ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1967

GREAT LAKES FISHERY COMMISSION

MEMBERS — 1967

CANADA	UNITED STATES
A. O. Blackhurst	C. F. Pautzke
E. W. Burridge	Claude Ver Duin
C. H. D. Clarke	L. P. Voigt
A. L. Pritchard	vacancy

SECRETARIAT

N. S. Baldwin, Executive Secretary
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Edith E. McPherson, Secretary
Trudy C. Woods, Secretary

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

1967

1451 Green Road
ANN ARBOR, MICHIGAN,
U. S. A.
1968

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 1967.

Respectfully,

L. P. Voigt, *Chairman*

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ANNUAL REPORT FOR 1967

INTRODUCTION

The Great Lakes Fishery Commission was established under the terms of the Convention on Great Lakes Fisheries ratified by the United States and Canada in 1955. Its major responsibilities are to formulate and coordinate research on fish stocks of common concern, to recommend measures to improve the productivity of the fishery, and eradicate or minimize the sea lamprey. The Commission relies on existing agencies to carry out the research it proposes and to implement the measures it recommends. Technical committees have been established for each lake to develop and coordinate local research and management while central committees advise the Commission on matters affecting the fishery as a whole. Control of the sea lamprey, a direct responsibility of the Commission, is carried out by contracts with federal agencies in each country.

The business of the Commission in 1967 was, in the main, transacted at two meetings. The Annual Meeting was held in Madison, Wisconsin on June 20-22, to consider the progress of various fishery research and management programs and to approve sea lamprey control plans for the fiscal year beginning July 1, 1968. An Interim Meeting was held in Ann Arbor, Michigan, on November 28-29, to review additional information and revise plans where required. The proceedings of these meetings are summarized, while the information presented at both is brought together in five appendices.

ANNUAL MEETING

PROCEEDINGS

The Twelfth Annual Meeting of the Great Lakes Fishery Commission in Madison, Wisconsin on June 20-22, 1967, was called to order by the Chairman Dr. A. L. Pritchard. In introducing the members of the Commission, Dr. Pritchard welcomed Mr. Clarence F. Pautzke, Deputy Assistant Secretary for Fish and Wildlife and Parks, Department of the Interior, who had been appointed to replace Mr. Donald L. McKernan. Before proceeding with the introduction of advisors and observers, the Chairman drew attention to the death of Dr. James W. Moffett on June 8, and paid tribute to his many contributions to improve the Great Lakes fishery, the spirit of cooperation he developed among agencies similarly engaged, and his service to the Commission.

The Honorable Warren P. Knowles, Governor of Wisconsin, welcomed the Commission to Madison and stressed the importance of meetings which enabled the two countries to coordinate their efforts to preserve the valuable natural resources of the Great Lakes.

The Commission adopted the proposed agenda, approved the Minutes of the 1966 Interim Meeting, and appointed two Commissioners and the Secretariat to prepare press releases.

The Chairman briefly reviewed the progress of lamprey control, the recovery of important species, and the high survival of planted fish. He pointed out that despite initial successes there were still problems to be faced in restoring the fishery which should not be underestimated. He urged that research not be neglected. He also expressed concern with a proposed reduction in funds for lamprey control and the delay this would cause to the program on Lake Huron.

Sea Lamprey Control and Research. The Commission accepted the report of the Sea Lamprey Control and Research Committee, including reports of its agents on their operations in 1966 and during the spring of 1967.[1] It discussed the proposed reduction of $100,000 in the United States' contribution

[1]Final reports covering operations in the United States and Canada in 1967 appear as Appendices C and D.

for fiscal year 1968 and agreed to suspend stream treatments on the west shore of Lake Huron until the contribution was finally determined.

The Commission also adopted a program and budget of $1,879,100 to carry out, in addition to its administrative functions, the following lamprey control and research activities in fiscal year 1969.

Lake Superior - Re-treat 22 streams (14 in Canada and 8 in the United States); continue re-examination of potential lamprey streams for newly established larval populations; survey treated streams to determine time for next treatment; operate 16 barriers on the United States streams and 8 barriers on Canadian streams to follow changes in lamprey abundance.

Lake Michigan - Re-treat 25 streams; continue surveys of potential lamprey streams; follow development of re-established larvae in treated streams.

Lake Huron - Treat 14 streams (9 in Canada and 4 in the United States); operate 9 barriers in Canada and 1 in the United States to follow lamprey abundance.

Research - Continue search for an irritant to use in surveys; screen compounds submitted by manufacturers for suitability as lampricides; study the action of TFM and Bayer 73 in waters with varying amounts of dissolved material; examine the effects of various food levels on growth, survival, and transformation of larvae; develop other means than barriers to follow changes in lamprey abundance; follow the larval production of certain streams with fyke nets; tag and release adult lamprey to define migration routes; follow changes in the number of streams re-infested and growth rate of larvae; systematically sample deep-water areas suspected of harboring sea lamprey larvae; and follow the growth and transformation of a single year class of lamprey.

The Commission recommended that the Department of Fisheries of Canada explore with the Ontario Department of Lands and Forests the possibility of installing a barrier dam on the lower Saugeen River to limit re-infestation and thereby reduce the cost of re-treating it.

Management and Research. The Commission accepted the report of the Management and Research Committee including recommendations submitted by the lake committees. The Commission, having been advised that the incidental catch of lake trout in large mesh gill nets fished in Lake Michigan during the spring of 1967 was of such magnitude in some areas as to jeopardize the rehabilitation of the fishery, recommended *that gill nets with mesh sizes larger than 2-3/4 inches (stretched measure) be restricted to use in Lake Michigan by permit only*

and that studies be carried out to determine the areas, depths, seasons, and mesh sizes of gill nets which could be fished without injury to protected salmonid species.

The Commission, after reviewing information that indicated sea lamprey were a major source of mortality to larger more desirable species in Lake Ontario, gave its assurance that it would extend the sea lamprey control program to Lake Ontario as soon as possible. The Commission asked the Lake Ontario Committee to cooperate with agents in preparing a plan, including cost estimates, for sea lamprey control and rehabilitation of major species beginning in fiscal year 1971.

The Commission, on the advice of its Scientific Advisory Committee, recommended that the two governments urge *fishery agencies to begin, if they have not already done so, the collection of biological data on all species in all areas of Lake Superior as described in the population assessment section of the "Prospectus for Investigations of the Great Lakes Fishery" (Commission Document 64-10).*

The Commission stressed again the need for full consultation with all agencies concerned before the introduction of a new species into the Great Lakes.

Economic Study. A preliminary report on the potential economic benefits of lamprey control, prepared by the Economic Study Group, was accepted by the Commission which agreed to sponsor a review of the report before its submission to the two governments and subsequent publication.[1]

Concluding business. After agreement to hold the Interim Meeting in Ann Arbor on November 28-29, the Chairman thanked the Wisconsin Conservation Department for the hospitality extended the Commission and its advisors and adjourned the meeting at 3:30 p.m. on June 22.

[1]Report (mimeo) entitled "An Economic Evaluation of Sea Lamprey Control and Lake Trout Restoration" was published by the Commission in June, 1968.

INTERIM MEETING

PROCEEDINGS

The Commission held its Interim Meeting in Ann Arbor on November 28-29, 1967, to hear reports on the progress of lamprey control, lake trout restoration, salmon introductions, development of selected splake brood stock, walleye study in western Lake Erie, and research on alewife.

Sea lamprey control and research. The Commission's agents submitted preliminary reports on lamprey operations in 1967.[1] Following discussion of these reports, the Commission reviewed the program and budget for fiscal year 1968 and 1969. The Commission was advised that a $100,000 reduction in the United States' contribution by the House of Representatives had been restored making possible the resumption of stream treatments on the west shore of Lake Huron.[2] The Commission was also advised that because of a limitation placed on the United States' contribution for fiscal year 1969, the lamprey program should be reduced to $1,611,600 by postponing treatment of the Nipigon, eliminating three field studies, and discontinuing Canadian barriers on Lake Superior. The Commission adopted the program with these changes.

Lake trout restoration. The Commission was advised that lake trout abundance continued to improve during 1967. Hatchery fish dominated the population but young trout spawned naturally the preceding fall were again taken in Wisconsin. Plantings in 1967 for all areas of Lake Superior totalled 3,031,000.[3]

The State of Michigan provided data on the incidental catch of salmon and trout in commercial gill nets lifted in Lake Michigan and indicated that fishing with this gear in both Lake Superior and Lake Michigan would be allowed under permit only. In areas where the incidental catch of salmonids was high, permits would be limited in number and fishing restricted to certain depths and seasons.

The Commission indicated its support of the permit system and asked the Lake Superior and Lake Michigan Committees

[1]Final reports by the United States Bureau of Commercial Fisheries and the Department of Fisheries of Canada for 1967 given in Appendices C and D.

[2]Retention of $55,200 subsequently by the United States Government forced postponement of operations on Lake Huron.

[3]Distribution of planted fish and marks used are given in Appendix B.

to review the problem of incidental catches at their March meetings. The Commission also asked for a review of the progress being made in establishing "limited entry."

Salmon introductions. Representatives from the State of Michigan reported that the catch plus escapement from the 659,400 coho smolt planted in the spring of 1966 in the Platte River and Bear Creek exceeded 30 percent. Adult coho were observed in a number of streams in which they had not been planted, including some Lake Huron tributaries.

In 1968, 1.8 million coho and 800,000 chinook would be available for planting. Some of the coho might be planted in Lake Huron streams while chinook would be restricted to the streams planted in 1967 (Big Huron in Lake Superior and the Manistee and Muskegon in Lake Michigan).

Kokanee planted by the Ontario Department of Lands and Forests in Lake Huron in 1964 and 1965 were taken by commercial fishermen and anglers in 1967 with the largest catch being made at the western end of Manitoulin Island as fish returned to the planting sites. Major spawning runs occurred in 3 streams—the Manitou and Blue Jay Rivers on Manitoulin Island and Oxendon Creek in southwestern Georgian Bay.

The Commission expressed concern regarding the effects of large numbers of coho on desirable native species and introduced splake. It urged Michigan, and other agencies planning to introduce salmon into the Great Lakes, to refrain from a major expansion of the planting program until results of natural spawning were assessed and the effects of large numbers of coho on other species could be evaluated.

Development of selected splake brood stock. Ontario representatives reported that the first brood stocks of highly selected splake had been allocated to production hatcheries at Marquette, Michigan, and Codrington, Ontario. Egg collections at Codrington began in October and 30,000 had eyed-up. By the fall of 1969, eyed-egg production should surpass 500,000. Yearling plantings from Ontario hatcheries should reach 500,000 by 1972. New facilities to handle this production were nearing completion at the Chatsworth Hatchery.

Walleye study. Dr. Regier presented the summary of a report he and his associates had prepared entitled "The Ecology and Management of Walleye in Western Lake Erie." The study had been carried out under contract with the Commission with the cost shared equally by the Ohio Division of Wildlife, Ontario Department of Lands and Forests, and the Commission.

The Commission referred the report and its recommendations to the Lake Erie Committee and Scientific Advisory Committee. It asked the latter to forward its opinions to the Lake Erie Committee for consideration at its regular meeting in March 1968.

Alewife research. The Commission received a report from the U. S. Bureau of Commercial Fisheries on the status of alewife in Lake Michigan and research on this species proposed by a Department of the Interior Task Force. The Commission, after reviewing the proposals, agreed to coordinate investigations and activities concerned with predicting alewife die-offs and restoring ecological balance.

APPENDIX A

SUMMARY OF MANAGEMENT AND RESEARCH

Information assembled by the lake committees on the current status and problems of the fisheries, the progress of investigations, and measures adopted to improve productivity have been presented by the Management and Research Committee to the Commission at the Annual and Interim Meetings. This information is summarized for each lake as follows.

Lake Superior

Lake trout stocks in Lake Superior showed further improvement in 1967. Relative abundance as measured by the number of marketable fish caught per 10,000 feet of gill net lifted during the spring increased by 51 percent over 1966. The lake-wide average CPE of 113 fish per 10,000 feet in 1967 was 2.4 times higher than the 1962 average of 48 fish per 10,000 feet. Spawning occurred in most areas of the lake and young-of-the-year naturally produced trout were taken for the fourth consecutive year in experimental nets fished in Wisconsin waters. Hatchery fish, however, still dominated the catches in inshore waters indicating that recruitment of naturally spawned trout in these areas was still meager. Lake trout on offshore grounds were considerably more abundant than on inshore grounds and in contrast to the inshore populations consisted largely of native fish.

Commercial fishing for lake trout was restricted for the sixth consecutive year to encourage the recovery of trout. Some fishing was permitted, however, to estimate the stage of recovery, evaluate the effects of plantings, and to measure the response of certain offshore populations to different levels of fishing. Catch limits for various jurisdictions were increased as follows:

	1966	1967
Ontario	150,000	170,000
Michigan	78,000	146,000
Wisconsin	60,000	75,000
Minnesota	9,000	13,000
Total	297,000	404,000

Increases in catch quotas for Ontario and Michigan waters were applied to offshore grounds to measure the response of these stocks to increased fishing. In Wisconsin and Minnesota the increase was to allow assessment of the condition of siscowet trout populations in deep water. Limits in other areas will remain in effect until it can be shown that stocks are able to sustain an increase over present fishing done for biological sampling.

The cooperative program of lake trout plantings was continued. In 1967, slightly more than 3.0 million yearling lake trout were planted: 2,059,400 in Michigan; 243,700 in Wisconsin; 228,100 in Minnesota, and 499,600 in Ontario waters. The number planted in Lake Superior since 1958 reached 19.1 million.[1] Experimental plantings of salmon by the State of Michigan entered its second year in Lake Superior as 467,000 yearling coho and 33,460 chinook fingerlings were planted in the Big Huron River.

Michigan's introduction of 192,400 coho in the Big Huron River in 1966 resulted in a total estimated survival of 31,200 fish (16.3 percent). These coho first appeared in Minnesota waters in late summer of 1966 where they remained until late in their second summer. They appeared in Wisconsin waters in November, 1966, and were taken by anglers mainly during April and May, 1967. Only one coho was reported taken in Ontario waters.

A significant sport fishery developed in Michigan waters during the spring and summer of 1967. Adult coho returned to the Big Huron River during the period from mid-September to mid-November, 1967, at an average size of 20.2 inches and 2.8 pounds. Straying was extensive as adults were observed in 22 Michigan streams and 5 Wisconsin streams. Spawning was observed in several streams and eggs were taken from redds in a tributary of the Big Huron during the winter.

Declining lake herring stocks in United States waters have been characterized in recent years by an increasing average size and age, and decreasing rate of recruitment. A study of the interrelationships of lake herring with other species by the University of Minnesota is expected to shed light on conditions responsible for their decline.

Lake Michigan

The resurgence of the whitefish, rainbow trout, and burbot populations; the rapid growth and survival of planted coho

[1]A summary of previous plantings and details of 1967 plantings of lake trout and salmon in the Great Lakes appear in Appendix B.

salmon and lake trout mark the initial stages of the recovery of the fishery in Lake Michigan.

Whitefish production in northern Lake Michigan, which plunged to an all-time low of 25,000 pounds in 1957, increased sharply in 1964 following completion of the first round of chemical treatments of lamprey-producing streams and has averaged slightly over 1 million pounds since that time. Experimental plantings of hatchery reared rainbow trout to restore this species after its severe depletion by lamprey have shown excellent growth and angling success has improved substantially in the last two years. Plantings of 7- to 9-inch rainbow trout in Wisconsin waters have attained average lengths of 20 inches after 1 year in the lake and 25 inches after two years in the lake; some individuals have attained lengths of 32 inches after 5 years in the lake. An increase in burbot, severely reduced by lamprey, is evident in large numbers caught incidentally by commercial nets fished for whitefish.

The survival of Michigan's introduction of 659,400 coho salmon in 1966 was estimated at 212,800 fish or 32.3 percent—spectacular by any standards. Evidence of success began to unfold when 7,500 precocious fish returned to the parent streams in 1966. In the early spring of 1967, commercial fishermen in Indiana waters caught an estimated 19,000 fish before protective regulations were put into effect. An intensive sport fishery developed during the first week of September in the Ludington and Manistee areas near the rivers in which the fish had been planted and continued for approximately 4 weeks. About 26,000 3-year-old coho averaging 12.1 pounds were taken by 30,000 boat-days (72,000 angler-days) of effort. Many coho from 14 to 17 pounds were taken and a few exceeded 22 pounds. The sport fishery continued within the Manistee River, Bear Creek, and Loon Lake (on the lower Platte River) in late September and October and then declined sharply during early November. An estimated 7,500 adult coho were taken in the river fishery plus about 2,500 precocious fish from the 1967 plant. Boat days of effort totalled 25,000 and angler days 85,000 (including shore effort). Adult returns to the parent streams totalled 155,000 fish averaging 10 pounds. Eight million eggs were taken some of which were given to Wisconsin, Ohio, Pennsylvania, New York, and Ontario. Approximately 17,000 adults were transferred to 10 northern Lake Michigan streams and another 2,000 were allowed to pass above the Bear Creek weir to spawn. A substantial number of coho were sold to commercial fishermen and wholesalers. Approximately 757,000 pounds were disposed of at 10 cents per pound, 220,000 pounds

at 3 cents per pound, and 314,000 pounds at 1-1/2 cents per pound. The lower priced fish were used for animal food and their eggs for caviar.

Planted lake trout have grown well. By the end of 1967, the average length of the 1965 plant was 18.5 inches, and the 1966 plant 14.5 inches. Most lake trout remain relatively close to the planting site moving quickly to the 10-20 fathom depth contour. In the second year after planting, they move deeper into 20 to 40 fathoms. Some have moved east through the Straits of Mackinac into northern Lake Huron.

Adult alewives which reached peak abundance in Lake Michigan in the fall of 1966 had decreased substantially by the fall of 1967. The decline appeared to be the combined result of the massive die-off in the spring and summer of 1967 and the subsequent "loss" of a significant part of the 1965 year class, rated as the second strongest on record. The 1967 year class has been rated as the third strongest and an increase in alewife stocks can be expected.

Lake trout plantings in Lake Michigan totalled 2,424,000 fish in 1967; 1,117,500 were planted in Michigan; 1,129,100 in Wisconsin; 87,400 in Indiana, and 90,400 in Illinois waters. The number of lake trout planted in Lake Michigan since 1965 totalled 5,404,700 fish. Salmon plantings in 1967 consisted of 1,732,300 coho and 801,400 chinook. Coho were planted in four Michigan streams (Little Manistee, Bear Creek, Platte River, and Thompson Creek) and chinook in two Michigan streams (Little Manistee and Muskegon Rivers). Plantings of other salmonids in 1967 included 32,300 rainbow trout and 24,600 brook trout in Michigan waters and 88,900 rainbow trout, 46,000 brown trout, and 9,000 brook trout in Wisconsin waters.

The high incidental catches of planted lake trout in commercial gill nets fished for other species was considered by management agencies and studies were undertaken to determine the areas, seasons, depths, and mesh sizes of gill nets that could be fished without excessive injury to protected salmonid species. A permit system to control the use of large mesh gill nets (2-3/4 inches and larger) was proposed for 1968.

Lake Huron

The fishery in Lake Huron remained in a depressed condition during 1967; total commercial landings dropped from 6.6 million pounds in 1966 to 5.8 million pounds in 1967—a decline of 12 percent. Chubs and whitefish were the major species in the Ontario catch and yellow perch and carp in the Michigan catch. Landings of 2.6 million pounds in Ontario and

3.2 million pounds in Michigan were 62 and 73 percent below respective normal levels. It is believed that the fishery will remain in this condition until sea lamprey are controlled. Furthermore, any failure to deal promptly with sea lamprey in Lake Huron proper will endanger the start of large plantings of desirable species by the Province of Ontario, the State of Michigan, and the United States Bureau of Sport Fisheries and Wildlife.

The collection of basic information on the fish populations in Canadian waters of Lake Huron was continued by the Ontario Department of Lands and Forests in 1967. Research of special importance included studies of certain whitefish populations which will provide information on changes in survival rates indicating the effectiveness of sea lamprey control. Studies of the eggs, fry, young-of-the-year, and yearling whitefish to determine at which stage year-class strength is established were also continued. Information on lamprey wounds and scars on whitefish continued to be collected by means of questionnaires to commercial fishermen and will be extended to the sucker fishery in 1968. Other investigations of special interest were the limnological studies of the effects of the nuclear plant operations at Douglas Point by the University of Toronto.

Fishery research in United States waters of Lake Huron has been limited, but plans call for establishment by the Michigan Department of Conservation of a fisheries station at Alpena in 1968. Moreover, the new Michigan research vessel *Steelhead* will be used to carry out some fish surveys in Lake Huron in 1968.

The Ontario Department of Lands and Forests continued its planting of kokanee salmon. Kokanee introduced in 1965 returned as mature fish to 10 streams along the southern shore of Manitoulin Island and the southwestern shore of Georgian Bay in the fall of 1967. Information has been collected on behavior, food habits, and migration patterns. Studies to evaluate natural reproduction have begun.

Three different age groups of highly selected splake which have been developed by Ontario for brood stock purposes have been shared equally with Michigan. Production of yearlings for planting in Lake Huron will not reach significant levels until 1970.

The Michigan Department of Conservation has concentrated its efforts to rehabilitate the fishery on developing hatchery stocks of steelhead, coho, and chinook for experimental introduction and on rearing the splake brood fish obtained from

Ontario. Plantings of 400,000 coho and 250,000 chinook are proposed for 1968.

Lake Erie

Commercial fish landings in Lake Erie, a large producer of fish among the Great Lakes, totalled 49.4 million pounds in 1967 as compared to 53.7 in 1966. Of the 1967 total, Ontario produced 76.5 percent, Ohio 19.9 percent, Michigan 2.1 percent, Pennsylvania 1.0 percent, and New York less than 1 percent. Yellow perch and smelt were the dominant species in the Ontario catch; yellow perch, carp, and sheepshead in the Ohio catch; carp and walleye in the Michigan catch; yellow perch in the Pennsylvania catch; and walleye and yellow perch in the New York catch.

Yellow perch catches were dependent upon the strong year classes of 1962 and 1965 along with the relatively weak year classes of 1963 and 1964. Experimental fishing suggested that the 1966 year class was weak and the 1967 year class fair. Good production of yellow perch is expected through 1968 and part of 1969 to be followed by a sharp decline until the 1967 year class enters the fishery. Walleye catches in the western basin in 1967 were dominated by fish from the 1965 year class. The 1966 year class appeared extremely weak and the 1967 year class only mediocre. The fishery would, therefore, be dependent on the strong 1965 year class which would no longer contribute significantly after the fall of 1968. Smelt catches in 1967, virtually all at Canadian ports, were dominated by fish from the 1965 year class. Spawning conditions were excellent for smelt in 1967 and a good hatch occurred. Catches of white bass in 1967 were dependent upon fish from the fair 1965 year class and the weak 1966 year class. The very strong 1967 year class is expected to provide fair commercial catches in the fall of 1968 and through 1969.

Sport fishing in western Lake Erie has relied heavily on yellow perch especially during the winter months when anglers fish through the ice. Qualitative information on the sport fishery was obtained by Ohio, Michigan, and Ontario. Angling for walleye in Ohio waters was considered fair to excellent in 1967. Smallmouth bass fishing was good in Pennsylvania and New York waters, but relatively poor in Ohio.

Management and regulation of the walleye fishery in western Lake Erie remained a difficult problem but several constructive steps were taken in 1967. A recently completed report entitled "The Ecology and Management of the Walleye

in Western Lake Erie" has indicated that an intensive fishery could lead to the marked instability of fish populations noted in Lake Erie. This instability would permit species such as yellow perch and smelt to gain periodic dominance to the detriment of such larger species as walleyes, Siltation, pollution, and other indirect effects of human activity have also acted to the serious detriment of walleye. However, the effects on walleye of pollution acting alone would be gradual and would not likely give rise to the pronounced fluctuations observed.

Eager to add to the sport fishery potential of their waters of Lake Erie, state agencies called a special meeting to consider an experimental introduction of coho salmon. After considerable discussion of the desirability of this step, agencies agreed to plant approximately 100,000 coho in a Pennsylvania stream, 25,000 in the Chagrin River, Ohio, and 5,000 in Cattaragus Creek, New York in 1968. Coordinated plans for assessing the results of these plantings were developed.

Lake Ontario

Commercial fish production in Ontario waters in 1967 totalled slightly less than 1.8 million pounds—an increase of 10 percent over 1966. The higher catch resulted primarily from increased landings of yellow perch, lake herring, and carp. Whitefish, walleye, and eel catches declined. Commercial production in New York waters in 1967, which totalled slightly more than 277,000 pounds, was composed largely of white perch. Sport fishing for smallmouth bass, northern pike, muskellunge, and yellow perch in 1967 was generally good.

The condition of the whitefish stocks appeared critical. However, higher catches of young whitefish in experimental nets offered hope of some recovery. Mortality of planted lake trout showed a noticeable increase between 1966 and 1967. Sea lamprey are believed to be causing heavy losses among both species and measures to build up these populations by reducing fishing pressure or by plantings are not expected to be effective while this parasite is abundant.

Lake Ontario's tributaries and shoals were also planted with kokanee in 1965 but significant runs of adults did not appear as in Lake Huron. Experimental fishing by Ontario failed to produce a single fish. A few kokanee appeared at the weirs in selected Ontario tributaries and a few others were reported to have passed above the weirs during high water.

APPENDIX B

SUMMARY OF TROUT AND SALMON PLANTINGS

Hatchery-reared salmonids have been stocked intensively in the Great Lakes by cooperating government agencies to speed the rehabilitation of the fisheries as sea lamprey are reduced. Lake trout have been planted annually in Lake Superior since 1958 and in Lake Michigan since 1965, kokanee salmon in Lake Huron and Lake Ontario since 1965, and coho salmon in Lake Superior and Lake Michigan since 1966. The first plantings of chinook salmon were made in Lake Superior and Lake Michigan in 1967.

The States of Michigan and Wisconsin and the Province of Ontario share the responsibility of providing lake trout eggs produced by brood fish maintained in hatcheries or inland lakes. The hatching, rearing, and distribution of lake trout are shared by the United States Bureau of Sport Fisheries and Wildlife, the conservation departments of the States of Wisconsin and Minnesota and the Ontario Department of Lands and Forests. These activities are coordinated by the lake committees. Tables 1 and 2 summarize annual plantings of lake trout in Lakes Superior and Michigan and Tables 3 and 4 present in

Table 1. Plantings (in thousands of fish) of lake trout in Lake Superior, 1958-1967.

Year	Michigan	Wisconsin	Minnesota	Ontario	Total
1958	298	184	-	505	987
1959	44	151	-	473	668
1960	394	210	-	446	1,050
1961	501	206	-	554	1,261
1962	1,012	257	77	508	1,854
1963	1,348	311	175	477	2,311
1964	1,196	743	220	472	2,631
1965	827	448	251	468	1,994
1966	2,218	377	257	450	3,302
1967	2,059	244	228	500	3,031
Total	9,897	3,131	1,208	4,853	19,089

Table 2. Plantings (in thousands of fish) of lake trout in Lake Michigan, 1965-1967.

Year	Michigan	Wisconsin	Illinois	Indiana	Total
1965	1,059	205	-	-	1,264
1966	956	761	-	-	1,717
1967	1,118	1,129	90	87	2,424
Total	3,133	2,095	90	87	5,405

detail the 1967 lake trout plantings in Lakes Superior and Michigan, respectively.

The Ontario Department of Lands and Forests introduced kokanee salmon in Lake Huron and Lake Ontario in 1965 and have carried out annual plantings since that time. Kokanee have been planted during the winter as eyed-eggs, swim-up fry, and fingerlings. Eyed-egg plantings were discontinued in Lake Ontario after 1965 and in Lake Huron after 1966. Table 5 summarizes the annual plantings of kokanee in Lakes Huron and Ontario and Tables 6 and 7 present in detail the 1967 kokanee plantings in these lakes.

The State of Michigan planted coho salmon in Lakes Superior and Michigan in 1966 and 1967, and introduced chinook salmon into these same lakes in 1967. The coho eggs were obtained from the States of Alaska, Oregon, and Washington, and the chinook eggs from Washington. Coho have been planted during the spring as 15-16 month reared yearlings and the chinook during the spring as 4-5 month reared fingerlings. Table 8 summarizes the coho plantings and Table 9 the chinook plantings.

Table 3. Plantings of lake trout in Lake Superior, 1967.

Location	Number	Fin clip
Michigan waters		
Silver City	109,540	dorsal
Black River Harbor	150,450	"
Eagle Harbor	90,370	"
Huron Bay	150,180	adipose and right ventral
Pequaming	108,640	"
Big Traverse Bay	151,800	"
Betsy River	102,370	"
Bete Grise	110,110	"
Grand Island	227,930	right pectoral and left ventral
Shelter Bay	100,800	"
Loma Farms	251,670	"
Grand Marais	252,700	"
Whitefish Bay	252,810	adipose and both ventrals
Sub-total	2,059,370	
Wisconsin waters		
Apostle Islands (central)	212,200	right ventral
Cat and outer islands	31,510	dorsal and right pectoral
Sub-total	243,710	
Minnesota waters		
Palmers	21,340	left pectoral and right ventral
Hovland	74,910	"
Grand Marais	74,460	"
Split Rock	18,620	"
East Beaver Bay	18,620	"
Knife River	20,130	"
Sub-total	228,180	
Ontario waters		
Caribou Island-Hare Island	124,800	left pectoral
Coutlee Island-Hare Island	124,800	both ventrals
Otterhead Pt.-Big Pic R.	125,000	right pectoral
Dog River and Pukaskwa R.	125,000	left ventral
Sub-total	449,600	
Total	3,030,860	

Table 4. Plantings of lake trout in Lake Michigan, 1967.

Location	Number	Fin clip
Michigan waters		
Petoskey	102,160	adipose and left pectoral
Charlevoix	98,210	"
Grand Traverse Bay (Acme)	80,940	"
" " " (Bowers H.)	80,570	"
Ludington	101,410	adipose and right pectoral
Leland	102,400	"
Port Sheldon	165,080	"
New Buffalo	101,740	"
Ludington—Manistee	285,000[1]	dorsal
Sub-total	1,117,510	
Wisconsin waters		
Sand Bay	101,280	adipose and left ventral
Sturgeon Bay	540,950	"
Kewaunee	202,280	"
Cheboygan—Pt. Washington	284,600[1]	dorsal
Sub-total	1,129,120	
Illinois waters		
Great Lakes Naval Dock	90,430	adipose and right ventral
Indiana waters		
Bethlehem Steel Pier (Portage, Indiana)	87,380	adipose and right ventral
Total	2,424,440	

[1]fingerlings.

Table 5. Plantings of kokanee salmon in Lake Huron and Lake Ontario, 1965-1967.

Year	Eggs	Fry	Fingerlings	Total
Lake Huron				
1965	805,000	824,500	287,600	1,917,100
1966	923,200	643,800	261,300	1,828,300
1967	-	1,025,500	146,800	1,172,300
Total	1,728,200	2,493,800	695,700	4,917,700
Lake Ontario				
1965	323,300	772,300	1,500	1,097,100
1966	-	1,389,00	-	1,389,000
1967	-	1,412,100	-	1,412,100
Total	323,300	3,573,400	1,500	3,898,200

Table 6. Plantings of kokanee salmon in Lake Huron, 1967.

Location	fry	fingerlings
South Bay	488,000	125,200
Blue Jay Creek	78,000	-
Manitou River	180,000	-
Colpoy Bay	15,000	-
Big Bay	15,000	-
North Channel (Ritchies Rock)	38,000	-
Mowat Island	82,000	-
Lion's Head	100,000	-
Meaford Shoal	29,500	-
George Lake	-	21,600
Total	1,025,500	146,800

Table 7. Plantings of kokanee salmon in Lake Ontario, 1967.

Location	fry
Shelter Valley Creek	286,000
Wilmot Creek	286,000
Salmon River	208,000
Glenora	214,500
Main Duck Island	208,000
Charity Shoal	208,000
Lake St. Lawrence	1,625
Total	1,412,125

Table 8. Plantings of coho salmon yearlings in Lake Michigan and Lake Superior, 1966-67.

Location	1966	1967	Total
Lake Michigan			
Platte River	264,600	502,700	767,300
Bear Creek	394,800	750,000	1,144,800
L. Manistee River	-	433,200	433,200
Thompson Creek	-	46,400	46,400
Sub-total	659,400	1,732,300	2,391,700
Lake Superior			
Big Huron River	192,400	467,000	659,400
Total	851,800	2,199,300	3,051,100

Table 9. Plantings of chinook salmon fingerlings in Lake Michigan and Lake Superior, 1967.

Location	
Lake Michigan	
L. Manistee River	590,830
Muskegon River	210,560
Sub-total	801,390
Lake Superior	
Big Huron River	33,460
Total	834,850

APPENDIX C

LAMPREY CONTROL AND RESEARCH IN THE UNITED STATES

Bernard R. Smith

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

Severe budget restrictions curtailed several phases of the sea lamprey program in 1967. All chemical control on tributaries of Lake Huron was discontinued on July 1 and several field research projects were reduced or terminated. The number of spawning-run sea lampreys taken at barriers on United States streams of Lake Superior again declined. The final count from the 16 barriers was 30 percent below the catch in 1966 and only 5 percent of the record catch of 1961. This year was the first since barriers have been operated that at least one weir did not capture more than 1,000 sea lampreys. Progress of chemical control on Lakes Superior and Michigan was excellent. Twenty-nine streams were treated in the 2 lakes and 14 Lake Huron tributaries were treated in the first half of the year (Table 1).

Lake Superior surveys

Forty-six previously treated streams were surveyed in 1967 and sea lamprey ammocetes were found in 27. Larvae in 15 streams were of size and number to require treatment;

Table 1. Summary of chemical treatments in United States waters of the Great Lakes in 1967.

	Number of streams	Discharge at mouth (cfs)	Stream miles treated	Lampricide used (pounds)	Synergist used (pounds)
Superior	17	2,628	304	27,672	755
Michigan	12	1,399	414	31,124	67
Huron	14	456	189	11,436	44
Total	43	4,483	907	70,232	866

13 were treated and 2 are scheduled for treatment in 1968. Re-surveys of 32 "negative" streams, including 10 on Isle Royale, showed no change of status.

Bayer 73 granules were used to survey deep or turbid sections of 8 streams where the use of electric shockers was impractical. A total of 46,250 square feet was treated with 333 pounds of granules. Sea lamprey ammocetes were recovered in 1 stream, native lamprey ammocetes in 4, and no ammocetes in 3. The St. Louis River and its tributaries below the barrier dam at Fond du Lac were surveyed with electric shockers and granular Bayer 73. No lampreys were found. Surveys were generally efficient in the tributaries, but deep water, heavy stream vegetation, and poor weather limited the effectiveness of the granules and hindered observations in the main stream.

Sea lamprey nests were found in 14 of the 19 Lake Superior streams examined for spawning adult sea lampreys in 1967. Fifty-one nests were counted in the index areas on the Bad River. Previous nest counts in the Bad River were 38 in 1966, 44 in 1965, and 189 in 1964. Spawning in Minnesota tributaries appeared heavier; 23 nests were found in 5 streams whereas only 13 nests were found last year. Most spawning surveys were hindered by high or turbid waters, and runs of adults may have been larger than indicated.

Lake Superior chemical treatments

Seventeen streams of Lake Superior having a total discharge of 2,628 cfs were treated (Table 2). Of these, 14 were treated with TFM and 3 with a synergistic mixture containing 99 percent by weight of TFM and 1 percent 5,2'-dichloro-4'-nitrosalicylanilide (TFM-1B). Two streams were treated for the second time, 11 for the third time, 2 for the fourth time, and 2 for the sixth time. The latter are treated often to control ammocete populations in lakes within their systems. Few residual ammocetes from previous treatment were in collections from the treated streams. Moderate numbers of re-established ammocetes were found in all streams except the Cranberry River, Seven Mile Creek, and Laughing Whitefish River, where re-established populations were small.

The Big Garlic River, one of the streams treated for the sixth time, was treated with granular Bayer 73 on its Sauxhead Lake delta. The effectiveness of the granules is indicated by collections from the 1966 and 1967 treatments. In 1966, 481 sea lamprey ammocetes were collected compared with 15 from

Table 2. Details on the application of lampricide to tributaries of Lake Superior in 1967.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		Lampricide (pounds)	Synergist (pounds)
			Minimum effective	Maximum allowable		
Fish Creek (Eileen)	April 28	85	3.0	9.0	990	. . .
Amnicon River	May 1	125	1.0	2.5	918	. . .
Nemadji River	May 13	408	3.0	5.0	3,492	. . .
Laughing Whitefish River	May 18	43	2.0	5.0	432	. . .
Little Garlic River	May 23	19	1.5	3.5	108	. . .
Big Garlic River	July 7	25	2.0	4.0	180	202[1]
Iron River	July 12	87	1.0	3.5	594	8
Beaver Lake Outlet	July 18	5	3.0	7.5	54	75[1]
Seven Mile Creek	July 19	17	3.0	8.0	144	. . .
Sucker River	July 27	80	1.5	5.0	684	75[1]
Ontonagon River	Aug. 16	820	3.0	6.0	10,332	. . .
Salmon-Trout River	Aug. 21	34	4.0	7.0	234	100[1]
Rock River	Aug. 31	20	6.0	10.0	375	. . .
Sturgeon River	Sept. 13	180	4.0	10.0	1,605	. . .
East Sleeping River	Oct. 3	8	3.0	9.0	570	200[1]
Cranberry River	Oct. 10	32	3.5	8.0	465	. . .
Tahquamenon River	Oct. 18	640	3.0	5.0	6,495	95
Total	. . .	2,628	. . .	. . .	27,672	755

[1]Heavy granules of 5 percent Bayer 73.

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Total	. . .	2,628	. . .	. . .	27,672	755

[1]Heavy granules of 5 percent Bayer 73.

a similar treatment this year. In addition to regular treatment, granular Bayer 73 was applied to the deltas of Little Beaver Creek in Little Beaver Lake and Sucker River in East Bay. Sea lamprey ammocetes surviving the previous treatment were collected on both deltas. Treatment will be repeated in 1968.

In summary, 168 treatments have been completed since 1958 on 75 streams; 19 streams have been treated once, 29 twice, 21 three times, 4 four times, and 2 six times. Sea lamprey ammocetes found in 4 other streams disappeared before treatment was necessary.

Lake Superior electric barrier operations

Electric barriers were operated in 1967 on 16 streams tributary to the south shore of Lake Superior from early April to July 13. A cold spring slowed the migration and unprecedented floods in mid-June inundated several weir sites, allowing some escapement.

The number of spawning migrants declined again in 1967. The total of 3,362 adults taken was 1,399 less than in 1966 and 63,339 less than the record high in 1961 (Table 3). The run developed slowly. Only 13 percent of the run was taken through May 25 compared with 31 percent in 1966. The peak was

Table 3. Catches of adult sea lampreys for comparable periods from 16 Lake Superior streams, 1961-1967.

Stream	1961	1962	1963	1964	1965	1966	1967
Betsy River	1,366	316	444	272	187	65	57
Two Hearted R.	7,498	1,757	2,447	1,425	1,265	878	796
Sucker River	3,209	474	698	386	532	223	166
Miners River	220	64	107	74	23	85	75
Furnace Creek	1,012	132	142	93	199	118	119
Rock River	3,660	399	353	229	237	158	439
Chocolay River	4,201	423	358	445	563	260	65
Iron River	2,430	1,161	110	178	283	491	643
Huron River	4,825	70	201	363	637	8	2
Silver River	5,052	267	760	593	847	1,010	339
Sturgeon River	427	397	1,445	375	135	259	43
Misery River	962	80	24	12	3	10	26
Firesteel River	1,118	70	178	327	11	15	9
Brule River	22,478	2,026	3,418	6,718	6,163	226	364
Middle River	3,502	311	48	45	52	17	19
Amnicon River	4,741	879	131	232	700	938	200
Total	66,701	8,826	10,864	11,767	11,837	4,761	3,362
Percentage change		-86.8	+23.1	+8.4	+0.6	-59.8	-29.4

between May 26 and June 4, when 25 percent of the total catch was taken. The migration then stabilized for 30 days and declined slowly during the last 10 days of weir operation.

The number of sea lampreys captured in weirs east of the Keweenaw Peninsula declined 22.8 percent and the number in western streams declined 48.8 percent from 1966. The counts from the Silver and Amnicon Rivers, the major producers in 1966, declined 66 and 79 percent, respectively. (The weir in the Ocqueoc River, Lake Huron, captured 674 adult sea lampreys compared with 3,272 in 1966.)

The average length and weight of mature sea lampreys from barriers in 10 index streams of Lake Superior increased in 1967. The average length was 16.5 inches in 1967 compared with 16.0 inches in 1966. The weight increased from 5.2 ounces in 1966 to 5.9 ounces in 1967. The percentage of males among adult sea lampreys captured at Lake Superior weirs continued to decline. Males composed 32.7 percent of the sample compared with 41.2 percent males in 1966 and 69.6 percent in 1962 when males reached the peak of dominance. The ratio of males to females is the lowest recorded from Lake Superior streams.

The number of longnose suckers in 9 tributaries to Lake Superior declined in 1967, whereas the numbers of white suckers and rainbow trout increased slightly. Sea lamprey scars on large rainbow trout from selected streams declined to 1.4 percent (Table 4), giving further evidence of the success of sea lamprey control.

Lake Michigan surveys

Seventeen Lake Michigan tributaries were surveyed in preparation for scheduled chemical treatments. Eight of the streams were treated and 9 are scheduled for treatment in 1968. An additional 31 tributaries treated previously were examined to determine the size and distribution of re-established larval populations. Sea lamprey larvae were found in 24. Initial surveys of 4 Beaver Island streams and 1 on Garden Island yielded no ammocetes. The drainages are inconsequential and provide little potential for production of lampreys. Re-surveys of 35 previously "negative" streams discovered one ammocete in each of 2 streams, the Big Suamico and the Kewaunee Rivers in Wisconsin.

Population estimates were made on sea lamprey ammocetes in Springer Creek, Menominee County, Michigan, from survey and chemical treatment collections. *Ichthyomyzon* spp. larvae

Table 4. Percentage of sea lamprey scarring on rainbow trout[1] from tributary streams of Lake Superior, 1960-1967.

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

Stream	1960	1961	1962	1963	1964	1965	1966	1967
Two Hearted River	24.0 (208)	2.8 (178)	4.6 (217)	1.6 (256)	1.6 (62)	1.4 (279)	0.4 (242)	1.2 (496)
Sucker River	9.7 (175)	2.4 (166)	4.2 (257)	5.6 (179)	3.0 (231)	1.3 (312)	1.4 (290)	1.9 (158)
Miners River	22.9 (83)	18.0 (100)	3.5 (201)	3.3 (90)	5.2 (77)	5.8 (120)	3.0 (164)	1.3 (224)
Furnace Creek	16.0 (25)	13.6 (22)	0.0 (8)	25.0 (4)	12.5 (8)	0.0 (13)	0.0 (14)	2.6 (38)
Huron River	12.2 (245)	11.5 (233)	2.3 (398)	3.4 (291)	2.2 (180)	5.6 (270)	3.8 (421)	2.3 (399)
Silver River	0.0 (21)	4.2 (72)	2.8 (71)	1.8 (56)	9.1 (55)	4.0 (50)	0.0 (42)	6.3 (16)
Misery River	2.3 (43)	3.2 (31)	0.0 (9)	0.0 (13)	0.0 (5)	. . . (0)	0.0 (11)	0.0 (9)
Firesteel River	0.0 (45)	0.0 (114)	0.0 (43)	0.0 (47)	0.0 (18)	0.0 (29)	0.0 (29)	0.0 (17)
Brule River	7.6 (92)	1.2 (82)	2.1 (140)	0.9 (227)	3.4 (177)	4.3 (255)	0.9 (414)	0.0 (271)
All streams	13.6 (937)	6.2 (998)	3.1 (1,344)	2.7 (1,163)	3.4 (813)	3.2 (1,328)	1.8 (1,627)	1.4 (1,628)

[1]Over 12 inches, total length.

(exotic to Springer Creek) were distributed as marked animals. Estimates of sea lamprey abundance were 1,226 from survey collections and 1,995 on the basis of after treatment collections. These estimates are part of a continuing project to establish a means of assessing abundance of lampreys in Great Lakes tributaries.

Lake Michigan chemical treatments

Chemical treatments began in April and continued until late October. Stream water discharges generally were higher than for the first treatments and more TFM was required.

Twelve streams having a combined discharge of 1,399 cfs were treated (Table 5). Three streams scheduled for 1967 were not treated. Crystal River and Acme Creek contained no sea lamprey larvae and the Boardman River contained ammocetes too small to require immediate treatment. The Betsie River, Benzie County, and the Ford River, Delta County, were treated with a synergistic mixture containing 99.5 percent by weight of TFM and 0.5-percent 5,2'-dichloro-4'-nitrosalicylanilide which gave an estimated savings of 6,900 pounds of TFM. Re-established sea lamprey larvae were more numerous in the Betsie, Little Manistee, and Platte Rivers than at the time of first treatment. The numbers of ammocetes in the other streams varied little from the numbers during previous treatments.

Mortality of fish was slight on all treated streams except in the Platte River. Some large spent rainbow trout were killed in an area of stream where the trout, hand-stripped of eggs, had been released by Platte River Hatchery personnel before treatment. Mortality of brown trout experienced during first treatment of the Platte and Little Manistee Rivers was avoided by treating in April and July, respectively, rather than in September.

Bureau personnel from the Hammond Bay and Ludington Stations assisted the Fish Division of the Michigan Department of Conservation in a fish eradication experiment on the Muskegon River between Big Rapids and Rogers Dam.

Lake Huron surveys

Pretreatment surveys were completed on 8 Lake Huron tributaries. Posttreatment surveys were made on 19 streams. Re-established sea lamprey ammocetes and a few residual ammocetes were found in 5 of the streams. Nine others had re-established populations. Sea lamprey larvae were absent in the 5 streams. Thirty-four "negative" streams were re-surveyed. Sea lamprey larvae were found for the first time in Martineau Creek in Mackinac County, Michigan. The other 33 streams remained negative.

Lake Huron chemical treatments

Fourteen tributaries, having a total discharge of 456 cfs, were treated between May 11 and June 29 (Table 6). Eleven streams were treated for the first time and 3 streams for the second time. Treatment costs were high because of high water and several streams that contain sections that required separate

Table 5. Details on the application of lampricide to tributaries of Lake Michigan in 1967.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		Lampricide (pounds)	Synergist (pounds)
			Minimum effective	Maximum allowable		
Platte River	April 19	422	5.0	12.0	8,760	. . .
Good Harbor Creek	April 26	69	4.0	10.0	792	. . .
Mitchell Creek	April 27	16	6.0	14.0	466	. . .
Springer Creek	June 3	6	6.0	12.0	90	. . .
Ford River	June 5	430	4.0	10.0	10,980	53
Little Manistee River	July 19	220	5.0	12.0	6,642	. . .
McGeach Creek	July 31	2	11.0	25.0	136	. . .
Betsie River	Aug. 30	200	3.0	6.0	2,448	14
Hog Island Creek	Oct. 26	4	5.0	10.0	180	. . .
Squaw Creek	Oct. 28	8	3.5	8.0	216	. . .
Valentine Creek	Oct. 29	15	2.0	4.0	306	. . .
Deadhorse Creek	Oct. 30	7	4.0	10.0	108	. . .
Total	. . .	1,399	. . .	. . .	31,124	67

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Table 6. Details on the application of lampricide to tributaries of Lake Huron in 1967.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		Lampricide (pounds)	Synergist (pounds)
			Minimum effective	Maximum allowable		
Schmidt Creek	May 11	52	3.0	10.0	769	. . .
Grace Creek	May 13	4	2.0	8.0	70	. . .
Seventeen Creek	May 13	2	8.0	15.0	35	. . .
Little Black River	May 14	28	5.0	10.0	897	. . .
Trout River	May 16	79	5.0	14.0	1,887	10[1]
Carp Creek[2]	May 25	15	5.0	10.0	300[3]	11
Swan River	May 26	62	8.0	14.0	2,444[4]	18
Greene Creek	May 31	4	3.0	10.0	48	. . .
Squaw Creek	June 11	3	8.0	17.0	72	. . .
Middle Lake	June 12	6	9.0	17.0	144	. . .
Munuscong River[2]	June 17	40	3.0	6.0	1,980	5
Little Munuscong River[2]	June 20	27	3.0	6.0	306	. . .
Tawas Lake Outlet	June 25	130	7.0	13.0	2,394	. . .
Sims Creek	June 26	4	9.0	14.0	90	. . .
Total	. . .	456	. . .	. . .	11,436	44

[1] 200 pounds of heavy granules of 5-percent Bayer 73.

[2] Re-treatment.

[3] 231 pounds of 3,4,6-trichloro-2-nitrophenol and 69 pounds of 2,5-dichloro-4-nitrophenol.

[4] Includes 1,011 pounds of 3,4,6-trichloro-2-nitrophenol and 303 pounds of 2,5-dichloro-4-nitrophenol.

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applications of chemical. Carp and Schmidt Creeks and Trout River each contained a lake in their system and needed individual treatment of each section; Swan Creek contained 2 lakes that divided the stream into three sections.

Budget restrictions curtailed all sea lamprey control as of July 1 on Lake Huron tributaries. Thirty of 51 streams known to contain sea lamprey were treated once and 3 were treated a second time. Seven of the 18 untreated streams contain large populations of sea lamprey ammocetes. The 7 are the Ocqueoc, Devils, Au Sable, East Au Gres, Au Gres, and Rifle Rivers, and Silver Creek.

Movement of tagged sea lampreys in the Great Lakes

Tags have been recovered from 289 of the 1,792 sea lampreys tagged and released in the fall of 1966 and spring of 1967. Two sea lampreys tagged and released at Sault Ste. Marie were captured at electric barriers on the Ocqueoc River and Echo Lake Outlet, Lake Huron. In Lake Superior, a sea lamprey tagged and released at Traverse Bay was captured in the Iron River weir, and 1 tagged and released in eastern Lake Superior was taken in the Brule River in western Lake Superior. A recently metamorphosed sea lamprey that was dye-marked and released in the Ocqueoc River, Lake Huron, on March 14, 1966, was captured at the electric barrier on the Manitou River, Lake Huron, on July 28, 1967.

Interlake dispersion of tagged sea lampreys was as follows: 18 tagged at St. Ignace (Lake Huron) were captured in Lake Michigan; 3 tagged in northern Lake Michigan were captured in Lake Huron; and 2 tagged in the St. Marys River were captured in Lake Superior.

Numbers of sea lampreys observed by commercial fishermen in St. Martins Bay, Lake Huron, near St. Ignace, were greatly reduced in July and August. In September, however, small lampreys were reported as numerous as in previous years. All the larger streams in this area producing parasitic-phase lampreys were treated in 1966. Apparently sea lampreys from streams of other areas have moved into St. Martins Bay. Monitoring of the fishery and tagging of sea lampreys were discontinued on July 1 because of a reduction in funds.

Re-establishment in treated streams

Re-established populations of sea lampreys were present in 23 streams of Lake Superior in 1967. The 1963 year class was present in 2 streams, the 1964 year class in 5, the 1965

year class in 8, the 1966 year class in 10, and the 1967 year class in 14.

Sea lamprey larvae were recovered in 3 small streams in Chippewa County that previously had not harbored re-established populations of sea lampreys for 4 or more years. In Naomikong Creek, one 20-millimeter ammocete (1967 year class) was recovered. No ammocetes were recovered in this stream in the 5 years, 1962-66. In Ankodosh Creek, a 65-millimeter larva, presumably of the 1965 year class, was collected. No other year classes were recovered in this stream during the 7 years, 1961-67. Two larvae, 48 and 54 millimeters, of the 1966 year class, were recovered in Galloway Creek. The 1966 year class is the only one re-established in Galloway Creek during the 6 years, 1962-67.

The reduction in the number of spawning sea lampreys captured at the electric barriers since 1961 was accompanied by a decline in the number of streams infested with young of the year and the mean number recovered per hour (Figure 1). The mean number of young of the year is measured by the rate of recovery per hour with an electric shocker at index stations in 9 streams. In 1966, the number of larvae recovered declined 83 percent and the number of streams infested declined 58 percent from the peak year of 1961.

Information collected from the Sturgeon River, Baraga County, indicates that sea lampreys may transform within 2 years. To substantiate the findings and provide additional evidence of metamorphosis at an early age, a study was initiated to provide data on growth and initial metamorphosis of ammocetes in the Sturgeon River. A total of 531 adult sea lampreys was tagged and released in the Sturgeon River in 1967 to establish a known-age year class. Although none of the tagged lampreys were recovered and only 11 nests were counted, young-of-the-year ammocetes are present in sufficient numbers to trace their growth. By mid-September the mean length of the larvae was 22 millimeters and in October the length had increased to 28 millimeters.

Re-establishment studies were terminated in Snyder-Deadhorse Creek and Hog Island Creek, tributaries to northern Lake Michigan, when the streams were treated, 7 years after the establishment of the 1960 year class of sea lampreys. The recovery of a recently metamorphosed sea lamprey in Snyder-Deadhorse Creek, prompted the treatment of the streams. The 2 streams were monitored annually for growth and relative abundance of ammocetes. Two metamorphosed sea lampreys

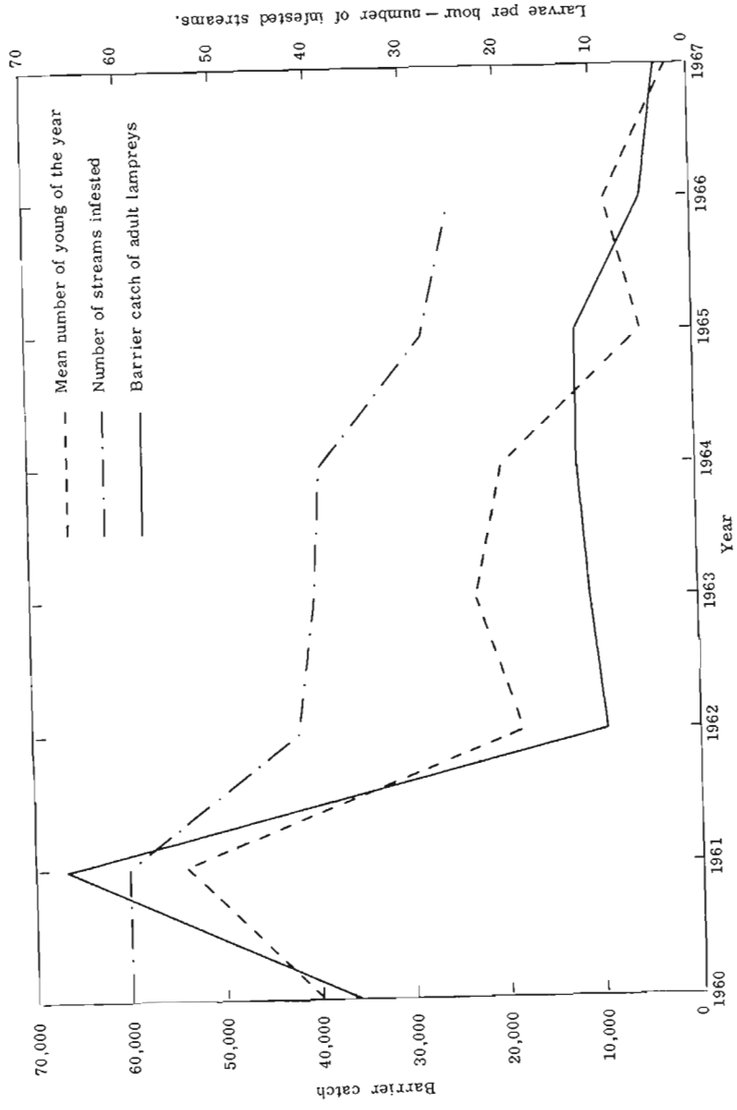

Figure 1.—Relation between the mean number of young of the year sea lampreys recovered per hour with electric shockers in 9 streams, the number of streams infested with young of the year, and the catch of adult sea lampreys at electric barriers on 16 index streams by year on the south shore of Lake Superior, 1960-67.

were collected in Snyder-Deadhorse Creek and 1 recently metamorphosed lamprey was recovered in Hog Island Creek. The ammocetes in the 2 streams were concentrated within the 1/4 mile of stream just above the mouth. The data show that a small and insignificant percentage of the sea lampreys begin metamorphosis in 7 years in the 2 streams.

The growth rate of re-established populations of sea lamprey larvae is being monitored in selected streams where age groups are distinct due to rapid growth or the absence of other year classes. The mean length of age-IV sea lampreys re-established in 1963 in the Mosquito River was 98 millimeters in September. This rate of growth parallels the growth of the known-age population in the Big Garlic River. In contrast, age-II larvae from the 1965 year class in the Bad River have attained a mean length of 105 millimeters. The Waiska River has an isolated year class which grew at a rate intermediate to that of lampreys in the Mosquito and Bad Rivers. Sea lampreys marked in May 1966 as age-II larvae in the Salmon-Trout River, Houghton County, were recovered during chemical treatment in August 1967 as age-III larvae. Fifty-four percent of the marked larvae were recovered and all were taken within 100 feet of the release site. The mean length of the larvae increased from 80 millimeters (range 61-110 millimeters) at marking to 144 millimeters (range 127-160 millimeters) at recovery. The annual growth of the ammocetes averaged 48 millimeters for the 3-year period—one of the most rapid growth rates recorded in Lake Superior tributaries. The ammocetes were in the length range where metamorphosis takes place, but no metamorphosed sea lampreys were found.

Lake-dwelling ammocete populations

A reduction in funds necessitated termination on July 1 of the project to monitor ammocetes in estuaries and inland lakes. The electric beam trawl was used before July 1 to survey areas in Lake Superior and northern Lake Huron. No sea lamprey ammocetes were collected in Lake Superior. Sea lamprey ammocetes were collected in northern Lake Huron off the mouths of Albany Island, Trout, and Nuns Creeks, and the Carp River. Rate of capture of sea lamprey larvae off the mouth of the Carp River increased from 2.8 per 100 minutes of tow time after treatment of the area with Bayer 73 in October 1966 to 66.7 per 100 minutes in June 1967. Failure to recapture any of the 1,000 ammocetes marked and released before chemical treatment in 1966 indicated a successful

treatment of the area. Apparently the increase in number of larvae captured off the mouth of the Carp River in June, 1967, was caused by immigration.

Lamprey population assessments

Assessment surveys were completed on 30 index streams in 1967 (9 each on Lakes Superior and Huron, and 12 on Lake Michigan). Twenty-five streams were checked for the first time this year and 5 were re-surveyed after initial examinations in 1966. Recovery of sea lamprey larvae of all lengths ranged from 88 per hour on Silver Creek on Lake Huron to none on the Two Hearted River on Lake Superior. Abundance of ammocetes apparently varied according to the natural productivity of the stream and to the number of year classes of ammocetes present. Yields were generally lowest from recently treated Lake Superior streams with control barriers, and highest from untreated Lake Huron tributaries without barriers.

The number of sea lamprey larvae increased noticeably at similar stations on 2 of the 5 index streams initially examined in 1966. The catch of sea lamprey ammocetes from 6 stations on the Platte River was 12.4 per hour this year compared with 9.5 per hour last year. Capture rates increased from 2.4 per hour to 5.5 per hour on 27 stations on the Pere Marquette River. The other streams that had been initially surveyed in 1966 were later treated, and 1967 surveys revealed mostly small re-established populations.

Although information from these first assessment surveys has little value regarding recent changes in lamprey populations, it does provide a basis for comparing results of subsequent surveys and perhaps determining trends in future abundance of larvae.

Sea lamprey research

The Hammond Bay Laboratory was concerned primarily with the development of larvicides, particularly those containing mixtures of TFM and Bayer 73. The chemicals have also been tested as an irritant to cause emergence of larval lampreys in surveys. Research has continued on the life history and physiology of ammocetes.

Development of larvicides. Studies of the usefulness of Bayer 73 in a synergistic mixture with TFM for lamprey control

demonstrated that a 2-percent addition, by weight, of Bayer 73 to TFM reduced larvicide requirements by about 50 percent without lowering selectivity below an acceptable level. Results of bioassays with this mixture were consistent in the laboratory and were reproduced in flowing-water raceway tests. The 2-percent mixture used in the field, however, produced fish kills that were completely unpredictable from pretreatment bioassays. Most of the streams were tributary to lower Lake Michigan. The mixture has been used more successfully in the softer waters of the Lake Superior watershed and in some streams tributary to northern Lake Michigan.

Additional studies were designed to define more closely the toxicity of TFM, Bayer 73, and several proportions of the 2 compounds. Inquiry also was made into the effect of water quality on synergistic action and the proper mixtures for use in waters of different qualities. The following observations on toxicity and selectivity have been made:

1. Regardless of species, test chemical, or mixture, the toxicity of the chemicals decreased with increased water alkalinity.
2. Increasing the proportion of Bayer 73 to TFM in the mixtures caused increased toxicity to all species, regardless of alkalinity.
3. Selectivity generally decreased with increased percentages of Bayer 73, although not with all species.
4. The amount of Bayer 73 needed to produce a 50-percent increase in toxicity over TFM alone varied with the dilution waters. In the least alkaline water a 4-percent addition was required; a 2-percent addition produced the same results in more alkaline waters. An 0.5-percent addition has consistently given a 35- to 40-percent increase in toxicity in test waters averaging 170 ppm in total alkalinity and has shown little or no loss in selectivity compared to TFM alone.

A satisfactory measurement of the synergistic action between TFM and Bayer 73 has not yet been possible. It appears, however, that the synergistic action between the 2 compounds is greater in waters with higher alkalinity. The interaction between the chemicals would tend to compound any adverse effect that would occur from improper concentrations. Domestic, industrial, and thermal pollution, presence of pesticides, and dense and varied fish populations, are factors that

may complicate treatment of tributaries to lower Lake Michigan. On the basis of our present knowledge, the following mixtures of TFM and Bayer 73 are recommended for treating streams:

Total alkalinity (ppm)	Percent Bayer 73
25 - 50	3.0
50 - 100	2.0
100 - 150	1.0
Over 150	0.5

Search for irritants. The testing of chemicals to determine their potential to cause irritation and emergence of larval lampreys is continuing. Compounds are first screened to determine their toxic level to fish and larval lampreys and then re-tested at levels nontoxic to fish to determine if they cause emergence of larvae within 24 hours. No promising chemicals were found among the approximately 1,400 tested.

Downstream lamprey migration in the Ocqueoc River. Fyke nets fished continuously in the Ocqueoc River for the past 5 years provided data on the characteristics and magnitude of downstream-migrating lampreys that will be valuable in determining the effectiveness of future chemical treatments. A single net has been fished continuously in the same location since 1963-64. The catch in this index net was 3,373 in 1963-64, 1,174 in 1964-65 (the net was lost during extremely high water in the spring), 3,913 in 1965-66, 3,248 in 1966-67, and 2,179 for the first half of the 1967-68 migrational year. To evaluate the efficiency of the index net and to provide a basis for calculating total downstream runs, mark-recapture studies were initiated during the 1963-64 migration. The number of downstream migrants was estimated at 42,000 in 1963-64; 57,000 in 1965-66; and 80,000 in 1966-67.

Starting with the 1965-66 runs, information has been collected on length frequency and sex ratios of downstream migrants. In 1965-66, the average length of 4,018 downstream migrants was 139.9 millimeters (range, 104-188 millimeters). The females averaged about 4.9 millimeters longer than the males. The percentage of males was 40.4 percent. In 1966-67, the average length of 2,571 downstream migrants was 144.9 millimeters (range, 109-198 millimeters). The females averaged about 6.6 millimeters longer than the males and the percentage of males was 44.4 percent.

Blood studies. A study was begun in 1966 to determine normal blood values for the various stages of the sea lamprey and to determine whether the time of metamorphosis can be predicted from ammocete blood values. Only red blood cells were studied because white blood cells could not be identified positively and counted accurately. The hematocrit, hemoglobin content, and erythrocyte count were determined for larval, metamorphosing, and adult sea lampreys. All the blood values in ammocetes increased with length. During morphological transformation the blood values decreased but increased as the adults began to feed. The mean blood values for mature adults are similar to those of ammocetes. At spawning, males exhibit higher blood values than do females. Hemoglobins have been separated electrophoretically at five stages of the sea lamprey's life cycle: larva, transforming individuals before downstream migration, recently transformed downstream migrants, parasitic lampreys, and fully mature spawning adults.

Experimental population of ammocetes. Ammocetes of the 1960 year class (now age-group VII) established in 1960 in the Big Garlic River, Marquette County, Michigan, metamorphosed for the third successive year. The all-season trap captured 223 metamorphosed lampreys in 1967. Of these, 2 were taken in April and were the first spring migrants captured. The trap captured 44 young adults in 1966 and 4 in 1965. The young parasitic lampreys ranged from 127 to 180 millimeters long and averaged 151 millimeters. The percentage of males was 40 percent in 1967 compared with 51 percent in 1966.

The catches of ammocetes in the all-season trap decreased in 1967. The trap captured 7,572 in 1967, 7,925 in 1966, 4,336 in 1965, 2,847 in 1964, 370 in 1963, and 9 in 1962. The percentage of males among ammocetes over 100 millimeters was 27 percent in 1967, 21 percent in 1966, and 19 percent in 1965. The annual growth rate of ammocetes continued to decrease. The mean length of 470 ammocetes was 113 millimeters (range, 72-165 millimeters), an increase of only 2 millimeters from 1966 (Table 7).

Since October 1962, 10,006 ammocetes have been marked and returned to the study area. Of the 419 marked lampreys recovered in 1967, 164 were recently metamorphosed. Ammocetes marked in 1962 still retain visible marks after 5 years. Marks on metamorphosed lampreys are obscured by pigment and difficult to detect. All parasitic-phase lampreys were dissected and examined for subcutaneous marks.

Table 7. Growth of 1960 year class of ammocetes in the Big Garlic River to October, 1967

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

Adult sea lampreys bypassed the downstream trap in June through a channel opened by flood waters. The upstream migration of these lampreys was limited by a natural barrier to the lower 1-1/2 miles of the 5-mile study area. Four nests were located in the study area and 7 of the escaped adults were captured at the trap. The young of the year averaged 15 millimeters long (range, 11-18 millimeters). The growth of this population and its influence on the age-VII larvae will be studied. A downstream trap was constructed in the bypass channel to prevent further escapement and to monitor any downstream movement of ammocetes and parasitic-phase lampreys.

Final data were collected on the staging of external metamorphosis of sea lamprey from the Big Garlic River. Five morphologically distinct stages and the period of time for metamorphosis were determined. Stages were based on development of the eye, oral fringe, sensory pores, mouth, and teeth. A sequence of metamorphosing lampreys was preserved to determine accompanying histological changes.

APPENDIX D

LAMPREY CONTROL EXPERIMENT IN CANADA

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

Resource Development Service
Department of Fisheries of Canada

This report describes the work carried out by the Sea Lamprey Control Experiment Station of the Resource Development Service, Department of Fisheries of Canada, Sault Ste. Marie, Ontario.

Lamprey control in Canada was affected by adverse weather conditions in the spring of 1967. The cold and late spring coupled with a snow cover somewhat deeper than normal resulted in flooded conditions in streams that lasted partway through May. Little rain fell in May and stream levels dropped rapidly once the snow had gone. However, the fire hazard soon became acute and numerous fires, some of which threatened northern towns including Chapleau and Sioux Lookout, occurred throughout the Province. During this period aircraft were not available for transporting the chemical treatment crew and equipment to inaccessible areas. The dry period persisted until early June when heavy rains eased the fire danger but concurrently increased flows and hindered operations. Inclement weather notwithstanding, the Department was able to complete the greater portion of its commitment to the Commission by the end of the 1967 field season.

Lamprey barrier operations

Electrical barriers have been operated on certain tributaries to Lake Superior since 1954. Originally designed and operated as control devices, these have been used in recent years to assess changes in the abundance of adult sea lampreys.

Electrical barriers were operated in Canada during 1967 on 8 Lake Superior streams (Big Carp, Harmony, Chippewa, Batchawana, Sable, Pancake, Pays Plat, and Gravel Rivers),

and 9 Lake Huron streams (Echo, Two Tree, Kaskawong, Still, Naiscoot-Harris, Mad, Manitou, Blue Jay, and Bayfield Rivers). The Lake Superior barriers have been operated, except for minor delays and interruptions, during May, June, and July each year since 1956, but in 1967, the Pays Plat and Gravel River barriers were not operated until May 19 and 24, respectively. Of the 9 Lake Huron barriers, the Kaskawong, Manitou, and Blue Jay were first operated in 1967. Direct current guiding devices were operated in conjunction with standard alternating current barriers on the latter two rivers.

The catch of 383 sea lampreys at the 8 Lake Superior barriers in 1967 (Table 1), was only 2 more than in 1966 and marked the first time since 1963 that the catch had not shown a significant decline. A total of 6,764 sea lampreys were taken at 9 Lake Huron barriers in 1967 (Table 2). The total catch of lampreys taken at the 6 barriers which were operated for comparable periods in both years was 24 percent higher in 1967 than in 1966.

Surveys

Electro-shocking, application of granular Bayer 73, or a combination of the two were used in surveying 42 streams in the Lake Superior drainage. These surveys included examination for re-established populations in 19 streams previously treated and 23 routine surveys of tributaries on the north shore between Terrace Bay and Pigeon River in which lamprey have not been found. Sea lampreys were discovered in 9 streams previously treated (Little Carp, Goulais, Sawmill, Pancake, Big Pic, Little Gravel, Jackfish, Nipigon, and Kaministikwia), but not in the others. In the Lake Huron drainage, 30 streams were surveyed. Sea lampreys had become re-established in 4 rivers which were treated in 1960 and 1961 (Nottawasaga, Sturgeon, Lafontaine, and Silver) and a sea lamprey ammocete was found for the first time in the Sydenham River. No sea lampreys were found in re-surveys of 20 small tributaries of the North Channel and 3 streams on Georgian Bay. Re-examination of the Saugeen and Bayfield rivers, not previously treated, indicated a reduction in their sea lamprey populations.

Chemical treatments

Of the 12 Lake Superior streams scheduled for treatment in 1967, only 9 were treated (Table 3) as pre-treatment surveys of the Dog, Pays Plat, and Pearl showed no larvae were

Table 1. Number of sea lampreys collected at 8 electrical barriers on the Canadian side of Lake Superior for the period May 15 to July 31 for the years 1957 to 1967.

Stream	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
					Sault Ste. Marie Area						
Big Carp	23	11	15	20	6	5	2	1	15	3	2
Harmony	15	6	7	19	14	3	0	4	5	0	0
Chippewa	353	171	290	1045	453	123	222	274	114	78	92
Batchawana	408	301	467	626	561	136	336	216	140	119	119
Sable	63	36	138	241	88	10	36	5	17	14	8
Pancake	1051	750	804	1286	931	187	387	257	94	64	138
Sault Area Total	1913	1275	1721	3237	2053	464	983	757	385	278	359
					Nipigon Area						
Pays Plat	3	4	30	10	31	9	9	5	0	2	1
Big Gravel	101	152	537	626	799	315	64	52	188	101	23
Nipigon Area Total	104	156	567	636	830	324	73	57	188	103	24
Total (8 barriers)	2017	1431	2288	3873	2883	788	1056	814	573	381	383

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Table 2. Numbers of upstream migrant adult sea lampreys collected at electrical barriers on Canadian tributaries to Lake Huron during the periods indicated for the years 1966 and 1967.

Stream	Operational period 1966	Lamprey collected	Operational period 1967	Lamprey collected
North Channel (western end)				
Echo	May 5-July 31	526	May 8-July 31	460
Two Tree	Apr. 22-July 31	20	Apr. 20-July 31	22
Kaskawong*	-	-	May 22-July 31	83
Georgian Bay				
Still	Apr. 28-July 15	1,820	May 5-July 15	1,839
Naiscoot-Harris	Apr. 22-July 15	968	May 4-July 15	1,635
Mad	Apr. 20-July 15	324	Apr. 15-July 15	333
Lake Huron (proper)				
Manitou*	-	-	May 23-July 31	639
Blue Jay*	-	-	May 9-July 31	964
Bayfield	Apr. 17-July 15	443	Apr. 14-July 15	789

*Not operated in 1966.

present. An additional stream, Corbett Creek, a tributary of the Kaministikwia River, was treated following the discovery of a large population of sea lamprey ammocetes.

Granular Bayer 73 was used to treat the estuaries and the adjacent areas of Batchawana Bay at the mouths of the Chippewa, Batchawana, and Sable Rivers. Areas at the mouths of the Wolf and Stillwater Rivers near Nipigon were similarly treated. The use of granular Bayer 73 in these areas has had encouraging results; more ammocetes were recovered following these applications than had ever been collected during treatment with liquid TFM formulations. In an effort to further reduce recruitment of sea lamprey to Batchawana Bay, 14 small unnamed streams were treated with lampricide and granular Bayer 73. Sea lamprey ammocetes were found in only 3 streams compared with 4 in 1966 and 7 in 1965.

In reviewing results of past surveys and treatments of 38 known lamprey-producing streams on the Canadian side of Lake Superior, it is possible to classify them on the basis of the probable need for re-treatment.

Table 3. Summary of streams treated with lampricide and Bayer 73 on the Canadian side of Lake Superior, 1967.

Stream	Date treated	Flow (cfs)	Stream miles and/or area (sq. feet) treated	TFM (lb)	Bayer 73 powder (lb)	Bayer 73 granular (lb)	Ammocete abundance
Harmony	May 15	26	2	131	2.1	-	Scarce
E. Davignon	May 25	6	5	75	0.5	-	Nil
W. Davignon	June 1	10	6	91	-	-	Nil
Sable	July 19	-	(482,400)	-	-	1,155	Scarce
" (con't)	July 26	22	0.8	108	-	-	Scarce
Batchawana	July 28	-	(1,965,900)	-	-	5,175	Moderate
Chippewa	Aug. 3	-	(437,400)	-	-	1,000	Scarce
Cypress	Aug. 16	37	3	138	2.8	-	Abundant
Stillwater	Aug. 20	8	3	74	-	-	Abundant
" (con't)	Sept. 19	-	(166,800)	-	-	396	Scarce
Otter Cove	Aug. 25	5	0.3	25	-	-	Scarce
Corbett*	Sept. 25	3	5	95	-	-	Abundant
Total		117	25.1 (3,052,500)	737	5.4	7,726	

*Tributary of Kaministikwia.

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Total		117	25.1 (3,052,500)	737	5.4	7,726	

*Tributary of Kaministikwia.

Group 1. Streams where larvae become re-established after each treatment and require re-treatment at more or less regular intervals:

Little Carp (20 cfs)	Little Gravel (95 cfs)
Big Carp (20 cfs)	Cypress (25 cfs)
Goulais (800 cfs)	Jackfish (50 cfs)
Sawmill (5 cfs)	Cash (30 cfs)
Chippewa (190 cfs)	Otter Cove (5 cfs)
Batchawana (210 cfs)	Stillwater (10 cfs)
Sable (45 cfs)	Black Sturgeon (650 cfs)
Pancake (60 cfs)	Wolf (150 cfs)
White (350 cfs)	Kaministikwia (1,150 cfs)
Big Gravel (160 cfs)	Pigeon (400 cfs)

Total flow 4,425 cfs.

Group 2. Large or complex rivers where significant numbers of lamprey do not immediately become re-established following a treatment and require re-treatment when surveys indicate that transformation and escapement of ammocetes are about to occur:

Agawa (500 cfs)	Little Pic (450 cfs)
Michipicoten (2,200 cfs)	Steel (750 cfs)
Big Pic (500 cfs)	Nipigon (3,800 cfs)

Total flow 8,200 cfs.

Group 3. Streams where re-established lampreys have been scarce or absent since the last treatment and may not require re-treatment:

Cranberry (25 cfs)	Pays Plat (220 cfs)
Stokeley (50 cfs)	Pearl (50 cfs)
Dog (200 cfs)	Blende (10 cfs)

Total flow 555 cfs.

Group 4. Streams where lamprey have not become re-established since initial treatment and will probably never require re-treatment:

East Davignon (10 cfs)	Sand (200 cfs)
West Davignon (15 cfs)	Prairie (100 cfs)
Harmony (25 cfs)	McIntyre (80 cfs)

Total flow 430 cfs.

The 18 streams in Groups 2, 3, and 4, have been removed from the regular treatment schedule. These streams will be kept under close surveillance and re-classified as required.

Twelve of the 13 scheduled Lake Huron streams were treated in 1967 (Table 4). A portion of the complex Echo River system had to be postponed because of low water. Sea lampreys were found in 6 of the 9 streams treated on the mainland, 1 of the 2 streams on St. Joseph Island and 1 of the 2 streams on Manitoulin Island. All of these streams flow into the North Channel or St. Mary's River. With the exception of the untreated portion of the Echo River, the only Lake Huron tributaries in Canada that remain to be treated are those flowing into Georgian Bay and the main lake.

Treatment of Lake Huron streams was begun in 1960 but was terminated in 1961 when available resources were concentrated on controlling lamprey in Lake Superior. Treatments were resumed in 1966 and were confined in both 1966 and 1967 to the St. Mary's River and North Channel tributaries in an attempt to minimize the possibility of recruitment to the reduced lamprey population in Lake Superior. Because of the lack of sea lamprey larvae, 5 North Channel streams (MacBeth, Lauzon, H-65, Spragge, and Kagawong) have been removed from the regular treatment schedule.

The usefulness of granular Bayer 73 in treating deep-water areas is presently hampered by a tendency for the granules to break up readily during blower application. The resulting powder settles slowly in the water, releasing toxicant in the upper layers where it can cause fish mortality. The problem appears to be one of quality control in formulation and has been brought to the attention of the manufacturer.

Lamprey trawling and tagging

Trawling for adult lampreys in the St. Mary's River below the locks was resumed in the autumn of 1967 in a continuing effort to follow the extent and direction of movement of lamprey between Lakes Huron and Superior. The lampreys were collected at night in beam trawls towed at the surface behind outboard-motor cruisers. Two boats, similarly equipped were operated concurrently in different areas to ascertain the extent of the lamprey aggregation, and also consecutively in the same area to detect diurnal variations in the rate of capture. The lampreys in the St. Mary's River congregated at the tailrace of the Edison Sault Electric Company's plant at Sault Ste. Marie, Michigan. Individuals were most frequently taken near

Table 4. Summary of streams treated with lampricide and Bayer 73 on the Canadian side of Lake Huron, 1967.

Stream	Date treated	Flow (cfs)	Stream miles treated	TFM (lb)	Bayer 73 powder (lb)	Bayer 73 granular (lb)	Ammocete
Echo	May 30	Variable	12	1,403	23.1	0	Moderate
" (con't)	June 6						
MacBeth	June 13	7	0.5	36	-	-	Nil
Livingstone	June 14	3	3	36	-	-	Scarce
Lauzon	June 20	7	0.5	18	-	-	Nil
Thessalon	June 21	675	74	3,603	54	333	Moderate to abundant
" (con't)	July 11						
Mississagi	Aug. 15	1,520	22.5	8,330	132	104	Abundant
Spragge (H-114)	Aug. 19	0.3	0.3	4.4	-	-	Nil
Serpent	Aug. 21	200	9	510	6.3	-	Scarce
Spanish	Aug. 24	2,265	56	14,548	236.3	32	Scarce
Kagawong	Aug. 25	8	1	54	1.7	-	Nil
Silver Lake	Sept. 12	2.3	3	105	2	-	Abundant
H-65	Sept. 20	2	0.4	12	-	20	Nil
H-68	Sept. 20	1.5	0.2	6	-	25	Scarce
Total		4,708	182	28,665.4	455.4	514	

Table 4. Summary of streams treated with lampricide and Bayer 73 on the Canadian side of Lake Huron, 1967.

Stream	Date treated	Flow (cfs)	Stream miles treated	TFM (lb)	Bayer 73 powder (lb)	Bayer 73 granular (lb)	Ammocete
Echo	May 30	Variable	12	1,403	23.1	0	Moderate
" (con't)	June 6						
MacBeth	June 13	7	0.5	36	-	-	Nil
Livingstone	June 14	3	3	36	-	-	Scarce
Lauzon	June 20	7	0.5	18	-	-	Nil
Thessalon	June 21	675	74	3,603	54	333	Moderate to abundant
" (con't)	July 11						
Mississagi	Aug. 15	1,520	22.5	8,330	132	104	Abundant
Spragge (H-114)	Aug. 19	0.3	0.3	4.4	-	-	Nil
Serpent	Aug. 21	200	9	510	6.3	-	Scarce
Spanish	Aug. 24	2,265	56	14,548	236.3	32	Scarce
Kagawong	Aug. 25	8	1	54	1.7	-	Nil
Silver Lake	Sept. 12	2.3	3	105	2	-	Abundant
H-65	Sept. 20	2	0.4	12	-	20	Nil
H-68	Sept. 20	1.5	0.2	6	-	25	Scarce
Total		4,708	182	28,665.4	455.4	514	

the surface between 8:00 p.m. and midnight. A total of 1,034 sea lampreys were captured during the fall and winter season, but the catch-per-hour of trawling was only about half that of the previous year. A total of 689 sea lampreys were tagged and released during the trawling.

Collection of adult (feeding) lamprey

In July, 1967, a reward was offered to commercial fishermen for sea lampreys caught in commercial fishing gear with data on location, date, and method of capture. A total of 2,469 specimens were purchased; 3 were from Lake Superior; 3 from Lake Erie; 585 from Lake Ontario, and 1,878 from Lake Huron. Laboratory examination revealed a striking seasonal shift in the sex ratio. Females began to outnumber males in mid-September and by the end of the fishing season catches in Lake Huron consisted of nearly 500 females to 1 male. This unbalanced sex ratio was also apparent in the smaller catches from the other lakes, as well as in the lamprey which had died during the tagging operation in the St. Mary's River. The full significance of this sex-ratio change is not clearly understood at this time. The commercially caught sea lampreys also revealed size segregation by area and method of capture and observations indicate that lampreys of different sizes were associated with prey of different sizes and species.

APPENDIX E

ADMINISTRATIVE REPORT FOR 1967

Meetings. The Commission held its 1967 Annual Meeting in Madison, Wisconsin, June 20-22, and its Interim Meeting in Ann Arbor, Michigan, on November 28-29.

The Sea Lamprey Control and Research Committee met in Ann Arbor on April 2, and drafted a program for fiscal year 1969 for consideration by the Commission at the 1967 Annual Meeting. Lake Committees held meetings during 1967 as follows:

Lake Superior Committee	Milwaukee, Wisconsin, March 8
Lake Michigan Committee	Milwaukee, Wisconsin, March 9
" " "	Grand Rapids, Michigan, May 8
Lake Huron Committee	Milwaukee, Wisconsin, March 7
Lake Erie Committee	Ann Arbor, Michigan, March 1-2
Lake Ontario Committee	Watertown, New York, April 5-6

Officers and staff. There were no changes in Commission officers or staff during 1967.

Accounts and audit. The Commission's accounts for the fiscal year ending June 30, 1967, were audited by Icerman, Johnson, and Hoffman, Ann Arbor. The firm's report is appended.

Contributitions to the program for fiscal year 1967. At the 1965 Annual Meeting, the Commission adopted a program of sea lamprey control and research for fiscal year 1967 estimated to cost $1,607,100. The estimated cost of administration and general research was $53,200. The program was subsequently revised at the Interim Meeting and estimates changed to $1,492,000 for sea lamprey control and research and $55,000 for administration and general research, in accordance with a limitation placed on the United States' contribution.

Requests for funds, contributions, and credits from underexpenditures were as follows:

	United States	*Canada*	*Total*
Sea lamprey control and research			
Commission request	$1,108,900	$498,200	$1,607,100
Appropriations	1,029,500	462,530	1,492,030
Transfer to Admin. Fund	-2,560	-1,150	-3,710
Sub-total	$1,026,940	$461,380	$1,488,320
Credits from fiscal year 1965	-3,821	-1,717	-5,538
	$1,023,119	$459,663	$1,482,782
Administration and general research			
Commission request	$26,600	$26,600	$53,200
Appropriations	27,500	27,500	55,000
Transfer from Sea Lamprey Fund	1,150	1,150	2,300
Sub-total	$28,650	$28,650	$57,300
Credits from fiscal year 1966	-800 [1]	-	-800
Contributions	$27,850	$28,650	$56,500

[1]Adjustment to maintain sharing formula after transfer between funds in fiscal year 1966.

Expenditures in fiscal year 1967. Agreements were made with the U. S. Bureau of Commercial Fisheries ($824,100) and the Department of Fisheries of Canada ($445,250) to carry out the revised sea lamprey program. The Commission also renewed its agreement with the Economic Study Group ($10,000). Following the Interim Meeting, the Commission initiated a study of walleye in western Lake Erie by Dr. Henry Regier, of the University of Toronto. The Ontario Department of Lands and Forests and the Ohio Division of Wildlife each agreed to cover one-third of the cost, estimated to be $7,000.

The program proposed for Lake Superior in the 1967 Memorandum of Agreement with the Bureau of Commercial Fisheries was completed except for treatment of the Ontonogan River which remained in flood throughout the spring and early summer. Three small streams (Amnicon, Laughing Whitefish, and Little Garlic) not specified in the Agreement were treated to eliminate ammocetes which surveys showed were on the point of transformation. On Lake Michigan, the Cedar River, which had been scheduled, did not require treatment. The Whitefish River could not be dealt with effectively because of low flow and treatment was postponed to fiscal year 1968. Three small streams on the northeast shore of Lake Michigan were treated ahead of schedule.

Early completion of treatments on Lakes Superior and Michigan allowed crews to move to Lake Huron where 20 streams were treated instead of 6 as proposed in the Agreement. At the end of fiscal year 1967, the Bureau returned

$6,100 in unexpended funds which the Commission used to replenish the lampricide reserve. An additional $5,400 returned later was also used for this purpose.

In Canada, treatments were completed on all streams specified in the Agreement with the exception of the Echo River on Lake Huron where unfavorable flow conditions forced a postponement. It was also not possible to complete construction of three barriers on the Thessalon, Manitou, and Blue Jay Rivers for operation in the spring of 1966 because of difficulties acquiring sites. Construction of a barrier on the Thessalon was abandoned, but barriers on the other rivers were completed by fall. At the end of fiscal year 1967, the Department of Fisheries returned $61,642 in unexpended funds which was used to purchase lampricide.

The walleye study, which dealt with a review of pertinent information on walleye generally, and analysis of data collected by investigators on Lake Erie, began on April 1. Expenses totalling $2,824.05 were charged against the general research allocation for fiscal year 1967. In order to cover its share, the Commission authorized the transfer of $3,710 from the Sea Lamprey Control and Research Fund to the Administration and General Research Fund, thereby providing $2,300 with the balance of $1,410 being credited to the United States' contribution in fiscal year 1968 to maintain the sharing formula. The study was completed in September and a report was submitted to the Commission at its Interim Meeting. The Ontario Department of Lands and Forests contributed $2,329 toward the cost and Ohio $2,300.

The Commission purchased 80,500 pounds of TFM from the Maumee Chemical Company, Toledo, Ohio, at $2.58 per pound. A total of 74,656 pounds were delivered—57,240 pounds to the U. S. agent and 17,416 to the Canadian agent. The total cost of the lampricide was $192,612. In addition, a royalty of $10,659 (5 percent) was paid to the patent holder (American Hoechst Corporation) for lampricide used in the United States.

At the close of fiscal year 1967, the Commission purchased 15,800 pounds of TFM with funds returned by its agents and 5,900 pounds representing the amount which the Maumee Company had not been able to deliver. These orders were placed with the American Hoechst Corporation which, as the low bidder, had been selected to supply TFM in fiscal year 1968.

The Commission also purchased 1,750 pounds of powdered Bayer 73 for use as a synergist in stream treatments and

27,650 pounds of granulated Bayer 73 for stream surveys and estuary treatments. The total cost of Bayer 73 was $27,079.

The Economic Study Group completed its field investigations and submitted a report at the 1967 Annual Meeting, which the Commission recommended be edited for possible publication in 1968.

Program and budget for fiscal year 1968. At the 1966 Annual Meeting, the Commission approved a program and budget for sea lamprey control and research of $1,785,000 and for administration and general research of $56,300. The Commission, when advised at its 1966 Interim Meeting that it should not expect an increase in the United States contribution, revised the program for sea lamprey control and research by reducing the estimated cost to $1,491,100.

A further minor revision was made at the 1967 Annual Meeting increasing the budget for administration and general research to $61,900 and reducing the sea lamprey control and research budget to $1,487,000. The revised program provided for the following activities:

Lake Superior - Re-treat 6 streams in the United States and 8 streams in Canada; examine lamprey streams and potential lamprey streams to determine when re-treatments should be carried out; operate assessment barriers on 16 streams in the United States and 8 in Canada.

Lake Michigan - Re-treat 7 streams; re-examine other lamprey streams to determine need for re-treatment.

Lake Huron - Treat 11 streams in the United States and 11 in Canada; survey lamprey streams to determine ammocete distribution and collect other information needed to carry out treatments; examine treated streams to determine rate of re-establishment of larvae; operate assessment barriers on 9 Canadian streams and 1 United States stream.

Research - Continue testing of potential lampricides; develop an irritant for use in stream surveys; continue to seek information on mode of action of TFM and salicylanilides; develop marks for lamprey larvae to persist through the parasitic stage; determine physiological norms to use in assessing condition and likely survival of ammocetes living under marginal conditions; continue fyke netting in streams to compare their lamprey production before and after treatments; tag adult lamprey to follow movements; examine populations of re-established larvae in treated streams to identify those re-infested each year; sample deep-water larval habitat with electrical trawls to locate and assess larval populations; continue the study of growth, movement, and transformation of a single year class (1960) in the Garlic River.

At its 1967 Annual Meeting, the Commission was advised that a reduction of $100,000 in the United States' contribution had been recommended which, if approved, would bring a reduction of $45,000 in the Canadian contribution. The Commission, therefore, suspended treatments planned for streams on the west shore of Lake Huron.

Agreements to carry out the program for fiscal year 1968 were made with the U. S. Bureau of Commercial Fisheries ($759,400) and the Canadian Department of Fisheries of Canada ($435,620). The Commission also ordered 68,800 pounds ($175,500) of lampricide for delivery in the spring and early summer of 1968 with all but 10,000 pounds to the Bureau of Commercial Fisheries.

In December, 1967, the Commission was advised that the United States' contribution to the program for fiscal year 1968 would be reduced by $55,200 rather than the $100,000 recommended. Funds for sea lamprey control and research would, therefore, total $1,411,100. None of the stream treatments suspended earlier could be re-scheduled for the last half of the fiscal year because of an increase in the cost of United States operations on Lake Superior and Lake Michigan.

Program and budget for fiscal year 1969. At the 1967 Annual Meeting, the Commission approved a program and budget of $1,814,100 for sea lamprey control and research and $65,000 for administration and general research in fiscal year 1969. When advised of the limitation of the United States' contribution, it reduced the program by postponing treatment of the Nipigon River, eliminating three field investigations, and discontinuing barriers on the Canadian shore of Lake Superior. The revised budget provided $1,611,600 for sea lamprey control and research and $62,000 for administration and general research.

Reports and publications. In addition to the 1966 Annual Report, the Commission published the following three papers in its technical report series:

"The relation between molecular structure and biological activity among mononitrophenols containing halogens," by Vernon C. Applegate, G. F. H. Johnson, and Manning A. Smith, Great Lakes Fish. Comm. Tech. Rep. 11: 1-19.

"Substituted nitrosalicylanilides: A new class of selectively toxic sea lamprey larvicides," by Roland J. Starkey and John H. Howell, Great Lakes Fish. Comm. Tech. Rep. 11: 21-29.

"Physical limnology of Saginaw Bay, Lake Huron," by Alfred M. Beeton, Stanford H. Smith, and Frank F. Hooper, Great Lakes Fish. Comm. Tech. Rep. 12, 1-56."

Results of studies carried out in connection with the sea lamprey control program and published elsewhere were as follows:

"Diatoms as food of larval sea lampreys in a small tributary of northern Lake Michigan," by Patrick J. Manion, Trans. Amer. Fish. Soc. 96(2): 224-226.

"An all-season trap for downstream migrating fish and other aquatic organisms," by Alberton L. McLain and Patrick J. Manion, Prog. Fish. Cult. 28(2): 114-117.

"Morphological abnormalities among lampreys," by Patrick J. Manion, Copeia, No. 3, September, 1967: 680-681."

ICERMAN, JOHNSON & HOFFMAN
Certified Public Accountants

P. F. Icerman, C.P.A.
R. L. Johnson, C.P.A.
C. A. Hoffman, C.P.A.
J. S. Burtt, C.P.A.
C. J. Morehouse, C.P.A.

303 National Bank and Trust Building
Ann Arbor, Michigan 48108

109 West Clinton Street
Howell, Michigan 48843

September 18, 1967

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

We have examined the statements of receipts and expenditures of the Great Lakes Fishery Commission Administration and General Research Fund, and Lamprey Control Operation Fund for the year ended June 30, 1967. Our examination was made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying statements of receipts and expenditures present fairly the fund balances of the designated funds of the Great Lakes Fishery Commission at June 30, 1967, arising from cash transactions and the receipts collected and expenditures made by it for the year then ended, on a basis consistent with that of the preceding year.

(signed)

Icerman, Johnson & Hoffman

Great Lakes Fishery Commission

Administration and General Research Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1967

	Actual	*Budget*
Receipts		
Canadian Government	$27,500	$28,650
United States Government	26,700	27,850
Transferred from Lamprey Operations	3,450	
Total	$57,650	$56,500
Expenditures		
Salaries (including tax and pension)	$44,371	$44,420
Travel	2,410	2,700
General research	2,824	2,300
Communication	948	1,000
Rents and utilities	751	600
Printing and reproduction	2,083	2,500
Other contractual services	391	400
Supplies	1,717	1,550
Equipment	1,805	1,830
Total	$57,300	$57,300A
Excess of receipts over expenditures	$ 350	
Fund balance, July 1, 1966	800	
Fund balance, June 30, 1967	$ 1,150	

Note A - Fund balance, July 1, 1966 -credited against U.S. Government budgeted receipts $ 800
Budgeted receipts 46,500
Total available funds $57,300

Great Lakes Fishery Commission

Lamprey Control Operation Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1967

	Actual	*Budget*
Receipts		
Canadian Government	$ 460,813	$ 462,530
United States Government	1,025,679	1,029,500
Refund from United States Fish and Wildlife Service	4,337	
Reserve fund for Lampricide Deliveries	107,421	
Reserve fund for Economic Study	10,000	
Total	$1,608,250	
Transferred to Administrative Funds	3,450	
	$1,604,800	$1,492,030
Expenditures		
Canadian Department of Fisheries	$ 383,608	$ 445,600
United States Fish and Wildlife Service	818,000	831,700
Lampricide Purchases	331,858	220,268
Economic Study Group	6,208	
Obligated for unpaid Lampricide purchase	65,608	
Total	$1,605,282	$1,497,568A
Excess of expenditures over receipts	$ 482	
Fund balance, July 1, 1966	5,538	
Fund balance, June 30, 1967	$ 5,056	

Note A - Fund balance, July 1, 1966 $ 5,538
Budgeted receipts 1,492,030
Total available funds $1,497,568

Bureau of Commercial Fisheries

Sea Lamprey Control and Research Program

Report of Expenditures for All Activities

July 1, 1966 through June 30, 1967

Activity	Funds Programmed[1]	Salaries	Expenses	Total	Unobligated Balance
Program costs					
Ann Arbor, Michigan Laboratory					
Chemical operations	$422,606	$313,811	$105,979	$419,790	$2,816
Barrier operations	93,202	66,251	25,868	92,119	1,083
Research	214,192	172,212	41,519	213,731	461
Washington, D.C.	25,800	24,723	976	25,699	101
General Administration and Executive Direction Ann Arbor, Michigan	62,200	36,070	25,191	61,261	939
Total	$818,000	$613,067	$199,533	$812,600	$5,400

[1]Does not include $6,100 returned to the Commission before end of fiscal year.

Bureau of Commercial Fisheries
Sea Lamprey Control and Research Program

Report of Expenditures for All Activities

July 1, 1966 through June 30, 1967

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[1]Does not include $6,100 returned to the Commission before end of fiscal year.

Department of Fisheries of Canada

Financial Report to Great Lakes Fishery Commission

April 1, 1966 to March 21, 1967

Administration		$ 92,732
Chemical Control		190,095
Operation of Barriers		97,244
Superannuation (6% of $140,084)		9,105
Contract Administration (6% of total disbursements)		23,351
Expenditures for 1966-67	Canadian funds	$412,527
	(U.S. funds)	($383,608)
Funds provided by Commission		$479,100
Costs applicable to 1966-67		412,527
		$ 66,573[1]
	(U.S. funds)	($ 61,642)

[1]Refunded to Commission.

COMMITTEE MEMBERS - 1967

[Commissioners in Italics]

SCIENTIFIC ADVISORY COMMITTEE

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

SEA LAMPREY CONTROL AND RESEARCH COMMITTEE

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

MANAGEMENT AND RESEARCH COMMITTEE

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

LAKE COMMITTEES

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

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