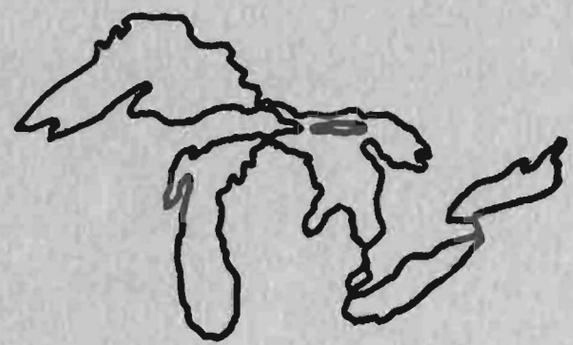
ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION



1966

GREAT LAKES FISHERY COMMISSION

MEMBERS — 1966

CANADA	UNITED STATES
A. O. Blackhurst	D. L. McKernan
C. H. D. Clarke	Claude Ver Duin
A. L. Pritchard	Lester P. Voigt

SECRETARIAT

N. S. Baldwin, Executive Secretary
Robert Saalfeld, Assistant Executive Secretary
Edith 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

1966

1451 Green Road
ANN ARBOR, MICHIGAN,
U. S. A.
1967

LETTER OF TRANSMITTAL

The Chairman of the Great Lakes Fishery Commission takes pleasure in transmitting to the Contracting Parties an Annual Report of the Commission's activities during 1966.

A. L. Pritchard, *Chairman*

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ANNUAL REPORT FOR 1966

INTRODUCTION

The Great Lakes Fishery Commission was established by the Convention on Great Lakes Fisheries ratified by the United States and Canada in 1955. Its major responsibilities are to (1) formulate and coordinate research to determine what measures should be taken to make possible maximum sustained production from fish stocks of common concern and (2) to formulate and implement a program to eradicate or minimize sea lamprey in the Great Lakes.

The two governments share equally the administration and general research costs of the Commission and provide funds for sea lamprey control and research according to a formula adopted at the organizational meeting by which 69 percent of the cost is borne by the United States and 31 percent by Canada. This division of cost was based on the value of the lake trout fishery in the two countries before the lamprey invasion and is subject to revision.

The Commission uses existing agencies, as far as possible, in carrying out its duties. The sea lamprey control and research program is carried out by the U.S. Bureau of Commercial Fisheries and the Department of Fisheries of Canada under contracts. The Commission has also relied on the research of federal, state, and provincial agencies to provide biological information on which to base its recommendations for improving the fishery but has occasionally contracted for special studies which these agencies could not undertake.

The Commission has organized technical committees for each of the lakes to assist it in carrying out its duties. These committees report to the Commission through its Management and Research Committee on the status of fish stocks, results of research, measures to improve the fishery, and serve to coordinate research and management. A Sea Lamprey Control and Research Committee reports to the Commission on the progress of the lamprey control program and submits plans and budgets for this activity. A Scientific Advisory Committee formed when the Commission was organized, advises it on matters relating to lamprey control and fishery research.[1]

[1] See 1965 Annual Report for committee duties and organization.

1966
ANNUAL MEETING

AGENDA

1. Call to order
2. Adoption of agenda
3. Approval of Minutes of Interim Meeting
4. News release
5. Report of Chairman
6. Report of Sea Lamprey Control and Research Committee
7. Report of Management and Research Committee
8. Report of Scientific Advisory Committee
9. Report of Economic Study Group
10. Recommendations to Contracting Parties
11. Time and place of Interim Meeting
12. Election of officers
13. Other business
14. Adjournment

ANNUAL MEETING

PROCEEDINGS

The Eleventh Annual Meeting of the Great Lakes Fishery Commission was held in Sault Ste. Marie, Ontario, on June 21-24, 1966.

Call to order. Dr. A. L. Pritchard opened the meeting at 9:00 a.m., June 21, in the absence of the Chairman, Mr. D. L. McKernan. Following introductions of advisors and observers, Dr. Tibbles, on behalf of the Minister of Fisheries of Canada, extended an invitation to all to attend the official opening of the Sea Lamprey Control Experiment Station and later observe chemical treatment of the Chippewa River.

Adoption of agenda. The agenda, circulated prior to the meeting, was adopted after several items were rescheduled for the second plenary session (June 22).

Approval of Minutes of Interim Meeting. The minutes of the Interim Meeting held in Toronto, November 30-December 1, 1965, were approved.

News release. The preparation of a news release was assigned to Commissioners Ver Duin and Blackhurst assisted by the Secretariat.

Report of Chairman. The Chairman described the accomplishments of the Commission since its organization in 1956, emphasizing the parts played by the federal governments, the Province of Ontario. and the Great Lakes States. A practical method for controlling sea lamprey had been applied to Lake Superior and their numbers had been reduced by about 90 percent. Lake trout were becoming abundant, more fish were reaching maturity, and natural reproduction had been resumed in inshore waters where it had virtually ceased in 1959. In order to offset failing natural reproduction, a planting program had been initiated in 1958 which illustrated the value of enlisting federal, state, and provincial agencies in a joint undertaking. Since 1958, about 12.8 million[1] yearling lake trout had been planted and these fish now make up a large percentage of the inshore population.

[1] Total plantings to end of 1965.

Although the results of control measures in Lake Michigan could not be as easily measured, lamprey had declined steadily since 1961. Species such as rainbow trout and whitefish, which had persisted at a low level under lamprey predation, were showing a remarkable increase in abundance and size. A rapid increase in alewife in Lake Michigan had created new problems that should be considered by the Commission.

The Chairman believed that the Commission should move as quickly as possible to deal with problems in Lake Huron, Lake Erie, and Lake Ontario. Although Lake Erie still produced about half the total landings in the Great Lakes, changes in species composition were seriously disrupting the sport and commercial fisheries. In the Great Lakes, and particularly in Lake Erie, pollution problems would have to be solved if the full potential of the fishery was to be realized.

The recovery of fish stocks following lamprey control raised questions regarding control of fishing effort and allocation of the allowable catch to the commercial and sport fishery. Expansion and requirements of the sport fishery would have to be studied to provide the information needed to assure the most beneficial use of the fishery resources. The introduction of exotic species held promise if this action was carefully considered beforehand.

In closing, the Chairman stated that although he believed it was better for local governments to manage their fisheries on behalf of their citizens, problems and interests were so clearly of common concern in the Great Lakes that independent action without joint consideration by a body such as the Commission was unrealistic. The Commission must be used as a coordinating agency; weaknesses in its operation noted, and modifications made to make it more effective.

Report of Sea Lamprey Control and Research Committee. The Commission was advised that final reports from its agents on sea lamprey control and research activities in 1965 and progress reports on operations during the spring of 1966 had been received and discussed by the Sea Lamprey Control and Research Committee.[1]

A number of recommendations from the two agents had been considered and all but one, which proposed release of marked ammocetes into Lake Superior for study purposes, had been approved. The Committee had suggested that the release of marked ammocetes be made in Lake Huron.

The Committee recommended:

[1] Final reports covering operations in the United States and Canada for 1966 appear as Appendices A and B.

(a) that stream treatment schedules for the United States be based on the potential for lamprey production, i.e. the number and size of larvae present, rather than on a set time schedule of 3, 4, or 5 years; the potential for production would be determined by analysis of data collected by all its investigative units with survey and re-establishment information of primary importance, but, fyke-net catches, collections during treatments, and other pertinent information should be weighed in making each decision.

(b) that the operation of three Lake Michigan barriers be discontinued in 1968 if counts of adult sea lamprey continued to decline as they had since 1961,

(c) that the tagging of adult sea lamprey for information on its parasitic life be continued,

(d) discontinuation of assessment barriers on Root and Garden Rivers (Lake Huron) where lamprey spawning runs were insignificant,

(e) termination of land acquisition for the proposed barrier on Thessalon River (Lake Huron),

(f) construction of barrier on Kaskawong River (St. Joseph Island), which had a relative large lamprey spawning run and could replace those discontinued on the Root and Garden Rivers,

(g) installation of D. C. guiding devices on the Blue Jay and Manitou Rivers (Manitoulin Island) to minimize losses of migrating rainbow trout,

(h) intensification of the search for an irritant or repellent to improve ammocete surveys.

Representatives of the State of Michigan stated that barrier operations were not compatible with the program to establish anadromous fish and suggested that they be discontinued and other methods of assessing lamprey abundance used. The Committee agreed that barriers delayed runs of spawning fish and that the public found them offensive, but since both agents urged continuation of barrier operations in Lake Superior, and because other reliable assessment methods had not been developed, an abrupt halt in barrier operations should not be made.

The Committee submitted a program for fiscal year 1968 estimated to cost $1,786,000 calling for the following activities on each lake:

Lake Superior—Re-treat 23 streams (13 in Canada and 10 in the United States); continue re-examination of potential lamprey streams to see if ammocetes had become established; survey treated streams to determine when lamprey become re-established and when re-treatment will be required; operate 16 barriers on United States streams and 8 on Canadian streams to follow changes in lamprey abundance.

Lake Michigan—Re-treat 15 streams on the east shore; continue surveys of potential lamprey streams; follow-re-establishment of larvae in treated streams.

Lake Huron—Treat 21 streams (9 in Canada and 12 in the United States); operate 9 barriers in Canada and 1 in the United States to assess lamprey abundance.

Lake Erie and Lake Ontario—Survey streams on the south shores to locate those producing lamprey and collect information with which to plan extension of the control program.

Research—Develop an irritant which would cause larvae to emerge from stream bottoms and facilitate surveys; continue to study the mode of action of lampricides; develop techniques to mark ammocetes for later recognition as adults; study the physiological condition and survival of larvae in marginal environments; assess the contribution of certain streams; tag adult lamprey to follow movements and exchange between lakes; study re-infestation of streams to determine which will remain consistent producers; sample bottom areas in deep water with electric trawls to determine presence of ammocetes; and continue to follow growth movements and transformation of a single year class of larvae in the Garlic River.

Report of the Management and Reasearch Committee. The Chairman explained that the Management and Research Committee had relied heavily on the information and recommendations provided by the lake committees in preparing its report. These committees had considered the questions referred to them by the Commission and had dealt with a number of other matters summarily.

Lake Superior. Agencies concerned with the Lake Superior fishery continued to carry out the cooperative program of lake trout rehabilitation. In 1966, slightly more than 3.3 million lake trout were planted, 2,217,700 in Michigan waters, 377,000 in Wisconsin waters, 257,000 in Minnesota waters, and 450,000 in Ontario waters. The number planted in Lake Superior since 1958 now totalled 16.1 million.[1]

Commercial fishing for lake trout was restricted for the fifth consecutive year. In the United States, some fishing with commercial gear was permitted to provide information on the recovery of lake trout and to evaluate hatchery plantings. A limited number of commercial fishermen operating under contracts or special permits took 46,000 trout weighing about 133,000 pounds. In Canada, the fishery operated under a 150,000-pound quota applied by season and area, and took 108,400 pounds of lake trout. Ninety-five percent of the catch was examined for biological information.

[1]A summary of previous plantings and details of 1966 plantings of lake trout and salmon in the Upper Great Lakes appear in Appendix C.

Lake trout stocks continued to show improvement in 1966. The incidence of lamprey-wounded trout in the fall catches remained below 2 percent in most areas, reflecting a low abundance of sea lamprey. Availability of trout as measured by the number of marketable fish caught per 10,000 feet of gill net lifted during the spring in inshore waters increased again in 1966. The catch was 2.4 times that measured in 1961. Availability indices between 1965 and 1966 rose from 135 to 150 in Wisconsin waters, 55 to 75 in Michigan waters, 59 to 99 in Ontario, but dropped from 50 to 22 in Minnesota waters.

The catch per effort of spawning lake trout on Gull Island reef in Wisconsin waters equalled that observed in 1964 and 1965 and was more than 100 times greater than in 1960. Furthermore, the capture of young-of-the-year from spawning in 1964 and 1965 indicated that natural reproduction had resumed in Wisconsin waters. Elsewhere in the lake, direct evidence of natural reproduction in inshore waters was lacking although mature fish had been taken in increasing numbers in the last 3 years.

Hatchery-reared trout continued to dominate the catches in inshore waters, comprising over 90 percent of legal-sized trout (over 17-inches) and 98 percent of the undersized trout. In offshore populations, however, hatchery trout represented less than 1 percent.

In 1965, the Commission had indicated its readiness to consider a relaxation of restrictions on certain lake trout populations in Lake Superior if biological information on the response of populations to increased fishing pressure was collected. The lake committee recommended that the lake trout catch quotas for 1966 remain unchanged. However, some expansion of the offshore fishery in Ontario would occur in 1967 if the boundaries of the offshore fishing zones were revised as proposed. The offshore fishing zone contained approximately 1,600 square miles of water 80 fathoms or shallower. Applying the same quota per year per unit area would give an annual catch limit of 75,000 pounds as compared with 50,000 pounds in 1966. The total quota would be divided between several sub-areas to distribute the sampling and the fishing pressure and would represent an increase in the Ontario lake trout catch from 150,000 pounds in 1966 to 175,000 pounds in 1967.

Some relaxation in restrictions on offshore grounds around Isle Royale and south of Caribou Island in 1967 was also recommended to permit commercial fishing on an experimental basis. The catch limit in each of these areas was 10,000 pounds in 1966. Conservative limits of 30,000 pounds for Isle Royale and 60,000 pounds for Caribou Island had been tentatively established. Intensive sampling would be continued to ensure that the offshore stocks in Ontario and Michigan would not be adversely affected by increased fishing pressure.

In Wisconsin waters of Lake Superior hatchery trout currently comprised the bulk of the lake trout population. Lake trout fishing should, therefore, continue to be restricted to requirements for biological sampling until there was evidence of greater recruitment of naturally-produced trout.

The fishery in Minnesota waters should continue to operate under a permit system within its assigned quota until the catch per unit effort reached approximately the pre-lamprey level. When this level was reached, and when there was additional evidence that adequate stocks with three year classes represented were present, a fishery should be permitted on an experimental basis, poundage limits established, and licenses issued in accordance with a proposed limited entry system.

It was suspected that the trout population in Michigan waters of Lake Superior had been too low to support even a small amount of lamprey predation and must be built up before any significant spawning could occur. Annual plantings in Michigan waters should be increased to about 2 million yearling trout for three years. In Wisconsin waters, a total planting of about 350,000 was made in 1966. This planting should be reduced to about 100,000 in subsequent years if investigations show this was desirable. Plantings should be maintained at 125,000 yearlings in Minnesota waters and from 400,000 to 500,000 in Ontario waters for several years. Total plantings in Lake Superior would, therefore, remain at about 3 million yearlings for the next several years at least.

Other management measures taken in Lake Superior included the introduction of coho salmon by the State of Michigan to add to the sport fishing potential of its waters. In the spring of 1966, 250,000 coho smolt were planted in the Big Huron River and this planting would be repeated for at least two more years.

All agencies have become keenly interested in the development of the sport fishery in Lake Superior. Ontario, Minnesota, and Wisconsin had introduced licensing or a special permit system that required reporting of the catches while Michigan has proposed a program to monitor the sport and commercial fishery.

Lake Michigan. Control of the sea lamprey and restoration of the lake trout were matters of first importance in Lake Michigan. The first round of chemical treatments of lamprey-producing streams was completed this spring and already there were

encouraging signs of their effectiveness. Federal and State agencies were working together under Commission auspices to rehabilitate lake trout. The program included the stocking of nearly 1.3 million yearling trout in 1965 and 1.7 million in 1966, and intensive sampling to assess the success of these plantings.

The alewife had increased to phenomenal numbers in Lake Michigan clogging city and industrial water intakes and polluting harbors and beaches during the summer die-offs. There was also evidence that alewife had been detrimental to formerly abundant species. Two kinds of action had been undertaken in dealing with this problem: (1) an intensification of the fishery on alewife, and (2) the introduction of desirable predators such as lake trout and coho salmon.

The development of new methods of catching and processing, and new market outlets for alewife had triggered a sharp increase in the commercial production of this species from 400 pounds in 1956 to over 14 million pounds in 1965, without noticeable effect on abundance. The influence of predators on alewife would not show for several years. Many important life history details were missing, and all agencies should intensify studies of the alewife and its interrelations with more desirable species.

Lake Huron. The Management and Research Committee believed that until sea lamprey were effectively controlled, there was little prospect for recovery of the fishery in Lake Huron unless species which were not as vulnerable to lamprey as lake trout could be established or much greater use made of presently abundant species. Attention had been directed to the use of hybrid trout or splake rather than lake trout in rehabilitating the trout fishery, and to introducing kokanee as a new recreational and commercial species.

Selective breeding by Ontario had produced a deep-swimming early-maturing hybrid splake. There were reasonable grounds for expecting that large-scale plantings of these fish in Lake Huron would result in their early establishment. Rehabilitation with splake would be quicker and cheaper than with lake trout, and the hybrids would be better adapted to cope with a residual sea lamprey population, and perhaps with commercial exploitation. The Committee, therefore, recommended that plantings of trout in Lake Huron be restricted to selected hybrids (spake).

Lack of knowledge of the fish and the fisheries of Lake Huron was a continuing handicap and a systematic monitoring of the sport and commercial fisheries to establish a continuing

inventory of the fishery resource should begin. A sampling system that would provide information on changes in mortality rates of important sport and commercial species was badly needed. It was essential that this information be collected now in order to assess the effectiveness of lamprey control measures and to enable predictions of the levels of lamprey control required in Lake Huron.

Lake Erie. Lake Erie was still the largest producer of fish among the Great Lakes with 1965 landings totalling 48.5 million pounds, mainly yellow perch (45 percent) and smelt (25 percent). These two species had become the mainstay of the commercial fishery replacing the traditionally valuable whitefish, cisco, and blue pike, which were no longer taken in significant quantities. Walleye, which dominated the catch in the 1950's now made only a minor contribution.

The decline of the walleye had been of particular concern in Lake Erie where the catch had fluctuated because of the failure of year classes in two of every three years since 1956. The commercial fishery now depended on a single year class as it reached legal size.

The Management and Research Committee recalled that in 1964 the Commission had assembled and reviewed information on walleye in Lake Erie to see if the factors responsible for the decline could be identified and what steps could be taken to encourage recovery of the population. It was not possible to say what caused the year class failure from the evidence available at that time, but two factors were suspected (1) over exploitation, and (2) major changes in environmental conditions. However, agencies on Lake Erie were unable to agree on management measures for walleyes in the western basin.

Disposing of large quantities of yellow perch landed in 1965-1966 had been a serious problem emphasizing the need for an economic study of marketing and fishing practices. Other questions that should be investigated on Lake Erie, which had not previously received sufficient attention, were (1) causes and magnitude of "normal" mortality, (2) effects of gas wells, (3) effects of gravel removal (4) factors responsible for unusual mortalities, and (5) sub-lethal factors and their effects.

Lake Ontario. Although the commercial catch in Lake Ontario had remained relatively constant over the past 20 years - ranging from 2 to 3 million pounds annually - the composition of the catch had changed significantly. Lake trout, lake herring, and blue pike were now commercially extinct and whitefish were at a record low. A small but uncertain fishery had developed on the smelt, American eel, and the white perch (a recent

immigrant) offsetting slightly the loss of other species. Sport fisheries were largely confined to the Bay of Quinte, eastern Lake Ontario, and Lake St. Lawrence. A sharp decline in walleye had seriously depressed the sport fishery in the Bay of Quinte, while Lake St. Lawrence, although well-served with public parks and launching facilities, had not provided attractive sport fishing to date.

A number of measures had been taken to improve fishing. Regulations were imposed by Ontario to reduce fishing pressure on whitefish. Lake trout had been planted by New York and Ontario to re-establish this species. Kokanee salmon were introduced by Ontario. In addition to these measures, state and provincial agencies had extended investigations to determine what other measures might be taken.

There was a tendency to minimize the effect of sea lamprey in the Lake Ontario fishery but the Commission should continue to consider lamprey control in this lake a major objective. Pollution, both chemical and thermal, and their long-range ecological effects, were also serious problems in Lake Ontario as well as Lake Erie. Studies to determine rates of eutrophication and effects on important species should be continued. Technological and economic studies carried out on other lakes should be extended to Lake Ontario to see if better use could be made of presently abundant species.

Report of Scientific Advisory Committee. The Scientific Advisory Committee reported that it had reviewed the role of barriers. In many areas they were effective as control and did not kill fish when properly designed. No other means for assessing lamprey abundance had been developed. The Committee, therefore, recommended that the Commission designate an item in its budget for a thorough investigation of other methods for assessing the success of the lamprey control program.

It endorsed the recommendation of the Management and Research Committee to double the plantings in Michigan waters of Lake Superior to provide a larger number of spawning trout if it was considered an experiment.

It recommended that the Commission support a proposal of the two governments to undertake studies of the effects of eutrophication on fish species in Lake Erie.

In regard to the walleye in Lake Erie the Committee concluded that it had not enough data before it to determine if the size regulation proposed by several agencies would be effective in improving stocks.

The Scientific Advisory Committee suggested that any agency considering the introduction of exotic species inform the Commission so that members of the committee as well as scientists in other agencies on the Great Lakes would have an opportunity to comment on the desirability of such introductions and probability of success.

Economic Study. A progress report was presented by the Economic Study Group on its examination of the costs and benefits of sea lamprey control on Lake Superior. Investigators from both countries working together would complete field work during the summer of 1966 and a final report submitted to the Commission at its Interim Meeting. Preliminary analysis indicated that the sport and commercial fisheries would show a favorable cost benefit ratio.

Recommendations to Contracting Parties. The Commission adopted the 1968 program and budget proposed by the Sea Lamprey Control and Research Committee for submission to the two governments. It also agreed to recommend as follows:

(a) that the lake trout catch limit on offshore grounds in Michigan and Ontario waters of Lake Superior be increased to 90,000 and 75,000 pounds, respectively, in 1967, and that the limits in other areas remain in effect until it could be shown that their stocks of lake trout were able to sustain an increase over present fishing done for biological sampling,

(b) that the planting of trout in Lake Huron be restricted to selected splake hybrids,

(c) that agencies concerned with fishery management and research in Lake Huron initiate an appropriate sampling program as soon as possible to provide full coverage of important species,

(d) that studies of the effects of eutrophication on fishes in Lake Erie and Lake Ontario be undertaken,

(e) that assessment of the introduction of kokanee be strongly supported,

(f) that investigations be developed to collect information on the survival of lake trout planted in Lake Ontario.

The Commission also urged both governments to consider extending technological assistance and economic studies to the Lake Ontario fishery.

Time and place of next meeting. The Commission agreed to hold its Interim Meeting in Ann Arbor, Michigan on November 30-December 1, 1966.

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

Other business. The Commission adopted a resolution recognizing the contribution made to the development of the Great Lakes fishery by the late John Van Oosten.

Adjourment. The Chairman, after expressing the Commission's appreciation for the hospitality extended by the Minister of Fisheries of Canada and his staff, adjourned the meeting at 11:00 a.m. on June 24.

ANNUAL MEETING

ATTENDANCE

Officers

Chairman: D. L. McKernan
Vice Chairman: A. L. Pritchard

MEMBER GOVERNMENTS

CANADA

Commissioners:
A. O. Blackhurst
C. H. D. Clarke
A. L. Pritchard

Scientific Advisors:
G. C. Armstrong
John Brubacher
E. W. Burridge
R. M. Christie
W. J. Christie
Carman Douglas
C. A. Elsey
R. G. Ferguson
Harold Frick
F. E. J. Fry
Arne Lamsa
A. H. Lawrie
J. W. Lockwood
K. H. Loftus
K. C. Lucas
F. P. Maher
J. D. Roseborough
G. F. M. Smith
Wm. M. Sprules
J. M. Taylor
J. J. Tibbles
W. H. R. Werner

UNITED STATES

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Claude Ver Duin
L. P. Voigt

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John Bardach
D. J. Curry
R. H. Full
R. A. Jensen
John Kitchel
D. J. Leedy
S. S. Sivertsen
G. E. Sprecher
H. O. Swenson
G. L. Trembley
Howard Woods

Scientific Advisors:
Ayers Brinser
C. R. Burrows
W. F. Carbine
W. R. Crowe
C. A. Dambach
L. F. Erkkila
Myrl Keller
C. N. Lloyd
J. W. Moffett
K. W. Morrison
R. L. Pycha
Edw. Schneberger
Wm. Shepherd
B. R. Smith
Lloyd L. Smith
H. A. Tanner
Wayne Tody

Observers:
L. R. Anderson
Richard Berndt
K. D. Brouillard
Lyman Buck
R. T. Crago
T. B. Durling
H. A. Favre
N. E. Fogel
J. E. Frost
G. L. Grant
Woodrow Jarvis
C. J. Kerswill
Clifford Long
R. D. Longmore
Ralph McCoy
C. C. Parker
W. A. Parkila
N. R. Payne
Jack Roberts
R. Schueler
J. A. Scott
A. L. W. Tuomi
Henry Vondett
Gordon Watson
H. F. Weekley
A. T. Wright

SECRETARIAT:
N. S. Baldwin, *Executive Secretary*
R. W. Saalfeld, *Asst. Executive Secretary*

INTERIM MEETING

The Commission held an Interim Meeting in Ann Arbor, Michigan on November 30-December 1, 1966, primarily to hear reports on the progress of sea lamprey control, review its program for fiscal year 1968, and consider significant research findings and management proposals for each of the lakes.

Reports presented by the Commission's agents showed continued progress in lamprey control with chemical operations on schedule, except in Lake Huron where the treatment of one stream in Canada was postponed because of low flow. Increased use of Bayer-73, both as a synergist with the lampricide (TFM), and in granular form as a survey tool, were of special interest in view of the Commission's desire to reduce program costs. In this same connection, the Commission urged its agents to develop methods for assessing lamprey abundance to replace electrical barrier operations.

The Commission, on being advised that it should not expect an increase in the United States contribution, revised its program for fiscal year 1968, eliminating surveys in the lower lakes and reducing other activities. The estimated cost of the program was ultimately reduced to $1,490,000 by curtailing the amount of lampricide to be purchased in fiscal year 1968 and drawing instead on the reserve supply.

Lake trout stocks in Lake Superior continued to improve through 1966 with mature fish again appearing in significant numbers on the major spawning areas in Wisconsin. Yearling and young-of-the-year lake trout taken during the year indicated that spawning in 1964 and 1965 had been successful. Agencies described arrangements for sampling the increased catch of lake trout on offshore grounds recommended by the Commission at the Annual Meeting. The Commission considered and approved a request for an increase in the 1968 catch limit in Wisconsin and Minnesota waters of 15,000 and 4,000 pounds, respectively.

The Commission was advised that an estimated 4,000 coho salmon had been taken in 1966, mostly as precocious males entering the streams in which they had been planted as smolts during the spring. The fish showed excellent growth and anglers had been quite successful catching them. The Commission asked that agencies considering introductions provide other agencies on the Great Lakes with their plans and evaluations so that they would have an opportunity to present their opinions, offer their advice, and lend assistance.

After considering two studies proposed for Lake Erie walleye the Commission asked its staff to cooperate with the agencies concerned in arranging an analysis of existing walleye data. A tagging study proposed, although desirable, was a much larger venture requiring careful planning by all agencies, and considerable financial support. Priority should be given analysis of existing data.

APPENDIX A

LAMPREY CONTROL AND RESEARCH IN THE UNITED STATES

Bernard R. Smith

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

Several important achievements were recorded by the sea lamprey program in 1966. The number of spawning-run sea lampreys taken at barriers on United States streams of Lake Superior again declined significantly. The total taken from the 16 barriers was 60 percent of the catch in 1965 and 7 percent of the record catch of 1961. Only one stream, the Silver River, produced more than 1,000 lampreys in 1966. Chemical control progressed rapidly and initial treatments of all lamprey streams tributary to Lake Michigan were completed by May 25. Early completion of the schedule on Lakes Superior and Michigan permitted the start of chemical treatments on Lake Huron tributaries. Thirty-five streams were treated in the three lakes (Table 1).

Table 1. Summary of chemical treatments in United States waters of the Great Lakes in 1966.

	Number of streams	Discharge at mouth (cfs)	Stream miles treated	Lampricide used (pounds)	Synergist used (pounds)
Superior	5	462	100	6,408	. . .
Michigan	12	821	506	16,819	. . .
Huron	18	858	437	25,463	20
Total	35	2,141	1,043	48,690	20

Research in 1966 was largely a continuation of laboratory studies at Hammond Bay and field investigations of lamprey life history. A new investigation was initiated in 1966 to see if the effectiveness of chemical control, hitherto measured mainly by the catch of adults at barriers, could be followed by monitoring

larval lamprey populations in streams. Permanent survey stations established on index streams will be examined systematically to follow changes in ammocete abundance, distribution, and age composition, and to see if these reflect the effects of the control program on the number of potential recruits to the adult population with satisfactory reliability.

Lake Superior surveys

Surveys in 1966 of 47 previously treated streams indicated that 18 contained ammocetes and 10 required immediate re-treatment. Of the 18 streams containing ammocetes, 15 had re-established populations and 6 contained a few survivors from the previous treatment. Additional surveys are needed on 8 of the 29 tributaries in which no ammocetes were found. Streams in Minnesota were re-examined earlier than scheduled because of the high rate of scarring on lake trout along the shoreline but no new populations of larvae were found. Of the 3 streams in Minnesota that previously supported lampreys, only the Arrowhead River contains ammocetes. The 1965 year class has disappeared from the Gooseberry River and no sea lampreys are present in the Split Rock River. Spawning activity continued to decline in Minnesota tributaries. Only 13 nests were observed in 3 of 7 streams examined compared with 24 nests in 1965. The numbers of nests were generally lower in all areas examined than in 1965. Thirteen other Lake Superior streams were re-surveyed but no sea lamprey larvae were discovered. Sea lamprey ammocetes have not been found in the St. Louis River where their absence has been blamed on pollution. However, over-winter survival of caged *Ichthyomyzon* spp. larvae indicates the need for a thorough re-examination. An intensive re-survey of the river with electric shockers and chemical irritants is scheduled in 1967.

Sea lamprey nests were observed in 14 of 30 streams examined for evidence of spawning in Wisconsin and Michigan. Thirty-eight nests were counted in the index areas of the Bad River (compared with 44 in 1965 and 189 in 1964).

Lake Superior chemical treatments

Five of 8 tributaries of Lake Superior scheduled for treatment in fiscal year 1967 were treated in August and September without difficulty (Table 2). Sullivans Creek was treated for the second time, the Chocolay, Silver, and Sturgeon Rivers were treated for the third time, and the Big Garlic River was treated

for the fifth time. The latter is treated annually to prevent recruitment to a lake population of ammocetes. Ammocetes had become established in moderate numbers in all these streams. The upstream distribution of larvae had not changed since the last treatment except in the Sturgeon River. In the Sturgeon, treatment was confined to the main river above Otter Lake because the 2 large tributaries and the main stream below Otter Lake contained no sea lamprey ammocetes.

The population of residual ammocetes discovered last year in the vicinity of the Big Garlic River's alluvial fan in Saux Head Lake was still present this year. Bayer 73 granules were broadcast on the alluvial fan and adjacent areas prior to the arrival of TFM from the treatment of the river. The alluvial fan area yielded 481 ammocetes.

Seventy-five of 77 streams on the United States shore of Lake Superior that at one time contained sea lamprey ammocetes have now been treated one or more times. Larvae disappeared from 2 of the streams before they were to be treated. Populations of sea lamprey ammocetes have become re-established in 57 streams. In 26 of these streams larvae are produced regularly each year.

Table 2. Details on the application of lampricide to tributaries of Lake Superior in 1966

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		Lampricide (pounds)
			Minimum effective	Maximum allowable	
Silver River	Aug. 10	30	2.0	4.0	342
Sturgeon River	Aug. 17	275	2.0	4.0	3,222
Chocolay River	Aug. 24	140	3.0	9.0	2,574
Sullivans Creek	Aug. 30	2	3.0	9.0	36
Big Garlic River	Sept. 20	15	2.5	7.0	234
Total	. . .	462	. . .	. . .	6,408

Lake Michigan surveys

Surveys were completed on 39 tributaries of Lake Michigan scheduled for treatment and sea lamprey larvae were found in 22 streams. The size and number of ammocetes in 11 streams indicated that early treatments were advisable. An additional 26 streams treated previously were examined to determine the size and distribution of re-established larval populations. Sea lamprey larvae were found in only 15.

Lake Michigan chemical treatments

Chemical treatments began April 26 and continued until mid-October. Treatments were hampered by high stream flows in the first half of the season and low stream flows during the last. Twelve streams with a combined discharge of 821 cfs of water were treated (Table 3). Six were initial treatments and 6 were re-treatments. The treatment of Burns Ditch, Gary, Indiana, in southern Lake Michigan on May 25, completed the first round of treatments on Lake Michigan tributaries. Larval populations were small and concentrated in specific locations. This kind of distribution is typical of streams entering southern Lake Michigan. The populations of re-established larvae were small in the 6 streams treated for the second time and residual ammocetes from the previous treatments were few. The distribution of larvae and consequently the number of miles requiring re-treatment remained the same for 5 streams, but 15 additional miles were treated on the Tacoosh River to ensure elimination of its population.

Bureau personnel assisted the Fish Division of the Michigan Department of Conservation in a project to eradicate chestnut lampreys and fish in a 50-mile section of the Manistee River. The treatment with Bayluscide (5,2'-dichloro-4'-nitrosalicylanilide) was successful. Fish control projects using Bayluscide are now being proposed for several streams and some may directly benefit the control of the sea lamprey.

Table 3. Details on the application of lampricide to tributaries of Lake Michigan in 1966

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		Lampricide (pounds)
			Minimum effective	Maximum allowable	
Blue Creek[1]	April 26	50	7.0	18.0	1,328
Galien River	May 5	135	7.0	18.0	3,682
Tacoosh River	May 13	29	3.0	8.0	630
Donns Creek	May 20	23	4.0	10.0	117
State Creek	May 20	36	2.0	5.0	139
Trail Creek	May 22	76	6.0	16.0	1,072
Burns Ditch	May 25	38	7.0	18.0	583
Hudson Creek	June 9	11	1.0	4.0	58
Milakokia River	June 12	131	3.0	9.0	1,824
Days River	June 15	120	3.0	7.0	1,224
Sturgeon River	July 21	105	3.0	12.0	3,426
Rapid River	Oct. 19	67	4.0	7.0	2,736
Total	. . .	821	. . .	. . .	16,819

[1]Tributary to the St. Joseph River.

Lake Huron surveys

Twenty-nine Lake Huron tributaries which contained sea lamprey larvae during the original surveys of 1961-62 were re-examined before initiating chemical treatments. Seventeen Creek, Presque Isle County, and Ceville and Nuns Creeks, Mackinac County, were no longer infested. Distribution of larvae in most streams of the Upper Peninsula had not changed appreciably, but was extended in the Sturgeon, Ocqueoc, Devils, and Pine Rivers, in the Lower Peninsula. Additional surveys of 4 previously treated streams revealed a sizeable population of re-established ammocetes only in the Big Munuscong River, Mackinac County. Ammocetes in the Little Munuscong River and Elliots Creek were few and small in size (less than 100 millimeters long). Thirty-three streams marginal for sea lamprey production, including 11 tributaries to Burt and Mullet Lakes, were re-surveyed and sea lampreys were found for the first time in 2 streams, Squaw Creek, Alpena County, and Steeles Creek, Mackinac County.

Lake Huron chemical treatments

Early completion of the treatment schedules on Lakes Michigan and Superior permitted the start of chemical treatments on Lake Huron tributaries. Eighteen streams with a total discharge of 858 cfs were treated (Table 4). All treatments were successful, but low water levels, limited access, and many beaver dams impeded operations. In Mulligan Creek, Bayer 73 (wettable-powder) was applied manually to the infested area as an experiment. Stream flow was at a minimum and few fish were present permitting the use of the chemical as a general toxicant. The treatment appeared to be successful, but final evaluation will not be made until 1967.

The Pine and Carp Rivers in Mackinac County, the Sturgeon and Pigeon Rivers tributary to the Cheboygan River in Cheboygan County, and the Pine River in Iosco County, were found on treatment to be major producers of sea lampreys. The total number of sea lampreys from all other streams treated was less than the production from any one of these streams. Collections from the Pine contained many metamorphosing lampreys.

Electric barrier operations

Electric barriers were operated on 16 streams tributary to the south shore of Lake Superior from early April to July 13. Weather and water conditions were favorable for efficient opera-

Table 4. Details on the application of lampricide to tributaries of Lake Huron in 1966

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		Lampricide (pounds)
			Minimum effective	Maximum allowable	
Caribou Creek	April 29	4	3.0	7.0	90
Albany Creek	April 29	15	3.0	6.0	324
Joe Straw Creek	April 30	7	4.0	10.0	144
Carr Creek	April 30	2	3.5	8.5	18
Trout Creek	May 1	10	3.0	7.0	126
Beavertail Creek	May 3	26	5.0	13.0	810
Prentiss Creek	May 4	14	7.0	14.0	234
Steeles Creek	May 4	11	7.0	14.0	162
McKay Creek	May 5	23	4.0	9.0	378
Carp River	June 23	110	4.0	13.0	3,112
Pine River	July 8	107	5.0	12.0	3,046
Sturgeon River	Aug. 4	200	12.0	16.0	6,084
Pigeon River	Aug. 7	150	9.0	14.0	4,770
Maple River	Aug. 18	80	7.0	14.0	1,512
Laperell Creek	Aug. 21	3	8.0	17.0	108
Elliot Creek[1]	Aug. 22	5	6.0	14.0	162
Pine River	Sept. 5	90	10.0	20.0	4,383
Mulligan Creek	Oct. 1	1	. . .	. . .	20[2]
Total	. . .	858	. . .	. . .	25,483

[1]Second treatment.
[2]Bayer 73 (wettable powder).

tion of the barriers. The number of adult sea lampreys caught again declined significantly. The total of 4,761 spawning-run adults taken was 7,076 less than in 1965, 61,940 less than the record high in 1961, and 4,065 less than the previous low in 1962 (Table 5). The run developed slowly. The largest 10-day catch was taken between May 21-30 (28.4 percent of the total run) with a second minor peak occurring June 20-24 (14.1 percent). The migration declined rapidly through late June and early July. Less than 1 percent of the total run was taken in the last 5 days of operation. The numbers of sea lampreys captured declined 83 percent west of the Keweenaw Peninsula and 23 percent in eastern streams compared to 1965. The catch from the barrier on the Brule River fell from 6,163 in 1965 to 226 in 1966, a 96 percent reduction.

Index barriers were operated on 3 streams tributary to northern Lake Michigan from April 4 until July 2 when they were dismantled and removed. The weirs captured 1,168 sea lampreys in 1966 compared with 3,277 in 1965. The number of

Table 5. Catches of adult sea lampreys for comparable periods from 16 Lake Superior streams and 3 Lake Michigan streams, 1961-1966

Stream	1961	1962	1963	1964	1965	1966
Lake Superior						
Betsy River	1,366	316	444	272	187	65
Two Hearted River	7,498	1,757	2,447	1,425	1,265	878
Sucker River	3,209	474	698	386	532	223
Miners River	220	64	107	74	23	85
Furnace Creek	1,012	132	142	93	199	118
Rock River	3,660	399	353	229	237	158
Chocolay River	4,201	423	358	445	563	260
Iron River	2,430	1,161	110	178	283	491
Huron River	4,825	70	201	363	637	8
Silver River	5,052	267	760	593	847	1,010
Sturgeon River	427	397	1,445	375	135	259
Misery River	962	80	24	12	3	10
Firesteel River	1,118	70	178	327	11	15
Brule River	22,478	2,026	3,418	6,718	6,163	226
Middle River	3,502	311	48	45	52	17
Amnicon River	4,741	879	131	232	700	938
TOTAL	66,701	8,826	10,864	11,767	11,837	4,761
Percentage change		-86.8	23.1	8.4	0.6	-59.8
Lake Michigan						
Sturgeon River	2,378	1,650	751	823	512	394
Bark River	1,085	710	298	202	189	113
Cedar River	9,423	5,729	6,412	3,568	2,576	661
TOTAL	12,886	8,089	7,461	4,593	3,277	1,168
Percentage change		-37.2	-7.8	-38.4	-28.6	-64.4

adult lampreys at these barriers had declined each year since 1961. The Ocqueoc River weir, Lake Huron, captured 3,272 adult sea lampreys in 1966 compared with 1,390 in 1965 and 2,677 in 1964.

The average length and weight of sea lampreys captured at the barriers on 10 index streams of Lake Superior declined in 1966. The average length decreased from 16.9 inches in 1965 to 16.0 inches in 1966, the shortest recorded from streams tributary to Lake Superior. The average weight of the lampreys decreased from 5.7 ounces in 1965 to 5.2 ounces in 1966. Only in 1960 and 1961, when the weights were 5.2 and 4.8 ounces, were the lampreys of equal or less weight. Sea lampreys from the Bark River, a tributary to northern Green Bay, Lake Michigan, increased in length and weight from 15.4 inches in 1965 to 15.6 inches in 1966, and from 4.1 ounces in 1965 to 4.3 ounces in 1966.

Table 6. Percentage of sea lamprey scarring on rainbow trout[1] from tributary streams of Lake Superior, 1960-1966

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

Stream	1960	1961	1962	1963	1964	1965	1966
Two Hearted River	24.0 (208)	2.8 (178)	4.6 (217)	1.6 (256)	1.6 (62)	1.4 (279)	0.4 (242)
Sucker River	9.7 (175)	2.4 (166)	4.2 (257)	5.6 (179)	3.0 (231)	1.3 (31?)	1.4 (290)
Miners River	22.9 (83)	18.0 (100)	3.5 (201)	3.3 (90)	5.2 (77)	5.8 (120)	3.0 (164)
Furnace Creek	16.0 (25)	13.6 (22)	0.0 (8)	25.0 (4)	12.5 (8)	0.0 (13)	0.0 (14)
Huron River	12.2 (245)	11.5 (233)	2.3 (398)	3.4 (281)	2.2 (180)	5.6 (270)	3.8 (421)
Silver River	0.0 (21)	4.2 (72)	2.8 (71)	1.8 (56)	9.1 (55)	4.0 (50)	0.0 (42)
Misery River	2.3 (43)	3.2 (31)	0.0 (9)	0.0 (13)	0.0 (5)	— (0)	0.0 (11)
Firesteel River	0.0 (45)	0.0 (114)	0.0 (43)	0.0 (47)	0.0 (18)	0.0 (29)	0.0 (29)
Brule River	7.6 (92)	1.2 (82)	2.1 (140)	0.9 (227)	3.4 (177)	4.3 (255)	0.9 (414)
Percentage scarred	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]Over 12 inches, total length.

The sex ratio of adult sea lampreys captured at the Lake Superior index barriers changed from a high of 69.6 percent males in 1962 to 41.2 percent males in 1966, the lowest recorded from Lake Superior streams. Males comprised 41.5 percent of the sea lampreys sampled from the Bark River, Lake Michigan. The ratio of males to females also is the lowest recorded for the Bark River.

The numbers of rainbow trout, white suckers, and longnose suckers taken by barriers on 9 tributaries to Lake Superior increased in 1966. The catch of spawning-run rainbow trout was 1,627 compared with the 6-year average (1960-65) of 1,097. The incidence of sea lamprey wounds on rainbow trout declined to 1.8 percent, the lowest level since observations began on Lake Superior (Table 6).

Movement of tagged sea lampreys in the Great Lakes

A tagging study to provide information on the movement of parasitic-phase lampreys and the duration of this period in their life was continued. A total of 1,826 sea lampreys was tagged and released from August 1965 through July 1966 by the Bureau of Commercial Fisheries, the Department of Fisheries of Canada, the Conservation Departments of Wisconsin and Minnesota, and many commercial fishermen.

Recoveries of tagged individuals continue to demonstrate wide movement and dispersion. A total of 205 was taken by commercial fishermen; 3 were captured at electric barriers on the Two Hearted, Silver, and Sturgeon Rivers tributary to Lake Superior; 2 at barriers on Lake Huron, and 1 was killed during the chemical treatment of Blue Creek, a small tributary to the St. Joseph River, Lake Michigan. Recoveries are summarized in Table 7.

Table 7. Recovery of tagged sea lampreys released, August 1965-July 1966

Location	Number released	Number recovered				
		Lake Superior	St. Marys River	Lake Huron	Lake Michigan	Total
Lake Superior	82	12	0	0	0	12
St. Marys River	826	5	2	33	0	40
Lake Huron	839	0	3	134	6	143
Lake Michigan	79	0	0	1	15	16
TOTAL	1,826	17	5	168	21	211

Interchange of tagged sea lampreys among the Great Lakes is as follows: 5 tagged at Sault Ste. Marie, Lake Huron, were captured in Lake Superior; 6 tagged at St. Ignace, Lake Huron, were recovered in Lake Michigan; and 1 individual tagged at Naubinway, Lake Michigan, was captured in lower Lake Huron. Two sea lampreys tagged in December 1965, which would normally spawn and die the following spring, were recovered in September 1966 indicating that some individuals may spend up to 2 years in the lake before spawning.

From August to December, 1966, 1,763 sea lampreys were tagged and released: 21 in Lake Superior; 36 in northern Lake Michigan; and 1,706 in Lake Huron, including 879 from Sault Ste. Marie. Tag returns from the second tagging project totalled 227 by December 31. Most of them were near the point of release.

A record was made of sea lamprey wounds on fish taken

by the fishery from which lampreys were obtained for tagging. Fresh wounds were found on 7.3 percent of 2,723 herring and 16.3 percent of 6,914 whitefish from the gill net fishery of northern Lake Huron. Only 0.6 percent of 6,287 whitefish inspected from the gill net fishery of northern Lake Michigan were scarred by sea lampreys. Fresh wounds were found on 3.0 percent of the 300 herring examined at Grand Marais, Minnesota, but herring examined in other areas of Lake Superior were not scarred.

Fyke net operations

Fyke nets were again fished in selected streams to monitor the extent of downstream movement of transforming and larval lampreys. Ice and inclement weather limited fishing in many areas to 2 weeks in late October. No sea lampreys were taken in 7 of 8 Lake Superior streams fished systematically since 1961. Nets in the Amnicon River captured 14 young parasitic lampreys, the first metamorphosing lampreys trapped in the Amnicon River since 1962. Nets were fished in several other streams and locations to provide additional information on movement of juvenile sea lampreys. Nets fished in the upper Brule River (Lake Superior) below a chain of lakes took no sea lampreys compared with 83 in 1965 indicating success of the retreatment.

Nets fished in the Sturgeon River (Lake Superior) below Otter Lake continued to catch newly metamorphosed sea lampreys, 44 in 1966 compared with 62 in 1965 and 93 in 1964. Surveys of the Otter River above the lake did not discover larval lampreys and the upper Sturgeon was treated in 1966. Nets fished in this tributary failed to yield parasitic-phase lampreys (15 lampreys were captured in this section in 1965). However, fyke nets fished in the Otter River trapped 4 sea lampreys, the first young parasitic-phase lampreys captured in this river. It is, therefore, apparent that a population of some size is present and the Otter River will be scheduled for treatment next year.

Nets failed to take sea lampreys in 4 of the 5 tributaries of northern Green Bay, Lake Michigan, in 1966. Transforming lampreys were taken in 4 of these streams in 1965. Fyke nets fished in the Whitefish River trapped 22 young parasitic-phase lampreys compared with 10 in 1965 and 260 in 1964. No transforming sea lampreys were captured in 5 streams along the east shore of Lake Michigan. Sixty-nine young adults were taken from water-intake screens of an industrial firm near the mouth of the Pere Marquette River during the October 1965-April 1966 migration. This represents a slight decline compared with the

75 caught during the migration of 1964-65 and a major decline when compared with the 19,793 caught during the migration preceding the 1964 chemical treatment of this river. Nets fished in tributaries of the Pere Marquette River failed to locate the source of these transforming individuals.

Fyke nets have been fished continuously in the Ocqueoc River, Lake Huron, since October 9, 1962. The fishing provides information on the downstream migrations of lampreys in the Ocqueoc River which will be valuable in measuring the effectiveness of future chemical treatment. In addition, it provides collections of sea lampreys and invertebrates for bioassays and studies in the laboratory.

The downstream movement of recently transformed lampreys in the Ocqueoc River generally begins in October or early November, and reaches a peak between November 4 and January when water temperatures drop to 40-46°F. It ends when the temperatures stabilize at 32-33°F. Volume of flow appears to determine the magnitude of the fall migration in relation to the total run. The spring migration peak occurs in March or April and is associated with water temperatures between 33° and 49°F and high water discharges. The size of the spring migration depends on the extent of the movement in the previous fall. Relatively low water during the fall of 1963, for example, resulted in a catch of only 18.6 percent of the total run compared to 71.2 percent during high stream flows in the fall of 1965.

A single fyke net has been fished continuously (except for spring of 1965) on the Ocqueoc in the same location since the 1963-64 migration. The catch was 3,373 in 1963-64, 3,913 in 1965-66, and 3,068 through January 31, in 1966-67, indicating a rather stable contribution.

Mark and recapture studies have been conducted to evaluate the efficiency of this net and provide a basis for calculating total runs. The mark-recapture data in the 1963-64 and 1965-66 migrations were sufficient to allow estimates of net efficiency and total migration. A total of 2,820 dye-marked lampreys was released in 2 migrational periods: 1,320 in 1963-64 and 1,500 in 1965-66. The percentages of marked lampreys recaptured were 8.0 percent in 1963-64 and 6.9 percent in 1965-66. Based on the application of these percentages to the number of migrants captured by the index net, the total downstream migrations were estimated to be 42,000 in 1963-64 and 57,000 in 1965-66.

Information has been collected on the length distribution and sex ratio of metamorphosing sea lampreys during the 1965-66 run. Of the 3,433 fall and winter migrants examined, 2,070 (60.3 percent) were females and 1,363 (39.7 percent) were males. The

mean length of the females was 141 millimeters compared to 137 millimeters for the males. A total of 585 spring migrants (captured after March 9, 1966) was sexed and measured. Of these, 325 (55.5 percent) were females and 260 (44.5 percent) were males. The average length of the females was 144 millimeters compared to 137 millimeters for the males. Females composed 59.5 percent of the entire 1965-66 run. The lengths ranged from 104 to 188 millimeters and averaged 140 millimeters.

Re-establishment in treated streams

Wide variation in growth rates and time to metamorphosis is revealed by populations of re-established larval sea lampreys in different streams. The minimum time to metamorphose is at least 7 years in some streams and only 2 years in others.

Sullivans Creek, the only remaining tributary to Lake Superior containing the 1960 year class of sea lampreys, was treated with TFM in August 1966. The 661 ammocetes recovered ranged in length from 27 to 151 millimeters. No transforming sea lampreys were found. The 1960 year class in other study streams in northern Lake Michigan (Snyder-Deadhorse and Hog Island Creeks) also failed to produce metamorphosing sea lampreys although larger larvae are becoming more abundant. In 1965 only 2 larvae over 120 millimeters were collected in each stream.

The rapid rate of larval growth and presence of transforming sea lampreys in the Sturgeon River, Baraga County, Michigan, indicate metamorphosis occurs for some about 2 1/2 years after hatching. Two-year-old larvae in this stream are as large as 6-year-old larvae in the Big Garlic River, Marquette County, Michigan. Data collected since 1962 indicate some metamorphosis of sea lampreys in 4 years in the Chocolay River, Marquette County, Michigan. During chemical treatment in August 1966, 19 transforming sea lampreys presumably the 1962 year class were recovered.

The number of streams infested annually with sea lampreys has declined since 1962. Sixty tributaries to Lake Superior contained the 1960 and 1961 year classes. The number of streams with young-of-the-year larvae from 1962 through 1964 was 42, 40, and 39, respectively. In 1965, only 26 streams were infested with young-of-the-year larvae.

Lake-dwelling ammocete populations

The electric trawl was used extensively in 1966 along the west and north shores of Lake Huron off the mouths of certain

streams scheduled for chemical treatment to measure estuarine populations. Sea lampreys were captured off the mouths of the Carp, Trout, and East Au Gres Rivers and McKay, Prentiss, Elliot, and Beavertail Creeks. Sea lamprey ammocetes were taken using paddles energized with power from the trawl boat in the Au Sable and Cheboygan Rivers and in the Grass Lake drainage to the Au Sable River. The rate of capture of sea lamprey larvae before treatment of the Carp River with TFM was 93 per 100 minutes of towing time compared with 53 after treatment. The rate of capture was only 3 per 100 minutes after application of granular Bayer 73 to the estuarine area.

No sea lamprey were captured in 5 hours of trawling in Lake Superior where lake-dwelling ammocetes were collected in previous years.

Lamprey population assessments

The primary objective of this project is to see if the effectiveness of the chemical control program can be assessed by monitoring the larval lamprey populations in index streams.

Approximately 50 tributaries to Lakes Superior, Michigan, and Huron are being considered as index streams. Investigations next year will determine which streams will be used and the number and location of the permanent survey stations. The final number of index streams probably will not be more than 40.

Assessment surveys were completed on 3 index streams on Lake Michigan and 2 on Lake Huron making possible some comparison of ammocete abundance in a lake where lampreys have been controlled and one where they have not. The recovery rates of sea lamprey ammocetes of all sizes at certain stations on the Sturgeon and Pine Rivers of Lake Huron were 45.2 and 27.8 per hour of shocking; on the Platte, Pere Marquette, and Galien Rivers on Lake Michigan, rates of recovery were 11.3, 12.2, and 4.2, respectively. Of greater significance was the observation that recently re-established ammocetes less than 40 millimeters in length were taken at a rate of 3.8 per hour on the Sturgeon, 1.9 on the Pine, as compared with 0.1 on the Platte, 0.2 on the Pere Marquette, and 0.1 on the Galien.

Sea lamprey research

The development of larvicides, particularly those containing mixtures of TFM and Bayer 73, has been the major objective of the Hammond Bay Laboratory. The Laboratory has also been concerned with the development and use of a "heavy" granular

formulation of Bayer 73 for survey and control of larval populations in lakes and estuaries. Research has continued on larval lampreys held in aquaria and on developing a marking technique for newly transformed lampreys.

Development of larvicides. A study to better define and compare the toxicity of TFM, Bayer 73, and various mixtures of the 2 compounds was continued in 1966. Bioassays were made in "soft" water from Pendills Creek, "hard water" from Trout River, and water of intermediate hardness from Lake Huron. Species tested were larval sea lampreys, rainbow trout, white suckers, bluegills, and black bullheads. Fathead minnows, yellow perch, and coho salmon remain to be tested.

Twenty-seven bioassays were made with each species of fish in each kind of water using TFM, Bayer 73, and mixtures containing 0.5, 1.0, 2.0, 4.0, 6.0, 8.0, and 10.0 percent Bayer 73. Bioassays covered 21 hours at a temperature of 55°F, and included larval sea lampreys as well as fish for data on selectivity of the various combinations. Each water sample was analyzed for 20 constituents.

A probit method was used to construct concentration-percent effect lines from the mortality data on each bioassay. Minimum lethal concentrations ($MLC_{99.9}$) for larval lampreys and maximum allowable concentrations (MAC_{25}) for fish were determined directly from regression lines. Permissible additional flow (PAF) values were used for measuring selectivity in a bioassay. The latter values represent the amount of dilution, as a multiple of the initial water volume, that can be tolerated before the MAC_{25} is reduced to the $MLC_{99.9}$. A value of less than 1.0 limits usefulness of a chemical for sea lamprey control.

The following characteristics of toxicity and selectivity are evident thus far:

1. Toxicity decreases with increasing water hardness regardless of the chemical or the test animal.
2. Increasing percentage increments of Bayer 73 in the mixtures lowered the $MLC_{99.9}$ and the MAC_{25} in every instance except for bluegills at the 10.0 percent mixture in soft water.
3. Except for rainbow trout, selectivity values tend to be greater in soft water for TFM, Bayer 73, and the mixtures tested.
4. Increasing the amount of Bayer 73 in the mixtures generally results in a loss of selectivity. (All mixtures containing less than 6 percent Bayer 73, however, had PAF values of 1.0 or greater. The mixture containing 0.5 percent Bayer 73 has consistently given the highest PAF values for the tests conducted.)

The characteristic steep slope of the mortality lines of TFM, Bayer 73, and their mixtures demonstrate that the "all or none" effect of these materials occurs within a very narrow range of concentrations. It, therefore, is important to maintain a homogeneous mix when applying the two compounds together. The increase in toxicity obtained by adding increments of Bayer 73 varies according to water quality. By using the minimum lethal concentration of TFM for lampreys as a base of toxicity, it is evident that a greater amount of Bayer 73 is required in softer water to give comparable increases in toxicity. A 4-percent mixture in Pendills Creek water reduces the $MLC_{99.9}$ of TFM by approximately 50 percent. A 2-percent mixture gives nearly the same results in the harder Lake Huron water. A 1-percent addition of Bayer 73 produces a comparable effect in the hardest water.

Granular Bayer 73. A granular Bayer 73 containing approximately 5 percent by weight of active ingredient has been tested as a possible survey tool and as a toxicant for estuarine larval populations. These granules spread on the surface of the water, sink rapidly, and release almost no chemical until they are on the lake or stream bottom. The granular Bayer 73 was tested in streams to determine the presence and abundance of larvae. Its efficiency as measured by the recovery of marked, introduced larval lampreys has ranged from 87 to 96 percent.

The application of granular Bayer 73 in streams could result in extremely high concentrations of the toxicant in the water immediately above the stream bottom, and the effect of these high concentrations on bottom-dwelling invertebrates was tested in the Ocqueoc River, Presque Isle County, Michigan, where 225 square feet were treated at the rate of 335 pounds per acre, approximately three times the normal application rate. Prior to the treatment, square-foot bottom samples were taken at 5 locations. Five additional samples were taken 24 hours, 96 hours, and 12 days after treatment. All bottom organisms were identified and counted. The application of Bayer 73 granules had little effect on the bottom-dwelling invertebrates with the single exception of clams, which were drastically reduced as was expected since Bayer 73 is used as a molluscicide.

Larval growth and transformation. Five groups of larvae hatched in streams in 1960 and 1962 have been held in 15-gal-

lon running-water aquaria. Twice each week the water entering the aquaria is shut off for a 24-hour period and 1 ounce of yeast introduced as food. Four of these groups represented the 1960 year class and one the 1962 year class. With the exception of ammocetes from the Big Gratiot River, which were lost because of equipment failure, the 1960 year class produced transformers in 1966. The 1962 year class from the Silver River produced no transformers although their size (132-161 millimeters) was within the range at which transformation could be expected.

Marking of recently transformed lampreys. A project to develop marks for downstream migrants which will persist and be recognizable through the remainder of their life has been underway since January, 1966. A total of 1,334 transformers from the downstream migration in the Ocqueoc River in late 1965 and early 1966 was marked and held with 100 controls. Mark retention and recognition have been studied for 14 different materials and locations. These included various dye-solvent combinations injected into the dorsal fin, polyvinylchloride (PVC) loop tags, color coded wire micro tags in the dorsal fin, a hole in the caudal fin, branding, and Petersen tags.

Although most of the marks have been retained, a rose flourescent dye, added before injection of either 3 percent Sotradecol[1] or 960 Carbopol[2] resin appears to be best. The mixture of rose dye-Sotradecol is easier to recognize than the Carbopol-dye mark. Sotradecol is a mild sclerosing agent which, on injection, produces a slight inflammation with the subsequent formation of scar tissue. Apparently when dye-Sotradecol mixtures are injected, the dye plug is walled off and prevents the dye from being absorbed.

Mortality among the marked and unmarked (control) lampreys held in the study has been extremely high. Of the initial 1,434 animals, only 138 remained on February 3, 1967. With the exception of 2 groups marked with PVC loop tags, however, some survivors remain in each group. The lampreys marked with loop tags threaded through the dorsal musculature did not feed and all died within 4 months. Mortality was concentrated during the period of May through August (88.5 percent). The major cause of death was fungus probably due to infection introduced with host fish and aggravated by warm water temperatures and crowding in the aquaria.

[1]Philadelphia Laboratories, Inc., Philadelphia, Pennsylvania, 19114.
[2]B. F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland, Ohio, 44115. Trade names referred to in this publication do not imply endorsement of commercial products.

Blood studies. Studies have begun to establish "normal" values for hematocrits, hemoglobin, and red and white cell counts for the blood of sea lamprey at various developmental stages. Hematocrit and hemoglobin values are obtained easily by routine procedures whereas blood cell counts present certain difficulties. Red and white blood cells cannot be readily separated in the hemocytometer even when stains are added to the diluting fluids. Blood smears are of no help because most of the fragile white cells are destroyed in the preparation of the smear. Therefore, an attempt is being made to develop an isotonic dilution stain that will differentially stain the blood cells and improve the accuracy of the blood cell counts in the hemocytometer.

Experimental population of ammocetes. The 1960 year class of sea lamprey ammocetes in the Big Garlic River continues to provide information on rate of growth of larvae, downstream drift, and number that metamorphose each year. The downstream trap captured 44 newly metamorphosed lampreys in 1966 compared with 4 in 1965. These lampreys ranged in length from 121 to 172 millimeters and averaged 150 millimeters. Fifty-one percent were males. Movement of ammocetes to the downstream trap increased substantially for the fourth year. The trap captured 7,925 ammocetes in 1966 compared to 4,336 in 1965, 2,847 in 1964, 370 in 1963, and 9 in 1962.

A total of 618 ammocetes was collected in October for annual growth studies. None of the ammocetes showed signs of metamorphosis. The mean length of the ammocetes was 111 millimeters (range 67-179 millimeters). The rate of growth declined in the past year (Table 8).

A total of 4,364 larvae was marked this year bringing the total number of marked animals returned to the study area to 10,006. A combination of colors and location of the marks has

Table 8. Growth of 1960 year class of ammocetes in the Big Garlic River to October, 1966.

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

been used to distinguish time and point of release. Sixty-seven marked ammocetes were captured at the downstream trap in 1966, including 26 of the 318 marked in 1962, 31 of 700 marked in 1963, and 10 of 2,296 marked in 1964. A collection made in October 1966 with an electric shocker contained 179 marked larvae; 79 were marked in 1966, 36 in 1965, 59 in 1964, 2 in 1963, and 3 in 1962.

Twenty-four (55 percent) of the 44 transforming individuals had been previously captured in the trap as ammocetes, and marked and returned to the study areas. These included 17 marked in 1964, 1 in 1965, and 6 in 1966. Since the marked lampreys had been released in areas that were sparsely populated or devoid of larvae, density may be a factor in stimulating metamorphosis.

APPENDIX B

LAMPREY CONTROL EXPERIMENT IN CANADA

J. J. Tibbles
Resource Development Service
Department of Fisheries of Canada

This report describes the work carried out by the Sea Lamprey Control Experiment Station at Sault Ste. Marie, Ontario. In June of 1966, the responsibility for this station was transferred from the Fisheries Research Board of Canada to the Resource Development Service of the Department of Fisheries of Canada.

Lamprey barrier operations

Electric barriers were operated for the purpose of assessing the size of the sea lamprey spawning populations on 8 Lake Superior tributaries (Big Carp, Harmony, Batchawana, Chippewa, Sable, Pancake, Pays Plat, and Gravel Rivers); and on 8 Lake Huron tributaries (Root, Garden, Echo, Two Tree, Still, Naiscoot-Harris, Mad, and Bayfield Rivers). The 8 Lake Superior barriers have been operated, except for minor delays and interruptions, during May, June, and July each year beginning in 1956. Operation of the Pancake River barrier was delayed until May 25 in 1966. Of the 8 Lake Huron barriers, 4 (on the Root, Garden, Naiscoot-Harris, and Still Rivers) were first operated in 1965, while those on the Echo and Two Tree (near Sault Ste. Marie), the Mad (tributary to the Nottawasaga River in Georgian Bay) and the Bayfield (in southern Lake Huron) were first operated in 1966. The barriers on the Root and Garden Rivers have been dismantled owing to the small numbers of lamprey taken from them. They will be replaced in 1967 by a barrier on the Kaskawong River on St. Joseph Island. It is planned that the Blue Jay and Manitou Rivers on Manitoulin Island will have D. C. guiding barriers in 1967.

The 8 Lake Superior barriers captured a total of 381 sea lamprey during the 1966 season (Table 1). This number is about two-thirds of the 1965 total and less than half the number taken in 1964. The 8 Lake Huron barriers took a total of 4,218

Table 1. Number of upstream migrant, adult sea lamprey collected annually at electrical barriers on 8 Canadian tributaries to Lake Superior during the period May 15 to July 31, for the years 1956 to 1966.

Stream	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
					SAULT STE. MARIE AREA						
Big Carp	23	23	11	15	20	6	5	2	1	15	3
Harmony	22	15	6	7	19	14	3	0	4	5	0
Chippewa	825	353	171	290	1045	453	123	222	274	114	78
Batchawana	382	408	301	467	626	561	136	336	216	140	119
Sable	58	63	36	138	241	88	10	36	5	17	14
Pancake	657	1051	750	804	1286	931	187	387	257	94	64
Sub-total	1967	1913	1275	1721	3237	2053	464	983	757	385	278
					NIPIGON AREA						
Pays Plat	4	3	4	30	10	31	9	9	5	0	2
Big Gravel	8	101	152	537	626	799	315	64	52	188	101
Sub-total	12	104	156	567	636	830	324	73	57	188	103
TOTAL	1979	2017	1431	2288	3873	2883	788	1056	814	573	381

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Batchawana	382	408	301	467	626	561	136	336	216	140	119
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Pays Plat	4	3	4	30	10	31	9	9	5	0	2
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Sub-total	12	104	156	567	636	830	324	73	57	188	103
TOTAL	1979	2017	1431	2288	3873	2883	788	1056	814	573	381

sea lamprey in 1966 (Table 2). The increase (more than 4-fold) is attributable in part to the fact that more Lake Huron barriers were operated and for longer periods in 1966, but it also reflects a real increase in the numbers of lamprey taken in corresponding weekly catches by the same barriers during the 1965 season.

Table 2. Numbers of upstream migrant, adult sea lamprey collected at electrical barriers on Canadian tributaries to Lake Huron, during the periods indicated for the years 1965 and 1966.

Stream	Operating Dates 1965	Lamprey collected	Operating Dates 1966	Lamprey collected
SAULT ST. MARIE AREA				
Root	May 19-July 31	16	May 2-July 31	10
Garden	June 3-July 31	35	May 14-July 31	107
Echo	*	-	May 5-July 31	526
Two Tree	*	-	Apr. 22-July 31	20
Sub-total		51		663
GEORGIAN BAY AREA				
Still	May 21-July 15	344	Apr. 28-July 15	1,820
Harris-Naiscoot	Apr. 27-July 15	593	Apr. 22-July 15	968
Mad	*	-	Apr. 20-July 15	324
Sub-total		937		3,112
SOUTHERN LAKE HURON				
Bayfield	*	-	Apr. 17-July 15	443
TOTAL		988		4,218

*Not operated in 1965.

Surveys

In the Lake Superior drainage surveys were limited to 14 small tributaries of Batchawana and Pancake Bays. These were surveyed in 1966 to assess the extent of re-establishment of ammocetes following lampricide treatments in 1965. With the possible exception of Westman's Creek, it is believed that lamprey do not spawn in these streams and that the presence of ammocetes in them is a result of migration from lake-dwelling populations. Electro-shocker and chemical surveys of these 14 streams in 1966 resulted in the collection of only a few sea lamprey ammocetes. In the Lake Huron drainage, 15 streams were checked for sea lamprey—4 streams on St. Joseph Island were re-surveyed with negative results, and another, Watson's Creek, was surveyed to map distribution prior to treatment.

During the summer and fall a new formulation of Bayer 73, known as granular Bayer 73, was tested as a survey technique in the Echo and Garden Rivers near Sault Ste. Marie and in the following Georgian Bay tributaries--Still, Naiscoot-Harris, Sturgeon, Silver, and Mad River. The chemical forms a dry coating on sand granules and can be easily applied to relatively large areas with hand-operated seed spreaders or compressed-air sprayers. The sand granules rapidly carry the toxicant to the bottom. Lamprey subjected to the granular Bayer 73 generally surfaced (facilitating collecting in turbid or deep water) in about 30 minutes, and it appears that once activated, the lamprey have received a lethal dosage of the toxicant. At the Echo River, all stages of lamprey from young-of-the-year to newly transformed adults were collected.

The new material provided an efficient means of collecting ammocetes, but its effectiveness appeared to be limited (similar to other techniques employed) to stream temperatures above 40°F.

Chemical treatments

In 1966, personnel and equipment were re-organized to create two stream-treatment groups, one for Lake Huron, the other for Lake Superior.

Fourteen Lake Superior tributaries were treated (Table 3). Except for Cash Creek, a tributary to Helen Lake in the Nipigon

Table 3. Canadian streams treated with lampricide, Lake Superior, 1966.

Stream	Date treated	Flow (cfs)	Stream miles treated	TFM (lbs.)	Synergist (lbs.)	Ammocoete abundance
Sable	June 14	83	6	550	0	Scarce
Chippewa	June 21	407	2	669	16	Scarce
Agawa	June 28	346	13	1,346	27	Scarce
Sand	June 29	129	0.4	143	2	Nil
Batchawana	July 4	217	8	1,526	33	Scarce
Wolf	July 12	152	10	1,429	40	Abundant
Big Gravel	July 14	123	10	627	11	Moderate
Black Sturgeon	July 18	590	51	5,495	75	Abundant
Cash	Aug. 5	24	16	1,029	21	Abundant
Prairie	Sept. 12	49	5	733	15	Nil
Steel	Sept. 14	394	6	3,886	92	Scarce
Little Pic	Sept. 20	342	35	4,546	95	Scarce
White	Sept. 30	255	3.5	3,688	62	Scarce
Big Carp	Oct. 19	72	10	524	7	Scarce
TOTAL		3,183	175.9	26,191	496	

River, all had been treated previously. Cash Creek was known to contain sea lamprey in 1963 but could not be treated until 1966. Following this treatment, 679 sea lamprey ammocetes were found after diligent searching. Chippewa, Batchawana, and Sable Rivers were again re-treated in order to minimize recruitment of ammocetes to Batchawana Bay. Lamprey larvae were, as usual, scarce and limited to the estuaries. Fewer than a dozen ammocetes were found in each of the Big Carp, Agawa, Little Pic, and Steel Rivers following treatment. Both the Big Gravel and the Wolf, last treated in 1962, yielded transforming sea lamprey in 1966. While the possibility that transformation may occur after four years of stream life is not ruled out, it is more likely that the occurrence of transforming animals resulted from escapement in the earlier treatments, or in the case of the Wolf River, re-entry from a lake-dwelling ammocete population.

White River, which was found to contain an abundance of ammocetes in the 1963 treatments, was scheduled for re-treatment in 1965: the shorter than normal interval is desirable for streams with large sea lamprey populations. Owing to flood conditions the second treatment was postponed until 1966 at which time 107 sea lamprey ammocetes were found.

Black Sturgeon River, first treated in 1960 and scheduled for re-treatment in 1964 and 1965, received its second treatment in 1966. Logging operations and flood conditions forced postponement of the earlier re-treatments. Following the latest treatment, a fishway in the lower dam 10 miles above the mouth was sealed and a steel lip was installed on the top stoplogs, thus preventing access by sea lamprey to another 40 miles of river.

Ten Lake Huron streams were treated in 1966 (Table 4). The Root, Bar, and Garden Rivers are close to Sault Ste. Marie while the other seven are located on St. Joseph Island. All but the Kaskawong, Watson's, Bar, and Garden had been treated previously. The Echo, scheduled for treatment in 1966, is postponed to 1967.

Kaskawong River appears to be the most productive stream for sea lamprey on St. Joseph Island. During the treatment 332 ammocetes were collected and over 200 adults were observed in the watershed.

Lamprey tagging

Lamprey tagging in the St. Mary's River below the Soo Locks was continued to determine the extent and direction of movement of lamprey and whether or not these lamprey are responsible for recruitment to the Lake Superior population. Lampreys are col-

Table 4. Canadian streams treated with lampricide, Lake Huron, 1966.

Stream	Date treated	Flow (cfs)	Stream miles treated	TFM (lbs.)	Synergist (lbs.)	Ammocoete abundance
Gawas	Apr. 26	16	0.5	198	5	Scarce
Brown's	Apr. 27	14	2	102	0	Moderate
Gordon's	Apr. 28	7	1	58	0	Scarce
Kaskawong	May 3	43	11	1,115	25	Moderate
Watson's	May 5	9	2.5	132	0	Scarce
Two Tree	May 10	24	15	481	6	Moderate
Richardson's	May 17	13	4	291	5	Scarce
Root	May 30	83	32	794	15	Scarce
Bar	Aug. 17	7	13	156	0	Scarce
Garden	Aug. 23	158	48	2,173	35	Abundant
TOTAL		374	129	5,500	91	

lected at night in a beam-type trawl which is hauled at the surface of the water immediately behind the transom of an outboard motor cruiser. Occasional monitoring with the trawl during the summer months produced no lamprey, however, in the fall the population slowly built up from mid-September reaching a peak between mid-October and mid-November and dropping off during December. During this period 1,278 adult lamprey were caught in one small area by surface trawling; 877 were tagged and released, 73 were removed from the population (handling mortality or for experimental purposes) and 328 were recaptured.

APPENDIX C

SUMMARY OF TROUT AND SALMON PLANTINGS

Hatchery-reared salmonids have been stocked intensively in the Great Lakes as a means of speeding the rehabilitation of the fisheries. Annual plantings of lake trout have been made in Lake Superior since 1958, and in Lake Michigan since 1965. Plantings of kokanee salmon were initiated in Lake Huron and Lake Ontario in 1964 and coho salmon in Lake Superior and Lake Michigan in 1966.

Several government agencies were engaged in the lake trout program and coordinate their efforts through the lake committees so that each one is engaged in the phase of the work it can best carry out. The States of Michigan and Wisconsin and the Province of Ontario share the responsibility for providing lake trout eggs which now come almost exclusively from brood fish maintained in hatcheries or in inland lakes. Agencies sharing in the hatching, rearing, and distribution of lake trout are the United States Bureau of Sport Fisheries and Wildlife, the state conservation agencies of Wisconsin and Minnesota, and the Province of Ontario. Table 1 summarizes the annual plantings of lake trout in Lakes Superior and Michigan. Tables 2 and 3 detail the 1966 lake trout plantings in Lake Superior and Lake Michigan, respectively.

Kokanee salmon were introduced in Lake Huron and Lake Ontario in 1964 by the Ontario Department of Lands and Forests for the purpose of providing a new sport and commercial species. Annual plantings have been carried out since that time. The eggs have been obtained from shore-spawning stocks in Colorado, Montana, and Washington, and from a stream-spawning stock in British Columbia. The kokanee have been planted during the winter and spring as eyed eggs, swim-up fry, and fingerlings. Eyed-egg plantings were discontinued in Lake Ontario after the winter of 1964-65. Tables 4 and 5 summarize the kokanee plantings in Lake Huron and Lake Ontario, respectively.

Coho salmon were introduced into Lake Michigan and Lake Superior in 1966 by the State of Michigan for the purpose of improving the sport fishing potential of its waters. The eggs were obtained from the Bonneville stock in Oregon. Coho smolt were planted during the spring in two Lake Michigan streams, the

Platte River and Bear Creek (tributary of the Big Manistee River), and the Big Huron River, Lake Superior. Table 6 summarizes the coho plantings.

Table 1. Plantings (in thousands of fish) of hatchery-reared lake trout in Lake Superior and Lake Michigan, 1958-1966.

LAKE SUPERIOR

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	1,853
1963	1,348	311	175	477	2,311
1964	1,196	743	220	472	2,631
1965	827	448	251	468	1,993
1966	2,218	377	257	450	3,302
Total	7,838	2,887	980	4,353	16,056

LAKE MICHIGAN

Year	Michigan	Wisconsin	Illinois	Indiana	Total
1965	1,059	205	-	-	1,264
1966	956	761	-	-	1,717
Total	2,015	966	-	-	2,981

Table 2. Plantings of hatchery-reared lake trout in Lake Superior, 1966.

Location	Number	Fin Clip
Michigan waters		
Ontonogan	172,400	Adipose & left ventral
Black River Harbor	66,200	"
Huron Bay	144,900	"
Pequaming	106,600	"
Big Traverse Bay	151,800	"
Betsy River	102,800	"
Bete Grise	92,400	"
Eagle Harbor	136,100	"
Grand Island	257,800	"
Shelter Bay	173,300	"
Marquette	126,100	"
Big Bay	178,800	"
Grand Marais	250,800	"
Pendills Bay	104,700	"
Whitefish Point	153,000	"
Sub-total	2,217,700	
Wisconsin waters		
Apostle Islands	376,900	dorsal & left ventral
Minnesota waters		
Knife River to Beaver Bay	149,500[1]	right pectoral
Split Rock to Beaver Bay	14,300	"
Beaver Bay	93,200	"
Sub-total	257,000	
Ontario waters		
Goulais Bay	50,000	dorsal & right ventral
Batchawana Bay	50,000	"
Jackfish Bay	75,000	doral & both ventrals
Nipigon Bay	75,000	both pectorals
Magnet Point to Fluor Island	75,000	adipose & left pectoral
Michipicoten Harbor to Otter Head Point	125,000	adipose & right pectoral
Sub-total	450,000	
United States total	2,851,600	
Canadian total	450,000	
Total	3,301,600	

[1]fingerlings

Table 3. Plantings of hatchery-reared lake trout in Lake Michigan, 1966.

Location		Number	Fin Clip
Michigan Waters			
Statistical district MM-3	Naubinway	83,800	right pectoral
	Epoufette	83,500	"
	Petoskey	185,000	"
	Charlevoix	75,400	"
Statistical district MM-4	Bowers Harbor	49,000	"
	Old Mission	48,900	"
	Grelickville	65,400	"
Statistical district MM-5	Leland	100,000	"
Statistical district MM-6	Ludington	165,000	dorsal & rt. pectoral
Statistical district MM-7	Port Sheldon	99,900	right pectoral
sub-total		955,900	
Wisconsin Waters			
Statistical district WM-1	Green Bay	190,300	dorsal & left ventral
Statistical district WM-3	Rowleys Bay	100,500	left pectoral
	Sturgeon Bay	148,200	"
Statistical district WM-4	Kewaunee	120,400	"
Statistical district WM-5	Milwaukee Reef	201,500	both ventrals
sub-total		760,900	
Total		1,716,800	

Table 4. Plantings of kokanee salmon in Lake Huron, 1964-1966.

Location	Number planted					
	1964-1965[1]	1965		1966		
	eggs	fry	fingerl.	eggs	fry	fingerl.
Sydenham River	150,000			180,000		
Bothwell Creek	45,000			20,000	24,000	
Indian R. (Thornbury)	45,000					
Go Home River	110,000			80,000		
Willow Cr. (Tobermory)	75,000			60,000		
South Bay	110,000	490,000	177,000		248,300	219,300
Manitou River	220,000			140,000		
Parry Sound		100,000				
Byng Inlet			45,900			
Michael Bay			53,600			
Oxenden Cr. (Colpoy Bay)		28,400	11,100			
Lions Head (Isthmus Bay)		116,000			116,000	
Big Bay (Georgian Bay)		19,000				
Balmy Beach		23,700			24,000	
Leith		23,700				
Centreville Creek		23,700			24,000	
Chickanishing Creek	50,000			100,000		
Colpoy Bay					30,000	
Keppel-Big Bay					18,000	
Mowat Island					100,000	
George Lake					59,500	
Saugeen River				180,000		
Sauble River				80,000		
Kagawong Creek				41,600		
Lauzon Creek				41,600		
Magnetewan River						42,000
Total	805,000	824,500	287,600	923,200	643,800	261,300

[1]Winter

Table 5. Plantings of kokanee salmon in Lake Ontario, 1964-1966.

Location	1964-1965[1] (eyed eggs)	1965 (fry)	1966 (fry)
Shelter Valley Creek	161,200	134,600	211,000
Wilmot Creek	162,000	65,200	211,000
Salmon River	-	134,600	194,800
Glenora	-	309,000	299,600
Main Duck Island	-	65,200	244,600
Charity Shoal	-	65,200	226,400
Lake St. Lawrence	-	1,500[2]	1,500
Total	323,300	773,800	1,389,000

[1]Winter
[2]fingerlings

Table 6. Plantings of hatchery-reared coho salmon smolts in Lake Michigan and Lake Superior (Michigan waters), 1966.

LAKE MICHIGAN	
Platte River	264,600
Bear Creek (tributary of Manistee River)	394,800
Sub-total	659,400
LAKE SUPERIOR	
Big Huron River	192,400
Total	851,800

APPENDIX D

ADMINISTRATIVE REPORT FOR 1966.

Meetings. The Commission held its 1966 Annual Meeting in Sault Ste. Marie, Ontario, June 21-24, and its Interim Meeting in Ann Arbor, Michigan, November 30-December 1.

Officers and staff. At the 1966 Annual Meeting, Dr. A. L. Pritchard was elected Chairman of the Commission succeeding Mr. D. L. McKernan. Mr. L. P. Voigt was elected Vice Chairman succeeding Dr. Pritchard in that office.

No changes occurred in the Commission's staff during 1966.

Accounts and audit. The Commission's accounts for fiscal year ending June 30, 1966 were audited by Icerman, Johnson, and Hoffman, Ann Arbor. The report is appended.

Contributitions to the program for fiscal year 1966. At its 1964 Annual Meeting, the Commission approved a program for fiscal year 1966 with an estimated cost of $49,000 for Administration and General Research, and $1,567,600 for Sea Lamprey Control and Research. The program and budget were submitted to the two governments in July, 1965. On August 27, 1966, the Commission was advised that the U.S. contribution would be less than the amount requested. The sea lamprey program was modified accordingly to reduce the cost to $1,496,300.

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

	United States	*Canada*	*Total*
Sea lamprey control and research			
Commission's request	$1,081,644	$485,956	$1,567,600
Appropriations	1,032,500	463,800	1,496,300
Credits - fiscal year 1964	2,247	1,009	3,256
	$1,030,253	$462,791	$1,493,044
Administration and general research			
Commission's request	$24,500	$24,500	$49,000
Appropriations	24,500	24,500	49,000
Credits - fiscal year 1965	2,495	2,495	4,990
	$22,005	$22,005	$44,010

Expenditures in fiscal year 1966. Agreements to carry out the sea lamprey program were made in 1965 with the U.S. Bureau of Commercial Fisheries ($783,600) and the Fisheries Research Board of Canada ($349,659). A research contract ($10,000) with a group of consultants for an economic study of costs and benefits of sea lamprey control and lake trout rehabilitation was continued.

Chemical operations in Canada in fiscal year 1966 were hampered by heavy rains and logging operations on two of the streams to be treated. Six of 9 streams, specified in the Agreement, were treated. Existing barriers were operated on Lake Superior and Lake Huron as proposed but construction of 4 of 8 new barriers on Lake Huron could not be completed because of difficulties acquiring sites. At the end of the year, $32,422 unexpended by the Fisheries Research Board of Canada were returned to the Commission and used to purchase lampricide.

Barriers were operated on 16 streams in Lake Superior and 3 streams in Lake Michigan as proposed in the Agreement. Thirteen of the 17 streams scheduled on the U.S. shore of Lake Superior were treated. No larvae approaching transformation could be found in the 4 streams not treated. Two streams, Huron River and Harlow Creek, were treated earlier than scheduled. On Lake Michigan, the Bureau treated 18 of the 20 streams specified. Two streams were omitted when it was found that they did not contain ammocetes. A considerable saving in lampricide occurred when it was found that only the headwaters of the Grand and St. Joseph Rivers required treatment. Three streams on Lake Michigan to be treated early in fiscal year 1967 were disposed of earlier than scheduled. The Bureau was also able to treat 10 small streams in Lake Huron ahead of schedule.

The Commission purchased 144,000 pounds of TFM and 440 pounds of Bayer-73 in fiscal year 1966. The American Hoechst Company, Kansas City, and the Hoechst Chemical Company, Montreal, delivered 49,552 pounds of TFM to the U.S. agent and 10,016 pounds to the Canadian agent. A second order of 84,420 pounds was placed with Maumee Chemical Company with all but 5,526 pounds going to the Canadian agent for use in fiscal year 1967.

At the end of fiscal year 1966, the Commission authorized the transfer of $1,600 to the Administration and General Research Fund from the Sea Lamprey Control and Research Fund. An additional $800 was withdrawn from the latter and returned to the United States to maintain the sharing formula.

Program and budget for fiscal year 1967. At the 1965 Annual Meeting, the Commission approved a program and budget

of $1,607,100 for Sea Lamprey Control and Research and $53,200 for Administration and General Research in fiscal year 1967. It was subsequently advised that an increase in the U.S. contribution was unlikely. Several modifications to the program, including the elimination of the three assessment barriers on Green Bay, were made to reduce the cost of the sea lamprey program to $1,492,030. The Commission also increased its Administration and General Research budget to $55,000 to cover increases in salaries, travel, and communication costs.

The revised program for fiscal year 1967 provided for the following sea lamprey control and research activities:

Lake Superior - Re-treat 14 streams in Canada and 10 streams in the United States; examine streams to follow the re-establishment of ammocete populations and determine when re-treatment will be necessary; keep under surveillance streams suitable for lamprey spawning; operate assessment barriers on 16 streams in the United States and 8 in Canada.

Lake Michigan - Re-treat 27 streams; re-examine potential lamprey streams for new spawning runs and treated streams for re-established populations; assess ammocete abundance in estuaries.

Lake Huron - Treat 18 streams in the United States and 11 in Canada; survey streams to locate new lamprey producers; operate 11 electrical barriers in Canada and 1 in the United States to follow changes in lamprey abundance.

Research - Investigate salicylanilides with potential as lampricides or as synergists with various nitrophenols; re-examine streams for build-up of residues in bottom sediments or fauna; follow changes in fauna of streams treated repeatedly with TFM; determine exposure to TFM which will cause irreversible damage to larvae; study depth of ammocetes in substrate and reaction to lowered water levels; follow growth and transformation of ammocetes in relation to their density; study effects of water chemistry and temperature on the biological activity of TFM; tag lamprey to obtain information on their movements and contributions of certain streams.

Agreements to carry out the revised program in fiscal year 1967 were made with the U.S. Bureau of Commercial Fisheries ($824,100) and the Canadian Department of Fisheries ($445,600). The Commission ordered 73,500 pounds of TFM for the Bureau from the Maumee Chemical Company at $2.71/pound. Requirements of the Department of Fisheries were filled with 79,000 pounds ordered in fiscal year 1966. The Commission purchased 500 pounds of Bayer-73 in powder form to be used as a synergist and 2,000 pounds in granular form for treatment of estuaries

and for surveys. An additional purchase of 800 pounds of Bayer-73 in powder form and 18,000 pounds in granular form will be made in the latter half of fiscal year 1967.

Report and puplications. In addition to the Annual Report, 2 Commission Technical Reports and 2 papers based on studies made in connection with the sea lamprey control and research program were published as follows:

"The relation between molecular structure and biological activity among mononitrophenols containing halogens," by Vernon C. Applegate, B. G. H. Johnson, and Manning A. Smith, Tech. Rep. No. 11, 19 p.

"Substituted nitrosalicylanilides: A new class of selectively toxic sea lamprey larvicides," by Ronald J. Starkey and John H. Howell, Tech. Rep. No. 11, 9 p.

"Treatment of East Bay, Alger County, Michigan, with toxaphene for control of sea lampreys," by William E. Gaylord and Bernard R. Smith, U.S. Fish and Wildl. Serv., Resource Pub. 11: 1-7.

"The life cycle of the sea lamprey and a toxicological approach to its control," by John H. Howell, In: Phylogeny of Immunity, University of Florida Press, 263-270.

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. Burt, C.P.A.
C.J. Morehouse, C.P.A.

303 National Bank and
Trust Building
Ann Arbor, Michigan

September 21, 1966

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, 1966. 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 balance of the designated funds of the Great Lakes Fishery Commission at June 30, 1966, arising from cash transactions and the receipts collected and expenditures made by it during the year then ended on a basis consistent with that of the preceding year.

(signed)

Icerman, Johnson & Hoffman

Great Lakes Fishery Commission

Lamprey Control Operation Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1966

	Actual	*Budget*
Receipts		
Canadian Government	$ 462,791	$ 462,743
United States Government	1,030,253	1,030,149
Credit for 1963-64 underexpenditure	3,256	
Refund from United States Fish and Wildlife Service	687	
Reserve fund for Economic Study	6,118	6,118
Total	$1,503,105	
Transferred to Administration Funds	-2,400	
Total	$1,500,705	$1,499,010
Expenditures		
Canadian Department of Fisheries	$ 317,237	$ 349,659
United States Fish and Wildlife Service	783,600	783,600
Lampricide purchases	275,642	353,041
Economic Study Group	4,675	6,118
Obligated for unpaid commitments:		
Lampricide ordered	107,421	
Economic Study Group	10,000	10,000
Total	$1,498,575	$1,502,418A
Excess of receipts over expenditures	$ 2,130	
Fund balance, July 1, 1965	3,408	
Fund balance, June 30, 1966	$ 5,538B	

Note A - Fund balance, July 1, 1965	$ 3,408
Budgeted receipts	1,499,010
Total available funds	$1,502,418

Note B - Cash in bank	$ 5,538

Great Lakes Fishery Commission

Administration and General Research Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1966

	Actual	*Budget*
Receipts		
Canadian Government	$22,005	$22,005
United States Government	22,005	22,004
Transferred from Lamprey Operations	2,400	
Total	$46,410	$44,009
Expenditures		
Salaries (including tax and pension)	$41,821	$40,250
Travel	2,911	2,800
Transportation	289	100
Communications	1,066	700
Rents and utilities	529	400
Printing and reproduction	775	2,400
Other contractual services	401	400
Supplies	2,116	1,700
Equipment	693	250
Total	$50,601	$49,000A
Excess of expenditures over receipts	$ 4,191	
Fund balance, July 1, 1965	4,991	
Fund balance, June 30, 1966	$ 800B	

Note A - The total of the beginning fund balance plus the budgeted receipts equals the budgeted expenditures:

Fund balance, July 1, 1965	$ 4,991
Budgeted receipts	44,009
Total available funds	$49,000

Note B - Cash in bank	$ 800

Fisheries Research Board of Canada

Financial Report to Great Lakes Fishery Commission
April 1, 1965 to March 31, 1966

Field Administration: 42.5% of	
Costs of London Headquarters (FRB work to Sept. 30, 1965 $37,959.59)	$ 16,132.83
Administration - October 1 to March 31, 1966	18,018.13
Operation of Barriers	95,928.94
Chemical Control	140,252.46
Stream Surveys	46,132.85
Contributions to Superannuation (6 1/2% of permanent salaries - $101,552.78)	6,600.93
	$323,066.14
Contract Administration (6% of total disbursements)	19,383.97
Total	$342,450.11
Funds Provided by Commission:	
Payment under 1965-66 Contract	$377,466.00
Cost applicable to 1965-66	342,450.11
Unexpended Balance	$ 35,015.89[1]
	($32,422 U.S.)

[1]Refunded to the Commission.

Bureau of Commercial Fisheries

Sea Lamprey Control and Research Program

Report of Expenditures for All Activities
July 1, 1965 through June 30, 1966

Activity	Funds Programmed	Salaries	Expenses	Total	Unobligated Balance
Program Costs					
Ann Arbor, Mich. Laboratory					
Chemical Operations	$475,000	$357,005	$116,058	$473,063	$1,937
Barrier Operations	143,200	102,764	39,559	142,323	877
Research	96,000	75,808	19,542	95,350	650
Washington, D.C.	25,000	24,943	57	25,000	-
General Administration and Executive Direction Ann Arbor, Michigan	44,400	43,487	40	43,527	873
Total	$783,600	$604,007	$175,256	$779,263	$4,337[1]

[1]Refunded to the Commission.

Bureau of Commercial Fisheries

Sea Lamprey Control and Research Program

Report of Expenditures for All Activities

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[1] Refunded to the Commission.

COMMITTEE MEMBERS - 1966

SCIENTIFIC ADVISORY COMMITTEE

CANADA	UNITED STATES
A. L. Pritchard, (Chm.)	D. L. McKernan
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G. F. M. Smith	C. A. Dambach

SEA LAMPREY CONTROL AND RESEARCH COMMITTEE

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	C. D. Harris
	W. F. Carbine

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D. J. Curry	W. G. Bentley

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