0	106	–
Little Two Hearted R.	July 9	40	1.5	4.0	371	–
Two Hearted River	July 12	240	2.0	6.0	2,990	–
Betsy River	July 23	160	1.0	3.0	653	–
Chocolay River	Aug. 4	130	2.0	6.0	1,936	–
Laughing Whitefish R.	Aug. 11	8	3.0	7.0	281	–
Deer Lake Outlet[1]	Aug. 13	–	–	–	–	4.0
Sturgeon River	Aug. 20	475	2.0	5.0	3,993	35.5
Falls River	Aug. 23	48	3.0	6.5	260	–
Harlow Creek[1]	Aug. 25	3	3.0	6.0	21	6.0
Harlow Creek[1]	Oct. 26	3	3.0	6.0	22	7.5
Total		1,113	–	–	10,633	53.0

[1]Delta treatments.

ment of the delta with Bayer 73 granules on August 25 produced 2 marked ammocetes, and a treatment on October 26 produced 1.

The deltas of the Sturgeon and Otter Rivers in Otter Lake were treated with Bayer 73 granules in conjunction with the TFM treatments. Sea lamprey ammocete populations were small on both deltas. The Otter River delta collections included 1 transforming sea lamprey.

Collections during treatment indicated that small ammocete populations had become reestablished in all streams except the Sturgeon River. Here, the collections indicated only moderate reestablishment, but because of the river's large size the total number of ammocetes was large. The relative scarcity of survivors from previous treatments indicated that the treatments were successful.

Lake Michigan surveys. Surveys were conducted on 36 Lake Michigan tributaries scheduled for chemical treatment in 1970 and 1971. Populations of sea lamprey ammocetes were relatively high in 3 of the larger streams (the Platte, Whitefish, and Ford Rivers), moderate in 7 streams, small in 23, and apparently lacking in 3 (surveys in 2 of the 3–the Manistique and Menominee Rivers–were restricted to areas above dams, however; populations below the dams are known to be sizable, from surveys made in 1969).

Forty-six streams were examined to assess reestablished sea lamprey populations. The relative abundance of sea lamprey larvae was high in 7 streams (Jordan, Betsie, Manistee, Little Manistee, Pere Marquette, White, and Muskegon Rivers), and ammocetes in 5 of these exhibited rapid growth rates and the capacity for early metamorphosis (Table 2). These and other tributaries with populations that may have a reduced larval life-span are being monitored semiannually (spring and fall) to insure treatment before metamorphosis occurs. Populations were small to moderate in 21 streams and lacking in 18.

Surveys of 50 streams where sea lamprey ammocetes had not been found resulted in the collection of 1 larva (60 mm long) from the estuary of the Bear River in Emmet County. Only native lampreys were found during continued work on the Fox River in northeastern Wisconsin, but some sections of the system have not yet been thoroughly checked. No larvae were found in resurveys of 2 untreated streams that had very small populations of sea lampreys in the past.

Table 2. Mean length (mm) and range (in parentheses) of sea lamprey ammocetes collected in October 1970.

Stream	Age		
	0	I	II
Betsie River	29 (22-39)	58 (45-72)	90 (73-117)
Manistee River	42 (29-52)	86 (65-118)	–
Little Manistee River	28 (23-37)	67 (46-89)	100 (76-120)
White River	44 (32-64)	–	–
Muskegon River	48 (30-59)	–	–

Surveys for spawning adults and nests were conducted on 4 Lower Peninsula streams in June to evaluate spawning intensity, locate preferred spawning areas, and provide a reference for comparative data in future years. Spawning was noted in 3 streams; 63 nests and 52 adults were counted in the Carp Lake River, 26 nests and 19 adults in the Platte River, and between 10 and 20 nests and 1 adult in the Pentwater River.

Lake Michigan chemical treatments. A total of 24 streams, with a combined flow of 1,870 cfs, were treated (Table 3). Fifteen additional streams should be treated to complete the treatment schedule. Six of these are characterized by extremely rapid runoffs, and water flow is suitable for effective treatment during only very limited periods. Treatment was not feasible during the 1970 field season, but these streams will be given priority in 1971.

The Elk and Manistique Rivers were treated for the first time in 1970. The Elk River has a dam at its mouth that is a barrier to sea lampreys, but a limited area immediately below the dam provides spawning habitat for adults

Table 3. Details on the application of lampricides to tributaries of Lake Michigan in 1970.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		TFM (pounds)	Bayer 73 (pounds)
			Minimum effective	Maximum allowable		
Sugar Creek	April 29	12	4.0	10.0	155	–
Arthur Bay Creek	April 29	7	3.5	10.0	88	–
State Creek	May 2	13	3.0	6.0	120	–
Rogers Creek	May 3	14	3.0	7.0	75	–
Galien River	May 5	112	10.0	20.0	2,775	–
Platte River	July 19	481	5.0	12.0	6,286	20.0
Pt. Patterson Cr.	July 26	11	4.5	10.0	153	–
Crow River	July 28	22	9.0	19.0	457	–
Elk River	Aug. 4	–	–	–	–	33.0
Horton Creek	Aug. 6	17	8.0	14.0	690	37.5
Porter Creek	Aug. 6	7	8.0	17.0	210	5.0
Norris Creek	Aug. 14	6	4.0	10.5	184	–
Big Bear Creek	Aug. 16	6	5.0	12.0	165	–
Muskegon River[1]	Aug. 16	3	7.5	16.0	60	–
Black Creek	Aug. 17	20	6.0	14.0	480	–
Marblehead Creek	Sept. 1	1	4.5	10.5	89	–
Manistique River	Sept. 2	800	2.0	3.0	5,236	166.0
Sturgeon River	Sept. 17	160	4.0	8.0	3,211	5.0
Hudson Creek	Sept. 30	10	2.0	4.0	111	–
Milakokia River	Oct. 1	153	4.0	9.0	2,708	–
Johnson Creek	Oct. 4	1	3.0	7.0	22	–
Bursaw Creek	Oct. 5	8	2.0	4.0	200	–
Poodle Pete Creek	Oct. 5	3	3.0	7.0	67	–
Parent Creek	Oct. 6	3	3.0	7.0	67	–
Total		1,870	–	–	23,609	266.5

[1]Only Brooks Creek, a tributary, was treated.

and has harbored an ammocete population. Since a normal TFM treatment was not practical because the tail water of the dam is at lake level, the area was treated as a lentic environment; Bayer 73 granules were spread over it at the rate of 200 pounds per acre. The area will be surveyed in 1971 to determine the effectiveness of the treatment. The treatment of the Manistique River was complicated by a paper mill dam and aqueduct just above the lamprey-infected portion of the stream. To insure adequate mixing, the chemical was introduced above the mill and through it. During treatment, however, an emergency shutdown in the mill held the treated water from the lower river until dark. As a result, few ammocetes were collected and the ammocete population could not be accurately assessed. The spraying of Bayer granules over 3 dredged channels where the chemical did not penetrate yielded no ammocetes.

Significant fish kills occurred during the treatment of Sugar and Norris Creeks and the Crow and Manistique Rivers. White suckers were killed in Sugar Creek, brown trout in Norris Creek, brook trout in the Crow River, and walleyes, northern pike, and coho salmon in the Manistique River. Mortality was severe only in Norris Creek.

The periodic sampling of the industrial water-intake screen on Pere Marquette Lake at Ludington was discontinued when high lake levels flooded the screen house and collection basket. Attempts to collect young adult sea lampreys during the downstream migration period with similar equipment have not been successful.

Analysis of collections made during treatments indicates that moderate numbers of sea lamprey ammocetes were present in all treated streams except the Platte and Elk Rivers. Many sea lamprey ammocetes were collected from the estuaries of these 2 streams.

Lake Huron surveys. Pretreatment surveys on 31 Lake Huron tributaries indicated relatively large populations in 9 streams, the Pine (Mackinac County), Carp, Cheboygan, Pigeon, Sturgeon, Pine (Iosco County), and Au Sable Rivers, and Mulligan and Carp Creeks; small to moderate numbers of larvae in 19; and none in 3. Larval sea lampreys had not previously been found in the main channel of the Cheboygan River; 450 larvae (30-162 mm long) were collected below the dam and boat locks by using granular Bayer.

Surveys for reestablished populations on 13 streams treated during 1967-69 showed that sea lampreys were relatively abundant in the Devils, East Au Gres, and Rifle Rivers; common to rare in 5 other streams; and absent from 5 small streams last treated in 1967. In the Rifle River, the 1969 year class represented 71% of the 1,669 sea lampreys collected, indicating considerable spawning after the 1969 treatment (May 26 to June 25) or significant survival of young-of-the-year larvae during treatment. Seventy-two streams with no past record of larval sea lamprey infestation were resurveyed. Small populations were found in Grass Creek in Cheboygan County and Johnny Appleseed Creek in Presque Isle County (both were subsequently treated). An additional 78 negative streams were visually examined and classified according to capacity for production of ammocetes.

Data were recorded on volume, temperature, accessibility of the stream mouth to adult sea lampreys, spawning gravel, and ammocete habitat. This classification will be used to determine the need for, and frequency of, future surveys of marginal drainages.

Of 16 Lake Huron streams checked for adults and nests, evidence of relatively intensive spawning was found in 5—the Au Sable, East Au Gres, Rifle, and Cheboygan Rivers, and Green Creek. Water was high and turbid during the spawning period in the other streams.

Lake Huron chemical treatments. High water levels in streams and cold weather delayed the start of Lake Huron chemical treatments until mid-May. Thereafter, low water levels hampered control efforts until mid-September, when heavy rains raised water levels to flood stage. Despite the water-level problems, 27 streams with a flow of 2,059 cfs were treated (Table 4). Included were 7 initial treatments: the Au Sable River, Canoe Lake Outlet, and Nuns, Hessel, Martineau, Grass, and Johnny Appleseed Creeks. The Au

Table 4. Details on the application of lampricides to tributaries of Lake Huron in 1970.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm) Minimum effective	Concentration (ppm) Maximum allowable	TFM (pounds)	Bayer 73 (pounds)
Canoe Lake Outlet	May 14	10	6.0	12.0	110	5.0
Caribou Creek	May 14	14	3.5	7.5	308	–
Carr Creek	May 14	3	2.0	6.0	44	–
Albany Creek	May 15	25	6.0	7.0	308	–
Steele Creek	May 16	8	3.5	10.0	129	–
Nuns Creek	May 16	22	3.5	10.0	351	–
Trout Creek	May 17	15	1.5	6.0	88	–
Prentiss Creek	May 17	20	3.5	10.0	370	–
McKay Creek	May 18	25	3.5	8.0	498	–
Beavertail Creek	May 19	30	3.5	10.0	794	–
Hessel Creek	May 20	11	6.0	12.0	172	4.5
Pine River	June 11	170	1.5	4.0	5,169	10.0
Martineau Creek	June 14	7	5.0	10.0	153	–
Carp River	June 16	190	3.5	12.0	4,192	20.0
Au Sable River	June 30	1,200	5.0	10.0	17,123	176.0
Green Creek	Sept. 2	1	–	–	–	15.5
Elliott Creek	Sept. 3	15	9.0	12.0	375	–
Mulligan Creek	Sept. 4	8	3.0	8.0	176	–
Black Mallard Creek	Sept. 6	20	9.0	13.0	242	22.5
Grass Creek	Sept. 6	5	7.0	14.0	77	–
Trout River	Sept. 18	15	11.0	14.0	613	–
Grace Creek	Sept. 21	15	–	–	–	10.0
Johnny Appleseed Cr.	Sept. 21	1	–	–	–	2.0
Schmidt Creek	Oct. 1	49	9.0	14.0	1,083	–
Swan Creek	Oct. 8	34	11.0	16.0	2,510	–
Little Munuscong R.	Oct. 15	50	3.0	7.0	925	–
Munuscong River	Oct. 18	96	4.5	9.0	3,699	5.0
Total		2,059	–	–	39,509	270.5

Sable River is a large stream which contained many sea lampreys, and the other 6 are small streams that contained few. Twenty streams were re-treatments; 18 were treated for the second time and 2 for the third time. Three streams originally scheduled for fiscal year 1972, Schmidt Creek and Trout and Swan Rivers, were treated when low water levels prevented treatment on the only lamprey-producing tributary to the Saginaw River, and Mill and Rock Falls Creeks. The treatment of these 3 streams and the Pigeon and Sturgeon Rivers will complete the treatment schedule for fiscal year 1971.

Ammocete populations were large in 10 treated streams, moderate in 3, and small in 14. The absence of residual ammocetes in the re-treated streams attested to the success of the previous treatments. Fish mortalities were small in all streams except Nuns and Green Creeks. Many large spawning white suckers were killed in Nuns Creek and 50 large coaster brook trout and 20 splake in Green Creek. Bayer 73 had been used as a general toxicant in Green Creek because it was assumed that few fish were in the stream.

Lake Ontario surveys. In surveys of Lake Ontario tributaries, which continued in 1970 in cooperation with the New York State Department of Environmental Conservation, larval distributions were defined and tentative chemical application points established on 18 steams where sea lamprey larvae were found in 1969 and 2 where they were discovered in 1970 (Table 5). The infected streams are confined to the eastern one-third of the basin. Except for the Salmon River, the streams to be treated are short and have normal flows of 20 cfs or less. About 52 miles of the Salmon River and its tributaries will require treatment at an estimated total flow of 400 cfs. The Oswego River drainage was not examined recently, but sea lamprey ammocetes have been found in tributaries of Oneida, Cayuga, and Seneca Lakes, which are part of this system. Survey of the system will be a major undertaking.

Surveys of estuarine areas in the upper Great Lakes. Bayer 73 granules continue to be the most efficient means to survey deep and turbid water for sea lamprey ammocetes. Sea lampreys were collected in 12 of 46 such areas (estuaries, lakes, and deltas) were the granules were used: in 3 of 16 Lake Superior (each of the 3 have had sea lamprey ammocete populations); in 6 of 11 in Lake Michigan (1 of these, Bear River in Emmet County, was formerly a negative stream); and in 3 of 18 in Lake Huron (including the main channel of the lower Cheboygan River were larvae had not been taken before).

Studies of adult sea lampreys

Migrant sea lampreys in Lake Superior. Electric assessment barriers were operated on 16 streams along the south shore of Lake Superior between April 13 and July 13, 1970. The catch of adult sea lampreys declined to the third-lowest total since the beginning of chemical control in 1958 (Table 6). The total catch of 5,690 lampreys was 3,634 less than that

Table 5. U.S. tributaries of Lake Ontario in which sea lamprey ammocetes were collected in 1969-1970.

County (New York) and stream	Estimated stream flow (cfs)	Miles of stream to be treated	Probable size of sea lamprey population
Jefferson County			
Stony Creek	10	4	Small
South Sandy Creek	15	7	Small
Oswego County			
Skinner Creek	10	15	Moderate
Lindsey Creek	10	15	Moderate
Blind Creek	2	5	Small
Little Sandy Creek	10	13	Moderate
Little Deer Creek	10	20	Moderate
Salmon River	400	52	Large
Grindstone Creek	10	17	Moderate
Snake Creek	5	9	Moderate
Sage Creek	5	15	Moderate
Little Salmon River	20	8	Small
Butterfly Creek	1	6	Small
Catfish Creek	8	13	Small
Rice Creek	2	2	Small
Cayuga County			
Sterling Creek	10	10	Small
Wayne County			
Wolcott Creek	6	5	Small
Sodus Creek	5	3	Small
Third Creek	2	3	Small
First Creek	2	3	Small

in 1969 and 61,011 less than the record high of 1961. The first lamprey was captured in the Iron River on April 22, and the run rose slowly to a peak between May 31 and June 14. More than 47% of the run was captured during this 15-day period. The streams east of the Keweenaw Peninsula contributed approximately 60% of the total catch, even though the catch was 12% below the number taken in 1969. The catch west of the Keweenaw Peninsula decreased 63% from the catch in 1969 due to a reduction in the Brule River catch from 3,374 in 1969 to 167 in 1970. The major producers for 1970 were the Two Hearted River (1,132) in eastern Lake Superior and the Amnicon River (1,733) in the western end.

The Ocqueoc River weir on Lake Huron captured 736 adult sea lampreys, compared with 3,288 in 1969 and 3,418 in 1968. This figure is probably not indicative of the total run, however, due to a 5-day equipment breakdown during the height of the spawning run.

The average size of sexually mature sea lampreys caught at selected barriers increased slightly in 1970. The length and weight of sea lampreys increased from 41.9 cm and 164 g in 1969 to 43.1 cm and 176 g in 1970.

Table 6. Catches of adult sea lampreys for comparable periods from 16 Lake Superior streams, 1961-1970.

Stream	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Betsy River	1,366	316	444	272	187	65	57	78	120	87
Two Hearted River	7,498	1,757	2,447	1,425	1,265	878	796	2,132	1,104	1,132
Sucker River	3,209	474	698	386	532	223	166	658	494	337
Miners River	220	64	107	74	23	85	75	158	57	90
Furnace Creek	1,012	132	142	93	199	118	119	126	178	83
Rock River	3,660	399	353	229	237	158	439	498	138	667
Chocolay River	4,201	423	358	445	563	260	65	122	142	291
Iron River	2,430	1,161	110	178	283	491	643	82	556	713
Huron River	4,825	70	201	363	637	8	2	14	280	4
Silver River	5,052	267	760	593	847	1,010	339	1,032	1,147	321
Sturgeon River	427	397	1,445	375	135	259	43	132	46	26
Misery River	962	80	24	12	3	10	26	52	90	12
Firesteel River	1,118	70	178	327	11	15	9	25	14	11
Brule River	22,478	2,026	3,418	6,718	6,163	226	364	2,657	3,374	167
Middle River	3,502	311	48	45	52	17	19	22	8	16
Amnicon River	4,741	879	131	232	700	938	200	148	1,576	1,733
Total	66,701	8,826	10,864	11,767	11,837	4,761	3,362	7,936	9,324	5,690
Percentage of the 1958-61 mean	131	17	21	23	23	9	6	16	18	11

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The proportion of males in the catch increased from 27.2% in 1969 to 35.2% in 1970. The percentage of lamprey wounds on large rainbow trout declined slightly in 1970. Of 1,675 examined, 2.4% bore lamprey scars. Only in 1966 and 1967 was the scarring rate lower for a similar number of fish. The number of rainbow trout handled at 9 selected control barriers reached an all-time high in 1970. The number of white and longnose suckers remained near the average for the previous years.

Parasitic sea lampreys. A study initiated in August 1969 to learn more about the parasitic phase of lampreys in Lake Superior was expanded in August 1970 to include Lakes Michigan and Huron. Approximately 200 commercial and sport fishermen are collecting lampreys from the fish caught. A reward of $1 per lamprey is being offered. The fisheries have produced 592 sea lampreys, 5 silver lampreys, and 1 chestnut lamprey. The number of parasitic-phase sea lampreys collected is shown by lake and statistical district in Table 7.

The 299 sea lampreys collected from Lake Superior in 1970 bring the total since August 1969 to 368 sea lampreys and 3 silver lampreys. Of the sea lampreys, 50% were collected from fisheries west of the Keweenaw Peninsula, 38% east of the Keweenaw Peninsula, and 12% along the north shore of Minnesota and off Isle Royale. Females predominated (74% of the total number). Forty-seven of the 368 sea lampreys had very recently

Table 7. Number of parasitic-phase sea lampreys collected by lake and statistical district[1]

Lake Superior		Lake Michigan		Lake Huron	
District	Number	District	Number	District	Number
M-1	8	MM-1	4	MH-1	66
M-2	12	MM-2	0	MH-2	0
M-3	26	MM-3	36	MH-3	10
Wisc.	161	MM-4	0	MH-4	11
MS-1	7	MM-5	0	MH-5	0
MS-2	12	MM-6	0	MH-6	1
MS-3	56	MM-7	0	–	–
MS-4	68	MM-8	0	–	–
MS-5	2	WM-1	2	–	–
MS-6	16	WM-2	1	–	–
–	–	WM-3	21	–	–
–	–	WM-4	67	–	–
–	–	WM-5	5	–	–
–	–	WM-6	0	–	–
–	–	Ill.	0	–	–
–	–	Ind.	0	–	–
Total	368		136		88

[1]Boundaries are defined in "Fishery Statistical Districts of the Great Lakes" by S. H. Smith, H. J. Buettner, and R. Hile published in Great Lakes Fishery Commission Technical Report No. 2, 1961.

completed metamorphosis, and 41 of these were collected in two statistical districts—23 in MS-3 (off the Keweenaw Peninsula) and 18 in Wisconsin. The 12 lampreys taken in January 1970 from Lake Superior were the largest, averaging 43 cm and 190 g.

Collections from Lake Michigan since August totaled 136 sea lampreys and 1 chestnut lamprey. Ninety-three (68%) sea lampreys were collected from fisheries along the west shore, 36 (27%) along the north shore, and 7 (5%) in Green Bay; 70% of the lampreys were females.

In August-December 1970, 88 sea lampreys and 2 silver lampreys were collected from Lake Huron. Sixty-six (75%) sea lampreys were collected from fisheries along the north shore, 21 (24%) in the Saginaw Bay area, and 1 (1%) along the southwest shore. Females predominated (59% of the total).

Reestablishment of larvae in treated streams

Ammocetes of the 1969 year class were collected in 32 tributaries of Lake Superior and those of the 1968 year class in 49. The 1968 year class was found in more streams than any year class since that of 1961. Young-of-the-year sea lamprey larvae were recovered in the Pine River (Marquette County) for the first time since 1961. The Salmon-Trout River, adjacent to the Pine River, is infected with larvae of the 1968-70 year classes after being negative in 1965-67.

The collection of larvae of the 1970 year class is not far enough advanced to show trends in abundance. Ammocetes were recovered in 8 of 19 streams examined. Of 59 streams examined in 1970 as part of reestablishment or posttreatment surveys, 5 contained ammocetes that had survived recent chemical treatments. Residual ammocetes were found in the main steams of the Sucker, Potato, Traverse, Bad, and Cranberry Rivers. In addition, 33 residual larvar were found in East Bay, 3 in Beaver Lake, and 1 off the mouth of the Silver River.

Fifteen streams have remained free of reinfestation by sea lampreys for the 8-year period from 1962-69. Most are small, cold, spring-fed streams with limited lamprey habitat that originally contained only small populations of ammocetes. During the same period, 16 other streams have been reinfested with only one year class, or the ammocetes have failed to survive to age II. These 31 streams have little potential for producing transformed sea lampreys—except for the Middle and Firesteel Rivers, where reinfestation has been prevented by electric barriers.

Transforming sea lampreys were collected in the Amnicon and Sturgeon Rivers during experimental treatments with the chemical TFM-4B. The chemical was used because electric shockers are inadequate for collecting samples from low-density populations of metamorphosed sea lampreys. A total of 25 transformed sea lampreys were recovered in the 1½-mile test section of the Sturgeon River. Two previous experimental treatments covering 6 miles in 1968 and 1969 yielded only 5 larvae and no transformed sea lampreys, indicating an extremely small residual population. Most of the transforming lampreys fell within the range of lengths of the III-group larvae, strongly indicating that

some sea lampreys metamorphose at age III in the Sturgeon River. Five transformed sea lampreys were recovered during the experimental treatment of a 2-mile section of the Amnicon River. Of these, 3 were less than 150 mm long and may have transformed from the 3-year old, 1967 year class, which dominated the larval population in the stream.

Age and growth of larvae in Big Garlic River

The isolated population of larval lampreys established in the Big Garlic River in 1960 continues to provide information on the rate of growth, downstream drift, and number that metamorphose each year. The known-age population is now 11 years old and has produced transformed lampreys for 6 consecutive years (1965-70). Their longevity is thus more than twice that previously estimated for sea lampreys. The downstream trap on the river captured 648 transformed individuals in the fall of 1970, compared with 334 during the same period in 1969. In addition, 80 of 418 large larvae held in cages metamorphosed, bringing the total number of transformed lampreys to 728.

Movement of ammocetes to the downstream trap decreased considerably in 1970. Only 6,015 larvae were captured compared with 12,990 in 1969—a decrease of over 50%. During the 5 migration seasons (largely fall and spring), the following numbers of larval and transformed sea lampreys have been taken:

Period	Larval	Transformed
1965-66	7,684	4
1966-67	[1] 7,931	46
1967-68	10,728	229
1968-69	[1] 13,244	398
1969-70	6,075	358

[1] Corrected totals of previously published figures.

The parasitic-phase lampreys taken in 1970 had a mean length of 144 mm (range, 116-179 mm). A total of 379 age-X larvae collected in October to determine annual growth had a mean length of 121 mm (range, 90-177 mm)—an increase of 7 mm since October 1969. The unusually large increase of 7 mm is equal to the total mean growth of the larvae during the 3 previous years (1966-69).

Since 1962, 10,905 larvae have been marked and released in the river, a combination of colors and location of marks distinguish the time and place of release. Of 595 marked individuals captured on the downstream trap in 1970, 270 were larvae and 325 had transformed. Retention and recognition of marks in ammocetes remain good; metamorphosed lampreys, however, must be skinned to identify the marks because of the increase in pigment during transformation.

In June 1968, larvae with a mean length of 138 mm (range, 127-164 mm) were marked and released in the river to determine the percentage

transformation among these large lampreys. To date, 171 (31%) have been recaptured as transformed lampreys at the downstream trap. Of the total, 101 were recaptured in the fall of 1968 (length range, 123-156 mm), 29 in 1969 (120-152 mm), and 41 in 1970 (125-168 mm). The mean length of the group increased from 138 mm in 1968 to 145 mm in 1970.

The adult sea lampreys that bypassed the trap in 1967 through a channel opened by flood waters are confined by a falls to the lower one--fifth of the study area. Growth of the 1967 year class thus far has been slower than that of the 1960 year class. The 1967 year class at age III had a mean length of 69 mm (range, 55-86 mm) compared with a mean length of 80 mm (range, 52-134 mm) for the 1960 year class at age III. The suggestion is that a succeeding year class grows at a slower rate than the first year class in a stream, probably due to increased density. Length distributions of the 1960 and 1967 year classes are expected to overlap in 1971, despite the 7-year difference in age.

APPENDIX D

LAMPREY CONTROL IN CANADA

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

Resource and Development Branch
Department of Fisheries and Forestry of Canada

This report summarizes activities during the period April 1, 1970 to March 31, 1971 in compliance with a Memorandum of Agreement between the Department of Fisheries and Forestry of Canada and the Great Lakes Fishery Commission. The Department acts as agent for the Commission in carrying out sea lamprey control on the Canadian side of the Great Lakes. The sea Lamprey Control Centre of the Department's Resource Development Branch at Sault Ste. Marie, Ontario, carried out the control work.

Electrical Barrier Operations

The nine Canadian electrical assessment barriers on Lake Huron tributaries caught a total of 1,749 sea lamprey in the 1970 operating season, a 77 per cent reduction from the average of the previous three years (see Table I). A thirty-three day period when the Echo River barrier was inoperative probably accounted for a decrease of about 100 animals in the count of sea lamprey.

The count at the three North Channel barriers was slightly above the previous three year average, a fact which may reflect escapement of ammocetes during lampricide treatments which is known to have occurred in inaccessible parts of the Garden and Echo River systems. The three Georgian Bay barriers in aggregate captured only 17 per cent of the four previous years' average catch. The major sea lamprey producing streams in Georgian Bay had been treated in 1968. The three barriers in the main basin of Lake Huron caught only 16 per cent of the average catch of the three previous years. Although some sea lamprey rivers flowing into this section of the lake remained to be treated, the treatment in 1968 of four Lake Huron streams in the United States may be the reason for the decline in runs to these three barriers.

Stream Surveys

In Lake Superior 93 streams were surveyed during 1970. In the course of 50 routine surveys, one unnamed stream near Pearl River was found to have sea lamprey; however in 12 other small streams not previously surveyed

Table I. Numbers of sea lamprey taken at Lake Huron electrical assessment barriers from 1966 to 1970, showing the operating dates for 1970.

Streams	Count for the season					Operating Dates 1970
	1966	1967	1968	1969	1970	
North Channel Area						
Echo	526	458	195	337	161	May 1–July 15
Two Tree	20	22	6	7	0	Apr. 28–July 15
Kaskawong		82	239	478	482	Apr. 24–July 15
Totals	546	562	440	822	643	
Georgian Bay Area						
Still	1,820	1,839	6,154	1,621	558	Apr. 29–July 15
Naiscoot-Harris	968	1,635	1,336	785	173	May 8–July 15
Mad	324	333	413	42	8	May 9–June 30
Totals	3,112	3,807	7,903	2,448	739	
Lake Huron Area						
Manitou		637	597	144	3	May 14–July 15
Blue Jay		957	1,807	1,130	236	May 14–July 15
Bayfield	443	789	191	582	128	Apr. 23–June 30
Totals	443	2383	2595	1856	367	
GRAND TOTAL	4,101	6,752	10,938	5,126	1,749	

no sea lamprey were found. In 23 re-establishment surveys of previously-treated streams, only nine streams were found to have re-established sea lamprey populations. Post-treatment surveys on the streams treated in 1970 failed to produce sea lamprey–thus indicating successful treatments. Pretreatment surveys were carried out to delineate larval distribution in streams treated in 1970.

In Lake Huron a total of 26 streams were surveyed. Routine surveys of six rivers failed to produce sea lamprey; re-establishment surveys of nine streams located ammocetes in five, and post-treatment surveys of ten rivers treated before 1970 failed to locate any residual sea lamprey. Pretreatment surveys were carried out on the streams treated in 1970.

In order to accelerate the advance of lamprey control to Lake Ontario, a co-operative program of re-surveys of streams tributary to Lake Ontario was performed by the Ontario Department of Lands and Forests under general direction from the Sea Lamprey Control Centre. Sea lamprey were found in two watersheds where they were previously undetected, bringing to 23 the number of known sea lamprey streams.

As the stream treatment program advances from one lake to another, the sources of sea lamprey ammocetes for use as bioassay specimens become increasingly scarce and more remote. The practice of using native species as test animals was discontinued when differences in their susceptibilities relative to sea lamprey were demonstrated. Because of the impending

shortage of sea lamprey, a survey team was dispatched to the Province of Quebec to investigate the possibility of obtaining sea-run lamprey ammocetes from tributaries of the St. Lawrence River. Approximately 400 specimens were collected from the St. Anne River, 60 miles west of Quebec City. Comparative bioassays indicated that these animals showed the same degree of susceptibility to TFM as do landlocked sea lamprey.

Lampricide Treatments

On Lake Superior, of 11 stream treatments originally planned, two were postponed–the Batchawana because of consistently high flows, and the White because of washouts in the control dam. Two other streams–Cranberry and Stokely Creeks–were added to the list of treatments after populations of sea lamprey were found in them during surveys. Table II shows details of the Lake Superior treatments in 1970. In a continuing effort to reduce recruitment to the offshore sea lamprey population in Batchawana Bay, 14 small streams flowing into the bay were also treated in 1970. Sea lamprey ammocetes were found in only two of these streams and are believed to be migrants from the lake.

Treatment-surveys with granular Bayer 73 were carried out in Batchawana and Haviland Bays, Lake Superior, in a continuing study of the extent of offshore population of sea lamprey in these areas. An area of 13,400 square feet off Chippewa River in Batchawana Bay and three areas totalling 75,000 square feet in Haviland Bay were surveyed.

On Lake Huron 13 treatments were originally scheduled but two rivers (Two Tree and Richardson's Creeks) were dropped when no sea lamprey were found in them during surveys. In addition the Saugeen River treatment was postponed because of delays in completing Denny's Dam and subsequently poor bioassay levels. A small tributary of Serpent River was added to the 1970 treatment schedule when transforming sea lamprey were found in it. Table III lists details of the 1970 lampricide treatments of Lake Huron streams.

Sea Lamprey from the Commercial Fishery

During 1970, 2,523 feeding phase sea lamprey together with relevant catch data were purchased from commercial fishermen. Most of the specimens came from Lake Ontario, the next largest collection was from Lake Huron while relatively few were from Lakes Superior and Erie. Sea lamprey from offshore commercial catches, as in former years, were characterized by (1) a predominance of females, and (2) a size segregation according to mesh-size of gear and size of prey (larger lamprey on larger fish in larger mesh).

Sea Lamprey from Humber River, Lake Ontario

The individual who has collected adult sea lamprey under contact since 1968 in the Humber River, caught a total of 2,185 specimens in 1970,

Table II. Summary of streams treated with lampricide on the Canadian side of Lake Superior, 1970.

Name	Date – 1970	Flow (cfs)	TFM lbs. active ingredient	Bayer 73 lbs. active ingredient	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream miles treated
Sable	June 16-17	35	186	6.9	34	Moderate	4.9
Wolf	July 13-14	158	1,914	36.8	206	Moderate	10.0
Big Gravel	July 17-18	186	1,402	25.9	8	Scarce	10.0
Pearl	July 21-22	31	296	5.5	145	Abundant	2.1
Cranberry	Aug. 6-11	6	39	–	–	Scarce	4.5
Stokely	Aug. 10-12	16	107	–	5	Scarce	7.0
Chippewa	Aug. 13-14	215	940	18.2	–	Scarce	1.8
Black Sturgeon	Aug. 25-28	305	2,366	47	12	Scarce	10.0
Michipicoten	Aug. 29–Sept. 1	1,948	9,328	162.4	–	Moderate	14.8
Pigeon	Sept. 2-3	174	1,267	24.9	–	Moderate	3.0
Nipigon	Sept. 6-8	1,250 (Aug.)	17,267	449.1	20	Scarce	8.0
Totals		4,324	35,112	776.6	430		76.1

Table III. Summary of streams treated with lampricide and Bayer 73 on the Canadian side of Lake Huron, 1970.

Name	Date – 1970	Flow (cfs)	TFM lbs. active ingredient	Bayer 73 lbs. active ingredient	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream miles and/or area treated
Bayfield	May 14-17 June 8-9	90	721	6.8	7.5	Moderate	24.9 / 300*
Brown's	May 20-21	7	58	–	–	Moderate	2.0
Gordon's	May 21-22	3	29	–	–	Moderate	0.8
Watson's	May 26	6	37	–	5.0	Abundant	0.5 / 225*
Kaskawong	May 28-31	18	261	–	–	Moderate	6.4
Sauble	June 15-17	104	3,286	30.5	–	Moderate	2.2
Root	July 2, 3, 6-10, 21, 29	36	477	–	848.5	Scarce	31.6 / 6.6A
Garden	July 16-18, Aug. 10-18	200	2,543	82.6	40.0	Abundant	46.9 / 2,000*
Gawas	July 29-31	7	130	2.2	–	Moderate	0.5
Muskoka	Sept. 22-24	277	1,968	–	–	Scarce	2.5
Serpent tributary	Oct. 14-15	8	80	–	12.0	Abundant	2.5
Totals		756	9,590	122.1	913.0		120.8 miles 2,525* 6.6A

*Area in sq. ft. treated with granular Bayer 73 A acres

compared with 1,464 in 1969 and 1,191 in 1968. The sex ratio (1.1 males per female) in 1970 was not significantly different from that observed in the two previous years, and average sizes were also virtually unchanged.

Trawling for Sea Lamprey in St. Marys River

The local and temporary population of adult sea lamprey in St. Marys River was again fished by surface trawling at night. The same boat, gear and technique were employed in 1970 as in 1969. The catch of 0.5 sea lamprey per hour of trawling was only one-quarter of the 1969 figure, a difference which appears to reflect a real decrease in abundance in this population. Sex ratios were close to unity in 1970 as was the case in 1969.

Final Results of Sea Lamprey Tagging at Burnt Island

Of the 496 tagged sea lamprey released in 1969 at Burnt Island, on the south side of Manitoulin Island, 94 were recaptured before the end of 1969. Since the beginning of 1970 three additional tagged specimens were returned, all taken in commercial fishing gear, two in Lake Huron, south of Manitoulin Island, and one in the North Channel. No tagged lamprey were found in any of the electric assessment barriers, and it is assumed that none of them remained alive after the summer of 1970.

APPENDIX E

ADMINISTRATIVE REPORT FOR 1970

Meetings. The commission held its 1970 Annual Meeting in St. Paul, Minnesota June 16-18, and its Interim Meeting in Ann Arbor, December 1-2, 1970. Meetings of committees held prior to the Annual Meeting were as follows:

Lake Erie Committee, Detroit, Michigan, March 3-4
Lake Ontario Committee, Detroit, Michigan, March 4-5
Lake Michigan Committee, Milwaukee, Wisconsin, March 10
Lake Superior Committee, Milwaukee, Wisconsin, March 11
Lake Huron Committee, Milwaukee, Wisconsin, March 12
Sea Lamprey Control and Research Committee, Milwaukee, Wisconsin, March 13 and Hammond Bay, June 2-3
Finance and Administration Committee, St. Paul, Minnesota, June 15

The Commission also sponsored a meeting of biologists and biometricians in Ann Arbor, April 13-16, to discuss the development of models for estimating lamprey–induced mortality in populations of lake trout and associated species.

Officers and staff. At the close of the 1970 Annual Meeting, the Commission elected Mr. E. W. Burridge, Chairman and Dr. W. M. Lawrence, Vice-Chairman, It also approved the assignment of its members to various committees as follows:

Sea Lamprey Control and Research Committee
W. M. Lawrence, Chairman
C. H. D. Clarke

Management and Research Committee
F. E. J. Fry, Chairman
Claude Ver Duin

Scientific Advisory Committee
A. L. Pritchard, Chairman
C. H. Meacham

Finance and Administration Committee
E. W. Burridge, Chairman
L. P. Voigt

The only change in Commission members during 1970 was the resignation of C. H. Meacham in November. There was no changes in Commission staff in 1970.

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

The Commission depends heavily on existing agencies in the Great Lakes for information on which to base its recommendations and guide its sea lamprey control program. These requirements have increased in recent years and greater demands have been made on agencies, particularly for information on fish mortality caused by sea lamprey. The Commission staff has continually encouraged agencies to develop their capabilities in this area, and as a result considerable impetus was given these studies in 1970 by the Great Lakes Fishery Laboratory of the U.S. Bureau of Commercial Fisheries and the Ontario Department of Lands and Forests.

The Commission has encountered increasing difficulty obtaining funds required for effective control of lamprey in the Great Lakes and much of the Executive Secretary's time was spent in preparing program justifications and revising these when new budget levels were established.

The Assistant Executive Secretary continued to devote considerable effort towards promoting and expediting cooperation among fishery agencies carrying out management and research programs on the Great Lakes. He also 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 these agencies for the maintenance of hatchery brood stocks and the distribution of lake trout eggs and fry for rearing. Lake trout planting levels and locations were determined in cooperation with scientists 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 assisgned to evaluate experimental plantings of lake trout, coho and chinook salmon, and rainbow, brook, and brown trout.

In addition to regular duties, the Commission staff participated in several related activities in 1969. The Executive Secretary continued to serve as Secretary of the International Association for Great Lakes Research, and the Assistant Executive Secretary continued to serve on the Fish Work Group of the Great Lakes Basin Commission.

The Commission staff also participated in the following conferences and meetings:

International Association for Great Lakes Research
Tri-State Fisheries Conference
Lake Superior Advisory Committee
Lake Michigan Study Group
Ontario Council of Commercial Fisheries
Michigan Fish Producers Association
Wisconsin Commercial Fisheries Advisory Council

Accounts and audit. The Commission's accounts for the fiscal year ending June 30, 1970 were audited by Icerman, Johnson, and Hoffman of Ann Arbor. the firm's report is appended.

Contributions in fiscal year 1970. At its 1968 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research for fiscal year 1970 estimated to cost $1,833,700 and an administrative and general research budget of $64,400. The program was subsequently revised and estimates changed to $1,879,000 for sea lamprey control and research and $68,600 for administration and general research to adjust to increased appropriations provided by the United States and Canadian Governments.

Requests for funds and contributions in fiscal year 1970 were as follows:[1]

Sea Lamprey Control and Research	*United States*	*Canada*	*Total*
Commission request	$1,265,253	$568,447	$1,833,700
Appropriations	1,296,300	582,700	1,879,000
Credit	(-)3,558	(-)1,598	(-)5,156
	$1,292,742	$581,102	$1,873,844
Administration and General Research			
Commission request	$ 32,200	$ 32,200	$ 64,400
Appropriations	$ 34,300	$ 34,300	$ 68,600

Expenditures in fiscal year 1970. Sea lamprey control and research in fiscal year 1970 was carried out under agreements with the U.S. Bureau of Commercial Fisheries ($779,800) and the Canadian Department of Fisheries and Forestry ($435,950). In January, 1970 the Commission increased the amount paid to the Bureau to $904,800 enabling it to resume stream treatments on the United States shore of Lake Huron.

[1] All funds are disbursements stated in U.S. dollars.

The Bureau treated the 15 Lake Superior streams specified in the Memorandum of Agreement plus 4 additional streams (Sucker, Bad, Ontonogan, and Beaver Lake Outlet) where stream surveys detected ammocetes large enough to metamorphose. Assessment barriers were operated on 16 lamprey streams on Lake Superior during the 1970 spawning run.

On Lake Michigan, 11 of the 24 streams specified in the Agreement were treated plus 3 additional streams (Sugar, Arthur Bay, and St. Joseph River) which contained ammocetes large enough to metamorphose. Low water forced postponement of Ford, Cedar, Days, and Crow River; and Three Mile, Hibbards, Springer, Marblehead, and Pt. Patterson Creek.

On Lake Huron, the Bureau treated the 12 streams specified in the Agreement, plus 13 additional streams (Steels, Nuns, and Hessels Creeks).

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

After a final accounting of expenditures had been made, the Bureau returned in August, 1971, $7,851 in unexpended funds to the Commission.

The Canadian Department of Fisheries and Forestry treated 3 of the 4 streams specified in the Agreement. The Nipigon River was not treated because surveys indicated that it could be deferred. The Sand and Cloud Rivers were added to the schedule after lamprey were found during surveys.

On Lake Huron, 6 of the 7 streams specified in the Agreement were treated. The treatment of the Muskoka River, in lower Georgian Bay, was deferred because of the small number of ammocetes collected during surveys. Assessment barriers were operated on 9 Lake Huron streams during the 1969 spawning run. At the end of fiscal year 1970, the Canadian Department of Fisheries and Forestry refunded $5,547 in unexpended funds.

The Commission purchased 75,000 lbs. of lampricide (TFM) at $2.75 per pound and 77,100 lbs. at $2.90 per pound from the North American subsidiaries of Farbewerke Hoechst Ag., Germany. The American Hoechst Corporation delivered 105,00 lbs. to the Bureau of Commercial Fisheries and Hoechst Chemicals of Canada delivered 47,100 lbs. to the Canadian Department of Fisheries and Forestry.

The Commission also purchased 33,650 lbs. of Bayer 73 granules for surveys and treatments of estuaries and 900 lbs. of Bayer 73 powder to synergize TFM in certain treatments. The Bayer 73 granules were supplied by the Chemagro Corporation and the Bayer 73 powder by the Haviland Agricultural Chemical Company.

Receipts for administration and general research in fiscal year 1970 exceeded expenditures by $1,847 and the balance was credited to fiscal year 1971.

Program and budget for fiscal year 1971. At the 1969 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research of $2,472,400 for fiscal year 1971. A budget of $68,100 was adopted for administration and general research.

In January 1970, the Commission was advised that the contribution recommended by the United States was $388,050 less than requested. Accordingly the proposed program was reduced to remain within an anticipated budget of $1,910,100. Proposed increase in surveys, the establishment of special crews to treat problem areas, and the proposed extension of chemical control to Lake Ontario were eliminated. The reduced program also made it necessary to draw heavily on the lampricide reserve to complete the treatment schedule.

At its 1970 Annual Meeting, the Commission agreed to proceed with the following program for sea lamprey control and research based on a budget of $1,910,100.

Lake Superior–Re-treat 26 streams (15 in the United States and 11 in Canada) which have larval populations approaching transformation; routine examination of other streams to determine time for re-treatment; operate assessment barriers on 8 Lake Superior streams.

Lake Michigan–Treat 20 streams and continue routine surveys to determine when treatments on other lamprey-producing streams are required to prevent escapement of young lamprey to the lake.

Lake Huron–Treat 26 streams (12 in the United States and 14 in Canada); continue surveys; and operate assessment barriers on 10 lamprey-producing streams to assess changes in lamprey abundance.

Research–At Hammond Bay investigate the mode of action of lampricides, screen chemicals for irritants for use in surveys, study the mechanism of transformation and the factors that influence it; continue field investigations on the growth and transformation of re-established larval populations, and the age, growth, movements, and transformation of the experimental larval population in the Big Garlic River.

Agreements to carry out the program in fiscal year 1971 were made with the Canadian Department of Fisheries and Forestry ($653,800) and with the Bureau of Commercial Fisheries for the first quarter and the Bureau of Sport Fisheries and Wildlife ($1,094,950) for the remaining three-quarters of fiscal year 1971. Orders were placed with Farbewerke Hoechst Ag., Germany for 96,900 lbs. of the lampricide TFM at $2.90 per pound.

The Commission reviewed the administration and general research budget for fiscal year 1971 and authorized an increase of $1,900 raising the budget to $70,000 to cover salary increases to staff and additional travel by scientific advisors.

Program and Budget for fiscal year 1971. At its 1970 Annual Meeting, the Commission adopted a program for sea lamprey control and research in fiscal year 1972 estimated to cost $2,536,000 for extension of lamprey control to Lake Ontario and intensification of the program on the Upper Great Lakes. A budget of $76,900 was adopted for administration and general research.

Reports and publications. The Commission published an Annual Report for 1969. The results of investigations supported by the Commission appeared in the following reports.

"Metamorphosis of the landlocked sea lamprey, *Petromyson marinus*" by Patrick J. Manion and Thomas M. Stauffer. J. Fish. Res. Bd. Canada, 27(10):1735-1746.

"Growth, age at metamorphosis, and sex ratio of northern brook lamprey in a tributary of southern Lake Superior" by Harold A. Purvis, Copeia, 1970, No. 2:326-332.

ICERMAN, JOHNSON & HOFFMAN
Certified Public Accountants
303 National Bank and Trust Building
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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 17, 1970

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

We have examined the statements of receipts and expenditures and analysis of fund balance of the Great Lakes Fishery Commission Administration and General Research Fund and Lamprey Control Operation Fund for the year ended June 30, 1970. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying statements of receipts and expenditures and analysis of fund balance present fairly the cash balances of the designated funds of the Great Lakes Fishery Commission at June 30, 1970, 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, 1970

(in United States Dollars)

	Actual	*Budget*
Receipts		
Canadian Government	$34,300	$34,300
United States Government	34,300	34,300
Other	749	
Totals	$69,349	$68,600
Accounts receivable, June 30, 1970	(2,521)	
	$66,828	
Expenditures		
Salaries	$46,440	$46,950
Fringe benefits	5,299	5,450
Travel	4,443	4,000
Communication	1,374	1,300
Rents and utilities		50
Printing and reproduction	2,539	3,900
Other contractual services	1,013	1,150
General Research	4,638	4,600
Supplies	1,204	1,200
Equipment	−0−	−0−
Total expenditures	$66,950	$68,600
Excess of expenditures over receipts	$ 122	
Cash deficit, July 1, 1969	116	
Cash deficit, June 30, 1970	$ 238	
Analysis of Fund Balance		
Cash deficit, June 30, 1970	$ 238	
Accounts receivable, June 30, 1970	2,085	
Fund balance, June 30, 1970	$ 1,847	

Great Lakes Fishery Commission

Lamprey Control Operation Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1970

(in United States Dollars)

		Actual	*Budget*
Receipts			
Canadian Government (Note A)		$ 583,690	$ 582,700
United States Government		1,296,300	1,296,300
Refund from Canadian Department of Fisheries and Forestry		5,334	
Refund from United States Bureau of Commercial Fisheries		8,369	
Sale of lamprey		228	
Totals		$1,893,921	$1,879,000
Accounts receivable, June 30, 1969		18,579	
Accounts receivable, June 30, 1970		(114,394)	
Total cash receipts		$1,798,106	
Expenditures			
United States Bureau of Commercial Fisheries		$ 971,900	$ 971,900
Canadian Department of Fisheries (Note B)		454,771	453,800
Lampricide purchases		443,454	453,300
Totals		$1,870,125	$1,879,000
Accounts and obligations payable, June 30, 1969		89,498	
Accounts and obligations payable, June 30, 1970		(238,319)	
Total cash expenditures		$1,721,304	
Excess of receipts over expenditures		$ 76,802	
Cash balance, July 1, 1969		76,075	
Cash balance, June 30, 1970		$ 152,877	
Analysis of Fund Balance			
Cash balance, June 30, 1970			$ 141,898
Plus accounts receivable, June 30, 1970:			
Refund from Canadian Department of Fisheries	$ 5,334		
Refund from United States Bureau of Commercial Fisheries	7,498		
Supplement for FY 6-30-70 by United States Government	66,600		
Supplement for FY 6-30-70 by Canadian Government	30,220		
Refund on overpayment–Canadian Hoescht	4,742		114,394
			$ 256,292
Less accounts payable: June 30, 1970			238,319
Fund balance, June 30, 1970			$ 17,973

Note A – The Canadian Government has an overpayment of $996 for fiscal year 1970 which was withdrawn from refund unexpended funds.

Note B – $454,770 was retained by the Canadian Government for use by the Department of Fisheries. The balance of $128,920 was received by the Great Lakes Fishery Commission for the purchase of lampricide.

DEPARTMENT OF FISHERIES AND FORESTRY

Financial Report to Great Lakes Fisheries Commission

April 1, 1969 to March 31, 1970

Canadian Funds

Administration	$128,065.03
Chemical Control, Lake Superior	159,456.28
Barriers, Lake Huron	42,663.74
Chemical Control, Lake Huron	136,116.40
Trawling, St. Mary's River	215.92
Final Statement	$466,517.37
Superannuation Costs (6.5% of $244,110.94)	15,867.21
Total Expenditure for 1969-70	$482,384.58

Funds Provided by Commission

1969-70 Contract	$489,000.00
Less Costs Applicable to 1969-70	-482,384.58
Less Overpayment of Contribution (8996. U.S. $1.0725 exchange)	-1,068.21
Unexpended Balance	$ 5,547.21

NATIONAL MARINE FISHERIES SERVICE

SEA LAMPREY CONTROL AND RESEARCH PROGRAM

Report of Expenditures for all Activities
July 1, 1969, through June 30, 1970

	Funds programmed	Salaries	Expenses	Total	Unobligated balance
Program Costs					
Ann Arbor, Michigan (Laboratory)	$877,100.00	$698,733.00	$170,868.72	$896,601.72	$7,498.28
Washington, D.C.	27,700.00	26,444.41	903.02	27,347.43	352.57
General Administrative Expense Ann Arbor, Michigan	67,100.00	65,400.00	1,700.00	67,100.00	—0—
Totals	$971,900.00	$790,577.41	$173,471.74	$964,049.15	$7,850.85

NATIONAL MARINE FISHERIES SERVICE
SEA LAMPREY CONTROL AND RESEARCH PROGRAM

Report of Expenditures for all Activities
July 1, 1969, through June 30, 1970

	Funds programmed	Salaries	Expenses	Total	Unobligated balance
Program Costs					
Ann Arbor, Michigan (Laboratory)	$877,100.00	$698,733.00	$170,868.72	$896,601.72	$7,498.28
Washington, D.C.	27,700.00	26,444.41	903.02	27,347.43	352.57
General Administrative Expense Ann Arbor, Michigan	67,100.00	65,400.00	1,700.00	67,100.00	–0–
Totals	$971,900.00	$790,577.41	$173,471.74	$964,049.15	$7,850.85

COMMITTEE MEMBERS - 1970

[Commissioners in Italics]

SCIENTIFIC ADVISORY COMMITTEE

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

SEA LAMPREY CONTROL AND RESEARCH COMMITTEE

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

MANAGEMENT AND RESEARCH COMMITTEE

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

LAKE COMMITTEES

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

LAKE MICHIGAN	LAKE SUPERIOR	LAKE ERIE
W. H. Tody, Chm.	C. N. Lloyd, Chm.	D. J. Johnston, Chm.
R. E. Bass	G. C. Armstrong	D. C. Armbruster
W. J. Harth	H. O. Swenson	W. G. Bentley
C. N. Lloyd	H. J. Vondett	A. D. Bradford
		J. A. Scott