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ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1972

GREAT LAKES FISHERY COMMISSION

MEMBERS – 1972

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

1972

1451 Green Road

ANN ARBOR, MICHIGAN,

U. S. A.

1973

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 1972.

Respectfully,

E. W. Burridge, *Chairman*

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ANNUAL REPORT FOR 1972

INTRODUCTION

The Convention on Great Lakes Fisheries, ratified by the Governments of the United States and Canada in 1955, provided for the establishment of the Great Lakes Fishery Commission. The Commission was charged with responsibility for developing and coordinating fishery research programs, advising governments on measures to improve the fisheries, and developing and implementing measures to control the sea lamprey.

Throughout its first several years the Commission's major efforts were devoted to control of the sea lamprey and to coordination of lake trout rehabilitation. Programs developed to meet these objectives have, in the main, been very successful. Nevertheless, certain basic problems remain—the residual population of sea lampreys continues to be a source of mortality among larger salmonids which has thwarted the development of self-sustaining stocks of lake trout. Although natural reproduction by lake trout is gradually increasing, particularly in Lake Superior, the population is still mainly dependent upon plantings of hatchery-reared fish. To overcome these problems the Commission has intensified and refined its efforts to control sea lamprey. Major lamprey-producing streams are being treated more frequently and special efforts are being made to eradicate lamprey larvae in lentic areas where regular lampricide treatments are ineffective. Consideration is also being given to the development of an integrated lamprey control program utilizing: (1) permanent barrier dams in certain streams to prevent spawning migration of adult sea lampreys and to eliminate the need for continuing lampricide treatments; and (2) biological controls employing such techniques as pathogens, chemical sterilants, . . .etc. Cooperating state, federal, and provincial fishery agencies are being encouraged to increase their hatchery production of salmonid fishes and to possibly accelerate natural reproduction by increasing plantings on or in close proximity to former lake trout spawning grounds. Special efforts are also being made to assess natural recruitment of lake trout in Lakes Superior and Michigan.

As an adjunct to sea lamprey control, the Commission has undertaken in 1971 and 1972 a wide range of toxicity and residue chemistry studies of the lampricides TFM and Bayer 73 as required by the U.S. Environmental Protection Agency for re-registration.

With sea lamprey control and lake trout rehabilitation having attained operational status, the Commission has in the past few years been able to devote more attention to other problems of vital and immediate concern. Recognizing that ultimately the welfare of the basin's fisheries resource depends upon maintaining an environment of the highest possible quality, the Commission, with the support of other fisheries agencies, is endeavoring to develop closer liaison with other governmental agencies who have direct responsibility in water quality, pollution abatement, and land use. The Commission believes that all users will be served if fisheries interests receive proper consideration in the planning and decision making process. Through the years of its existence, the Commission has encouraged close cooperation among state, provincial, and federal fisheries agencies on the Great Lakes, particularly the eight bordering states and the Province of Ontario, who have jurisdiction in their respective waters. Many, and probably most, of the fisheries problems are of concern to all agencies. The development of integrated and mutually acceptable management programs, supported by adequate biological and statistical information, is vital to all agencies and the Commission is pleased to see significant progress in the past few years. The efforts of special inter-agency groups to summarize, evaluate, and recommend action toward the solution of particular problems have been especially noteworthy.

The Commission's Annual Meeting was held in Milwaukee, Wisconsin, June 14-16, 1972 and its Interim Meeting convened in Ann Arbor, Michigan, December 5-6, 1972.

ANNUAL MEETING

PROCEEDINGS

The seventeenth Annual Meeting of the Great Lakes Fishery Commission was held in Milwaukee, Wisconsin, June 14-16, 1972.

A special welcome was given to Commissioner Nathaniel P. Reed, Assistant Secretary for Fish and Wildlife and Parks, United States Department of the Interior, who had been appointed to the United States Section of the Commission by President Nixon on November 4, 1971.

In enumerating some of the more important activities carried on by the Commission and cooperating agencies in 1972, the Chairman commented on the sheer physical magnitude of the Great Lakes with some 95,000 square miles of water surfaces and 295,000 square miles of drainage basin. This vast area, in the heartland of the continent, contains 29,000,000 people, or about 13 percent of the 226,000,000 people that dwell in the United States and Canada. Intimate association with this tremendous resource is an awesome responsibility.

A deteriorating environment, made manifest by accelerated eutrophication, proliferation of exotic contaminants, and a fisheries resource characterized by instability and, until very recently, decline, were cited as foremost problems. Also stressed was the necessity for the Commission and other agencies that deal with the complex of fisheries problems on the Great Lakes to assist and support pollution control agencies and other groups concerned with the environment and general water quality. It is of vital importance that fisheries, at the very least as indicators of the health of the ecosystem, be considered in the establishment of environmental standards. Close liaison and open communication with appropriate governmental bodies must be developed and expanded. The reported decline in Lake Michigan of DDT residues in fish flesh, perhaps related to the bans imposed in Wisconsin and Michigan, represents an encouraging example.

Problems of more direct and immediate concern to the Commission were the decline or instability of certain valuable species such as lake herring, chubs, perch, and walleyes. Management measures to restore or preserve these stocks have yet to be tested and evaluated. Abundant stocks of self-sustaining lake trout have not been established on a lake-wide basis; however, natural reproduction appears to be developing in a few areas, particularly in Lake Superior. Efforts to restore and enhance the resource base through massive plantings of salmonids have been very successful, as evidenced by the development of the very productive sport fishery in the Great Lakes.

Registration-oriented studies on lampricides were continued in 1972. The research program is designed to meet the requirements specified by the

Environmental Protection Agency to re-register the lampricides TFM and Bayer 73. It is apparent that when and if new lampricides are incorporated into the lamprey control program they will be subject to the same rigorous testing.

In 1972, research and planning toward the development of an integrated lamprey control program continued. Techniques being considered include permanent barrier dams on certain streams and certain biological controls.

Over the past few years the Commission and its Lake Committees have devoted increasing attention to the total fishery resource rather than concentrating almost exclusively on sea lamprey control and lake trout restoration—this necessary and desirable trend continued in 1972.

In conclusion, all agencies were encouraged to continue the cooperative effort toward the solution of mutual problems and the development of sound management programs. The Commission has endeavored to foster open communication and negotiation, keeping the welfare of the resource as the paramount consideration.

Management and Research.[1] Reports from each Lake Committee (Superior, Michigan, Huron, Erie, and Ontario) covering activities in 1972 were accepted by the Commission. The problems enumerated in the last Annual Report (1971) continue to be of major concern. They include:

Sea lamprey. The biological response by the sea lamprey to improved conditions (more food and decreased competition) adds to the control problems. Since it is difficult to eradicate larval lamprey from lentic areas within stream systems or off streams mouths, these areas probably continue to add recruits to the parasitic populations in the lake. The expansion of the control program to Lake Ontario will further dilute essential surveillance efforts unless adequate funds and personnel are made available.

Lake trout. The initial phase of the restoration program (simple replacement of the lake trout in the Great Lakes) has been very successful, *but* development of self-sustaining stocks of lake trout continues to be discouragingly slow. Numbers of large lake trout (potential spawners) continue to increase and self-sustaining stocks appear to be established in certain local areas in Lake Superior. Naturally-spawned juveniles have not yet been found in Lake Michigan, although an appreciable amount of spawning has occurred for at least two years. Some concern remains that exploitation, in the absence of natural reproduction and with finite limits on hatchery production, may be excessive. In the hope of accelerating natural reproduction, plans are being developed to plant more lake trout on or in close proximity to reefs that were formerly used by lake trout for spawning.

[1]Information on management programs and the status of stocks is presented in Appendix A.

Hatchery facilities. Existing hatcheries in the basin are unable to meet optimum salmonid planting rates. The Commission, therefore, has encouraged the development of additional hatchery facilities by state, provincial and federal agencies.

Contaminants. Reported declines of DDT residues in Lake Michigan fish are encouraging. The Commission will continue to develop closer liaison and communication with governmental bodies responsible for environmental and water quality standards.

Instability and decline of indigenous fish populations. The deliberations of special study groups to deal with walleyes, lake herring, and yellow perch serve to define and clarify some of the problems. Management strategies are being developed. The gradual and carefully considered development of compatible lake-wide and basin-wide management programs that will promote stability is promising. The initiation of direct controls and quotas along with efforts to manage the entire resource, rather than species by species, is a hopeful trend.

Catch statistics, commercial and sport. For many years all the agencies have cooperated in providing statistics on the commercial catch in their respective waters. Progress is being made towards obtaining equivalent statistics on the sport fishery. Reliable quantitative and biological data on the fisheries are essential to the development of a sound management program.

Sea Lamprey Control and Research. The Commission accepted the reports of its two agents on lamprey control operations in 1972.[1] The Commission adopted a sea lamprey control and research budget for fiscal year 1973 as follows:

	United States	*Canada*	*Total*
Sea Lamprey Control and Research	$1,841,750	$824,950	$2,666,700
Administration and General Research	42,350	42,350	84,700
Total	$1,884,100	$867,300	$2,751,400

The program calls for the following activities in fiscal year 1973:

Lake Superior—Retreat 26 streams (13 in the United States and 13 in Canada). Operate eight assessment barriers in U.S. waters. Intensify survey activities in lentic areas, and continue systematic surveillance for lamprey-producing streams.
Lake Michigan—Retreat 23 streams. Intensify survey efforts in lentic areas, and continue systematic stream survey to assess reinfestation. The increased survey program will be made possible by the addition of two survey crews.

[1]Reports covering sea lamprey control and research in the United States and Canada in 1972 appear as Appendices C, D, E, and F.

Lake Huron—Retreat 25 streams (12 in Canada and 13 in the United States). The Canadian treatments will be supplemented by application of Bayer 73 in lentic areas suspected of harboring ammocetes. Intensify the survey program in the U.S. with an additional survey crew. Operate eight assessment barriers, seven in Canada and one in the United States.
Lake Ontario—All the 43 known lamprey-producing streams tributary to the lake were treated in fiscal year 1972; consequently no chemical treatments are scheduled for fiscal year 1973. Conduct surveys to assess reestablishment of lamprey populations and/or residual populations.
Research—Continue investigations of the biological attributes of larval sea lampreys. Expand and intensify research to develop methods for survey and treatment of lentic habitats. Continue research into feasibility of biological control methods. Under the direction of the La Crosse Laboratory continue research into degredation and acute and chronic toxicity of TFM as required by the EPA.

The Commission also adopted a proposed budget for sea lamprey control and research for the fiscal year 1974 of $3,248,320 ($2,241,340 from the United States; $1,006,980 from Canada). The program proposed for fiscal year 1974 covers the following activities.

Lake Superior—Retreat 20 streams (14 in the United States, 6 in Canada), and five lentic areas in Canada. Intensify survey efforts in estuarine and lentic areas and maintain the surveillance program on streams. Continue operation of eight assessment barriers in the U.S.
Lake Michigan—Retreat 26 streams, and lentic areas off the mouths of Porter and Horton Creeks and Elk Lake Outlet. Continue the intensive survey and surveillance program.
Lake Huron—Retreat 18 streams (12 in the United States and 6 in Canada), and three lentic areas in Canada. Continue the intensive surveillance program. Operate eight assessment barriers (7 in Canada and 1 in the United States).
Lake Ontario—No chemical treatments are scheduled, but survey program will continue.
Research—Continue investigation of ammocete biology in streams and lentic areas. At Hammond Bay, continue research in support of field operations; continue research on the physiology of transformation and the feasibility of biological control. At the La Crosse Laboratory continue the extensive registration-oriented research program on TFM and Bayer 73 in accordance with the EPA specifications.

Finance and Administration. The report of the Finance and Administration Committee indicated the Commission's financial affairs were in good order, and that proper fiscal procedures were being followed. Upon recommendation of the committee, the Commission approved the Administration and General Research budgets of $84,700 and $101,500 for fiscal years 1973 and 1974, respectively.

Election of officers. Dr. W. Mason Lawrence (United States) was elected Chairman and Dr. C. J. Kerswill (Canada) Vice Chairman for two-year terms.

Adjournment. The 1972 Annual Meeting adjourned at 11:00 a.m. on June 16.

INTERIM MEETING

PROCEEDINGS

The Commission held its Interim Meeting in Ann Arbor, Michigan on December 5-6, 1972. Matters considered included the sea lamprey control and research program, reports on the intensive research program directed toward registration of lampricides being used in the lamprey control program, and reports on a broad range of fisheries management and research activities.

Sea Lamprey Control and Research. Reports on the progress of sea lamprey control operations in 1972 were presented by the Commission's agents (Appendices C and D). Reports on the incidence of lamprey wounds in the fall of 1972 in Lakes Superior, Michigan, Huron, and Ontario were presented by the Bureau of Sport Fisheries and Wildlife, Ontario Ministry of Natural Resources, and the State of Michigan. Incidence of lamprey wounding on lake trout in Lake Superior was less in 1972 than in 1971. In Lake Michigan, incidence of lamprey wounding on lake trout was low; differences between 1971 and 1972 were not significant except perhaps in Wisconsin waters of the lake where fewer wounds were found on larger lake trout in 1972 than in 1971. In Michigan waters of Lake Huron wounding rates on age III coho and age II chinook were less in 1972 than in 1971; for older chinook (III's and IV's) the rate rose from 13% in 1971 to 26% in 1972. For whitefish, wounding rates remained at the very low rates (0-1%) observed since 1970.

As part of an integrated lamprey control program, the Commission has encouraged the construction of permanent barriers on suitable lamprey streams. United States and Canadian task forces presented preliminary information on the development and coordination of the program.

The Commission reviewed the Sea Lamprey Control and Research Program and Budget for fiscal years 1973 and 1974.

Budget for fiscal year 1973 was as follows:

	United States	*Canada*	*Total*
Sea Lamprey Control and Research	$1,841,750	$824,950	$2,666,700
Administration and General Research	42,350	42,350	84,700
Total	$1,884,100	$867,300	$2,751,400

The U.S. program in fiscal year 1973 called for treatment of 48 streams—13 in Lake Superior, 12 in Lake Huron, and 23 in Lake Michigan. The program also called for the operation of nine lamprey assessment barriers

(8 on Lake Superior, 1 on Lake Huron) and continuation of the survey program to monitor stream and lake populations of larval sea lampreys, including post-treatment surveys of Lake Ontario tributaries. Furthermore, 25 streams (Lake Superior-12, Lake Huron-5, and Lake Michigan-8) not originally scheduled were treated in the first half of the fiscal year.

The Canadian program called for TFM treatments on 26 streams–14 on Lake Superior and 12 on Lake Huron. Treatments with Bayer 73 were scheduled for 11 lentic areas in Lake Superior, 6 in Lake Huron and a treatment with TFM and Bayer 73 was planned for the international St. Marys River. Continuation and intensification of larval surveys and the operation of seven assessment barriers (Lake Huron) were specified in the Agreement. With minor exceptions the program was completed as scheduled.

At its Annual Meeting in Milwaukee in June, 1972 the Commission proposed a total budget of $3,248,320 for fiscal year 1974. Subsequently, it was ascertained that the U.S. would not be able to meet the full request, and it was, therefore, necessary to revise the program; consequently the Commission adopted the following amended budget for fiscal year 1974:

	United States	*Canada*	*Total*
Sea Lamprey Control and Research	$2,100,000	$943,500	$3,043,500
Administration and General Research	50,750	50,750	101,500
Total	$2,150,750	$994,250	$3,145,000

The program for fiscal year 1974 called for (1) continuation and intensification of the lamprey control and survey program on Lake Superior, Lake Michigan, Lake Huron, and Lake Ontario, (2) operation of assessment barriers on Lakes Superior and Huron, (3) continuation of research in support of the field program and toward the development of biological control methods, and (4) continuation of registration-oriented research on lampricides. Available monies would not allow substantial expenditures for barrier dams as a segment of integrated lamprey control.

Management and Research. Lake Committees, which had met in March, 1972, established three special subcommittees to address themselves to fishery problems of urgent concern and to formulate recommendations for Commission consideration. To bring the Commission abreast of current developments, brief progress reports by these special committees were presented at the December, 1972 meeting. Comprehensive reports would be provided at the Annual Meeting of the Commission in June, 1973 after review and consideration by the Lake Committees in March, 1973.

The Lake Superior Herring Committee planned to: (1) review the literature and summarize the biology of herring in the Great Lakes, particularly Lake Superior, (2) review, evaluate, and summarize those factors most likely to have been responsible for the decline of herring stocks, and (3) prepare a summary, including management alternatives. Representatives from Ontario, Michigan, Wisconsin, and Minnesota–the jurisdictional agencies surrounding Lake Superior–held discussions in October which, after consolidation, are to be presented to the Lake Superior Committee for consideration in March, 1973.

The Lake Erie Yellow Perch Ad hoc Committee held three meetings to consider the availability of information and the research requirements to develop a comprehensive management program for perch stocks in Lake Erie.

A subcommittee established to reevaluate the allocation of federally-raised lake trout between and within U.S. waters of Lake Michigan and Lake Superior, and also the distribution of federally-raised fish (lake trout, splake or lake trout X splake [backcrosses]) for Lake Huron, met on October 25, 1973 to establish planting schedules for 1973 and 1974-1979. The subcommittee's recommendations would be presented to the appropriate Lake Committees in March, 1973.

Following discovery of kidney disease in the splake brood stock held in Michigan's Marquette hatchery, the lake trout-splake program on Lake Huron was considered in depth by representatives from Ontario, Michigan, and the Bureau of Sport Fisheries and Wildlife, at an emergency meeting convened by the Commission staff in Ann Arbor on October 20, 1972. Since the lake trout and splake (Lake Huron only) rehabilitation program is a cooperative venture whereby Michigan maintains the brood stock for lake trout and splake, and supplies the eggs to the Bureau for rearing and planting in the various state waters of the Upper Great Lakes, the discovery of diseased splake brood fish precluded the Bureau's acceptance of splake eggs for subsequent stocking in Lake Huron. Since Michigan felt that its fishery rehabilitation efforts in Lake Huron could not be allowed to lag any further behind efforts in Lake Michigan and Lake Superior, acceptable planting programs that would include lake trout and backcrosses were established. The plan will meet most of the management objectives of both Ontario and Michigan.

Representatives from New York, Ontario, the Bureau of Sport Fisheries and Wildlife, and Alfred University (New York) cooperated during 1972 in a study of fish stocks in Lake Ontario as part of the International Field Year on the Great Lakes (IFYGL). A representative of this committee provided a preliminary report describing plans, objectives, and a resumé of field operations of this comprehensive cooperative program.

APPENDIX A

SUMMARY OF MANAGEMENT AND RESEARCH

The Commission's programs to control sea lampreys and coordinate management and restoration of the fisheries resource have been continued throughout the Convention Area. Nevertheless, certain phases of the program have, of necessity, progressed from lake to lake. Furthermore, because of different problems on each lake, programs have been adjusted or developed to meet the particular problems or demands. Considered here will be the problems and programs on each lake, and the program as it applies throughout the Convention Area.

Lake Superior. Sea lamprey control with lampricides and lake trout restoration by means of massive plantings of hatchery-reared yearlings were initiated in Lake Superior in 1958. The programs were started on Lake Superior for several reasons—the native stock of lake trout had not been eliminated as it had in Lakes Michigan, Huron, and Ontario; Lake Superior appeared to offer the best chance to determine the efficacy of lamprey control and lake trout restoration efforts; and the international character of the program made its initiation on Lake Superior reasonable.

Some 122 streams (about 80 in the United States and about 42 in Canada) tributary to Lake Superior have been found to contain larval sea lampreys. The first round of chemical treatments of lamprey-producing streams entering Lake Superior was completed in 1962; the second in 1966.

From the beginning of the control program, efforts have been made to obtain quantitative measurements of lamprey abundance. Each autumn, a sample of lake trout was examined for the presence of fresh lamprey wounds, and each spring counts of adult lampreys were made at certain lamprey barriers. A high degree of correlation between fall wounding rates and the number of spawning adults in the runs the following spring has been found. The counts at the barriers provide direct quantitative data. These data, when combined with other observations (general wounding and scarring rates, survival and growth of planted salmonids) have enabled the Commission to assess results of the control program with a fair degree of confidence.

The control program has been effective—lamprey abundance in Lake Superior has been drastically reduced, by 80% or more. The number of lampreys in the spawning runs dropped dramatically in 1962 following the completion of the first round of treatments. The decline in the number of mature sea lampreys captured at eight electrical barriers on U.S. tributaries to Lake Superior, 1958-1972, is illustrated in Figure 1. Actual catch at the barriers is shown in Table 1.

Despite the success achieved in reducing lamprey abundance, some serious problems remain. Since the sea lamprey has not been eliminated, the residual population continues to prey on lake trout and other salmonids and coregonids—in fact lampreys continue to be a major source of mortality among the older and larger lake trout that are the potential spawners.

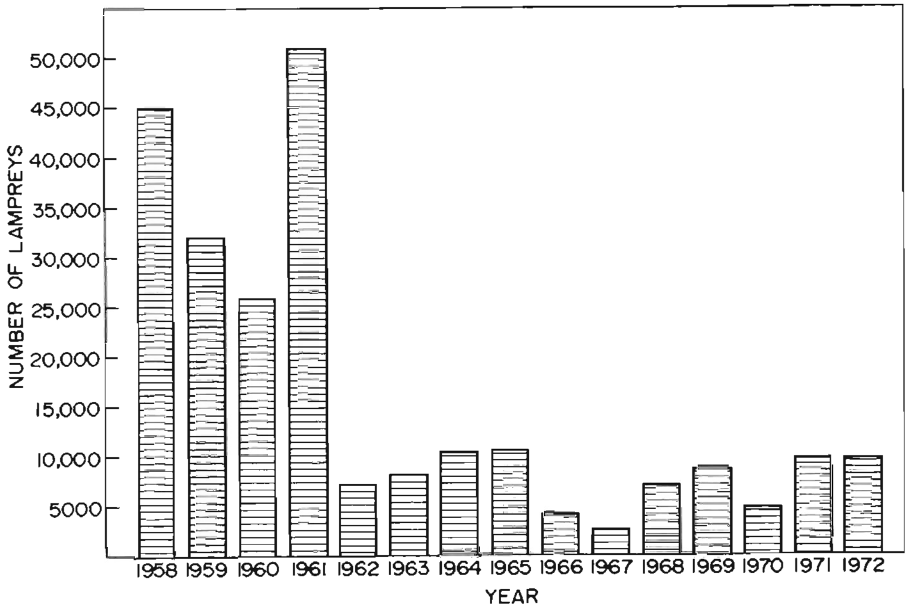

Figure 1. Number of adult sea lampreys captured at electric barriers on eight tributaries of Lake Superior, 1958-1972.

Also, the control program is plagued with certain persistent problems. Larval lampreys are often present in lentic areas within stream systems or in the lake itself off stream mouths. These areas are difficult to treat and the effectiveness of treatments is difficult to determine. Survey programs to assess reestablishment of larval populations or imminent metamorphosis of existing populations of larvae must be systematic and continuous—an expensive and time consuming segment of the control program. Techniques for pre-treatment bioassays and chemical treatments of lamprey infested streams have been developed and refined, but problems continue to arise.

Because of increased concern over persistent environmental contaminants the Commission has been obliged to support an extensive research program to evaluate the acute and chronic toxicity and degradation of the lampricides being used. It is expected that this program will result in approval (registration) of these chemicals for lamprey control.

To improve the entire lamprey control effort, the Commission initiated efforts to develop an integrated control program that would include permanent barriers and biological controls to complement and supplement present methods.

Concurrently with lamprey control, efforts to rehabilitate the lake trout population in Lake Superior with massive plantings of hatchery-reared

Table 1. Number of adult sea lampreys taken at electric barriers operated in eight tributaries of Lake Superior, 1958-1972.

Tributary	Year														
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Betsy River	1,071	1,000	686	1,366	316	444	272	187	65	57	78	120	87	104	146
Two Hearted River	3,418	3,990	4,222	7,498	1,757	2,447	1,425	1,265	878	796	2,132	1,104	1,132	1,035	1,507
Sucker River	1,727	2,457	4,670	3,209	474	698	386	532	223	166	658	494	337	495	642
Chocolay River	6,168	3,490	4,167	4,201	423	358	445	563	260	65	122	142	291	53	294
Iron River	401	257	310	2,430	1,161	110	178	283	491	643	82	556	713	1,518	280
Silver River	2,111	773	1,261	5,052	267	760	593	847	1,010	339	1,032	1,147	321	340	2,574
Brule River	22,593	19,225	9,523	22,478	2,026	3,418	6,718	6,718	226	364	2,657	3,374	167	1,754	4,121
Amnicon River	7,584	980	1,081	4,741	879	131	232	700	938	200	148	1,576	1,733	4,324	132
Total	45,073	32,172	25,920	50,975	7,303	8,366	10,540	10,540	4,091	2,630	6,909	8,513	4,781	9,613	9,696
% of 1958-61 mean	117	83	67	132	19	22	27	27	11	7	18	22	12	25	25

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Amnicon River	7,584	980	1,081	4,741	879	131	232	700	938	200	148	1,576	1,733	4,324	132
Total	45,073	32,172	25,920	50,975	7,303	8,366	10,540	10,540	4,091	2,630	6,909	8,513	4,781	9,613	9,696
% of 1958-61 mean	117	83	67	132	19	22	27	27	11	7	18	22	12	25	25

yearling lake trout were initiated in 1958.[1] In the period 1958-1972 about 32.5 million lake trout were released in Lake Superior. The primary objective of the lake trout planting program is the reestablishment of a population of lake trout that can maintain itself through natural reproduction. In an effort to accelerate the restoration program, and to further enhance the resource base, the State of Michigan started to plant coho salmon in 1966 and chinook salmon in 1967. Minnesota has planted coho since 1969 and Ontario 1969-1971. In the 1966-1972 period, about 3.3 million coho salmon and 1.0 million chinook salmon were planted. Wisconsin also initiated Atlantic salmon plants in 1972. In addition, rainbow trout, brook trout, and brown trout have been planted.

The ultimate worth of lamprey control has been clearly demonstrated by the survival and growth of lake trout and other salmonids planted since control became effective in 1962. Lake trout planted experimentally prior to 1958 were eliminated by sea lampreys—very few of the planted lake trout yearlings survived beyond a length of 17-20 inches. At the same time lampreys were preying heavily on the residual population of native lake trout, particularly the larger fish, and natural reproduction by lake trout had been reduced to insignificance by 1959.

On the premise that lamprey control would be effective, lake trout planting on an operational basis was initiated in 1958. Prior studies had shown that planted lake trout yearlings were not attacked by sea lampreys until they had reached a length of about 15-17 inches after they had been in the lake for two or three years. Therefore, it was hoped that lake trout planted in 1958 would be safe from lampreys for two or three years by which time lamprey abundance would have been greatly reduced.

Lake Superior now supports an abundant population of lake trout and other salmonids. In many areas of the lake, lake trout are as abundant as at any time within the past 50 years. Most of this population, however, consists of planted fish. The objective of self-maintenance through natural reproduction has not yet been achieved, except that by the fall of 1972 the Gull Island Shoal area of Wisconsin appeared to reach the stage of self support—80% of the spawning fish were native. Increasing numbers of large lake trout (potential spawners) and observed spawning activity in the other areas in the past several years auger substantial natural recruitment in the near future, although the establishment of strong natural reproduction has been distressingly slow. As previously mentioned, natural recruitment may well have been retarded by sea lamprey predation on the larger, older lake trout which are particularly vulnerable because of lamprey selection and exposure to lamprey attack over an extended time.

The commercial fishery for lake trout has been restricted since 1962; consequently statistics from the commercial fishery are not indicative of abundance. A measure of lake trout abundance has been obtained from the

[1]Plantings of lake trout and other salmonids in the Great Lakes in 1958-1972 are summarized in Appendix B.

catch rate in experimental fishing. Catch rates rose steadily through the 1962-1971 period (Table 2); some decline has been apparent in the Wisconsin waters of the lake in 1971 and 1972, owing probably to reduced stocking rates. In Ontario, the sampling program was modified after 1970. However, abundance of lake trout in Ontario waters of the lake continues to increase.

Table 2. Numbers of marketable trout caught per 10,000 feet of large-mesh gillnet lifted during the spring, Lake Superior, 1962-1972.

Year	Michigan	Wisconsin	Minnesota	Ontario	Average (unweighted)
1962	39	77	43	34	48
1963	46	81	58	32	54
1964	43	11	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
1971	505	326	39	. . .	290
1972	507	263	46	. . .	272

The reestablishment and growth of the lake trout sport fishery over the past 6-8 years, particularly in U.S. waters, is also indicative of the abundant population of lake trout. Since 1968, the States of Michigan, Wisconsin, and Minnesota have endeavored to estimate angling effort and yield for salmonids. The Michigan estimates, obtained by means of a post card survey, are presented in Table 3.

The present commercial fishery in Lake Superior is mainly dependent upon four species—lake herring, chubs[1], smelt, and whitefish. In each of the past 5 years these four fishes have constituted about 90% of the total commercial harvest (Table 4). Not only do these four species support the existing commercial fishery, but chubs, herring, and smelt are also important foods of lake trout and salmon.

Of the five Great Lakes, only Lake Superior now contains lake herring in sufficient quantity to support a commerical fishery. In the other four lakes the species has declined to insignificance. The herring catch in Lake Superior declined precipitously and steadily from 1961 (13.2 million pounds) to 1972 (3.4 million pounds) of which most (2.6 million pounds) came from Ontario waters. There can be no question that the catch statistics reflect a genuine decline in actual abundance of the species—in fact, the actual decline is probably even greater than that indicated because the herring population in Lake Superior shows all the classic symptoms of ill

[1]In the commercial statistics, various species (bloater–*Coregonus* (*Leucichthys*) *hoyi*, blackfin–*C. nigripinnis*, shortjaw–*C. zenithicus*, kiyi–*C. kiyi*, shortnose–*C. reighardi*, are termed "chubs".

Table 3. Estimated* effort (angler-days) and catch of salmonids by anglers in Michigan waters of Lakes Superior, Michigan, Huron, 1968-1972.

Year	Effort	Catch: Lake trout	Catch: Salmon	Catch: Other Salmonids	Catch: Total
			Superior		
1968	. . .	16,526	3,302	6,442	26,270
1969	352,000	172,000	97,000	7,000	276,000
1970	413,420	172,380	43,890	235,370	451,640
1971	464,720	143,640	55,560	130,720	329,920
1972	295,800	122,230	56,780	140,930	319,940
			Michigan		
1968	508,437	144	86,379	2,985	89,508
1969	1,217,000	93,000	378,000	167,000	638,000
1970	2,062,620	244,890	713,860	577,300	1,536,050
1971	2,932,720	311,040	870,740	561,860	1,743,640
1972	1,517,590	373,150	720,290	406,980	1,500,420
			Huron		
1968	. . .	. . .	. . .	. . .	. . .
1969	221,000	1,000	54,000	1,000	56,000
1970	652,560	560	101,670	85,820	188,050
1971	1,469,240	2,820	116,420	105,900	225,140
1972	313,990	2,040	154,870	95,320	252,230
			All lakes		
1968	508,437	16,670	89,681	9,427	115,778
1969	1,790,000	266,000	529,000	175,000	970,000
1970	3,128,600	417,830	859,420	898,490	2,175,740
1971	4,866,680	457,500	1,042,720	798,480	2,298,700
1972	2,127,380	497,420	931,940	643,230	2,072,590

*Estimates cover open waters of the lakes and tributaries.

Table 4. Commercial catch in thousands of pounds, 1968-1972, Lake Superior

Species	1968	1969	1970	1971	1972
Herring	6,238	4,647	4,253	3,758	3,441
Chubs	844	989	1,323	1,862	1,439
Smelt	1,395	1,067	1,576	2,448	1,180
Whitefish	740	839	655	895	916
Others	722	648	584	586	786
Total	9,939	8,190	8,391	9,549	7,762

health such as increased growth rates, abnormal sex ratios, and poor recruitment.

Serious concern over dwindling stocks of herring in Lake Superior led to the establishment, by the Lake Superior Committee at their March, 1972 meeting, of a lake herring subcommittee with the following assignment: review the knowledge presently available on herring stocks and formulate recommendations for the management measures needed to prevent further depletion. The subcommittee, consisting of representatives from Michigan, Minnesota, Wisconsin, Ontario, the Bureau of Sport Fisheries and Wildlife, and the Commission staff, started their deliberations in 1972, and expect to report to the Lake Superior Committee in 1973.

In Lake Superior, deepwater coregonines (collectively called chubs) were once represented by five species—the bloater, blackfin, shortjaw, kiyi, and shortnose. The largest species, the blackfin, was heavily exploited by the commercial fishery at the turn of the century, and was virtually eliminated by 1907. Later, the fishery turned to the shortjaw, the next largest species, and its numbers were severely reduced by the 1940's. Since that time the chub catch in U.S. waters has been dominated by the bloater. Chubs have not been so heavily exploited in Canadian waters of the lake, and as recently as 1971 bloaters and shortjaws were represented about equally in sampled catches. In 1941-1957[1] the annual catch varied between 58,000 pounds (1950) and 598,000 pounds (1941) and averaged 313,000 pounds. For the past 15 years (1958-1972), however, the fishery for chubs, at least in U.S. waters, has been intense. Lakewide catches have varied between 831,000 pounds (1964) and 2,196,000 pounds (1965) and have averaged 1.4 million pounds, more than four times the 1941-1957 average. Bloaters predominate in the catch, though the kiyi, the shortjaw, and the shortnose are represented. The traditional "fishing up" process, wherein the fishery seeks target species in new areas when stocks in the traditional fishing grounds have been decimated, seems to be operating. Chub stocks in Lake Superior appear to be following the same declining trends as those in Lakes Huron and Michigan, but the process is not yet so far advanced. Biologists suggest that catches should be restricted, and some agencies are seriously considering the imposition of catch quotas, but positive action has not yet been taken.

Smelt did not appear in the commercial catch of Lake Superior until 1952 when 45,000 pounds were reported. By 1960, the catch had risen to 948,000 pounds, and has averaged 1.46 million pounds annually in 1961-1972. Virtually the entire catch comes from the U.S., mainly from Minnesota and Wisconsin waters. The smelt population in Lake Superior seems to be fairly stable and does not exhibit severe symptoms of stress. Modest post-spawning dieoffs have been reported from Minnesota waters. Some biologists have suggested that smelt are a serious competitor of the lake herring and may have been a factor in the herring decline. Smelt are a major component in the diet of lake trout.

Whitefish now constitute by far the most valuable segment of the commercial fishery in Lake Superior. The fishery has been fairly steady since about 1911—varying between 0.47 million pounds (1913) and 1.6 million pounds (1949) with an average for the 62-year period of 0.82 million pounds. From 1885-1910 the catch averaged 2.95 million pounds. The statistics indicate clearly that the early fishery removed a large portion of the native stock in a few years and thereafter the fishery has been supported by the annual production from a much smaller stock. Unquestionably, the whitefish in Lake Superior are being harvested at or close to the productive capacity of the stock. Nevertheless, the present fishery is fairly stable, and the stock does not appear to be in jeopardy. Most fishery biologists on Lake Superior believe that more intensive management (quotas and/or other catch restrictions) would produce beneficial results to the stock and to the fishery.

[1]Before 1941, chubs and herring were not separated in the statistics.

In broad terms, the situation in Lake Superior appears to be more stable than in the other Great Lakes. Cultural eutrophication is less advanced and the fisheries resource has not changed so drastically as in the other Great Lakes.

Lake Michigan. Lamprey control with chemicals was initiated on the 110 lamprey-infested tributaries of Lake Michigan in 1960, and the first round of treatments was completed in 1966. On Lake Michigan direct quantitative measurements of the degree of lamprey control have not been available because assessment barriers comparable to those in Lake Superior have not been operated. Nevertheless, other observations such as the decline in numbers of wounds and scars on lake trout, the increase in the whitefish and rainbow trout (steelhead) populations, and growth and survival of planted salmonids indicate that the lamprey control program in Lake Michigan has been about as successful as in Lake Superior. Problems in sea lamprey control in Lake Michigan are similar to those encountered in Lake Superior with the added difficulty that because of harder waters entering Lake Michigan the danger of fish kills during chemical applications increased. In certain tributaries it has been necessary to exercise the greatest of caution to avoid fish kills, especially when the synergist Bayer 73 has been used in conjunction with TFM.

The lake trout catch started to decline precipitously in 1944-1945, and by the early 1950's the lake trout in Lake Michigan were virtually exterminated by the sea lamprey.

The effort to reestablish lake trout in Lake Michigan was initiated in 1965 with the planting of 1.27 million yearlings. As in Lake Superior, it was felt that some "lead time" could be gained by starting the plants a year or two in advance of effective lamprey control. In 1965-1972, a total of 16.5 million yearling lake trout were planted in Lake Michigan. To further enhance the resource, the State of Michigan introduced Pacific salmon, starting in 1966, followed by Wisconsin and Illinois in 1969, and Indiana in 1970. Through 1972, 15.8 million coho and 8.5 million chinook have been planted. Large numbers of rainbow, brown, and brook trout have also been stocked.

The ultimate demonstration of the worth of lamprey control lies in the development of the outstanding recreational fishery on Lake Michigan. Survival and growth of planted salmonids has been excellent and has been accompanied by an expanding and very successful sport fishery (Figure 2).

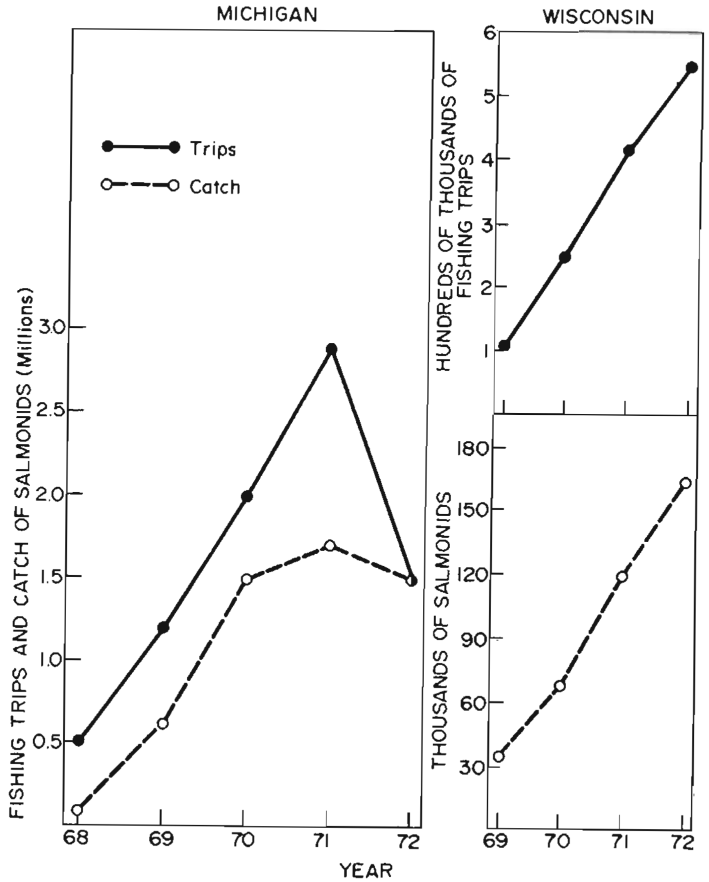

Figure 2. Catch of salmonids and number of fishing trips, Michigan and Wisconsin waters of Lake Michigan, 1968-1972.

Table 3 shows that Lake Michigan presently provides the major sport fishery in Michigan waters of the Great Lakes.

As in Lake Superior the primary objective of the lake trout stocking program is the reestablishment of a self-sustaining population of lake trout, but in bays and near-shore areas where lake trout are sought by sportsmen the Commission agreed that emphasis should be placed on plantings to encourage the catch of lake trout and maintain high levels of abundance, should this prove necessary. In Lake Michigan, the growth of the planted lake trout has been rapid and by 1970 considerable numbers of the planted fish had attained maturity. Spawning in increasing amounts has occurred in 1970, 1971, and 1972. Eggs from mature, planted lake trout from Lake Michigan, incubated in fish hatcheries and in the laboratory, have produced healthy fry. No observations to date suggest any serious loss of fecundity or viability in the hatchery-reared lake trout planted in Lake Michigan, but

through 1972, wild (i.e. unmarked) juvenile lake trout have not been observed or collected. Planted lake trout have shown a tendency to return to shore planting sites, and attempt to spawn in areas that seem unsuitable. This behavior may have reduced effectiveness of spawning. In an effort to enhance successful reproduction some plantings have been made directly on or in close proximity to spawning grounds formerly used by native lake trout. Results have not yet been assessed.

Over the past 20-30 years the fisheries in Lake Michigan have been characterized by instability and change. Nearly all of the problems associated with the fishery resources of the entire Great Lakes basin are present in Lake Michigan. These can be mentioned but briefly here.

The disappearance of lake trout, and subsequent restoration efforts have already been described.

Whitefish were heavily exploited by the early commercial fishery and annual catches of 5 to 12 million pounds were recorded before the turn of the century. Thereafter, for a period of about 60 years (1891-1953) a remarkably stable fishery, supported by the annual production of the stock, persisted. Catches varied between 0.94 (1920) and 5.8 (1947) million pounds, and averaged 2.2 million pounds. During the entire period the catch exceeded 3.0 million pounds in only 10 years and fell below 1.0 million only three times. Years of unusually high production (1928-1932, 1947-1949) resulted from very strong year classes that contributed to the fishery over a period of three to five years before disappearing. In 1954, the catch dropped to 0.8 million pounds and fell rapidly to an all time low of only 25,000 pounds in 1957. Average catch for the 10-year period, 1954-1963, was only 240,000 pounds. The scarcity during this period almost certainly resulted from predation by sea lampreys that turned to whitefish when the lake trout were gone and the continued intensive exploitation by the commercial fishery. In 1964, the catch rose to 0.8 million pounds, probably because control efforts had reduced lamprey abundance and permitted rapid recovery of whitefish stocks. Catches averaged 1.6 million pounds over the 9-year period, 1964-1972.

Lake herring made up an important segment of the commerical fishery until the mid-1950's, with the catch usually exceeding 5.0 million pounds. The catch declined drastically after about 1955, and herring are now reduced to insignificance in the commercial catch.

Originally, Lake Michigan contained seven species of deepwater coregonids, collectively termed chubs. The two large species, the blackfin (*Coregonus nigripinnis*) and the deepwater cisco (*C. johannae*) have disappeared; four species of intermediate size are rare, and the fishery now depends on the smallest species of the original seven, the bloater (*C. hoyi*). Catch of bloaters has declined, and the species shows symptoms of reduced abundance—increased growth rate, abnormal sex ratio, and poor recruitment.

Smelt entered Lake Michigan after they were planted in Crystal Lake, Michigan in 1912. By 1931 they had entered the commercial catch when 86,000 pounds were reported. Their abundance increased until 1943 when a massive dieoff occurred, presumably from some pathogen. The population was severely reduced after the dieoff but its resurgence was rapid, and the catch has averaged 3.3 million pounds annually over the past 20 years (1953-1972). Throughout the 1950's catches were nearly always over 5.0 million pounds, but after 1960 they have been under 2.0 million pounds.

Alewives were first reported in Lake Michigan in 1949, and the population increased explosively thereafter, reaching a maximum in 1966-1967. The peak of the commercial catch was reached in 1967 when 41.9 million pounds were landed. That same year was marked by a massive dieoff that littered the beaches with dead alewives, caused serious nuisance problems, and may have reduced the alewife population by as much as 70%. Index fishing and the absence of serious annual dieoffs indicate that the alewife population may have stabilized at a level of abundance below the peak of 1966-1967. Also, predation by lake trout and Pacific salmon, both of which feed extensively on alewives, may have helped to keep the alewife population in check.

The commercial catch in Lake Michigan, 1968-1972, is summarized in Table 5. Various factors have combined to produce change and instability in the commercial fisheries of Lake Michigan. Prior to the mid-1940's the true effects of the exploitive commercial fishery were masked by shifts in composition of the catch, increased effort, or by fishing out, one after another, different segments of the population. The loss of one or several species could be compensated by the pursuit of something else.

Table 5. Commercial catch, thousands of pounds, Lake Michigan 1968-1972.

Species	1968	1969	1970	1971	1972
Alewives	27,194	29,248	22,461	29,654	31,033
Chubs	10,183	9,161	9,646	5,713	5,267
Whitefish	893	1,387	1,729	2,894	3,504
Yellow perch	631	723	692	746	1,026
Smelt	1,789	2,481	1,977	1,387	704
Carp	2,352	2,119	1,935	2,465	1,326
Others	2,768	2,370	3,650	1,821	711
Total	45,810	47,489	42,090	44,680	43,571

By the early 1940's the sea lamprey was firmly established in Lake Michigan and the effects of this predator were immediate and spectacular. Lake trout were eliminated, and whitefish severely damaged. To compensate for the loss of these valuable fishes, the fishery was forced to concentrate its efforts on less valuable species—herring, chubs, perch, and smelt, while continuing to seek the remanants of the populations of lake trout and whitefish.

The loss of the top predators, especially the lake trout, probably contributed to the explosive increase of alewives in the 1950's. Alewives certainly had detrimental effects on native species by competing with them for space and planktonic food, as well as by direct predation on eggs and larval fishes. Concurrently, the commercial fishery continued to operate thereby compounding the stresses imposed by sea lampreys and alewives.

In common with the other Great Lakes, the difficulties faced by the fisheries in Lake Michigan have been intensified by problems associated with man's activities—for convenience all of these problems have been lumped under the term "cultural eutrophication". Exotic contaminants, such as DDT, aldrin, dieldrin, mercury, and PCB's have had deleterious effects on the fisheries. The discovery of contaminant residues in fish flesh that exceed permissible levels, has often resulted in the banning for sale of particular species or of certain size fish. On the optimistic side, however, recent restrictions on the sale of DDT imposed by the States of Michigan and Wisconsin apparently have been effective. DDT residues appear to have declined over the past two or three years.

The situation in Lake Michigan does not seem irreversible. Lamprey control and efforts to restore or enhance the fisheries resource have been generally successful to date. Many problems associated with cultural eutrophication are confined to the inshore waters, and probably can be ameliorated by careful planning. The fisheries resource is responding favorably to intensive and cooperative management.

Lake Huron. Problems pertaining to the fisheries in Lake Huron are similar to those already described for Lake Michigan. Differences in the problems between Lakes Huron and Michigan may be attributed to differences in the basic fertility in the two lakes and to the lesser urbanization on the shores of Lake Huron. Also, many of the problems such as the invasion of the lake by sea lampreys, virtual disappearance of lake trout, and appearance of alewives, all developed several years earlier in Lake Huron than in Lake Michigan. Further, efforts to control sea lampreys and restore a viable population of salmonids occurred later in Lake Huron. Consequently, the fisheries resource in Lake Huron has deteriorated to an even greater degree than it has in Lake Michigan.

Table 6 shows that only 4 species contribute more than 0.5 million pounds to the commercial catch in Lake Huron—carp, whitefish, yellow perch, and chubs.

Table 6. Commercial catch, thousands of pounds, Lake Huron, 1968-1972.

Species	1968	1969	1970	1971	1972
Carp	1,098	1,400	1,261	1,436	941
Whitefish	1,022	1,155	1,163	1,165	1,114
Yellow perch	1,008	971	811	947	543
Chubs	548	256	192	686	634
Other	1,432	1,444	1,109	1,338	1,130
Total	5,108	5,226	4,536	5,572	4,362

Lamprey control with TFM was initiated in Lake Huron in 1960, but was discontinued after 1961 when insufficient monies were available to continue the program on Lake Huron without weakening control efforts on Lakes Superior and Michigan. The program was resumed in 1966, and the first round of treatments was completed in 1971. Although lamprey control in Lake Huron has not been in effect as long as it has in Lakes Superior and Michigan, observations to date indicate that control has been effective. Scarring and wounding rates on salmon have declined considerably since 1969, and the catch of adult lampreys at electrical assessment barriers has dropped to 41% of the preceding four year's average catch. There seems to be little doubt that the downward trend since 1968 in catches of sea lamprey at the assessment weirs reflects a significant decrease in abundance of sea lamprey in Lake Huron waters.

Efforts to rehabilitate the fisheries in Lake Huron have also lagged behind equivalent efforts in Lakes Superior and Michigan, partly because the supply of fish for planting was limited, and also because plantings without effective lamprey control were likely to be futile. Moreover, the restoration effort in Lake Huron has differed somewhat from that in Lakes Superior and Michigan. Research in the Province of Ontario had suggested that splake (lake trout X brook trout hybrids) selected for deep swimming and early maturity would offer advantages over lake trout–the splake would spawn at a younger age (by age III) and at a smaller size; therefore, they might be expected to spawn before falling prey to sea lampreys and a self-maintaining population might be developed more rapidly with splake than with lake trout. Recognizing the potential advantage of selected splake, the Lake Huron Committee, at its annual meeting in 1966, adopted the recommendation *that planting of trout in Lake Huron be restricted to selected hybrids.*

To accelerate restoration of the fishery resource and to establish a fishery, the Province of Ontario initiated an experimental program with kokanee in 1965. Kokanee have been planted as eggs, fry, and fingerlings. Through 1972 plantings have totalled 13.0 million kokanee, mostly fry. For the same reasons, the State of Michigan initiated plantings with Pacific salmon in 1968. Through 1972, some 2.9 million coho, and 2.6 million chinook have been planted. In addition, 9,000 Atlantic salmon smolts were planted in the Au Sable River in 1972. Plantings of highly selected splake were initiated in 1969 when 35,000 fish were planted in Ontario waters of the lake. Through 1972, 1.4 million selected splake have been planted, part in Michigan waters, the rest in Ontario. In the continuing effort to rehabilitate the Lake Huron fishery, rainbow and steelhead, brook, and brown trout have also been planted.

In Lake Huron, the recreational fishery has not developed to the same degree as in Lake Michigan. Pacific salmon, planted before lamprey control became effective, were heavily attacked by sea lampreys. However, since lamprey control has become effective, wounding and scarring rates have declined and the growth and development of the sport fishery is expanding (Table 3).

Certain developments in 1972 resulted in a modification of plans to rehabilitate the fishery in Lake Huron with selected splake. Kidney disease was detected in splake brood stock being held in Michigan's Marquette Hatchery. Therefore, the Bureau of Sport Fisheries and Wildlife, who rear and stock the splake and lake trout from eggs supplied by the state hatchery, advised that splake eggs from Marquette could not be accepted for incubation. The problem necessitated a review by Michigan, Ontario, and the Commission of plans for the restoration program. Michigan expressed the view that they could not allow the program in Lake Huron to continue to lag behind Lakes Michigan and Superior, and that a plant of 1,000,000 lake trout or splake annually was imperative. It was agreed that the Bureau's plantings of 200,000 selected splake in the fall of 1972 would be supplemented with 450,000 lake trout-splake backcrosses and 350,000 lake trout in 1973. In 1974, 1.0 million lake trout yearlings would be planted. The lake trout would be stocked in areas that would provide as much separation as possible from Ontario's splake plants.

Lake Erie. The fisheries situation in Lake Erie is very different from that in the other Great Lakes. Cultural eutrophication is far advanced, and the general physical environment has deteriorated, particularly over the past 20-30 years. Because it is relatively shallow, Lake Erie has always been tremendously productive, and despite marked deterioration over the past several decades, it continues to produce far more fish per unit of area than any of the other Great Lakes. In fact, commercial fish production from Lake Erie has frequently nearly equalled the combined production of the other Great Lakes. However, in the last 20 years, at least four species, blue pike, sauger, whitefish, and lake herring, have almost disappeared from Lake Erie because of environmental deterioration. Moreover, because of high mercury residues the marketing of walleyes from the western basin has been prohibited since 1970; for the same reason white bass over 10-1/2 inches from the same area may not be sold. Consequently, the commercial fishery in Lake Erie is now supported by yellow perch, smelt, carp, white bass, and freshwater drum (Table 7).

Table 7. Commercial catch, thousands of pounds, Lake Erie, 1968-1972.

Species	1968	1969	1970	1971	1972
Yellow perch	28,169	33,166	23,024	16,562	17,293
Smelt	12,224	15,078	9,404	13,132	10,522
Carp	2,777	3,210	3,431	3,421	3,315
White bass	1,478	2,094	1,298	1,089	2,525
Drum	3,795	2,399	1,308	932	1,182
Walleye	843	476	99	85	141
Other	2,049	2,654	2,737	2,697	2,880
Total	51,335	59,077	41,301	37,918	37,858

Sea lampreys and alewives, although present in Lake Erie, have not been a serious problem, presumably because environmental conditions are not particularly suitable for them.

To encourage and enhance the fishery in Lake Erie, the States of Ohio, New York, and Pennsylvania began experimental plantings of coho and chinook salmon in 1968. Through 1972, 1.5 million coho and 0.6 million chinook have been planted. To the present (1972) only a modest recreational fishery has developed, but the Pacific salmon have shown fair survival and growth in Lake Erie.

Environmental deterioration in Lake Erie has been serious and many of the changes in the fish population seem irreversible. Nevertheless, the lake remains highly productive and because of the relatively rapid rate of water exchange in the basin it is probable that Lake Erie can respond rather quickly to programs designed to reduce or control pollution, and other effects of cultural eutrophication.

Lake Ontario. Among the Great Lakes, the deterioration of the fisheries resource appears to have proceeded farthest in Lake Ontario. Historically, the lake was the "poorest" among the Great Lakes as a producer of fish. Originally, however, it supported viable populations of Atlantic salmon, lake trout, whitefish, lake herring, and chubs, in addition to various inshore species. Since 1941, commercial production (80 to 90 percent from Canadian waters) has varied between 1.9 (1966) and 3.7 (1941) million pounds annually and has averaged 2.6. Catch for the period 1968-1972 is summarized in Table 8. Overfishing appears to have been the main cause for the initial decline of the fisheries resource, although the impact of sea lamprey predation is uncertain. In more recent years environmental deterioration and sea lamprey predation have imposed additional stress on the resource. The open waters of the lake are now dominated by smelt and alewives, and the fishery is dependent upon inshore species. Sea lampreys are abundant, and the lake now contains no significant populations of top predators.

Table 8. Commercial catch, thousands of pounds, Lake Ontario, 1968-1972.

Species	1968	1969	1970	1971	1972
Yellow perch	318	453	1,004	921	900
White perch	328	309	558	719	327
Carp	461	611	515	498	462
Bullheads	196	293	331	272	241
American eel	247	207	196	206	296
Smelt	168	146	165	205	221
Sunfishes	196	168	179	162	169
Other	437	379	290	229	217
Total	2,351	2,566	3,238	3,212	2,833

Experience in Lakes Superior, Michigan, and Huron suggests that the potential for restoration of the fisheries of Lake Ontario through lamprey control and salmonid stocking is excellent. Lake Ontario has about 45 tributaries known to produce sea lampreys. Lamprey control was started in 1971 when 23 lamprey-producing streams in Canada received initial treatments. The program was extended to U.S. waters in 1972, and by the end of that year the initial round of treatments on Lake Ontario had been completed. It is too early to assess the effectiveness of the control program, but preliminary observations indicate some reduction in lamprey activity and it is expected that effects of control will be apparent in 1973.

Prior to effective lamprey control, salmonid plantings in Lake Ontario were unlikely to be successful. Nevertheless, in an effort to develop and enhance the fishery, the Province of Ontario made experimental introductions of kokanee starting in 1965. It was hoped that kokanee would not be particularly vulnerable to sea lampreys. Plantings of eggs, fry, and fingerlings were made. Through 1972, some 6.1 million kokanee have been planted (5.6 million fry). In anticipation of lamprey control, experimental plants of other salmonids were started in 1968 by New York and in 1969 by Ontario. Through 1972 plantings have amounted to 1.4 million coho salmon, 1.1 million chinook, and 48,000 selected splake. To the present, only limited sport fisheries with the coho and chinook have developed, but preliminary results have been encouraging.

Summary. Problems of major concern relative to the fisheries of the Great Lakes may be grouped into several main categories.

Not surprisingly, the original fisheries resource has been seriously and directly affected by the intensive and selective commercial fishery that developed after about 1850. Several species were practically exterminated and the stocks of many others, especially those of greatest value, were reduced. The effects of the fishery were gradual, and were masked by increased fishing effort, more efficient gear, replacement in the catch of one species by another, and fishing in new areas. Simultaneously, the growth of the human population in the basin and the activities that accompanied it (growth of cities, industry, lumbering and agriculture) placed additional stresses on the whole ecosystem, generally to the detriment of the fisheries.

Several species of fish that entered the Great Lakes, either by intent (carp, smelt) or by chance (alewives, sea lamprey) have been very successful often at the expense of native species. The contribution of other introduced species, such as rainbow trout and brown trout, has been beneficial. Many other exotic species have either failed to become established or have not become abundant.

Over the past 30-40 years the eutrophication process has accelerated and the amplitude and rapidity of change has increased greatly. Exotic contaminants, such as pesticides, PCB's, and mercury have compounded the "normal" problems of pollution and habitat destruction, but basically, the environment continues to be of good quality.

Despite these many problems, the fisheries of the Great Lakes remain highly resilient and have shown themselves capable of responding to wise management.

APPENDIX B

SUMMARY OF LAKE TROUT, SPLAKE, AND SALMON PLANTINGS

Intensive annual plantings of hatchery-reared salmonids continue to be the principle 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 Bureau of Sport Fisheries and Wildlife, the states of Michigan, Wisconsin, and Minnesota, and the Province of Ontario. Lake trout eggs are obtained from brood fish in hatcheries or from mature lake trout from inland lakes. Nearly all trout are reared to yearlings and planted during the spring and early summer. In the fall of 1971, however, a modification in the stocking program was tested at one site in Lake Michigan. Survival and growth of regular size fall fingerlings (approximately 80/pound) were compared with fingerlings whose growth had been accelerated to yearling size (about 30/pound) through diet and the use of heated rearing water. Assessment fishing in 1972 has shown better survival for the accelerated growth fish, by about 2:1, over the normal growth fall fingerlings. In the fall of 1972, this program was expanded to two sites in Wisconsin waters and one additional site in Michigan waters for a total of four different locations in Lake Michigan. If the fall plants of accelerated growth fingerlings continue to be advantageous, U.S. Federal hatchery production could be increased substantially at minimum cost. Table 1 summarizes annual plantings of lake trout in Lake Superior and Lake Michigan, and Tables 2 and 3 detail the 1972 plantings in Lake Superior and Lake Michigan, respectively.

Plantings of highly selected splake (brook trout X lake trout hybrids) in Lake Huron were initiated in Ontario waters in 1969 and in Michigan waters in 1970. These fish are planted mostly as fingerlings and yearlings. Table 4 summarizes the annual plantings in Lake Huron and Table 5 details the plantings for 1972 in United States waters and in the major geographical divisions of the Canadian waters.

Plantings of highly selected yearling splake in Lake Ontario were also initiated in 1972 by the Province of Ontario, marking the beginning of efforts to reestablish a self-sustaining population of these fish in the lowermost of the Great Lakes (Table 6). These fish were stocked over former lake trout spawning reefs in the eastern basin of Lake Ontario.

Kokanee plantings have been made in Lake Huron and Lake Ontario since 1965 by the Ontario Ministry of Natural Resources. 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 7 summarizes the annual plantings of kokanee in Lakes Huron and Ontario, and Table 8 presents in detail the 1972 plantings in these lakes. United States agencies have not stocked kokanee in Great Lakes waters.

Coho salmon, usually stocked in the spring as yearlings, have been planted annually in Lakes Superior and Michigan since 1966, and in Lakes Huron, Erie, and Ontario since 1968. Table 9 summarizes annual plantings in each of the Great Lakes and Table 10 details the 1972 plantings in each of the Great Lakes.

Annual plantings of chinook salmon, usually stocked in the spring as fingerlings, have been made in Lakes Superior and Michigan since 1967, in Lake Huron since 1968, in Lake Erie since 1970, and in Lake Ontario since 1969. Table 11 summarizes annual plantings of chinook in the Great Lakes while Table 12 details the 1972 planting in each of the Great Lakes.

In 1972, Wisconsin and Michigan initiated Atlantic salmon plants in the upper Great Lakes (Table 13). Wisconsin plantings in Lake Superior consisted of 8,000 3-year-old and 12,000 2-year-old fish. Michigan stocked 10,000 2-year-old fish in a Lake Michigan tributary and 9,000 2-year-old fish in a Lake Huron tributary.

Table 1. Annual plantings (in thousands) of lake trout in Lake Superior and Lake Michigan, 1958-1972.

LAKE SUPERIOR

Year	Michigan	Wisconsin	Minnesota	Ontario	Total
1958	298	184	–	505	987
1959	44	151	–	473	668
1960	393	211	–	446	1,050
1961	392	314	–	554	1,260
1962	775	493	77	508	1,853
1963	1,348	311	175	477	2,311
1964	1,196	743	220	472	2,631
1965	780	448	251	468	1,947
1966	2,218	352	259	450	3,279
1967	2,059	349	382	500	3,290
1968	2,260	239	377	500	3,376
1969	1,860	251	216	500	2,827
1970	1,944	204	226	500	2,874
1971	1,055	207	280	475	2,017
1972	1,063	259	293	491	2,106
subtotal	17,685	4,716	2,756	7,319	32,476

LAKE MICHIGAN

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	2,001
1970	875	900	100	85	1,960
1971	1,195	945	100	103	2,343
1972	1,422	1,284	110	110	2,926
subtotal	8,367	6,925	625	604	16,521
			TOTAL		48,997

Table 2. Lake Trout Plantings in Lake Superior, 1972

Location	Numbers	Fin clip
Michigan waters		
Porcupine Mountains	184,193	left ventral
Baraga	52,100	left ventral
Pequaming	100,270	left ventral
Huron Bay	109,030	left ventral
Loma Farms (Marquette)	150,170	left ventral
Marquette	108,700	left ventral

Table 2–Cont'd

Location	Numbers	Fin clip
Shelter Bay	110,850	left ventral
Grand Marais	54,975	left ventral
Pendills Bay	192,220	left ventral
subtotal	1,062,508	
Wisconsin waters		
Bayfield Area	259,430	adipose-right ventral
Minnesota waters		
Duluth (Pumping Station)	60,315	left ventral
Two Harbors	73,218	left ventral
Split Rock	30,123	left ventral
Beaver Bay (King's Landing)	34,960	left ventral
Little Marais	28,885	left ventral
Tofte	40,017	left ventral
Grand Marais	24,996	left ventral
subtotal	292,514	
Ontario waters		
West end		
Thunder Bay	120,600	right ventral
Nipigon Bay (Rossport area)	120,500	right ventral
East end		
Inner Batchawana Bay	60,000	left pectoral
Pancake Bay	70,000	left pectoral
Agawa Bay (Sinclair Cove)	60,000	left pectoral
Michipicoten Bay (vicinity of Wawa)	60,000	left pectoral
subtotal	491,100	
Total	2,105,552	

Table 3. Lake Trout Plantings in Lake Michigan, 1972

Location	Numbers	Fin clip
Michigan waters		
Escanaba	104,700	dorsal-left ventral
Thompson	104,350	right ventral
Petoskey	125,500	right ventral
Charlevoix	100,000	right ventral
Grand Traverse Bay, East Arm	75,000	right ventral
Grand Traverse Bay, West Arm	151,400	right ventral
Glen Arbor	50,000	right ventral
Frankfort	75,000	right ventral

Table 3–Cont'd

Location	Numbers	Fin clip
Manistee	75,000	right ventral
Pentwater	75,000	right ventral
Montague	50,000	right ventral
Port Sheldon	25,640	right ventral
South Haven	50,000	right ventral
Benton Harbor	49,360	right ventral
total regular planting	1,110,950	
Grand Haven*	109,170	adipose-right pectoral
Grand Haven**	100,000	right pectoral-left ventral
Grand Traverse Bay, west*	51,800	dorsal-left pectoral
Grand Traverse Bay, west**	50,000	dorsal-right pectoral
total experimental fall plant	310,970	
subtotal	1,421, 920	
Wisconsin waters		
Sturgeon Bay	330,000	right ventral
Algoma	150,000	right ventral
Kewaunee	150,000	right ventral
Manitowoc	150,000	right ventral
Sheboygan	100,000	right ventral
Milwaukee	100,000	right ventral
Racine	100,000	right ventral
total regular planting	1,080,000	
Kewaunee*	53,600	dorsal-left pectoral
Kewaunee**	50,000	dorsal-right pectoral
Sheboygan*	50,000	dorsal-left pectoral
Sheboygan**	50,000	dorsal-right pectoral
Total experimental fall plant	203,600	
subtotal	1,283,600	
Illinois waters		
North Ave. Pier, Chicago	110,000	right ventral
Indiana waters		
Bethlehem Steel Pier	110,000	right ventral
Total	2,925,520	

*accelerated growth fingerlings
**normal growth fall fingerlings

Table 4. Annual plantings (in thousands) of splake in Lake Huron, 1969-1972.

Year	Michigan	Ontario	Total
1969	–	35	35
1970	43	247	290
1971	74	468	542
1972	215	333	548
Total	332	1,083	1,415

Table 5. Plantings of splake in Lake Huron, 1972

Location		Number	Age	Fin clip
Ontario waters				
Georgian Bay	– Kilbear Point Provincial Park	14,000	yearlings	right ventral
		3,000	3-year-olds	right pectoral-right ventral
	– Meaford	27,200	yearlings	right ventral[1]
		600	3-year-olds	right pectoral-right ventral[2]
		100	7-year-olds	adipose
		200	6-and 8-year-olds	tagged
	– Vail Point	27,900	yearlings	right ventral
		2,500	3-year-olds	right pectoral-right ventral[2]
		200	7-year-olds	adipose
	– Lion's Head	110,000	yearlings	right ventral
Main basin	– Burnt Island	93,000	fingerlings	left pectoral-right ventral
	– South Bay	54,000	yearlings	adipose
subtotal		332,700		
Michigan waters				
Detour		52,000	fingerlings	right ventral
Cedarville		52,070	fingerlings	right ventral
		2,034	yearlings	adipose-left ventral
		3,498	3-year-olds	adipose-left ventral
Brulee Point		52,090	fingerlings	right ventral
St. Ignace		53,000	fingerlings	right ventral
subtotal		214,692		
Total		547,392		

[1]591 of these were tagged
[2]A total of 1,100 fish from these plantings were tagged

Table 6. Plantings of splake in Lake Ontario, 1972

Location	Numbers	Fin clip
Ontario waters		
Eastern Basin (Charity Shoal)	32,619	right ventral
	15,681	left pectoral
Total	48,300[1]	

[1] Yearlings

Table 7. Annual plantings (in thousands) of kokanee salmon in Lake Huron and Lake Ontario, 1965-1972.

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
1971	–	2,796	50	2,846
1972	–	1,200	62	1,262
subtotal	1,728	10,397	910	13,035
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	46	852
1971	–	679	50	729
1972	–	–	61	61
subtotal	323	5,620	179	6,122
Total	2,051	16,017	1,089	19,157

Table 8. Plantings of kokanee in Lake Huron and Lake Ontario, 1972

Location	Fry	Fingerlings	Total
Lake Huron			
Georgian Bay			
Sturgeon River	100,000	–	100,000
Balm Beach	100,000	–	100,000
Nottawasaga River	500,000	–	500,000
Sydenham River	150,000	–	150,000
Colpoy Creek	150,000	–	150,000
subtotal	1,000,000	–	1,000,000
Main basin Lake Huron			
South Bay	–	62,000[1]	62,000
Saugeen River	200,000	–	200,000
subtotal	200,000	62,000	262,000
Total, Lake Huron	1,200,000	62,000	1,262,000
Lake Ontario			
Shelter Valley Creek	–	61,000[2]	61,000
Total, Lake Ontario	–	61,000	61,000

[1] right pectoral fin clip
[2] left pectoral fin clip

Table 9. Annual plantings (in thousands) of coho salmon in the Great Lakes, 1966-1972.

LAKE SUPERIOR				
Year	Michigan	Minnesota	Ontario	Total
1966	192	–	–	192
1967	467	–	–	467
1968	382	–	–	382
1969	526	110	20	656
1970	507	111	31	649
1971	402	188	27	617
1972	152	145	–	297
subtotal	2,628	554	78	3,260

Table 9–Cont'd

LAKE MICHIGAN

Year	Michigan	Wisconsin	Indiana	Illinois	Total
1966	660	–	–	–	660
1967	1,732	–	–	–	1,732
1968	1,176	25	–	–	1,201
1969	3,054	217	–	9	3,280
1970	3,155	340	48	–	3,543
1971	2,411	267	68	4	2,750
1972	2,269	259	92	–	2,620
subtotal	14,457	1,108	208	13	15,786

LAKE HURON

Year	Michigan	Total
1968	402	402
1969	667	667
1970	571	571
1971	975	975
1972	249	249
subtotal	2,864	2,864

LAKE ERIE

Year	Ohio	Pennsylvania	New York	Total
1968	30	86	5	121
1969	92	134	10	236
1970	254	197	74	525
1971	122	152	95	369
1972	38	131	50	219
subtotal	536	700	234	1,470

LAKE ONTARIO

Year	Ontario	New York	Total
1968	–	40	40
1969	130	109	239
1970	145	294	439
1971	160	122	282
1972	122	230	352
subtotal	557	795	1,352
Great Lakes Total, 1966-1972			24,732

Table 10. Plantings of coho salmon in the Great Lakes, 1972

LAKE SUPERIOR

Location	Numbers	Fin clip
Michigan waters		
Black River Harbor	75,600*	none
Marquette area (Dead River)	76,204*	right pectoral (25,000 marked)
subtotal	151,804	

*Alaskan strain

Location	Numbers	Fin clip
Minnesota waters		
French River	109,600	
Beaver River	35,200	
subtotal	144,800	
Total Lake Superior	296,604	

LAKE MICHIGAN

Location	Numbers	Fin clip
Michigan waters		
Whitefish River	50,000*	none
Thompson Creek	109,512*	none
Manistique River	50,200*	none
Lake Charlevoix	25,171*	none
Grand Traverse Bay (East Arm)	21,185	none
Grand Traverse Bay (West Arm)	98,188*[1]	none
Platte River	406,330	left ventral
Point Betsie	201,737	none
Manistee River	100,010	none
Little Manistee River	150,067	none
Portage Lake	200,001	none
Big Sable River	70,050	none
Sable Point	202,490	adipose
Muskegon River	132,500	none
Grand River	179,011	none
Kalamazoo River	140,047	none
St. Joseph River	132,379	none
subtotal	2,268,878	

*Alaskan strain
[1]Includes 50,000 Alaskan strain

Location	Numbers	Fin clip
Wisconsin waters		
Little River	38,000	none
Ahnapee River	40,000	none
Kewaunee	40,000	none
Two Rivers	19,200	none

Table 10–Cont'd

Location	Numbers	Fin clip
Little Manitowoc River	43,000	none
Sheboygan River	40,228	none
Oak Creek (Milwaukee)	38,200	adipose-left ventral, adipose-left pectoral, adipose-right pectoral, right ventral, right maxillary, left maxillary[2]
subtotal	258,628	
Indiana waters		
Trail Creek	46,000	left pectoral
Little Calumet River	46,000	right pectoral
subtotal	92,000	
Total Lake Michigan	2,619,506	

[2]Six different clips for Sea Grant imprinting studies.

LAKE HURON

Location	Numbers	Fin clip
Michigan waters		
Tawas River	105,027	none
Cass River	144,019	none
Total Lake Huron	249,046	

LAKE ERIE

Location	Numbers	Fin clip
Ohio waters		
Huron River	28,451	none
Conneaut Creek	9,200	none
subtotal	37,651	
Pennsylvania waters		
Raccoon Creek	10,000	none
Elk Creek	11,143	adipose
Grimshaw Run	15,126	adipose
Walnut (Bear) Creek	18,034	adipose
Godfrey Run	56,324	adipose
Presque Isle Bay	5,000	adipose- right ventral
Six Mile Creek	9,000	adipose
Orchard Beach Run	6,600	adipose
subtotal	131,227	

Table 10–Cont'd

Location	Numbers	Fin clip
New York waters		
Eighteen Mile Creek	11,750	adipose-left pectoral
Dunkirk Creek	24,650	adipose-left ventral
Chautauqua Creek	13,150	adipose-right pectoral
subtotal	49,550	
Total Lake Erie	218,428	

LAKE ONTARIO

Location	Numbers	Fin clip
Ontario waters		
Bronte Creek	22,500	right ventral
Credit River	98,000	right ventral
Eastern basin	1,000	right pectoral and tag
subtotal	121,500	
New York waters		
Skinner Creek	39,650	adipose (19, 700 fish only)
Salmon River	112,650	adipose right pectoral left pectoral left ventral none
Salmon Creek	27,800	adipose
Sandy Creek	49,800	left ventral
subtotal	229,900	
Total Lake Ontario	351,400	
Grand Total Great Lakes	3,738,756	

Table 11. Annual plantings (in thousands) of chinook salmon in the Great Lakes, 1967-1972.

LAKE SUPERIOR

Year	Michigan	Total
1967	33	33
1968	50	50
1969	50	50

Table 11–Cont'd

Year	Michigan	Total
1970	150	150
1971	252	252
1972	472	472
subtotal	1,007	1,007

LAKE MICHIGAN

Year	Michigan	Wisconsin	Indiana	Illinois	Total
1967	802	–	–	–	802
1968	687	–	–	–	687
1969	652	66	–	–	718
1970	1,675	119	100	10	1,904
1971	1,865	264	180	8	2,317
1972	1,691	317	–	24	2,032
subtotal	7,372	766	280	42	8,460

LAKE HURON

Year	Michigan	Total
1968	274	274
1969	255	255
1970	643	643
1971	894	894
1972	515	515
subtotal	2,581	2,581

LAKE ERIE

Year	Ohio	Pennsylvania	Total
1970	150	–	150
1971	180	129	309
1972	–	150	150
subtotal	330	279	609

Table 11–Cont'd

LAKE ONTARIO

Year	Ontario	New York	Total
1969	–	70	70
1970	–	141	141
1971	89	149	238
1972	190	426	616
subtotal	279	786	1,065
Great Lakes Total 1967-1972			13,722

Table 12. Plantings of chinook salmon in the Great Lakes, 1972

LAKE SUPERIOR

Location	Numbers	Fin clip
Michigan waters		
Black River Harbor	80,032	none
Keweenaw Bay (Falls River)	75,030	none
Marquette area (Dead River)	216,250	none
Sucker River (Grand Marais)	100,376	none
Total Lake Superior	471,688	

LAKE MICHIGAN

Location	Numbers	Fin clip
Michigan waters		
Menominee River	100,528	none
Platte River	40,630	none
Manistee River	161,118	none
Little Manistee River	300,908	none
Muskegon River	315,775	none
Big Sable River	94,634	none
Grand River	332,745	none

Table 12–Cont'd

Location	Numbers	Fin clip
Kalamazoo River	101,448	none
St. Joseph River	234,666	none
subtotal	1,691,452	
Wisconsin waters		
Little River (Marinette)	24,000	none
Strawberry Creek (Sturgeon Bay)	80,000	none
Kewaunee River	60,000	none
Little Manitowoc River	40,000	none
Sheboygan River	25,000	none
Kenosha	88,000	none
subtotal	317,000	
Illinois waters		
Diversey Harbor	11,435	left pectoral
Illinois Power Plant	6,741	left pectoral
Winnetka Power Plant	5,500	right pectoral
subtotal	23,676	
Total Lake Michigan	2,032,128	

LAKE HURON

Location	Numbers	Fin clip
Michigan waters		
Thunder Bay River	80,400	right ventral (200 fish)
Lake Huron (Harrisville)	201,078	none
Au Gres River	71,331	none
Cass River	161,736	none
Total Lake Huron	514,545	

LAKE ERIE

Location	Numbers	Fin clip
Pennsylvania waters		
Trout Run	150,000	none
Total Lake Erie	150,000	

Table 12–Cont'd

Location	Numbers	Fin clip
LAKE ONTARIO		
Ontario waters		
Shelter Valley Creek	189,860	adipose
New York waters		
Skinner Creek	19,900	none
	19,750	left ventral
Salmon River	19,950	left ventral
	19,950	right ventral
	65,750	none
Grindstone Creek	34,500	none
Little Salmon River	86,100	none
Salmon Creek	59,900	none
Sandy Creek	99,800	none
subtotal	425,600	
Total Lake Ontario	615,460	
Grand total, Great Lakes	3,783,821	

Table 13. Plantings of Atlantic Salmon in the Great Lakes, 1972

State	Lake	Area	Number
Wisconsin	Superior	Bayfield	20,000
Michigan	Michigan	Boyne River	10,000
	Huron	Au Sable River	9,000
Total			39,000

APPENDIX C

LAMPREY CONTROL IN THE UNITED STATES

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

The number of spawning-run sea lampreys captured at eight electrical barriers increased slightly in 1972. The final count of 9,696 was 83 more than in 1971 and 4,915 more than in 1970, but 41,279 less than in the peak year of 1961 for the same streams. The average size (length, 44.3 cm; weight, 192 g) of sea lampreys captured at the barriers did not change appreciably from that in 1971. The percentage of males increased from 30.6 to 31.1.

Excellent progress was made during the year; 75 streams with a total flow of 8,956 cfs were treated on the upper three Great Lakes and Lake Ontario. The tributaries of Lake Ontario were treated for the first time. The addition of a third treatment crew afforded wider latitude in scheduling and increased efficiency during treatments of large streams.

Surveys and chemical treatments

Lake Superior surveys. Stream surveys were delayed by high water until late June; then 15 streams were surveyed in preparation for chemical treatments. Moderate numbers of sea lampreys were found in 10 streams and relatively small numbers in 5. The lengths of ammocetes taken in a survey of the Brule River just before its treatment in July indicated that larvae there may metamorphose at age III. A collection of 17 sea lampreys contained 13 longer than 120 mm (range, 122-157 mm). Previous treatment of the stream had been in July 1969.

During posttreatment examinations of seven streams treated in 1971 and 1972, small populations of ammocetes that survived chemical treatment were discovered in four–the Rock, Bad, Amnicon, and Nemadji Rivers. The Amnicon and Nemadji Rivers were subsequently re-treated.

Sea lamprey larvae were found in 7 of 14 streams surveyed to determine whether lampreys had become reestablished–the Betsy, Two Hearted, Laughing Whitefish, Chocolay, Little Garlic, Little Iron, and Arrowhead Rivers. The one ammocete (71 mm long) taken in the Little Iron River was the first recorded since its treatment in May 1964.

The examination of 22 streams with no record of sea lamprey production yielded no ammocetes. Included were streams on the Apostle Islands where surveys were prompted by reports of spawning adults and their subsequent capture by personnel of the Wisconsin Department of Natural Resources at Bayfield, Wisconsin.

In spawning surveys in the Bad River, 86 nests were found in 1972 as compared with 51 in 1971. In annual checks of the same areas in the river in 1964-72, the number of nests has ranged from 189 in 1964 to 38 in 1966.

Lake Superior chemical treatments. Twenty-four tributaries of Lake Superior, with a combined flow of 2,298 cfs, were treated during the period July 5-October 3 (Table 1). One stream was originally scheduled in fiscal year 1971, 4 were postponed from fiscal year 1972, 7 were added to the schedule to intensify the control effort, and the other 12 were scheduled for fiscal year 1973. The Ontonagon River remains to be treated to complete the treatment schedule for fiscal year 1973.

The Cranberry and East Sleeping Rivers were treated in 1972, after their treatments were postponed in fiscal years 1971 and 1972 because of low water levels. Large numbers of ammocetes were killed in both treatments. It is likely that they contributed to the parasitic population in Lake Superior in the fall of 1971.

Eliza Creek was treated for the first time since 1963. Considering its small flow, which was about 1 cfs at the time of treatment, it contained a large population of ammocetes. In addition, 37 adult lampreys were killed on spawning beds.

The complex of streams (Silver, Slate, and Ravine Rivers) flowing into Huron Bay was treated in an attempt to reduce the ammocete population in the bay. Ammocetes were scarce in the Ravine and Slate Rivers and on their deltas, but were numerous in the Silver River and on its delta. Hopefully, consecutive treatments will control what may be a large population of ammocetes in Huron Bay.

The annual treatment of the Sucker River and its delta in East Bay was made in August. A significant reduction in the numbers (602 in 1971 and 288 in 1972) and length (average, 81 mm in 1971 and 59 mm in 1972) of ammocetes from the delta indicates the degree of success of annual treatments made to control delta populations. The number of ammocetes 120 mm long and longer decreased from 106 in 1971 to 21 in 1972.

The removal of the Middle River weir in 1970 allowed many spawning sea lampreys to reach the upper river in 1971. In a survey made to determine whether an ammocete population developed after this relatively large run, we collected a few large ammocetes and two transforming sea lampreys. Subsequent treatment destroyed large numbers of larvae of the 1971 year class, and posttreatment collections included 16 transforming sea lampreys.

The other treatments were routine, and disclosed only moderate to small ammocete populations. No significant fish kills occurred.

Table 1. Details on the application of lampricides to tributaries of Lake Superior in 1972.
[Lampricides used are in pounds of active ingredient.]

			TFM				Bayer 73		
			Concentration (ppm)				Powder	Granules	
Stream	Date	Discharge at mouth (cfs)	Minimum effective	Maximum allowable	Pounds used	Hours applied	Pounds used	Pounds used	Acres treated
Harlow Creek	July 5	11	2.0	5.0	132	14	–	10.0	1.3
Amnicon River	July 13	20	2.0	4.0	242	14	–	–	–
Nemadji River	July 15	25	2.0	5.0	242	6	–	–	–
Brule River	July 17	180	2.5	6.0	1,716	12	–	–	–
Fish Creek	July 19	90	2.5	6.0	792	12	–	–	–
Huron River	July 26	43	1.5	4.0	396	13	–	–	–
Silver River	July 27	46	1.5	4.0	374	6	–	10.0	1.3
Ravine River	July 27	8	1.5	4.0	66	12	–	17.6	2.4
Slate River	July 28	10	1.5	4.0	44	6	–	13.0	1.8
Sturgeon River	July 29	1,015	1.5	4.0	5,918	12	41.3	4.0	0.5
Eliza Creek	Aug. 3	1	1.5	4.0	22	10	–	–	–
Big Gratiot River	Aug. 5	11	2.0	5.0	66	10	–	–	–
Salmon Trout River	Aug. 5	35	2.5	6.0	308	10	–	–	–
Little Gratiot River	Aug. 6	7	2.0	5.0	154	12	–	–	–
Iron River	Aug. 9	65	1.5	4.0	814	16	–	–	–
Au Train River	Aug. 10	200	2.5	5.0	2,200	12	18.6	30.0	4.0
Sucker River	Aug. 18	75	2.0	5.0	792	12	–	39.0	5.2
Cranberry River	Aug. 24	130	1.5	3.5	528	13	–	–	–
East Sleeping River	Aug. 27	20	2.0	5.5	418	12	7.0	–	–
Big Garlic River	Sept. 6	32	2.0	5.5	440	16	–	5.0	0.8
Middle River	Sept. 24	100	1.5	3.0	770	14	–	–	–
Pine River	Sept. 27	37	1.5	4.0	352	14	–	–	–
Waiska River	Oct. 2	87	1.5	3.5	638	12	–	–	–
Sand River	Oct. 3	50	1.0	4.0	440	12	–	–	–
Total	–	2,298	–	–	17,864	–	66.9	128.6	17.3

Table 1. Details on the application of lampricides to tributaries of Lake Superior in 1972.
[Lampricides used are in pounds of active ingredient.]

Stream	Date	Discharge at mouth (cfs)	TFM: Concentration (ppm): Minimum effective	TFM: Concentration (ppm): Maximum allowable	TFM: Pounds used	TFM: Hours applied	Bayer 73: Powder: Pounds used	Bayer 73: Granules: Pounds used	Bayer 73: Granules: Acres treated
Harlow Creek	July 5	11	2.0	5.0	132	14	–	10.0	1.3
Amnicon River	July 13	20	2.0	4.0	242	14	–	–	–
Nemadji River	July 15	25	2.0	5.0	242	6	–	–	–
Brule River	July 17	180	2.5	6.0	1,716	12	–	–	–
Fish Creek	July 19	90	2.5	6.0	792	12	–	–	–
Huron River	July 26	43	1.5	4.0	396	13	–	–	–
Silver River	July 27	46	1.5	4.0	374	6	–	10.0	1.3
Ravine River	July 27	8	1.5	4.0	66	12	–	17.6	2.4
Slate River	July 28	10	1.5	4.0	44	6	–	13.0	1.8
Sturgeon River	July 29	1,015	1.5	4.0	5,918	12	41.3	4.0	0.5
Eliza Creek	Aug. 3	1	1.5	4.0	22	10	–	–	–
Big Gratiot River	Aug. 5	11	2.0	5.0	66	10	–	–	–
Salmon Trout River	Aug. 5	35	2.5	6.0	308	10	–	–	–
Little Gratiot River	Aug. 6	7	2.0	5.0	154	12	–	–	–
Iron River	Aug. 9	65	1.5	4.0	814	16	–	–	–
Au Train River	Aug. 10	200	2.5	5.0	2,200	12	18.6	30.0	4.0
Sucker River	Aug. 18	75	2.0	5.0	792	12	–	39.0	5.2
Cranberry River	Aug. 24	130	1.5	3.5	528	13	–	–	–
East Sleeping River	Aug. 27	20	2.0	5.5	418	12	7.0	–	–
Big Garlic River	Sept. 6	32	2.0	5.5	440	16	–	5.0	0.8
Middle River	Sept. 24	100	1.5	3.0	770	14	–	–	–
Pine River	Sept. 27	37	1.5	4.0	352	14	–	–	–
Waiska River	Oct. 2	87	1.5	3.5	638	12	–	–	–
Sand River	Oct. 3	50	1.0	4.0	440	12	–	–	–
Total	–	2,298	–	–	17,864	–	66.9	128.6	17.3

Lake Michigan surveys. Pretreatment surveys were completed on 20 Lake Michigan tributaries in 1972, and large numbers of sea lamprey larvae were evident in four–the Black, Millecoquins, Rapid, and Ford Rivers.

Reestablishment surveys on 69 streams found many ammocetes in the Platte, Betsie, Manistee, and Whitefish Rivers, and in sections of the Ford River that were not included in the 1972 partial treatment. During the survey of the Ford River numerous high-water channels and oxbow ponds were treated with powdered and granular Bayer 73 to eliminate larval concentrations in areas isolated from the lampricide during stream treatment. Moderate to small reestablished populations were indicated in 26 streams, and no sea lampreys were found in 38 others. Many of the streams with no reestablished larvae are either small and do not produce lampreys regularly, or they were chemically treated recently.

A transforming sea lamprey was collected during a routine fall survey of the Muskegon River, about 5 miles upstream from Newaygo. This section of the river was not accessible to spawning sea lampreys until a hydroelectric dam at Newaygo was removed in fall 1968. The river above Newaygo was chemically treated during the July 30, 1969, treatment of the Muskegon River. It therefore appears that the age of this lone lamprey was 3 years or less. Efforts to collect additional transforming lampreys were unsuccessful.

Sea lamprey larvae were found in 1972 for the first time in the East Twin River, Manitowoc County, Wisconsin; 11 larvae, 69-133 mm long, were collected. The stream has a history of large adult runs, but until this year no ammocetes had been found.

The deltas of five Lower Peninsula streams were examined to determine whether lampreys had become reestablished and to evaluate previous chemical treatments. Populations off the mouths of Horton and Porter Creeks were substantially lower than in 1969; as compared with 332 larvae taken from the Horton Creek delta and 94 larvae from the Porter Creek delta in 1969, only 1 and 3 were taken in 1972. Both deltas were treated in 1970 and 1971. A large sea lamprey population was found on the delta of Boyne River, where 268 sea lampreys were collected from a 3/4-acre plot, and on the delta of Monroe Creek, where 72 were taken from a 1/4-acre plot. A population on the Jordan River delta remains very small.

Twenty-four streams in the Lower Peninsula were examined for spawning sea lampreys and nests. Between June 2 and August 4, 189 adults and 669 nests were found in 11 streams; no adults or nests were found in 13 streams. A total of 158 nests were counted in 15 miles of the Muskegon River. Nesting activity was observed in the Carp Lake River as late as August 4, when two adults and two nests were seen.

The concentration of adult lampreys below the dam on the Manistique River was sampled for the second year to supply data on a Lake Michigan spawning run. The run in 1972 appeared to peak about 3 weeks earlier than in 1971. Investigations to determine how adults get above the dam at Manistique have been fruitless. Because the plans of the Manistique Pulp and Paper Company to lower the water levels in the flume were cancelled, it was not possible to examine the structure from the inside for escape routes. Collection of two ammocetes (each 38 mm long) at a point about 60 miles upstream indicates that adults probably bypassed the dam again in 1971.

Length-frequency data for sea lamprey ammocetes were collected from five streams (Table 2). Growth data for the season were available from three streams–the Platte, White, and Muskegon Rivers.

Table 2. Mean length (mm) and length increment of age groups of sea lamprey ammocetes collected in the spring and fall from five tributaries of Lake Michigan, 1972 [Numbers of ammocetes measured are shown in parentheses.]

Stream	Age group							
	0	I			II			III
	Fall	Spring	Fall	Increment	Spring	Fall	Increment	Spring
Platte River	32 (9)	46 (145)	81 (195)	35	– (0)	– (0)	–	– (0)
Betsie River[1]	36 (450)	– (0)	– (0)	–	– (0)	– (0)	–	– (0)
Manistee River[2]	47 (255)	48 (239)	– (0)	–	88 (436)	– (0)	–	125 (124)
White River	38 (77)	56 (81)	84 (353)	28	98 (296)	117 (309)	19	– (0)
Muskegon River	31 (116)	46 (286)	68 (218)	22	97 (370)	111 (74)	14	– (0)

[1]No spring sample; stream was treated with TFM on August 6, 1971.
[2]Stream was treated with TFM on May 28, 1972.

Lake Michigan chemical treatments. A total of 18 Lake Michigan streams with a total flow of 3,613 cfs were treated in 1972 (Table 3); 11 streams were scheduled for fiscal year 1973, 1 was postponed from fiscal year 1971 and 4 from fiscal year 1972, and 2 were added to the list when large ammocetes were discovered. In five streams, treatment was postponed because only small ammocetes were present. A total of 10 Lake Michigan streams are scheduled for treatment by June 30, 1973.

The third annual TFM and granular Bayer 73 treatments of two tributaries of Lake Charlevoix–Horton and Porter Creeks–demonstrated the effectiveness of this method for the control of a population of sea lampreys established on a delta. In Horton Creek, only 4 larval sea lampreys were collected during the treatment, compared with 389 in 1971. All were on the delta and all were more than 160 mm long. Apparently, there has been no recruitment to the delta population since annual treatments began in 1970. In Porter Creek, collections indicated a decreasing population of sea lampreys on the delta; scarcity of large larvae was especially noteworthy.

The series of annual treatments used successfully on Horton and Porter Creeks were initiated in 1972 on the Boyne River and its delta in Lake Charlevoix. The planned treatments will be complicated by large runs of

Table 3. Details on the application of lampricides to tributaries of Lake Michigan in 1972. [Lampricides used are in pounds of active ingredient.]

Stream	Date	TFM					Bayer 73		
		Discharge at mouth (cfs)	Concentration (ppm)		Pounds used	Hours applied	Powder	Granules	
			Minimum effective	Maximum allowable			Pounds used	Pounds used	Acres treated
Gurney Creek	April 27	15	3.0	7.0	110	11	–	–	–
Pere Marquette River	May 16	770	5.0	13.0	21,406	16	–	–	–
Manistee River	May 28	2,101	4.0	11.0	29,782	10	96.6	25.0	3.4
Ford River	June 10	225	4.0	8.0	4,928	12	31.5	–	–
Bailey Creek	Aug. 29	1	5.0	12.5	66	24	–	–	–
Beattie Creek	Aug. 30	3	5.5	17.0	44	12	0.4	–	–
Springer Creek	Aug. 31	1	7.5	16.5	66	12	–	–	–
Rapid River	Sept. 8	35	4.0	12.0	1,364	14	–	–	–
Milleoquin River	Sept. 13	212	3.0	9.0	3,806	15	4.2	5.0	0.8
Mile Creek	Sept. 27	6	1.5	4.0	132	18	–	–	–
Black River	Sept. 27	94	2.5	5.5	1,122	15	–	–	–
Horton Creek	Oct. 5	20	6.0	13.0	264	6	–	5.0	0.8
Porter Creek	Oct. 6	23	4.0	11.0	198	7	–	3.7	0.5
Monroe Creek	Oct. 7	13	6.0	13.0	220	9	–	10.0	1.3
Big Stone Creek	Oct. 9	3	5.0	14.0	44	10	–	–	–
Wycamp Creek	Oct. 19	31	7.0	9.0	528	11	–	–	–
Big Sucker Creek	Oct. 20	6	5.0	11.0	286	13	–	–	–
Crystal River	Oct. 23	54	5.0	12.0	858	10	–	–	–
Total	–	3,613	–	–	65,224	–	132.7	48.7	6.8

Table 3. Details on the application of lampricides to tributaries of Lake Michigan in 1972. [Lampricides used are in pounds of active ingredient.]

Stream	Date	Discharge at mouth (cfs)	TFM: Concentration (ppm) Minimum effective	TFM: Concentration (ppm) Maximum allowable	TFM: Pounds used	TFM: Hours applied	Bayer 73: Powder Pounds used	Bayer 73: Granules Pounds used	Bayer 73: Granules Acres treated
Gurney Creek	April 27	15	3.0	7.0	110	11	–	–	–
Pere Marquette River	May 16	770	5.0	13.0	21,406	16	–	–	–
Manistee River	May 28	2,101	4.0	11.0	29,782	10	96.6	25.0	3.4
Ford River	June 10	225	4.0	8.0	4,928	12	31.5	–	–
Bailey Creek	Aug. 29	1	5.0	12.5	66	24	–	–	–
Beattie Creek	Aug. 30	3	5.5	17.0	44	12	0.4	–	–
Springer Creek	Aug. 31	1	7.5	16.5	66	12	–	–	–
Rapid River	Sept. 8	35	4.0	12.0	1,364	14	–	–	–
Millecoquin River	Sept. 13	212	3.0	9.0	3,806	15	4.2	5.0	0.8
Mile Creek	Sept. 27	6	1.5	4.0	132	18	–	–	–
Black River	Sept. 27	94	2.5	5.5	1,122	15	–	–	–
Horton Creek	Oct. 5	20	6.0	13.0	264	6	–	5.0	0.8
Porter Creek	Oct. 6	23	4.0	11.0	198	7	–	3.7	0.5
Monroe Creek	Oct. 7	13	6.0	13.0	220	9	–	10.0	1.3
Big Stone Creek	Oct. 9	3	5.0	14.0	44	10	–	–	–
Wycamp Creek	Oct. 19	31	7.0	9.0	528	11	–	–	–
Big Sucker Creek	Oct. 20	6	5.0	11.0	286	13	–	–	–
Crystal River	Oct. 23	54	5.0	12.0	858	10	–	–	–
Total	–	3,613	–	–	65,224	–	132.7	48.7	6.8

rainbow trout, coho salmon, chinook salmon, and the recently planted Atlantic salmon.

The lower 40 miles of the Ford River were re-treated in 1972 to eliminate the ammocete population that survived the 1971 treatment. Water levels were high enough to carry the chemical into many of the side channels and bayous that were not reached during earlier treatments at lower water levels. The ammocete kill in the lower river and bayous was high.

The Rapid River was treated after a 2-year postponement due to low water levels. Although less-than-optimum water levels during treatment caused problems in the application of chemical in the upper river, post-treatment surveys in three areas of the upper river failed to produce ammocetes. Large numbers of transforming lampreys and ammocetes over 100 mm long were killed during the treatment.

Lake Huron surveys. Fifteen sea lamprey streams were surveyed in preparation for chemical treatments; 11 were treated, and 4 were scheduled for treatment during the 1973 field season.

Two Saginaw River tributaries, Chippewa River and Bluff Creek, were resurveyed following reports of adult sea lampreys passing through fishways in the dam at the Dow Chemical Plant at Midland. Small numbers of age-0 sea lampreys were found in both streams.

The application of granular Bayer 73 to the deltas of the Ocqueoc and Devils Rivers, as part of pretreatment surveys, yielded 12 larvae (31-77 mm long) from the Ocqueoc and 17 (33-78 mm long) from the Devils.

Reestablishment surveys in 29 Lake Huron tributaries indicated the reestablishment of sea lamprey larvae in 20, and small numbers of residual larvae in Little Munuscong River and Prentiss Creek. The nine streams with no reestablished sea lampreys are small and have a history of sporadic production.

Five streams having no record of sea lamprey production were resurveyed. Small populations were found in McCloud Creek and Bear Lake Outlet, both very small tributaries in the Upper Peninsula.

A spring sample of ammocetes from the Rifle River indicated a potential for metamorphosis at age III. The average length of a sample of 130 larvae was 117 mm and the maximum length was 155 mm. Collections made during treatment of the main stream in mid-July included one well-developed transforming sea lamprey (107 mm long). None of the larger ammocetes showed signs of metamorphosis.

Thirteen streams were examined for spawning adults and nests; a total of 380 adults and 1,803 nests were counted in 12, and 148 adults (97 males and 51 females) were captured. Spawning was most intense in the Rifle River (909 nests and 202 adults) and East Au Gres River (517 nests and 113 adults).

Lake Huron chemical treatments. Twelve streams totaling 936 cfs were treated with TFM and one stream, the Cheboygan River below Cheboygan Dam, was spot-treated with granular Bayer 73 (Table 4). Sea lamprey larvae were abundant in the Devils, East Au Gres, Rifle, and Ocqueoc Rivers, and common to scarce in the other streams.

Fish mortality occurred during the treatment of the headwaters of the Rifle and East Au Gres (Whitney Drain) Rivers, where increasing stream volume between successive access points required the application of high TFM concentrations to ensure minimum lethal concentrations of larvicide throughout the stream. These two rivers are probably the major sea lamprey-producers on the U.S. side of Lake Huron.

The chemical treatment of the Devils River near Ossineke, Michigan, was programmed to allow filming of the operation for the television program, "Michigan Outdoors." The treatment progressed well and excellent TV coverage was obtained.

The treatment of the Cheboygan River and estuary below the Paper Mill Dam in the City of Cheboygan, Michigan, was accomplished with granular Bayer 73. Sea lamprey larvae were concentrated in several areas and these were spot-treated with excellent results. Reports by local citizens and the Department of Natural Resources of the presence of thousands of fish (walleyes, northern pike, and chinook salmon) in the area caused concern; however, no fish were killed.

McCloud Creek, a small north shore tributary, was treated for the first time. A random sample of 607 ammocetes from the collections included 12 sea lampreys.

Lake Ontario chemical treatments. The initial round of chemical treatments along the south shore of Lake Ontario began on May 8 and was completed June 15. Twenty streams with a total flow of 2,109 cfs were treated (Table 5).

Rain and high stream water levels both helped and hindered treatment crews. On the one hand, the rain and higher flows speeded treatment of streams, softened the stream water, and thus reduced the concentration of larvicide needed to attain toxic levels; high water also aided treatment of beaver ponds and other still-water areas within stream systems, which are difficult or impossible to treat at normal stream levels. On the other hand, intermittent springs and seepages which provided areas for sea lamprey ammocetes to escape lethal concentrations of larvicide, increased in number during the rains and high flows; and treatment of the large volume of water required increased quantities of larvicide despite lower concentrations. On balance, many of the streams might have been treated more effectively during a period of stable flows and less rain.

Populations of sea lampreys were small in First, Third, Wolcott, Rice, Stony, Sterling, and South Sandy Creeks; moderate in Blind, Butterfly, and Sodus Creeks and Little Salmon River; and large in Snake, Lindsey, Skinner, Sage, Deer, Little Sandy, Catfish, and Grindstone Creeks. The lower reaches of the Salmon River contained the largest ammocete population ever seen by the experienced treatment crew. Populations of sea lampreys in tributaries of the Salmon River were moderate in Beaverdam Creek and large in Trout and

Table 4. Details on the application of lampricides to tributaries of Lake Huron in 1972.
[Lampricides used are in pounds of active ingredient.]

			TFM				Bayer 73		
		Discharge	Concentration (ppm)				Powder	Granules	
Stream	Date	at mouth (cfs)	Minimum effective	Maximum allowable	Pounds used	Hours applied	Pounds used	Pounds used	Acres treated
Rifle River	June 17	306	4.0	15.0	9,777	16	10.7	15.1	2.0
East Au Gres River	July 22	61	6.0	14.0	2,332	16	–	10.0	1.3
Grace Creek	Aug. 4	1	3.0	8.0	22	14	–	–	–
Mulligan Creek	Aug. 4	11	3.0	8.0	176	28	–	–	–
Ocqueoc River	Aug. 5	297	3.0	12.0	5,566	17	4.2	45.0	6.0
Cheboygan River[1]	Aug. 23	–	–	–	–	–	–	50.0	6.7
Devils River	Aug. 30	61	7.0	12.0	2,046	16	–	22.6	3.0
Tawas River[2]	Sept. 5	7	6.0	13.0	99	11	–	5.0	0.8
Au Gres River	Sept. 21	70	7.0	11.0	2,310	16	–	–	–
Pine River	Oct. 12	110	3.0	10.0	4,356	18	–	–	–
Martineau Creek	Oct. 25	5	3.5	9.0	198	21	1.4	–	–
McCloud Creek	Oct. 25	3	5.0	14.0	88	18	–	–	–
Trout Creek	Oct. 25	4	2.5	7.0	88	19	–	–	–
Total	–	936	–	–	27,058	–	16.3	147.7	19.8

[1]Treated stream and estuary below Cheboygan Dam.
[2]Treated Cold Creek only, a tributary.

Table 4. Details on the application of lampricides to tributaries of Lake Huron in 1972. [Lampricides used are in pounds of active ingredient.]

Stream	Date	Discharge at mouth (cfs)	TFM: Concentration (ppm) Minimum effective	TFM: Concentration (ppm) Maximum allowable	TFM: Pounds used	TFM: Hours applied	Bayer 73: Powder Pounds used	Bayer 73: Granules Pounds used	Bayer 73: Granules Acres treated
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East Au Gres River	July 22	61	6.0	14.0	2,332	16	–	10.0	1.3
Grace Creek	Aug. 4	1	3.0	8.0	22	14	–	–	–
Mulligan Creek	Aug. 4	11	3.0	8.0	176	28	–	–	–
Ocqueoc River	Aug. 5	297	3.0	12.0	5,566	17	–	–	–
Cheboygan River[1]	Aug. 23	–	–	–	–	–	4.2	45.0	6.0
Devils River	Aug. 30	61	7.0	12.0	2,046	16	–	50.0	6.7
Tawas River[2]	Sept. 5	7	6.0	13.0	99	11	–	22.6	3.0
Au Gres River	Sept. 21	70	7.0	11.0	2,310	16	–	5.0	0.8
Pine River	Oct. 12	110	3.0	10.0	4,356	18	–	–	–
Martineau Creek	Oct. 25	5	3.5	9.0	198	21	–	–	–
McCloud Creek	Oct. 25	3	5.0	14.0	88	18	1.4	–	–
Trout Creek	Oct. 25	4	2.5	7.0	88	19	–	–	–
Total	–	936	–	–	27,058	–	16.3	147.7	19.8

[1]Treated stream and estuary below Cheboygan Dam.
[2]Treated Cold Creek only, a tributary.

Table 5. Details on the application of lampricide to tributaries of Lake Ontario in 1972. [Lampricide used is in pounds of active ingredient.]

Stream	Date	Discharge at mouth (cfs)	TFM: Concentration (ppm) Minimum effective	TFM: Concentration (ppm) Maximum allowable	TFM: Pounds used	TFM: Hours applied
First Creek	May 8	12	2.5	9.0	77	6
Third Creek	May 8	15	2.5	9.0	176	9
Blind Creek	May 10	20	2.0	8.0	176	15
Snake Creek	May 11	15	1.5	8.0	121	12
Lindsey Creek	May 13	35	1.5	9.0	418	12
Skinner Creek	May 14	50	1.5	9.0	583	12
Butterfly Creek	May 16	30	1.5	8.0	374	7
Sodus Creek	May 18	15	4.0	13.0	198	7
Wolcott Creek	May 18	50	3.5	12.0	462	8
Rice Creek	May 20	30	2.0	6.0	418	7
Sage Creek	May 21	20	2.0	8.0	264	7
Deer Creek	May 24	20	1.5	8.0	297	11
Little Sandy Creek	May 26	36	1.5	8.0	352	20
Catfish Creek	May 27	85	2.0	6.0	594	14
Little Salmon River	May 29	60	2.0	6.0	638	12
Stony Creek	May 31	18	6.0	11.0	374	10
Sterling Creek	June 3	90	4.5	9.0	1,232	10
Grindstone Creek	June 3	115	1.5	6.0	968	13
Salmon River	June 13	1,276	0.75	3.0	5,478	12
South Sandy Creek	June 15	117	2.0	6.0	770	12
Total	–	2,109	–	–	13,970	–

Orwell Brooks. Nearly 13,000 ammocetes (95% sea lampreys) and 293 sea lamprey adults were collected for biological data.

Posttreatment surveys indicated that some lampreys survived treatment in 11 streams, but the numbers were significant in only 5 (Skinner, Lindsey, Little Deer, and Little Sandy Creeks and the Salmon River).

Slight fish kills were observed in Sage, Little Deer, Little Sandy, Stony, and Grindstone Creeks and the Little Salmon River. Minnows, bullheads, and white suckers made up the bulk of the mortality, but a few northern pike also were found. Local residents claimed that trout were killed on Sage Creek, but none were collected by the treatment crew.

Studies of adult sea lampreys

Migrant sea lampreys. Electric barriers were operated between April 18 and July 13 on eight streams along the south shore of Lake Superior to measure changes in abundance and to provide data on the biological characteristics of sea lampreys.

A total of 9,696 adult sea lampreys were taken during the period of operation (Table 6). This number is 83 more than in 1971 and 4,915 more

Table 6. Number of adult sea lampreys taken at electric barriers operated in eight tributaries of Lake Superior through July 13, 1961-72.

Stream	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Betsy River	1,366	316	444	272	187	65	57	78	120	87	104	146
Two Hearted River	7,498	1,757	2,447	1,425	1,265	878	796	2,132	1,104	1,132	1,035	1,507
Sucker River	3,209	474	698	386	532	223	166	658	494	337	485	642
Chocolay River	4,201	423	358	445	563	260	65	122	142	291	53	294
Iron River	2,430	1,161	110	178	283	491	643	82	556	713	1,518	280
Silver River	5,052	267	760	593	847	1,010	339	1,032	1,147	321	340	2,574
Brule River	22,478	2,026	3,418	6,718	6,163	226	364	2,657	3,374	167	1,754	4,121
Amnicon River	4,741	879	131	232	700	938	200	148	1,576	1,733	4,324	132
Total	50,975	7,303	8,366	10,249	10,540	4,091	2,630	6,909	8,513	4,781	9,613	9,696
Percentage of the 1958-61 mean	132	19	22	27	27	11	7	18	22	12	25	25

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Stream	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Betsy River	1,366	316	444	272	187	65	57	78	120	87	104	146
Two Hearted River	7,498	1,757	2,447	1,425	1,265	878	796	2,132	1,104	1,132	1,035	1,507
Sucker River	3,209	474	698	386	532	223	166	658	494	337	485	642
Chocolay River	4,201	423	358	445	563	260	65	122	142	291	53	294
Iron River	2,430	1,161	110	178	283	491	643	82	556	713	1,518	280
Silver River	5,052	267	760	593	847	1,010	339	1,032	1,147	321	340	2,574
Brule River	22,478	2,026	3,418	6,718	6,163	226	364	2,657	3,374	167	1,754	4,121
Amnicon River	4,741	879	131	232	700	938	200	148	1,576	1,733	4,324	132
Total	50,975	7,303	8,366	10,249	10,540	4,091	2,630	6,909	8,513	4,781	9,613	9,696
Percentage of the 1958-61 mean	132	19	22	27	27	11	7	18	22	12	25	25

than in 1970, but 41,279 less than in 1961, for the same streams. The catch is 25% of the precontrol (1958-61) average (38,535).

The spawning run developed slowly in Lake Superior. Drift ice was prevalent along the south shore in May and unseasonably cold weather during June and the first 2 weeks of July delayed the run. The last 10 days of operation produced 1,648 sea lampreys, or 17% of the total run compared with an average of 5.5% for the last 10 days of operation in 1964-71.

In comparison with the 1971 catches, the numbers of sea lampreys declined 30% west of the Keweenaw Peninsula and increased 53% in eastern Lake Superior. About 84% of the total were taken in three streams: 42% (4,121) in the Brule River in western Lake Superior; 27% (2,574) in the Silver River in central Lake Superior; and 15% (1,507) in the Two Hearted River in eastern Lake Superior. The catch from the barrier on the Amnicon River declined from 4,324 in 1971 to 132 in 1972, a 97% reduction.

The average length (44.3 cm) and weight (192 g) of sea lampreys sampled from the eight Lake Superior streams did not change appreciably from last year. The percentage of males in the catch increased from 30.6 in 1971 to 31.1 in 1972.

The percentage (3.3) of rainbow trout with sea lamprey wounds or scars increased for the third consecutive year; it was the highest since 1964.

The number of rainbow trout, white suckers, and longnose suckers taken at the eight barriers in Lake Superior declined in 1972 from 1971. The number of fish of these species taken in 1972 and (in parentheses) the average number caught in 1966-71 were as follows: spawning-run rainbow trout, 1,169 (1,031); white suckers, 9,849 (13,162); and longnose suckers, 9,598 (27,737). The numbers of white suckers and longnose suckers were 26 and 66%, respectively, below the 6-year average.

The weir on the Ocqueoc River, a tributary of Lake Huron, captured 2,847 adult sea lampreys. Fluctuations in the water level of Lake Huron may have influenced the efficiency of the weir and the count of sea lampreys. A new weir is under construction.

A total of 818 spawning-run sea lampreys from tributaries of Lake Michigan and 324 from tributaries of Lake Ontario were obtained from stream surveys, chemical treatments, and fishermen. The lampreys from Lake Michigan tributaries averaged 46.6 cm in length and 230 g in weight, and 34.2% were males. For those from Lake Ontario tributaries, the respective values were 41.2 cm, 173 g, and 53.7%.

Parasitic sea lampreys. Parastitic-phase sea lampreys have been collected from Lake Superior since August 1969, from Lakes Michigan and Huron since August 1970, and from Lake Erie since September 1971 (Table 7). Collections from Lake Ontario have been limited to those made by personnel of the New York Department of Environmental Conservation. Analysis of the 1972 October-December collections are incomplete.

Table 7. Number of sea lampreys collected in commercial fisheries by lake and statistical district, 1969-72.

[Collections were begun in August 1969 in Lake Superior and August 1970 in Lakes Michigan and Huron. No spawning-phase sea lampreys were taken in 1969-70. Collections are not complete for October-December 1972.]

Statistical district[1]	Parasitic-phase: Length 200 mm or less 1969	1970	1971	1972	Length greater than 200 mm 1969	1970	1971	1972	Spawning-phase 1971	1972
Lake Superior										
M-1	0	0	0	0	1	3	1	3	0	2
M-2	0	0	0	0	7	6	5	10	0	7
M-3	0	0	0	1	11	16	16	3	0	0
Wisc.	3	15	8	3	30	101	302	220	0	0
MS-1	0	0	0	0	3	4	0	0	0	0
MS-2	0	0	0	0	1	10	23	8	0	2
MS-3	6	13	32	9	18	19	67	23	0	0
MS-4	2	2	5	1	24	49	143	115	0	3
MS-5	0	0	0	0	2	0	18	5	0	0
MS-6	1	1	2	1	9	6	12	3	0	0
Total	12	31	47	15	106	214	587	390	0	14
Lake Michigan										
MM-1	–	0	0	1	–	6	29	39	0	0
MM-2	–	25	2	1	–	5	20	8	0	0
MM-3	–	3	14	21	–	40	68	92	3	2
MM-4	–	0	0	0	–	0	0	0	0	0
MM-5	–	4	2	9	–	2	3	6	0	4
MM-6	–	0	0	0	–	0	0	0	0	0
MM-7	–	0	0	0	–	0	2	0	0	0
MM-8	–	1	2	1	–	0	1	0	0	0
WM-1	–	1	3	5	–	2	62	26	16	40
WM-2	–	0	175	143	–	1	410	426	0	0
WM-3	–	11	23	4	–	20	123	71	0	0
WM-4	–	1	8	2	–	66	112	12	130	160
WM-5	–	1	9	5	–	5	14	9	0	0
WM-6	–	0	0	2	–	0	0	0	0	0
Ill.	–	0	0	0	–	0	0	0	0	0
Ind.	–	0	0	0	–	0	0	0	0	0
Total	–	47	238	194	–	147	844	689	149	206
Lake Huron										
MH-1	–	0	1	2	–	69	109	64	0	0
MH-2	–	0	0	0	–	0	0	0	0	0
MH-3	–	0	0	4	–	10	40	0	0	0
MH-4	–	0	0	0	–	11	35	6	0	0
MH-5	–	0	0	0	–	0	0	0	0	0
MH-6	–	0	0	0	–	1	15	0	0	0
Total	–	0	1	6	–	91	199	70	0	0

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

Table 8. Number of sea lampreys collected in commercial fisheries by lake and month, 1969-72.

[No spawning-phase sea lampreys were collected in 1969-70. Collections are not complete for October-December 1972.]

Month	Parasitic-phase: Length 200 mm or less 1969	1970	1971	1972	Length greater than 200 mm 1969	1970	1971	1972	Spawning-phase 1971	1972
Lake Superior										
January	–	0	6	4	–	12	25	74	0	0
February	–	1	0	1	–	15	27	56	0	0
March	–	0	3	1	–	19	53	54	0	0
April	–	1	2	0	–	18	51	20	0	0
May	–	1	2	2	–	19	52	33	0	2
June	–	1	5	5	–	4	39	33	0	3
July	–	0	2	1	–	12	91	39	0	1
August	0	0	0	0	11	22	65	32	0	1
September	0	0	0	0	32	31	52	45	0	7
October	0	0	3	0	11	19	30	4	0	0
November	4	7	9	1	9	7	12	0	0	0
December	8	20	15	0	43	36	90	0	0	0
Total	12	31	47	15	106	214	587	390	0	14
Lake Michigan										
January	–	–	7	6	–	–	11	21	0	0
February	–	–	14	2	–	–	4	0	0	0
March	–	–	6	1	–	–	7	2	3	0
April	–	–	10	5	–	–	70	16	34	0
May	–	–	54	51	–	–	76	81	94	123
June	–	–	135	113	–	–	334	243	16	77
July	–	–	3	14	–	–	71	204	0	5
August	–	0	4	1	–	18	114	58	2	1
September	–	0	0	0	–	42	50	59	0	0
October	–	0	0	1	–	31	70	5	0	0
November	–	5	0	0	–	22	11	0	0	0
December	–	42	5	0	–	34	26	0	0	0
Total	–	47	238	194	–	147	844	689	149	206
Lake Huron										
January	–	–	0	0	–	–	2	0	0	0
February	–	–	0	0	–	–	0	1	0	0
March	–	–	0	0	–	–	0	0	0	0
April	–	–	0	4	–	–	1	0	0	0
May	–	–	1	1	–	–	5	4	0	0
June	–	–	0	1	–	–	25	11	0	0
July	–	–	0	0	–	–	34	16	0	0
August	–	0	0	0	–	13	48	6	0	0
September	–	0	0	0	–	49	48	32	0	0
October	–	0	0	0	–	29	31	0	0	0
November	–	0	0	0	–	0	3	0	0	0
December	–	0	0	0	–	0	2	0	0	0
Total	–	0	1	6	–	91	199	70	0	0

In 1972, 419 sea lampreys were taken by Lake Superior commercial and sport fisherman. Of these, 53% were taken in Wisconsin. Eight collected during August and September were sexually mature. Seven of these were captured in September near the water intake of the pellet plant at Taconite Harbor, Minnesota (Table 8).

Fishermen operating in statistical district MS-3 (Keweenaw Peninsula area) contributed 57% of the parasitic-phase sea lampreys less than 201 mm long taken in 1969-72.

The percentage males has been consistently higher among sea lampreys caught at the weirs than among those taken by fishermen. In 1970-72, the percentage was 32% in weir catches and 23% in the fisheries.

Lake Michigan fisherman captured 1,089 sea lampreys in 1972, of which 52% were taken from statistical district WM-2 (Gills Rock, Wisconsin area). The percentage males among parasitic-phase sea lampreys was 30.4 in 1970, 30.7 in 1971, and 39.8 in 1972.

Sixty-six percent of the parasitic-phase sea lampreys less than 201 mm long were collected from statistical district WM-2 (Gills Rock, Wisconsin area) in 1970-72.

In 1972, 76 parasitic-phase sea lampreys were collected from the Lake Huron fisheries; 87% were taken from statistical district MH-1 (Cheboygan, Michigan area). The percentage of male parastic-phase sea lampreys was 38.4 in 1970, 35.1 in 1971, and 27.6 in 1972.

Collections from Lakes Erie and Ontario each included 11 parastic-phase sea lampreys.

The programming and analysis of data are continuing.

Reestablishment of larvae in treated streams

Reestablishment studies were expanded in 1972 with the addition of two biologists to the project. In addition to collecting routine data on reestablished populations, data were collected on ammocetes in estuaries and offshore areas of Lake Superior and the locations of marginal and residual populations in streams.

The Montreal River was added to the list of streams tributary to Lake Superior that contain sea lampreys. One ammocete (51 mm long) was collected in the short stretch of stream available to lampreys below the dam and powerhouse near the mouth. Ammocetes were collected for the first time since 1966 in the main Nemadji River above its confluence with the Black River; three larvae of the 1971 year class were collected in the south fork, below its junction with Net River.

The operation of an electric weir on the Firesteel River prevented the development of ammocete populations in 1964-70. After removal of the weir in 1970, however, populations became reestablished in 1971 and 1972.

A report of substantial numbers of adult sea lampreys in the Kewaunee and East Twin Rivers (Lake Michigan) near Green Bay, Wisconsin, and the possibility of adults homing to their parent stream or being attracted by ammocetes, prompted a special investigation of the ammocete populations in these two rivers. In previous surveys no sea lamprey larvae were taken in East Twin River and only one was collected in the Kewaunee River. In 1972, four sea lamprey ammocetes (68-143 mm long) were collected from the Kewaunee River and five (86-103 mm long) from the East Twin River. These collections indicate a low density of ammocetes.

In the Middle River (Lake Superior), a significant increase in the spawning population in 1971 following an average barrier catch of only 16 adults for the 5-year period, 1966-70, also indicated a possible source of undetected ammocetes. Subsequently, five large sea lamprey larvae (137-154 mm long) and two transforming sea lampreys were collected in the estuary below the former electrical weir. The river was then treated with TFM. Samples of ammocetes collected during the chemical treatment confirmed that the population of large ammocetes was restricted to the immediate area of the estuary.

Evidence of extremely late spawning was noted in two streams. Small larvae, 8-10 mm long, were recovered in a nest in Boston-Lily Creek on October 5, 1972, and five spawning adult sea lampreys were observed below the newly reconstructed dam on the Rock River on September 6, 1972. The collection of 50 residual larvae of the 1971 year class in the Rock River after the treatment on September 21, 1971, also suggests late spawning in this stream last year.

During July 1972, an estimated 200 to 300 spawning adult sea lampreys were observed below the dam on the Rock River. Children were observed capturing and throwing the adults on the surrounding banks and the possibility of these animals escaping over the dam existed. However, several inspections of the Rock River above the dam for spawning lampreys proved negative. Surveys with electric shockers also failed to collect any young-of-the-year larvae, indicating no escapement past the barrier in 1972. An inspection of the area immediately below the dam by a skin diver showed that most of the lampreys were in crevices in bedrock. When granular Bayer 73 was introduced into the crevices, 43 lampreys were collected. The crevice area was devoid of lampreys when it was checked five times from July 27 to September 6, suggesting a residual repellant effect of the granular Bayer 73. Although lampreys were in the area below the dam as late as September 6, none were found in the crevices. This study will be repeated in 1973 to determine whether the granular Bayer 73 has a residual repelling effect.

Several offshore areas of Lake Superior were checked with granular Bayer 73 for the presence of ammocetes. A population was discovered 300 to 400 yards off the mouth of Eliza Creek in Eagle Harbor. The ammocetes (smaller than those collected in Eliza Creek) were found in silt deposits around submerged pilings and cribbing. Submerged pilings off the mouth of the Slate and Falls Rivers were also checked with granular Bayer 73. Four sea lampreys were recovered off the mouth of the Slate River (none off the Falls River). One ammocete was collected in a rocky area on the wave-swept shoreline off the mouth of the Little Garlic River.

Areas of sandy, wave-swept shoreline previously considered as poor ammocete habitat may contain pockets of suitable habitat for ammocetes that migrate into the lake. Many of these areas will be checked by scuba divers in 1973.

Ammocetes surviving chemical treatment were collected in six streams in 1972. The Potato River, tributary to the Bad River, still contained many residual larvae. In the Huron River, a backwater area contained a small population of age-I residual larvae. Although three residual larvae were collected in the upper Traverse River, none were taken in the estuary, which had previously contained large numbers of residual larvae. Surveys of the Little Two Hearted and Mosquito Rivers resulted in the collection of one and two residual ammocetes, respectively.

The percentage of males among larvae collected in the treatment of six Lake Ontario tributaries in 1972 ranged from 13 to 54. Ammocetes taken in the Salmon River, considered the largest producer of sea lampreys along the U.S. shoreline, were 49% male. Spawning sea lampreys collected in the Salmon River in 1972 were 54% male. If Lake Ontario sea lamprey populations follow the trends of those in the upper Great Lakes, drastic shifts in the sex ratio can be expected after the numbers have been reduced by chemical treatments. Future collections of ammocetes from these rivers will provide data on changes that take place in sex ratios in relation to the adult sex ratios.

Ammocetes of the 1972 year class were collected in 24 of 58 streams examined on Lake Superior. The accelerated schedule of chemical treatments during 1972 undoubtedly eliminated ammocetes of the 1972 year class in many streams before they were sampled. Ammocetes were reestablished in an average of 42 streams per year in 1968-71, compared with an average of 30 streams in 1965-67.

Age and growth of larvae in Big Garlic River

The known-age sea lampreys established in the Big Garlic River in 1960 are in their 13th year of life.

The area of the Big Garlic River accessible to the adult lampreys that bypassed the downstream trap in 1967 was treated with TFM on September 6, 1972. Marked larvae were released in the area before treatment to obtain a population estimate. An estimated 20,000 larvae and 1,100 transformed lampreys were killed. Although only one-fifth of the study area was treated, shocker collections throughout the river in October 1972 indicated that about two-thirds of the total population was removed.

The trap captured 159 recently metamorphosed lampreys in the fall of 1972, compared with 830 in 1971. The reduction is the result of the treatment. If the transformed lampreys (estimated 1,100 animals) had not been killed in the chemical treatment, the trap catch probably would have been about 1,300.

Movement of ammocetes to the downstream trap decreased for the third consecutive year. The chemical treatment had little effect on the number of larvae captured in the trap as major migrations occur in the spring. During the seven 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	7,931	46
1967-68	10,728	229
1968-69	13,244	398
1969-70	6,075	358
1970-71	3,759	659
1971-72	3,062	901

All live larvae captured at the trap were delivered to the Hammond Bay Laboratory for studies on sterility and growth, and for use in bioassays.

A total of 100 ammocetes were collected with an electric shocker in October for a continuing study of annual growth. The average length was 129 mm (range, 98-173 mm), an increase of 2 mm from 1971.

A series of metamorphosed lampreys were analyzed to determine percentage of body fat. The average percentage of body fat to total weight was 8.8 in late March and 8.3 about 1 month later. Fat content among individuals varied from 5 to 11% and tended to be lowest among the smaller lampreys.

APPENDIX D

SEA LAMPREY CONTROL IN CANADA

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This report summarizes activities during the period April 1, 1972 to March 31, 1973 in compliance with a Memorandum of Agreement between Canada's Department of the Environment 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 program is the responsibility of the Department's Sea Lamprey Control Centre located at Sault St. Marie, Ontario.

Electric Barrier Operations

In 1972 seven electrical assessment barriers were operated on tributaries on the Canadian side of Lake Huron: one on the North Channel, three in Georgian Bay, and three in the main basin of Lake Huron. The total catch was 1,506 sea lamprey in 1972 (Table I)—a decrease of 26 percent from the 1971 catch and of 67 percent from the average catch in 1968-1972.

Although most of the decline occurring between 1971 and 1972 was attributable to one river—the Still—there has been a general downward trend in the catch at all barriers since 1968. The reduced catch is believed to reflect a reduction in the sea lamprey population in Lake Huron resulting from the lampricide treatments which have been carried on regularly since 1966.

Stream Surveys

Surveys in Lake Superior during 1972 were conducted on 22 tributaries. No new sea lamprey streams were discovered in the course of four routine surveys. Reestablished sea lamprey population were found in four out of five streams that had been treated with lampricide in previous years. Distribution surveys were performed on 10 streams prior to treatment and post-treatment surveys were conducted on 11 streams.

Surveys of 50 Lake Huron tributaries were carried out—9 North Channel streams, 25 Georgian Bay streams, 12 main basin streams, and 4 streams in the Gloucester Pool drainage of the lower Severn River.

Table I. Numbers of sea lamprey taken in electrical assessment barriers, Lake Huron, from 1968 to 1972 inclusive.

Streams	Count for season 1968	1969	1970	1971	1972
North Channel Area					
Kaskawong	239	478	482	271	207
Totals	239	478	482	271	207
Georgian Bay Area					
Still	6,154	1,621	558	960	426
Naiscoot-Harris	1,336	785	173	446	474
Mad	413	42	8	15	1
Totals	7,903	2,448	739	1,421	901
Lake Huron Area					
Manitou	597	144	3	12	11
Blue Jay	1,807	1,130	236	332	380
Bayfield	191	582	128	7	7
Totals	2,595	1,856	367	351	398
Grand Totals	10,737	4,782	1,588	2,043	1,506

One new sea lamprey stream—Nisbet Creek in the Key River System—was found during routine surveys of 31 streams. Reestablishment surveys of 14 streams found sea lamprey in 10. Distribution surveys were performed on five streams. In addition, nine estuaries of Lake Huron tributaries and part of the St. Marys River around Whitefish Island were surveyed by applying granular Bayer 73 to selected areas.

In the Lake Ontario drainage 34 streams were surveyed. Routine surveys of twelve streams were all negative for sea lamprey. Reestablishment of sea lamprey since the 1971 treatments was found to have occurred in ten of 21 streams surveyed. A special survey of the Humber River was conducted following reports of sighting sea lamprey, but no sea lamprey ammocoetes were found.

Lampricide Treatments

On Lake Superior 13 of the 14 streams specified in the Memorandum of Agreement were treated: East Davignon, West Davignon, Little Carp, Big Carp, Goulais, Harmony, Chippewa, Little Pic, Prairie, Steel, Little Gravel, Big Squaw and Neebing. Wolf River was treated in addition when large sea lamprey ammocoetes were found in it. Sawmill Creek was omitted because pretreatment surveys found no sea lamprey larvae (see Table II). Eleven other

Table II. Summary of streams treated with lampricide on the Canadian side of Lake Superior, 1972.

Stream Name	Date-1972	Flow (cfs)	TFM lbs. active ingredient	Bayer 73 lbs. active ingredient	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream miles treated
East Davignon	May 17-18	12	59	–	–	Moderate	2.8
Little Carp	May 18-19	13	56	–	–	Moderate	7.0
Harmony	May 25-26	16	67	–	–	Moderate	1.8
West Davignon	May 31-June 1	13	102	–	–	Abundant	6.3
Big Carp	June 5-8	12	117	–	–	Abundant	10.3
Little Gravel	June 17-18	12	68	–	–	Moderate	2.1
Prairie	June 19-20	66	821	16	–	Scarce	2.4
Big Squaw	June 21-23	9	123	3	–	Nil	4.6
Neebing	June 26-30	30	182	4	–	Scarce	10.9
Steel	July 17-18	300	2,281	46	33	Scarce	6.3
Chippewa	July 20-21	365	1,337	26	–	Scarce	1.5
Little Pic	Aug. 12-15	260	2,161	42	53	Scarce	20.1
Wolf	Aug. 19-20	111	1,478	20	–	Abundant	8.5
Goulais	Sept. 16-27	790	5,082	92	8	Abundant	83.6
Totals		2,009	13,934	249	94		168

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areas in lakes, bays, and estuaries, comprising parts of St. Marys River, Batchawana Bay, Mountain Bay, and Nipigon Bay, were treated with granular Bayer 73 in an effort to reduce sea lamprey populations in these lentic habitats.

In Lake Huron, eleven of the twelve streams specified in the Memorandum of Agreement were treated: Chickanishing, Still, Magnetawan, Naiscoot-Harris, Boyne, Sturgeon, Mad, Pretty, Silver, Bothwell and Sydenham. The Echo River treatment was postponed. Two additional streams were treated—the Spanish, when large ammocoetes were found in it, and Nisbet Creek following the discovery of sea lamprey for the first time (see Table III). Six estuaries on Lake Huron were treated with granular Bayer 73: the Root, Serpent, Mississagi, Still, Squirrel, and Silver.

Sea Lamprey from Commercial Fisherman

During 1972, 1,008 sea lamprey with related catch data were received from commercial fishermen on the Great Lakes in response to the offer of a reward. The collection included 13 specimens from Lake Superior, 52 from the North Channel, 3 from Georgian Bay, 227 from Lake Huron proper, 1 from Lake Erie, and 712 from Lake Ontario. Although examination of the collection is incomplete, preliminary evidence indicates that the parasitic sea lamprey populations in the Great Lakes continued to be segregated by sex and size according to area of the lake, fishing gear, and prey species. Females predominated in offshore commercial catches and large lamprey were associated with larger species of fish.

Sea Lamprey from Humber River, Lake Ontario

The individual who has collected sea lamprey under contract since 1968 from the Humber River in Toronto, captured 4,609 specimens during the spawning run in April, May, and June 1972—nearly double the 1971 catch. It is probable that the apparent increase in the Humber River run was due to a concentration in this river of the runs that might have gone into some other rivers had there been no lampricide treatments in 1971. It has been a common observation that sea lamprey runs to rivers in the year following their treatment with lampricide are greatly reduced. The Humber, being the only river with a sea lamprey run but no ammocoetes on the Canadian side of Lake Ontario, was not treated in 1971. The sex ratio (1.2 males per female), average length (41 cm) and weight (155 g) of the specimens taken in the Humber in 1972 did not differ significantly from those observed in 1971.

Trawling for Sea Lamprey in St. Marys River

The transient adult sea lamprey population in St. Marys River just downstream of the International Rapids was again sampled by surface trawling at night during October, November, and December, 1972. The

Table III. Summary of streams treated with lampricide on the Canadian side of Lake Huron, 1972.

Stream Name	Date treated	Flow (cfs)	TFM lbs. active ingredient	Bayer 73 lbs. active ingredient	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream miles treated
Silver Creek	May 23-24	17	299	3	35	Moderate	4
Pretty	May 24-25	23	597	4	27	Scarce	8
Bothwell	May 29-30	16	519	6	18	Moderate	5
Mad	June 5-8	83	2,713	13	88	Scarce	35
Sydenham	June 10-11	53	1,101	10	0	Scarce	1
Sturgeon	June 12-17	30	1,229	11	155	Abundant	14
Magnetawan	July 10-12	939	2,491	0	10	Moderate	6
Still	July 14-19	30	231	0	3	Scarce	12
Boyne	July 20-22	19	156	0	29	Moderate	5
Spanish	Aug. 14-20	2,031	13,258	253	41	Scarce	47
Naiscoot-Harris	Sept. 8-11	151	858	0	5	Moderate	12
Chikanishing	Sept. 13-14	17	81	0	0	Moderate	4
Nisbet	Sept. 16-17	2	19	0	22	Scarce	1
Two Tree	Sept. 24-25	9	394	0	14	Scarce	9
Totals		3,420	23,946	300	447		163

average catch per hour was 0.24 animals, less than one-quarter the figure for 1971—an observation that supports other evidence of a decrease in abundance of sea lamprey in the Lake Huron basin. The sexes in 1972 were almost equally divided, unlike the situation in 1971 when there were twice as many females as males.

Sea Lamprey Barrier Dams

The dam built in 1971 on the Echo River (Lake Huron) withstood the 1972 spring floods but was further reinforced by the addition of rock fill to the banks. The old Duffin Creek Dam (Lake Ontario) was repaired following a washout in the spring of 1972. The Sea Lamprey Barrier Dam Task Force established a priority listing of streams for the construction of barrier dams on Great Lakes tributaries and consulted with Provincial authorities to develop a set of specific recommendations.

APPENDIX E

SEA LAMPREY RESEARCH, 1972

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Fish Control Laboratories
Bureau of Sport Fisheries and Wildlife
Hammond Bay Biological Station
Millersburg, Michigan

Work performed for the Great Lakes Fishery Commission by the Hammond Bay Biological Station is divided into two categories: Studies in direct support of the ongoing sea lamprey control programs and studies directed toward the feasibility of using some type of an integrated control program to further reduce the residual sea lamprey population.

STUDIES IN SUPPORT OF THE FIELD PROGRAM

Tests of delayed-release antimycin. Several formulations of the fish toxicant antimycin have been tested in the laboratory to evaluate its potential as a bottom toxin for larval lampreys. The results from some of these experiments have been encouraging. Tests were conducted with an experimental granular formulation of antimycin which is designed to sink to the bottom before releasing any toxicant. It then releases all the toxicant within a few minutes.

In these tests, kills of exposed lampreys were 98 percent or greater. Antimycin is also highly toxic to fish. When tested in a static water situation all the toxicant stayed on the bottom and no fish were killed. However, when tested in flowing water there was an apparent upwelling of the toxicant and fish kills of as high as 90 percent were observed.

While the results from these tests are not conclusive, they do demonstrate that granular antimycin, when applied to the water surface, does create a lethal layer on the bottom. It also appeared in these tests that some penetration and retention of the toxicant in the substrate did occur.

Comparative toxicity of antimycin on burrowed and free-swimming sea lamprey larvae. Bioassay tests were conducted on the concentration/contact time of antimycin on test populations of burrowed versus free-swimming larval sea lamprey. It was demonstrated that burrowed larvae were much less vulnerable to relatively short exposures of antimycin than were free swimmers. In one assay series a one-hour exposure produced an LC50 of 560.0 μg/l for burrowed larval sea lampreys. The LC50 for a free-swimming

population exposed simultaneously was 18.5 μg/l. While 1500 μg/l was required to produce an LC100 for the burrowed population, only 30 μg/l was needed for the same rate of kill among the free-swimmers in the one-hour exposure. This disparity of response is probably due to a slow interchange or penetration of treated water into the substrate which results in a delayed or reduced exposure to burrowed lampreys.

Comparative toxicity of antimycin and Bayluscide. Bioassays were conducted with antimycin and Bayluscide on burrowed larvae exposed for one and two hours at common concentrations. It was shown that Bayluscide was more irritating to larvae than antimycin when emergence rates were compared for the same concentrations. This was especially pronounced in the two-hour exposure. The data indicated that if enough Bayluscide reaches a larva to cause it to emerge, a lethal dose has been received. With Bayluscide, the mortality rates were nearly equal to the emergence rates. In contrast, antimycin was much more subtle in its action by being highly lethal without causing any swimming activity of the larvae.

Field bioassays using burrowed and free-swimming larval lampreys. A mobile bioassay trailer was used to compare the susceptibility of burrowed versus free-swimming sea lamprey larvae to lampricides during an actual stream treatment. This experiment was conducted in cooperation with the staff from the Sea Lamprey Control Station, Ludington, Michigan, during recent larvicide treatments of the Ocqueoc River system.

One trough in the trailer was used to hold free-swimming sea lamprey larvae while the other trough held a burrowed test population. Ocqueoc River water was pumped into the troughs for several days to acclimate the test populations before the stream treatment. The larvae were then exposed to the treated water as it moved downstream.

During the treatment of the upper river, a 100-percent kill of the free-swimming population in the trailer occurred in 5 hours. A complete kill of the burrowed population required 6.5 hours of exposure—a lag time of 1.5 hours.

The experiment was repeated in the lower Ocqueoc River near the mouth where the river flow was greatly affected by seiches. A mixture containing 99.5-percent TFM and 0.5-percent Bayluscide was used in this treatment. A 7.5-hour exposure to the treated water was required to produce 100-percent mortality in the free-swimming population. A complete kill of the burrowed population occurred after nine hours of exposure—again, a 1.5-hour lag time.

The results from these tests indicate that during lampricide treatments some survival could occur among burrowed stream populations, especially if the treatments are controlled solely on the basis of pretreatment bioassay data from free-swimming larvae. In practice, however, treatment concentrations are usually maintained above the minimum lethal levels and exposure times indicated by pretreatment bioassays.

STUDIES ON THE FEASIBILITY OF INTEGRATED CONTROL

Sea lamprey culture. *1969 year class.* A total of 251 sea lamprey larvae from the 1969 year class are being held in the laboratory. As of August 1, 1972, they averaged 79.0 mm in length with a range of 63 to 110 mm. No transformation has occurred in any laboratory-reared larvae as yet.

1970 year class. Approximately 800 larvae from this year class are being held in the laboratory.

A group from this year class was held in a constant temperature (15.5 C) trough for two years. As of September 12, 1972, the 310 survivors had attained an average length of 93.5 mm (range, 64-119 mm). Thus it appears we should be able to produce 100 mm larvae in the laboratory in two years.

Other larvae from this year class are being used in feeding experiments to determine optimum feed rates and feeding schedules.

1971 year class. A total of 3,048 sea lamprey larvae from this year class are being held in the laboratory.

1972 year class. Approximately 11,000 young-of-the-year sea lamprey larvae are being held in the laboratory.

Effect of temperature on larval growth. We placed 1,800 young-of-the-year sea lamprey larvae in each of four constant temperature troughs. After two months in the trough, growth rates of a subsample (100 larvae) from each trough were as follows:

Trough temperature (C)	Average size (mm)	Size range (mm)
4.4	16.6	12-20
10.0	17.8	15-23
15.6	22.1	16-29
21.1	27.0	18-35

Sterilization of spawning lampreys. A total of 323 lampreys were injected with potential chemosterilants at dose rates between 10 and 100 mg/kg. Emphasis was placed on the compound which looked so promising last year (P, P-bis (l-aziridinyl)-N-methyl phosphinothioic amide). Fifteen lampreys were injected with this compound each week throughout the spawning migration and released in an artificial spawning channel constructed in the laboratory.

Two lampreys (one male and one female) injected at a dose rate of 100 mg/kg were observed attempting to spawn. They were removed from the channel and spawned with sexually mature normal partners. All embryos developed fertilization membranes and a few showed some signs of cleavage. All embryos were dead within a week.

One male lamprey injected at a dose rate of 50 mg/kg was observed attempting to spawn. He was artificially spawned with a normal female. Although almost all of the eggs were fertilized, most died before reaching stage 4 (eight cells) and none reached stage 5 (sixteen cells). As a control, a normal male was spawned with the normal female and they produced hundreds of normal burrowing larvae.

Three lampreys (all males) injected at a dose rate of 10 mg/kg were observed spawning and artificially spawned with normal females. The majority of the embryos developed to stage 8 (full blastula) or stage 9 (gastrula) and then died. Most of those that developed further were badly retarded, particularly in the development of the head. Many that reached stage 13 (prehatching) and stage 14 (hatching) had distorted, twisted bodies and balloon hearts. Nevertheless, one batch produced 72 normal burrowing larvae. Controls were used for two of these batches and produced several thousand normal larvae. Apparently, a dose rate of 10 mg/kg is slightly below that needed to produce complete sterility.

Studies of spawning populations. Starting with the first migrants, one-third of all the spawning run lampreys entering the Ocqueoc River in the spring of 1972 were weighed, measured, and tagged. They were then released in Ocqueoc Lake. Only 25 of the 914 tagged lampreys were recovered.

Twenty-four of the tags were recovered from below Ocqueoc Falls, the major spawning area in the river. The earliest recapture was 11 days after tagging and the latest was 34 days. The average time from tagging to recapture was 20 days. Generally, lampreys early in the run spent a longer time in the river before spawning than those taken toward the end of the spawning run. However, one lamprey tagged on June 2 was taken off a nest on July 6—a period of 34 days.

Spawning lampreys undergo a considerable loss in length and weight after they enter a spawning stream. This loss is greater for females than for males. The average male had lost 47.3 mm in length and 16.3 g in weight between the time of entry to the river and spawning. Comparative losses in females averaged 66 mm and 56 g. Loss of length and weight is roughly correlated with the time spent in the river. For example, one female lost 120 mm and 110 g during the 34 days between entering the river and spawning.

One lamprey tagged on May 18 was recovered by a commercial fisherman. This lamprey, attached to a 20-inch whitefish, was taken on August 25 in 15 fathoms of water five miles north of Lansing Shoal Light. Lansing Shoal Light is located approximately 50 miles west of the Straits of Mackinac. Therefore, this lamprey had left the Ocqueoc River after being tagged and migrated approximately 100 miles to the point where it was captured.

Through the cooperation of the Marquette Sea Lamprey Control Station we were able to obtain this specimen preserved in 10-percent formalin. It was a female. The gut was much reduced in size, the liver greenish in color, and the eggs approximately 1 mm in size.

This lamprey would have undoubtedly spawned sometime in the late summer or early fall of 1972. In the last few years there have been numerous reports of lampreys spawning later in the year. The presence of this specimen in the lake on August 25, in spawning condition, indicates that it would probably have been a fall spawner.

APPENDIX F

REGISTRATION-ORIENTED RESEARCH ON LAMPRICIDES, IN 1972

Joseph B. Hunn

Fish Control Laboratories
La Crosse, Wisconsin

INTRODUCTION

The Fish Control Laboratories accelerated registration-oriented research to retain and ultimately renew the registration of lampricides used to control sea lamprey in the Great Lakes. The level of research activity increased within the Bureau laboratories, and contracts were let to private companies and universities to provide services unavailable in Bureau facilities.

TFM

Toxicity to non-target animals

Mammals—Contract studies at WARF Institute, Madison, Wisconsin are underway which will fulfill Environmental Protection Agency requirements for life span feeding trials with two species of rodents (rats and hamsters). These studies will encompass three generations of animals.

Birds—Studies conducted at the Bureau's Denver Wildlife Research Center have established the acute oral toxicity for TFM (35%) against mallard drakes, ring-billed gulls, and California quail hens.

Fish—The toxicity of TFM to fish in flow-through assays is quite similar to that in static assays using water of comparable hardness. Toxic action is rapid and there is little or no increase in toxicity from 6 hours to 30 days.

Invertebrates—Toxicity testing of invertebrates was accomplished at the Bureau's Fish-Pesticide Research Laboratory, Columbia, Missouri and under contract at various universities. TFM is relatively nontoxic to invertebrates. In general, accumulation of radioactive TFM residues in invertebrates appears dependent upon the concentration in water and magnification factors are low (2 to 50). Residues of TFM are rapidly eliminated from scuds with 90 percent excreted in 8 days.

Plants—Preliminary studies on the toxicity of TFM to algae are underway. Representative green, blue-green, and diatom species in unialgal cultures are exposed to TFM for 96 hours. Inhibition of growth was noted at a concentration of 5 mg/l of TFM (35%).

Efficacy of lampricides

Larval sea lamprey (6-8 cm long) were exposed to TFM in reconstituted waters of four different hardnesses, buffered to pH 6.5, 7.5, 8.5, and 9.0, and at temperatures of 7, 12, 17, and 22 C. Temperature, apparently, had little influence on the toxicity of the lampricide. TFM became significantly less toxic at higher (alkaline) pH's and in harder water when the pH was alkaline. Sea lamprey prolarvae (stage 17) also were exposed to TFM in four different hardnesses of reconstituted water which was buffered to the four pH's at 17 C. The toxicity followed approximately the same pattern as that of the larger sea lamprey larvae, except the smaller lamprey were consistently more resistant, requiring about 50 percent more TFM to produce mortality in the same time period.

The toxicity of TFM to lamprey burrowed in sand was compared with that of lamprey confined without substrate in a flowing system which was designed to eliminate the influence of toxicant adsorption on the sand. A concentration of 5.2 mg/l killed free-swimming lamprey in 3 hours, but did not start killing burrowed lamprey until after 7 hours.

Physiology

Biotransformation of TFM—Studies in Bureau laboratories as well as those by Dr. John Lech, Medical College of Wisconsin, Milwaukee, Wisconsin indicate that rainbow trout exposed to TFM in water or by intraperitoneal injection conjugate the compound in the liver. The conjugate—the glucuronide of TFM—is secreted into the gallbladder bile. TFM glucuronide is excreted in the urine and presumably in the feces.

Residues

Fish—The residues of TFM in fish muscle are correlated with the pH of the solution that the fish were exposed in. Channel catfish were exposed to 1 mg/l of TFM for 12 hours at 18.5 C. Muscle residues in fish averaged 3.21 µg/g at pH 6 and 0.03 µg/g at pH 9.

Environmental—Environmental samples were collected before, during, and following the treatment of the East Au Gres River in Michigan with

TFM. Samples of water, bottom soil, plants, insects, crayfish, snails and fish were analyzed for TFM residue. Snails had the highest concentrations of TFM during the 96-hour post-treatment. All other samples had 0.06 μg/g of residue or less after 96 hours of withdrawal.

BAYLUSCIDE (Bayer 73)

Toxicity to non-target animals

Invertebrates—Laboratory studies were conducted on the toxicity of Bayluscide and a mixture containing 2-percent Bayluscide and 98-percent TFM (TFM-2B) to selected aquatic invertebrates in Lake Huron water. All bioassays were at 12.8 C with an exposure period of 24 hours. Maximum test concentrations were set at 50 mg/l for Bayluscide and at 100 mg/l for TFM-2B. The soft-bodied organisms were generally sensitive to both compounds. No mortality occurred among crayfish, water boatmen, dragonflies, snipeflies, and Dobson flies exposed to the highest test concentrations. Turbellarians, tubifex, water fleas, and snails (*Physa* sp.) were the most severly affected by exposure to Bayluscide. The order of sensitivity among the various species was similar in the TFM-2B series of bioassays with the soft bodied species again being the most sensitive.

ANTIMYCIN

Ayerst Laboratories have developed a coated granule which will sink 5 to 10 feet without releasing any toxicant and then release all the active ingredient within 10 minutes. This new formulation was tested against larval sea lamprey in the lower end of Black Mallard River, Michigan. Treatment was calculated to supply 200 μg/l of antimycin to the bottom 2 inches of water.

Lamprey larvae burrowed in pans of sand with cages attached suffered 87-percent mortalities. Free-swimming larvae in cages survived, indicating that most of the toxicant stayed very close to the bottom.

CONTRACT RESEARCH

Bureau contracts for the following studies were awarded in 1972.

1. Safety evaluation of the sea lamprey larvicide TFM. Amendment to 1971 contract.
   WARF Institute, Inc., Madison, Wisconsin
   Amendment awarded on February 25, 1972.
2. Study on the toxicity and metabolism of TFM to chironomid larvae.
   Viterbo College (Dr. Joseph Kawatski). La Crosse, Wisconsin
   Contract awarded on February 25, 1972.

3. Research study on the microbial degradation of TFM.
   University of Wisconsin-Milwaukee, Center for Great Lakes Studies (Dr. Alfred Beeton), Milwaukee, Wis.
   Contract awarded on March 9, 1972.
4. Research study on the uptake, distribution and metabolism of ^{14}C TFM in rainbow trout and sea lamprey.
   The Medical College of Wisconsin (Dr. John Lech), Milwaukee, Wis.
   Contract awarded on March 9, 1972.
5. Manufacture 20 millicuries of ^{14}C TFM.
   Mallinckrodt Chemical Works, St. Louis, Mo.
   Contract awarded on March 20, 1972.
6. Determination of the toxicity of Bayluscide and TFM to *Hexagenia* mayfly nymphs.
   Winona State College (Dr. Calvin Fremling), Winona, Minn.
   Contract awarded on March 29, 1972.
7. Research study on the toxicity of TFM to stream invertebrates, algae, and macrophytes.
   Michigan State University (Dr. Howard Johnson), E. Lansing, Mich.
   Contract awarded on May 2, 1972.

Inter-laboratory transfers of funds for studies

8. Measurement of TFM residues in fish, water, and sediments; uptake and elimination of TFM in fish.
   Southeastern Fish Control Laboratory, Warm Springs, Ga.
   Effective on July 1, 1972.
9. Toxicity of TFM to selected aquatic invertebrates in static and flowing bioassays; uptake and retention of radioactive TFM in invertebrates.
   Fish-Pesticide Research Laboratory, Columbia, Mo.
   Effective on February 7, 1972.
10. Analytical study of gel permeation column to evaluate recovery of free and acetylated TFM; determine extent that TFM is separated from fish lipids by GPC; synthesize ^{14}C-labeled and unlabeled RTFM; and determine extent that TFM is sorbed on polyurethane foams for possible application in water sampling.
   Fish-Pesticide Research Laboratory, Columbia, Mo.
   Effective on June 1, 1972.

APPENDIX G

ADMINISTRATIVE REPORT FOR 1972

Meetings–The Commission held its 1972 Annual Meeting in Milwaukee, Wisconsin, June 14-16, and its Interim Meeting in Ann Arbor, December 5-6, 1972. Meetings of Committees during 1972 were:

Lake Erie Committee, Toledo, Ohio, March 1-2
Lake Ontario Committee, Toledo, Ohio, March 2-3
Lake Michigan Committee, Milwaukee, Wisconsin, March 7
Lake Superior Committee, Milwaukee, Wisconsin, March 8
Lake Huron Committee, Milwaukee, Wisconsin, March 9
Sea Lamprey Control and Research Committee, Ann Arbor, April 7
Scientific Advisory Committee, Ann Arbor, April 16,
Finance and Administration Committee, Milwaukee, Wisconsin, June 14

Officers and staff–The only change in Commission members in 1972 was the appointment to the Canadian Section in December of Mr. K. H. Loftus, Ontario Ministry of Natural Resources, to replace Dr. C. H. D. Clarke who resigned to accept an assignment in Africa.

At the close of the 1972 Annual Meeting, the Commission elected Dr. W. M. Lawrence, Chairman and Dr. C. J. Kerswill, Vice-Chairman.

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

Sea Lamprey Control and Research Committee

K. H. Loftus, Chairman
L. P. Voigt

Management and Research Committee

Claude Ver Duin, Chairman
C. J. Kerswill

Scientific Advisory Committee

F. E. J. Fry, Chairman
W. M. Lawrence

Finance and Administration Committee

E. W. Burridge, Chairman
N. P. Reed

Changes in the Commission's staff in 1972 included the appointment of Mr. Aarne K. Lamsa to the position of Assistant Executive Secretary and the employment of Mr. Walter R. Crowe as part-time Administrative Assistant to assist the staff in various duties.

Staff activities–A major duty of the Commission staff is to promote and enhance the development of coordinated fishery research and management programs on the Great Lakes. These activities have become more complex with the recovery of the fish stocks. Greater participation in the fishery by anglers has placed new demands on agencies responsible for their administration and has added new dimensions to problems of coordinating fishery management. As a result the Commission's staff spent considerable time in 1972 in planning and expediting meetings of the Commission and its lake committees, arranging for the presentation of scientific information on various subjects, and in the preparation and dissemination of minutes of such meetings. Several subcommittees and scientific work groups were established by the staff to deal with special problems and to resolve difficult management problems.

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

The new Assistant Executive Secretary spent considerable time becoming acquainted with the coordination of lake rehabilitation programs which involve intensive plantings of salmonid species by State, Federal, and Provincial agencies. Plans were prepared in cooperation with these agencies for improving hatchery brood stocks of lake trout and splake, the distribution of eggs for rearing, and the equitable distribution of lake trout yearlings reared by U.S. federal hatcheries for plantings in U.S. jurisdictional areas in Upper Great Lakes waters. Lake trout planting levels and locations were determined under consultation with research and management agencies and fin clip assignments were made to evaluate plantings of salmonid species.

In addition to their regular duties, the Commission staff attended and participated in the following related conferences:

Lake Superior Advisory Committee
Lake Michigan Study Group
Man and His Environment Symposium (State University of New York)
Great Lakes Commission
Great Lakes Basin Commission
Biological and Engineering Fish Rearing Workshop
American Fisheries Society
Michigan Great Lakes Fishery Advisory Committee
Canadian Committee for Freshwater Fisheries Research

Accounts and audit. The Commission accounts for the fiscal year ending June 30, 1972 were audited by Icerman, Johnson, and Hoffman of Ann Arbor. The firm's report is appended.

Contributions in fiscal year 1972. At its 1970 Annual Meeting, the Commission adopted a program and budget for fiscal year 1972 which called for intensification of sea lamprey control in the Upper Great Lakes and extension of control to Lake Ontario. The estimated cost for sea lamprey control and research was $2,536,000 and for administration and general research $76,900. Subsequently, the program for sea lamprey control and research was twice revised and estimates ultimately changed to $2,585,800. The revisions needed were to (1) meet limited appropriations by the United States Government, and (2) adjust to supplemental funds ($290,000) provided by both countries ($200,000 United States and $90,000 Canada) to carry out a wide range of toxicology and residue chemistry tests required by the U.S. Environmental Protection Agency for the reregistration of the major lampricide TFM.

Requests for funds and contributions in U.S. dollars in fiscal year 1972 were as follows:

Sea Lamprey Control and Research	*United States*	*Canada*	*Total*
Commission request	$1,749,850	$786,150	$2,612,900[1]
Appropriations	1,788,550	797,250	2,585,800[1]
Credit (fiscal year 1971)	81,580	36,654	118,234
Contributions (regular)	$1,870,130	$833,904	$2,704,034
Contributions (supplementary)	–	–	–
Michigan United Conservation Club	4,176	–	4,176
Total	$1,874,306	$833,904	$2,708,210
Administration and General Research			
Commission request	$38,450	$38,450	$76,900
Appropriations	38,450	38,450	76,900
Credit (fiscal year 1971)	647	647	1,294
Total	$39,097	$39,097	$78,194

[1] Includes $290,000 supplemental payment ($200,000 United States and $90,000 Canada) for special studies required for reregistration of TFM).

Expenditures in fiscal year 1972. Sea lamprey control and research in fiscal year 1972 was carried out under agreements with the Canadian Department of Fisheries and Forestry ($669,400) and the U.S. Bureau of Sport Fisheries and Wildlife ($1,500,000). All funds and disbursements are in U.S. dollars.

The Bureau treated 8 of the 13 tributaries of Lake Superior specified in the Memorandum of Agreement and was forced to postpone 5 because of unsuitable water levels. In addition, 8 streams that contained sea lampreys approaching the size of transformation were treated. The eight assessment barriers specified in the Agreement were operated. On Lake Michigan, 13 of the 17 streams specified in the Agreement were treated and 4 were postponed because of unsuitable water levels. In addition, 3 streams that contained ammocetes of transformation size were treated. On Lake Huron, 5 of the 6 streams specified in the Agreement were treated and 1 was postponed because of unsuitable water levels. On Lake Ontario, all 20 of the streams specified in the Agreement were treated.

The Bureau continued two field studies on reestablishment of lamprey larvae and age and growth of larvae. Laboratory research at Hammond Bay has been steadily shifted from the development of selective lampricides toward investigations to determine the feasibility of biological controls. Research on selective lampricides was limited to the development of bottom-type toxicants and to the toxicity of Bayer 73 and TFM-2B on aquatic organisms. Research on the feasibility of biological control was directed towards the development of methods for maintaining the entire lamprey life cycle in the laboratory. Evaluation of chemosterilants revealed one compound with considerable promise—further testing of this compound and additional chemosterilants would be facilitated by the development of an artificial spawning stream in the laboratory.

The Bureau's Fish Control Laboratories continued studies to evaluate the safety, efficacy, mode of action and residues of the lampricide TFM in accordance with the registration requirements of the U.S. Environmental Protection Agency. Studies also included other lampricide materials (Bayer 73) as funds permitted.

Following the end of fiscal year 1972, the Bureau returned $20,489 in unexpended funds which were used for the purchase of lampricide.

The Canadian Department of Fisheries and Forestry treated 13 of the 14 streams specified in the Memorandum of Agreement. Sawmill Creek was omitted because pretreatment survey showed no sea lamprey larvae. Wolf River was added when survey revealed the presence of large sea lamprey larvae. In addition to the stream treatments. 11 lentic areas were treated with granular Bayer 73. Eleven of the 12 Lake Huron streams specified in the Agreement were treated; treatment of the Echo River was postponed. The Spanish River and Nisbet Creek were added when sea lamprey ammocetes approaching the size of transformation were discovered in the former and sea lamprey were found for the first time in the latter. Six lentic areas in Lake Huron were also treated with granular Bayer 73. Electrical assessment barriers were operated on 7 Lake Huron streams to follow changes in lamprey abundance. At the close of fiscal year 1972, the Canadian Department of Fisheries and Wildlife returned $441 in unexpended funds; these monies were used for the purchase of lampricides.

The Commission purchased 220 pounds of the lampricide (TFM) at $2.80 per pound, 127,000 pounds at $3.30 per pound, and 9,000 pounds at $3.49 per pound from the North American subsidiaries of Farbewerke Hoeschst Ag., Germany. The American Hoechst Corporation delivered

111,220 pounds to the U.S. Bureau of Sport Fisheries and Wildlife, and Hoechst Chemicals of Canada delivered 25,000 pounds to the Canadian Department of the Environment. The American Hoechst Corporation refunded to the Commission $5,187 to compensate for TFM lost from leaky containers.

The Commission also purchased 40,000 pounds ($28,000) of Bayer 73 granules for surveys and treatment of estuaries and 1,200 pounds ($7,986) 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 1972 exceeded expenditures by $373 and the balance was credited to fiscal year 1973.

Program and Budget for fiscal year 1973. At its 1971 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research in fiscal year 1973 estimated at $2,622,900 for intensification of the program on the Upper Great Lakes and continuation of registration-oriented studies on the lampricide TFM. A budget of $73,000 was adopted for Administration and General Research. Following several revisions to adjust to changes in proposed contributions by the two governments, the Commission ultimately proceeded with the following program for sea lamprey control and research on a budget of $2,666,700.

Lake Superior—retreat 18 streams (13 in the United States and 5 in Canada) which have larval populations approaching transformation; treat with granular Bayer 73 the estuaries of 11 streams in Canada; routinely survey other streams to determine time for retreatment; and operate assessment barriers on 8 lamprey spawning streams in the Unites States.

Lake Michigan—retreat 23 streams and continue routine surveys to determine when treatments on other lamprey-infested streams are required to prevent escapement of parasitic lamprey to the lake.

Lake Huron—retreat 19 streams (12 in the United States and 7 in Canada); treat with granular Bayer 73 the estuaries of 22 streams in Canada; continue routine surveys on other streams to determine need for retreatment; and operate 8 assessment barriers (7 in Canada and 1 in the United States) to assess changes in abundance of lamprey spawning stocks.

Lake Ontario—retreat 19 streams (11 in Canada and 8 in the United States); and continue routine surveys to determine need for retreatment.

Research—Study the growth and transformation of reestablished lamprey populations over a wide range of conditions to determine changes occasioned by stream treatments; and study the growth, movements, and transformations of larval sea lampreys in an experimental section of the Big Garlic River.

Develop more effective chemicals for treating deep-water larval habitat; develop the laboratory culture of sea lamprey ammocetes; determine the resistance of embryological stages of sea lamprey to the lampricide TFM; investigate the feasibility of biological control using such techniques as chemical and immunological methods of lamprey sterilization, the possibility of sex control of laboratory-reared ammocetes, and the competitive displacement potential of hybrid lampreys; and conduct research on induction of transformation, detection of biochemical changes, and searching for early indicators of transformation.

Conduct research to develop the data required to reregister the lampricides TFM and the TFM-Bayer 73 mixture; investigate the acute and chronic toxicity and reproductive effect of Bayer 73 on fish and invertebrates; conduct standard toxicological tests of TFM-Bayer 73 mixtures on non-target organisms (wildlife and mammals); and determine the safety (toxicity) of TFM on nontarget organisms (wildlife and mammals).

Agreements to carry out the program were made with the U.S. Bureau of Sport Fisheries and Wildlife ($1,521,100) and the Canadian Department of Environment ($723,700[1]). Orders were placed with the North American subsidiaries of Farbewerke Hoechst Ag., Germany for 120,400 pounds of the lampricide TFM at $3.47 per pound—the only bid received.

The Commission reviewed its Administration and General Research budget for fiscal year 1973 and approved an increase in the budget from $73,000 to $84,700 to cover the salary of a part-time Administrative Assistant and additional printing costs.

The current and proposed funding for fiscal year 1973 is as follows:

Commission request	*United States*	*Canada*	*Total*
Sea Lamprey Control & Research	$1,841,750	$824,950	$2,666,700
Administration & General Research	42,350	42,350	84,700
Total	$1,884,100	$867,300	$2,751,400
Contributions (unconfirmed)			
Sea Lamprey Control & Research	$1,857,750[1]	$824,950	$2,682,700
Administration & General Research	42,350	42,350	84,700
Total	$1,900,100	$867,300	$2,767,400

[1] Includes supplemental contribution totalling $16,000 made at end of fiscal year 1973 (July, 1973) to partially cover cost-of-living increases to employees of Commission's U.S. agent.

Program and budget for fiscal year 1974.—At the 1972 Annual Meeting, the Commission adopted a program for sea lamprey control and research in fiscal year 1974 estimated to cost $3,248,320. Generally, the program provides for continuation of intensified control in the upper lakes, continuation of Hammond Bay sea lamprey research, and registration-oriented studies on lampricides, and a modest beginning for design and construction of lamprey barrier dams as a segment of an integrated program to control sea lamprey. A budget of $98,000 was adopted for administration and general research.

[1] U.S. dollars.

Reports and publications.–The Commission published an Annual Report for 1970 and the following technical report:

"New parasite records for Lake Erie fish" by Alex O. Dechtiar. Great Lakes Fishery Commission, Tech. Rep. 17, 43 p.

The results of investigations supported by the Commission appeared in the following publications:

"Downstream migration of recently transformed sea lampreys before and after treatment of a Lake Michigan tributary with a lampricide" by John W. Hodges. J. Fish. Res. Bd. Canada 29: 1237-1240.

"Variations in melanophores among lampreys in the Upper Great Lakes" by Patrick J. Manion. Trans. Amer. Fish. Soc. 101(4):662-666.

"Fecundity of the sea lamprey (*Petromyzon marinus*) in Lake Superior" by Patrick J. Manion. Trans. Amer. Fish. Soc. 101(4):718-720.

"An evaluation of selected marks and tags for marking recently metamorphosed sea lampreys" by Lee H. Hanson. Progressive Fish-Culturist 34(2):70-75.

"Comparative dietary toxicities of pesticides to birds" by Robert G. Heath, James W. Spann, Elwood F. Hill, and James F. Kreitzer. U.S. Bureau of Sport Fisheries and Wildlife, Special Scientific Report–Wildlife No. 152:1-57.

"Isolation and identification of TFM glucuronide in bile of TFM exposed rainbow trout" by John J. Lech. Federation Proceedings 31(2):606.

"*In vitro* and *In vivo* metabolism of 3-trifluoromethyl-4-nitrophenol (TFM) in rainbow trout" by John J. Lech and Nicholas V. Costrini. Comparative and General Pharmacology 3(10):160-166.

"A review of literature on TFM (3-trifluoromethyl-4-nitrophenol) as a lamprey larvicide" by Rosalie A. Schnick. U.S. Bureau of Sport Fisheries and Wildlife, Investigations in Fish Control, No. 44:1-31.

ICERMAN, JOHNSON & HOFFMAN
Certified Public Accountants
303 National Bank and Trust Building
Ann Arbor, Michigan 48108

R. L. Johnson, C.P.A.	OFFICES
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.	Ann Arbor, Michigan
J. R. Suits, C.P.A.	Howell, Michigan
D. L. Bredernitz, C.P.A.	

August 18, 1972

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

In connection with our examination of the financial statements of the designated funds of the Great Lakes Fishery Commission for the year ended June 30, 1972, we have also examined the additional information presented in the following pages. In our opinion, such information is fairly presented although it is not necessary for a fair presentation of financial position or revenues and expenditures.

(signed)

Icerman, Johnson & Hoffman

Exhibit A
Great Lakes Fishery Commission
Statement of Assets and Liabilities
Arising from Cash Transactions
June 30, 1972
(In United States Dollars)

	Administration and General Research Fund	*Lamprey Control Operation Fund*	*Total*
Assets			
Cash in bank (Page 7)	$6,809	$106,416	$113,225
Account receivable (Note A) (page 6)	-0-	40,117	40,117
Totals (Note B)	$6,809	$146,533	$153,342
Liabilities and Fund Balance			
Liabilities:			
Accounts payable	$1,936	$ 5,985	$ 7,921
Reserve for publication of SCOL papers in Technical Report series	4,500	-0-	4,500
Reserve for lampricide obligation	-0-	15,988	15,988
Fund balance (pages 3 and 4)	373	124,560	124,933
Totals	$6,809	$146,533	$153,342

Note A – Included in accounts receivable is a $5,187 claim for refund requested from a supplier for loss of lampricide. The exact amount has not been determined at this time, but the supplier has stated his intent to make restitution subject to verification of the amount. Also included is a refund of unexpended funds for 1971-72 from United States Bureau of Sport Fisheries and Wildlife of $20,489. However, the Bureau has requested approval of the Commission to retain $13,900 of this refund for the purchase of equipment during 1972-73. This request has not been acted on by the Commission at this time, and therefore the $13,900 has not been deducted from accounts receivable.

Note B – Assets do not include program property such as land and improvements, equipment and inventories.

Exhibit B
Great Lakes Fishery Commission
Administrative and General Research Fund
Statement of Revenues, Expenditures and Fund Balance
Year Ended June 30, 1972
(In United States Dollars)

Revenues	*Actual*	*Budget*
Canadian Government	$38,450	$38,450
United States Government	38,450	38,450
Transfer from Lamprey Control Operation Fund	1,500	–0–
Sale of office equipment	90	–0–
Totals	$78,490	$76,900
Expenditures (including reserve at June 30, 1972)		
Salaries	$45,406	$53,600
Fringe benefits	6,508	10,400
Travel	6,117	3,900
Communication	1,778	1,500
Rents and utilities	935	900
Printing and reproduction	6,932	3,200
Other contractual services	6,668	1,300
Supplies	749	1,200
Equipment	3,024	900
Totals	$78,117	$76,900
Increase in fund balance	$ 373	
Fund balance, July 1, 1971	–0–	
Fund balance, June 30, 1972	$ 373	

Exhibit C
Great Lakes Fishery Commission
Lamprey Control Operation Fund
Statement of Revenues, Expenditures and Fund Balance
Year Ended June 30, 1972
(In United States Dollars)

	Actual	Budget
Revenues		
Canadian Government	$ 797,250	$ 797,250
United States Government (Note)	1,788,550	1,788,550
Michigan United Conservation Clubs	4,156	–0–
Refund from Canadian Department of the Environment	441	–0–
Refund from United States Bureau of Sport Fisheries and Wildlife	20,489	–0–
Refund for loss of lampricide	5,187	–0–
Totals	$2,616,073	$2,585,800
Expenditures (including reserve at June 30, 1972)		
Canadian Department of the Environment	$ 690,442	
United States Bureau of Sport Fisheries and Wildlife	1,500,000	
Lampricide purchases	360,577	
Grants in aid of research	26,625	
Transfer to Administration and General Research Fund	1,500	
Totals	$2,579,144	$2,585,800
Increase in fund balance	$ 36,929	
Fund balance, July 1, 1971	87,631	
Fund balance, June 30, 1972	$ 124,560	

Note – Includes $14,000 supplemental payment which was not matched by the Canadian Government.

DEPARTMENT OF THE ENVIRONMENT
Financial Report to Great Lakes Fishery Commission
April 1, 1971 to March 31, 1972

Canadian Funds

Administration	$149,599.37
Chemical Control, Lake Superior	14,706.04
Chemical Control, Lake Huron	199,757.71
Chemical Control, Lake Ontario	195,576.17
Barriers, Lake Huron	29,644.97
Stream Surveys, Lake Superior	42,603.51
Stream Surveys, Lake Huron	38,545.53
	670,433.30
Superannuation Costs (7% of $336,202.02)	23,534.14
	693,967.44
Cheque issue to follow	432.56
Funds Provided by Commission	694,400.00

BUREAU OF SPORT FISHERIES AND WILDLIFE
SEA LAMPREY CONTROL AND RESEARCH PROGRAM

Report of Expenditures for All Activities
July 1, 1971 through June 30, 1972

Activity	Funds Programmed	Salaries	Expenses	Total	Unobligated Balance
Program Costs Marquette, Michigan Ludington, Michigan Hammond Bay, Michigan La Crosse, Wisconsin	$1,338,000	$778,950	$538,784	$1,317,734	$20,266
Washington, D.C.	40,000	–0–	40,000	40,000	–0–
Regional Office Administrative Services	67,500	62,775	4,725	67,500	–0–
Regional Office Supervision	54,500	45,598	8,679	54,277	223
Totals	$1,500,000	$887,323	$592,188	$1,479,511	$20,489

COMMITTEE MEMBERS - 1972

[Commissioners in Italics]

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	C. N. Lloyd
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	J. A. Scott
	H. O. Swenson
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	H. J. Vondett

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