ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1963

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 1963.

D. L. McKernan, *Chairman*

CONTENTS

ANNUAL REPORT FOR 1963

INTRODUCTION

The need for international cooperation in the solution of problems confronting fishery interests on the Great Lakes has long been recognized. Several boards and commissions have been established for limited periods since 1897 by the United States and Canada to advise governments on measures to conserve the fisheries. Most of the measures proposed, however, were regulatory or restrictive and proved unacceptable to the state and provincial governments responsible for the administration of the resource.

In 1940, the United States and Canada established the International Board of Inquiry for the Great Lakes Fisheries, which conducted a broad survey of conditions in the fishery. The Board's recommendations included a proposal that the fishery be investigated by a common or joint agency which would be responsible for formulating and testing measures to improve production. Subsequent attempts to establish such a body were delayed by World War II. In 1946, a convention was drafted, but never ratified because of vigorous opposition to a provision which granted authority to a commission to regulate the fisheries. Continuing and intensified problems of conservation of the fishery and increasing severe depredations by the parasitic sea lamprey, however, led to review and modification of early treaty drafts in 1952, and ultimately ratification of the present Convention on Great Lakes Fisheries on October 11, 1955.

The Convention provided for the establishment of a Great Lakes Fishery Commission composed of six commissioners, three from each country, with the following duties:

(a) to formulate a research program or programs designed to determine the need for measures to make possible the maximum sustained productivity of any stock of fish in the Convention Area which, in the opinion of the Commission, is of common concern to the fisheries of the United States of America and Canada and to determine what measures are best adapted for such purpose;

(b) to coordinate research made pursuant to such programs and, if necessary, to undertake such research itself;

(c) to recommend appropriate measures to the Contracting Parties on the basis of the findings of such research programs;

(d) to formulate and implement a comprehensive program for the purpose of eradicating or minimizing the sea lamprey populations in the Convention Area; and

(e) to publish or authorize the publication of scientific and other information obtained by the Commission in the performance of its duties.

It was apparent in 1956 that the fisheries on the upper Great Lakes had suffered a serious decline as a result of the sea lamprey attack on preferred species. Some commercial fishermen were deprived of much of their living and sportsmen lost an important recreational resource. The fisheries in the lower lakes, although experiencing problems, were continuing to produce at about the usual level. The Commission, therefore, gave immediate attention to sea lamprey control, and preliminary consideration to re-establishment of lake trout in areas where they had been eliminated or drastically reduced.

When the Commission assumed responsibility for controlling the sea lamprey, an extensive but incomplete network of electrical barriers was in operation on Lake Superior and Lake Michigan streams to prevent sea lampreys from spawning. Construction of electrical barriers was continued by the Commission while the feasibility of other control techniques was investigated. These investigations led to the development of a chemical treatment method designed to destroy young lamprey during their early nonparasitic life in streams.

Chemical operations began in Lake Superior in the spring of 1958 and by 1960 most of the streams known to have large populations of young lamprey had been treated. Subsequent resurveys led to the discovery of populations of young lamprey in additional streams, bringing the total number to 110, of which 100 have been treated.

The first indication that control methods had caused a reduction in the adult lamprey population in Lake Superior came in the fall of 1961 when the incidence of lamprey-wounded trout was encouragingly low. Subsequently, in the spring of 1962 the catch of adult lamprey at assessment barriers dropped to 14 percent of the previous year's catch, and 18 percent of the average catch during the preceding five years. Although the catch increased slightly in the spring of 1963, it amounted to only 17 percent of the 1961 catch.

Lake trout populations in Lake Superior have responded sharply to the reduction in sea lamprey. Catches in United States and Canadian waters in 1962 indicated improved survival, particularly of larger and older trout, and an increase in average size and availability. The most striking improvements were seen in the Wisconsin waters. Improvements were less pronounced in the Michigan and Ontario waters and occurred mainly in the catch of larger trout.

Treatment of lamprey streams was extended to Lake Huron and Lake Michigan in 1960. Later it was restricted to Lake Michigan when it became evident that increased costs of treating Lake Michigan streams prohibited an effective program on three lakes with funds available. Nine tributaries to Georgian Bay and 11 tributaries to the North Channel and St. Mary's River were disposed of before treatments were discontinued. Surveys completed in the fall of 1963 have located a total of 90 lamprey streams on Lake Huron. Sixty-three of the 99 lamprey streams on Lake Michigan have been treated. These

are located on the west and north shores and on the east shore north of Grand Traverse Bay, while those remaining are located mainly on the east shore.

In 1959 and 1960 the Commission submitted recommendations on research for each lake to provide general guide lines until information could be assembled on which to base more specific recommendations. A review of the fishery problems and the information and investigations required for their solution was begun in 1962 by the Commission with the help of agencies and individuals concerned with the Great Lakes fishery. The review led to the preparation of a prospectus for investigation of the Great Lakes fishery.

1963

ANNUAL MEETING

AGENDA

1. Call to order.
2. Adoption of agenda.
3. Approval of minutes of Interim Meeting.
4. News release on meeting.
5. Report of the Chairman.
6. Consideration of Lake Erie walleye fishery.
7. Progress reports on sea lamprey program.
8. Report of Lake Trout Rehabilitation Committee.
9. Recent changes in status of lake trout in Lake Superior.
10. Statement by Scientific Advisory Committee.
11. Review of 1963–64 program.
12. Consideration of 1964–65 program.
13. Consideration of prospectus draft.
14. Administrative matters.
15. Time and place of next meeting.
16. Adjournment.

ANNUAL MEETING

PROCEEDINGS

The Eighth Annual Meeting of the Great Lakes Fishery Commission was held in Ann Arbor, Michigan, on June 26 and 27, 1963.

Call to order. The Chairman, Dr. A. L. Pritchard, called the meeting to order and introduced members of the Commission. Advisors and observers were introduced by chairmen of the National Sections.

Adoption of agenda. The tentative agenda was adopted after minor revisions.

Approval of minutes of Interim Meeting. The summary minutes of the Interim Meeting, held in Ottawa, Canada, on November 27–28, 1962 were approved.

News release on meeting. The Chairman appointed a committee of Commissioners Claude Ver Duin, J. R. Dymond, and the Executive Secretary to assist a representative of the University of Michigan News Service in preparing a news release on the meeting.

Report of the Chairman. The Chairman reported a slightly higher catch of spawning lamprey at barriers in the spring of 1963, which indicated no significant change in lamprey abundance in Lake Superior since 1962. The lake trout population, nevertheless, continued to show signs of recovery as larger fish were becoming more abundant. On the other hand, the increasing proportion of marked hatchery fish in samples of juvenile trout indicated that natural reproduction was still inadequate. The propagation activities undertaken by agencies in both countries were therefore an important element in the restoration of lake trout.

He drew attention to the increasing cost of the lamprey control program as a result of the extension of operations into Lake Michigan and emphasized the need to investigate new methods and materials which might reduce program costs. Some preliminary work had already indicated that it might be possible to increase the effectiveness of TFM (3-trifluormethyl-4-nitrophenol) by using a synergist.

The Chairman reported that the preparation of the prospectus outlining investigations needed on the Great Lakes was well underway and some sections had been sent to agencies and individuals for review. He suggested that the Commission's advisors give some preliminary consideration to ways of encouraging implementation of the proposed investigations.

Consideration of Lake Erie walleye fishery. The Chairman advised the Commission that information on the fishery in Canadian waters,

which was to supplement reports given at the Interim Meeting, had not been received. Since the Scientific Advisory Committee had asked for the opportunity to study this additional data before reporting, he suggested that consideration be postponed. The Commission, therefore, agreed to defer discussion of the walleye fishery until the Interim Meeting.

Reports on the sea lamprey program. The Commission accepted the final reports of its agents describing sea lamprey control operations in 1962, and received progress reports on the program during the first part of 1963.* Catches of lamprey at barriers were up slightly from the catch for the same period in 1962, but well below the 1961 level. Bureau scientists believed that no further major reduction should be expected until 1964 or 1965 after most second treatments were completed. Staff of the Fisheries Research Board believed that further reductions could be expected as a result of improved survey and stream treatment procedures, but larvae now living outside river mouths would continue to contribute.

The Executive Secretary presented two summary reports describing studies of larval lamprey by the Institute for Fisheries Research of the Michigan Department of Conservation, and the results of toxicity tests of TFM by the Wisconsin Alumni Research Foundation Laboratory. It was pointed out that because of increasing government concern for long-term effects of pesticides, the Commission might need to investigate the possibility that TFM would accumulate in fish, food organisms, or contaminate ground water. It was suggested that emphasis be placed on the development of new lampricides which would break down at a more rapid rate than TFM, thereby reducing the chance of residue accumulation.

Report of the Lake Trout Rehabilitation Committee. The Commission received the report of its Lake Trout Rehabilitation Committee for 1962.† The Commission discussed the catch limit proposed by the Committee (88,200 lake trout) in relation to an earlier recommendation that the catch be limited to the effort required to support necessary biological studies of lake trout populations. It was explained that this level of fishing was necessary if small year to year changes in the status of trout were to be measured. It was agreed that the Commission should weigh its requirements for precise information against the possibility that the fishing to gather it might slow the rate of recovery of the populations.

Recent changes in the status of lake trout in Lake Superior. Wisconsin representatives reported a further increase in the abundance of lake

* Report of the Fisheries Research Board of Canada for 1963 on page 24.
Report of the U.S. Bureau of Commercial Fisheries for 1963 on page 30.
† Final report of the Lake Trout Rehabilitation Committee is given on page 42.

trout over 25 inches in length and believed that there would be a marked improvement in spawning in the fall of 1963. The proportion of hatchery fish continued to increase, indicating the important contribution being made by plantings. Despite a slight increase in catch of spawning lamprey, the incidence of lamprey wounds continued to decline in Wisconsin waters.

The Bureau of Commercial Fisheries reported that all sizes of trout were more abundant in State of Michigan waters of Lake Superior during the spring of 1963. Increases in the average size of trout and their generally low abundance appeared to be the principal reasons for the continued high incidence of scarring.

Data from the Canadian fishery, collected by staff of the Fisheries Research Board during May 1963, did not indicate any significant change in the size or abundance of lake trout since the previous year. The proportion of hatchery fish in the catches continued to increase at both ends of the lake.

Statement by Scientific Advisory Committee. The chairman of the Scientific Advisory Committee presented the following assessment of sea lamprey control:

> The Committee has reviewed the lamprey catches at barriers on Lake Superior this spring and information on lamprey wounding and believes that the level of lamprey abundance has not changed materially since the decrease in 1961. Although treatments in 1961 have apparently caused no significant change, surveys of treated streams and catches of downstream migrants in fyke nets indicate that recent treatments have been more effective than initial treatments and a further reduction in lamprey abundance can therefore be expected. Improvement of treatments and assessment of results should continue to be emphasized. The Committee believes that variations in the proportion of the catch taken by individual barriers necessitates a continuation of the network on Lake Superior with no reduction in numbers for the moment.
>
> The Committee also recommends that assessment measures be extended, as soon as possible, to Lake Michigan and Lake Huron, for its ability to advise the Commission is seriously limited by insufficient information on the effect of techniques used in initial treatments. The Committee believes that it will not be possible to follow the progress of operations without the establishment of a more extensive sampling of the spawning run by barriers, augmented by information from surveys of ammocetes in streams and fyke netting to assess recruitment. It is suggested that the Commission rely on the judgment of its agents in selecting sites and establishing the period of operation for these assessment barriers.
>
> The Committee believes that until more efficient methods of appraisal are developed, barrier operations should continue to be an essential part of the control program.

Representatives of the Bureau of Commercial Fisheries suggested that barriers on 4 Lake Superior streams, which had not provided definitive data, be discontinued. This action would allow reactivation of the barrier on the Pere Marquette River on Lake Michigan. The Commission was also asked to study the possibility of operating 10

additional assessment barriers on Lake Michigan, if additional funds were provided.

The Commission accepted the recommendation of the Scientific Advisory Committee, but pointed out that program changes would depend on government appropriations in FY 1964 and the cost of maintaining the treatment schedule. The Bureau's proposal represented a satisfactory compromise between the latter and the recommendation of the Committee.

Review of the 1963–64 program. The Commission reviewed the 1963–64 program approved in July 1962, which provided for the following activities:

> *Lake Superior.*—Operate 34 assessment barriers, 26 in the United States and 8 in Canada, to follow changes in lamprey abundance; resurvey about half of the potential lamprey streams for newly established populations; treat 21 streams in the United States and 9 in Canada with lampricide.
>
> *Lake Michigan.*—Operate 3 assessment barriers on Green Bay; continue surveys of streams to locate new populations; treat 15 streams on the east shore.
>
> *Lake Huron.*—Complete surveys to locate lamprey streams and record distribution of ammocetes.
>
> *Research.*—Develop radioactive marking techniques for studying ammocete abundance; screen chemicals with potential as lampricides; develop synergists for TFM; investigate methods of destroying ammocetes living in deep water off stream mouths.

Several changes were suggested in the program. Difficulties in treating the remaining streams on Green Bay during the spring of 1963 had caused a postponement of five until 1963–64. At the same time, three streams on Lake Superior originally scheduled for 1963–64 had been treated earlier. The Commission's agents had also recommended that four new lamprey streams, which had been discovered on the south shore of Lake Superior and three on the north, be treated in 1963–64.

The recommendation of the Bureau of Commercial Fisheries regarding assessment barriers, which had already been adopted by the Commission, would reduce the number in 1964 on Lake Superior to 30, and increase the number on Lake Michigan to 4. The Fisheries Research Board also advised that the investigation of radioactive marking techniques should be postponed because of lack of qualified persons to carry it out. It suggested that the funds for the work be used for the construction of a warehouse at Sault Ste. Marie to replace one destroyed by fire the previous winter.

The Commission adopted the changes proposed and approved contracts with its agents. Since appropriations had not been approved in the United States, the Commission limited its initial obligations to $1,410,800.

Consideration of 1964–65 program. The Commission considered a program for fiscal year 1964–65 which included the following activities:

> *Lake Superior.*—Maintenance of electrical barriers at the 1963–64 level; continuation of surveys to locate residual populations; treatment of 16 streams in the United States and 11 in Canada.
>
> *Lake Michigan.*—Construct 4 additional assessment barriers; increase resurveys of potential lamprey streams; treat 5 streams on the east shore for the first time and 26 streams on the north shore for the second time.
>
> *Research.*—Increase investigations of new lampricides; initiate radioactive marking project.

The Commission asked the Executive Secretary to investigate the possibility of reducing the number of barriers on Lake Superior and increasing the number on Lake Michigan, and submit a revised program to the Commission for approval by July 15, 1963.

Consideration of the prospectus draft. The Chairman reported that a draft containing proposals for economic and technological work on all the Great Lakes, and biological-limnological studies on Lakes Superior, Michigan, and Erie had been issued to the agencies directly concerned with the fishery, to a number of research groups, and to persons representing the commercial and sport fishery interests. He explained that the Secretariat would appreciate any further guidance for improving the final draft. The Commission agreed, however, that discussion should be deferred until the advisors had the opportunity, in meetings of the National Sections, to consider the draft in greater detail. The Chairman urged that consideration be given in these meetings to procedures which the Commission might follow to facilitate implementation of a program.

Administrative matters. The Commission again indicated its concern that certain state agencies still lacked discretionary power to regulate fisheries in their waters of the Great Lakes. The Commission therefore agreed to resubmit its recommendation that a transfer of discretionary power be made.

Time and place of next meeting. The Commission agreed to hold its Interim Meeting during the first week of December 1963 at a place designated by the Chairman.

Adjournment. The Chairman expressed the Commission's appreciation for the interest shown by all participants. The meeting was adjourned at 4:30 p.m. on June 27.

ADMINISTRATIVE REPORT FOR 1963

Officers and staff. There was no change in the Commission's officers. The Secretariat consisted of the Executive Secretary, Assistant Executive Secretary, a secretary, and a typist employed half-time.

Accounts and audit. The accounts of the Commission for fiscal year 1962–63 were audited by the Ann Arbor firm of Icerman, Johnson and Hoffman. The Auditor's Report appears on page 19.

Contributions to the 1962–63 program. The Commission's 1962–63 program and budget were approved in July 1962 and subsequently revised at the 1962 Interim Meeting to provide for continued operation of assessment barriers at a higher level than originally proposed. Contributions requested by the Commission were approved by the Government of Canada and its first installment provided in July 1962. Appropriations by the Government of the United States in October 1962 were $47,000 less than requested and $48,000 below the appropriations for the previous year. The total reduction, including the Canadian readjustment, was $69,275.

At its Interim Meeting, the Commission authorized the use of 1963–64 funds to complete the purchase of lampricide ordered in July 1962. As a result of refunds from the Commission's contracts with the Bureau of Commercial Fisheries and the Fisheries Research Board of Canada, it was necessary to obligate only $10,603 of the 1963–64 funds.

Requests for funds, credits, and contributions for fiscal year 1962–63 were as follows:

	Canada	*United States*	*Total*
Sea lamprey control and research			
Commission request	$424,328.00	$944,472.00	$1,368,800.00
Appropriations	402,865.00	896,700.00	1,299,565.00
Credits from FY 1960–61	8,999.24	20,030.69	29,029.93
	$393,865.76	$876,669.31	$1,270,535.07
Administration and general research			
Commission request	$ 22,300.00	$ 22,300.00	$ 44,600.00
Appropriations	22,300.00	22,300.00	44,600.00
Credits from FY 1961–62	3,063.02	3,063.02	6,126.04
	$ 19,236.98	$ 19,236.98	$ 38,473.96

Expenditures in 1962–63. Agreements were made in 1962 with the Fisheries Research Board of Canada ($302,803) and the U.S. Bureau of Commercial Fisheries ($737,100), which continued in force until March 31 and June 30, 1963, respectively. The Commission also purchased 46,852 pounds of TFM for use in the United States. Towards the end of the fiscal year, the Commission received refunds

from both the Board and the Bureau as the result of underexpenditures, which totalled $58,772. This amount was applied to the purchase of lampricide in the United States.

The program in Canada resulted in the treatment of 13 Lake Superior streams, 5 for the first time. In addition to surveys stipulated, an examination was made of the Welland Canal after sections were drained, to see if lamprey were moving between Lake Ontario and Lake Erie. A number of tributaries to Lake Simcoe and the Severn River were surveyed to assess their suitability for sea lamprey spawning. The study was made in connection with the proposed lock system to replace a marine railway, providing boat passage from Lake Simcoe to Georgian Bay, Lake Huron. A statement of expenditures by the Board appears on page 22.

The program in the United States was handicapped by low flows in the Green Bay tributaries, which were scheduled for treatment in the spring of 1963. Treatments were postponed on the Three Mile, Ahnapee, Pensaukee, Cedar, and Ford Rivers. A resurvey of the mouth of the Manistique River failed to locate ammocetes and the proposed treatment was cancelled. The Lake Michigan treatment crew was shifted to Lake Superior to deal with the Bad, Fish, and Sturgeon Rivers that required earlier re-treatment. A statement of expenditures by the Bureau appears on page 21.

Expenditures for sea lamprey control and research in 1962–63 totalled $1,310,168 against a contribution of $1,299,565. Obligations of $10,603 for lampricide were carried forward into 1963–64. Expenditures in administration and general research totalled $40,756 against a budget of $44,600. The underexpenditure of $3,844 was due largely to the employment of a clerk-typist part time rather than full time.

Contributions to the 1963–64 program. The 1963–64 program was approved by correspondence in July 1962, and was reviewed at the Interim Meeting, November 27–28. In May, the Commission was advised that the Canadian Government had approved the program and its share of the cost. At the Annual Meeting in June, the Commission was advised that the United States contribution had not been approved, but the Commission could anticipate receiving a contribution of $996,000 (approximately $55,000 less than requested, but an increase over the 1962–63 appropriation). On December 19, the Commission was advised that the United States contribution would be $1,030,700.

Agreements with agents in 1963–64. Agreements with agents and orders for lampricide were made in July on the basis of a United States appropriation for lamprey control of $973,500, or a program budget of $1,410,800. Subsequent approval of a contribution of $1,008,200

provided a budget of $1,461,160 of which $1,383,890 had been obligated by December 31, 1963 as follows:

Agreements with agents:	
Bureau of Commercial Fisheries	$ 756,700
Fisheries Research Board of Canada ($355,400 Canadian)	330,500
	$1,087,200
Lampricide purchases:	
For Bureau of Commercial Fisheries:	
60,000 lbs. of TFM at $2.98	$ 178,800
1,500 lbs. Bayer-73 at $5.86 (packaged)	8,790
For Fisheries Research Board:	
40,000 lbs. of TFM at $2.59	103,600
1,000 lbs. of Bayer-73 at $5.50 (bulk)	5,500
	$ 296,690
Total	$1,383,890

Purchases of TFM were based on bids received after invitations were issued separately in the United States and Canada. Bayer-73, the synergist used with TFM, was obtained by a negotiated purchase from the Haviland Agricultural Chemicals Company, a distributor for the Chemagro Corporation, agents for Bayer's agricultural chemicals.

Reports and publications. The 1961 Annual Report was published in March. Publications in the Technical Report Series during 1963 were:

"Lake Erie surveys 1959 and 1960" by Alfred M. Beeton. Great Lakes Fishery Commission, Tech. Rep. No. 6, 32 p.

"The use of alkalinity and conductivity measurements to estimate concentrations of 3-trifluormethyl-4-nitrophenol required for treating lamprey streams" by Richard K. Kanayama. Great Lakes Fishery Commission, Tech. Rep. No. 7, 10 p.

Auditors Report to Commission

ICERMAN, JOHNSON & HOFFMAN

Certified Public Accountants

303 National Bank and Trust Building

Ann Arbor, Michigan

October 1, 1963

Great Lakes Fishery Commission

Room 106

Natural Resources Building

Ann Arbor, Michigan

We have examined the accounts of the Great Lakes Fishery Commission Administration and General Research Fund, and Lamprey Control Operation Fund for the year ended June 30, 1963.

Our examination included tracing of receipts to the depository, verification of the bank balance by direct confirmation, tracing of expenditures to supporting vouchers, and such other tests of the accounting records as we considered appropriate in the circumstances. We did not verify receipts by communication with the payors.

In our opinion, the attached statements of receipts and expenditures present fairly the position of the designated funds of the Great Lakes Fishery Commission at June 30, 1963, and the results of operations for the year then ended.

Icerman, Johnson & Hoffman

Great Lakes Fishery Commission

Administration and General Research Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1963

Receipts

	Actual	*Budget*
Canadian Government	$19,236.98	$19,236.98
United States Government	19,236.98	19,236.98
Total	$38,473.96	$38,473.96

Expenditures

Communication	$ 802.46	$ 800.00
Equipment	410.54	200.00
Insurance, bonding, and audit	375.83	400.00
Rents and utilities	363.79	100.00
Reproduction and printing	1,899.77	2,000.00
Salaries (incuding F.I.C.A. and pension)	32,853.84	35,950.00
Supplies and equipment maintenance	1,704.44	1,800.00
Transportation	12.25	50.00
Travel	2,332.64	3,300.00
Total	$40,755.56	$44,600.00A
Excess of expenditures over receipts	2,281.60	
Fund balance, July 1, 1962	6,126.04	
Fund balance, June 30, 1963	$ 3,844.44B	

Note A—A total of the beginning fund balance plus the anticipated receipts is equal to the anticipated expenditures.

Cash balance, July 1, 1962	$ 6,126.04
Anticipated receipts	38,473.96
Total anticipated available funds	$44,600.00

Note B—Petty Cash $ 5.60
Cash in bank $ 3,838.84
$ 3,844.44

Great Lakes Fishery Commission

Lamprey Control Operation Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1963

Receipts

	Actual	*Budget*
Canadian Government	$ 402,098.00	$ 402,865.00
Advance of 1963–64 funds from Canadian Government	10,603.46A	
United States Government	895,576.85	896,700.00
Refund from Hoechst Chemicals Co.	5,651.10B	—0—
Refund from Fisheries Research Board of Canada for 1962–63 underexpenditures	37,398.62	—0—
Refund from Bureau of Commercial Fisheries or 1962–63 underexpenditures	21,373.51	—0—
Total	$1,372,701.54	$1,299,565.00

Expenditures

Canadian Department of Fisheries	$ 302,802.89	$ 268,770.00
U.S. Fish and Wildlife Service	737,100.00	725,585.00
Lampricide purchases	329,037.70	374,445.00
Obligated for unpaid commitments of 1962–63	584.04	—0—
Total	$1,369,524.63	$1,368,800.00
Excess of receipts over disbursements	$ 3,176.91	
Fund balance, July 1, 1962	2,474.19	
Fund balance, June 30, 1963	$ 5,651.10	

Note A—It was necessary for the Commission to suspend Financial Regulations 4(b) and 5(d) temporarily so that a portion of advanced 1963–64 funds could be used to cover 1962–63 obligations.

Note B—This is the portion of obligations for unpaid commitments of 1961–62 which has been cancelled during 1962–63 due to loss of chemicals during refiltering process.

Statement of Advanced Funds Received

Advance of 1963–64 funds by Canadian Government 6–3–63	$40,000.00	
Portion expended to cover 1962–63 obligations	10,603.46	$ 29,396.54
Advance of 1963–64 funds by Canadian Government 6–25–63		324,974.00
Balance of 1963–64 funds in bank as of June 30, 1963		$354,370.54

Fisheries Research Board of Canada

Financial Report to Great Lakes Fishery Commission

April 1, 1962 to March 31, 1963

Administration in field (41.9% of costs of London Headquarters)	($104,083.06)	$ 43,610.80
Operations:		
Operation and Maintenance of Electric Barriers		40,494.16
Chemical Control		133,644.72
Stream Surveys		45,683.13
		$263,432.81
Contributions to Superannuation		
6½% of Permanent Salaries	($ 95,683.08)	6,219.40
		$269,652.21
Contract Administration		
6% of Total Disbursements		16,179.13
	(Canadian)	$285,831.34
Funds provided by Commission		
Payments under 1962–63 Contract	$326,162.00	
Cost applicable to 1962–63	285,831.34	
Unexpended Balance (Canadian)	$ 40,330.66	

Bureau of Commercial Fisheries
Sea Lamprey Control and Research Program
Report of Expenditures for All Activities
July 1, 1962 through June 30, 1963

Activity	*Funds Programed*	*Expenditures and Obligations* — *Salaries*	*Expenses*	*Total*	*Unobligated Balance*
Program costs:					
Ann Arbor Laboratory					
Chemical Control	$432,926.00	$311,798.60	$115,266.26	$427,064.86	$ 5,861.14
Barrier Operations	155,598.00	98,435.64	49,122.22	147,557.86	8,040.14
Research	87,076.00	63,522.12	22,490.17	86,012.29	1,063.71
	$675,600.00	$473,756.36	$186,878.65	$660,635.01	$ 14,964.99
Washington, D.C.	$ 21,100.00	$ 18,766.85	$ 1,929.21	$ 20,696.06	$ 403.94
General Administration and Executive Direction					
Ann Arbor	$ 36,200.00	$ 35,208.53	$ 700.43	$ 35,908.96	$ 291.04
Totals	$732,900.00A	$527,731.74	$189,508.29	$717,240.03	$ 15,659.97B

Note A—$737,100 provided by Commission
2,800 provided from equipment sales
739,900
7,000 refunded to Commission before end of fiscal year
$732,900

Note B—$14,373.51 refunded to Commission before end of fiscal year
1,286.46 refunded to Commission after end of fiscal year
$15,659.97

Bureau of Commercial Fisheries
Sea Lamprey Control and Research Program
Report of Expenditures for All Activities
July 1, 1962 through June 30, 1963

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LAMPREY CONTROL EXPERIMENT IN CANADA

by

Fisheries Research Board of Canada

The following report is based on work carried out by the Fisheries Research Board's Biological Station at London, Ontario.

Lamprey run assessment

Electrical barriers were operated on eight Lake Superior tributaries in 1963 for the purpose of assessing the relative size of the spawning population of sea lampreys. All barriers were operated continuously, for all practical purposes, from the day activated (May 15) until July 31. The number of sea lampreys collected at each barrier between May 15 and July 31 in each of the years 1956 to 1961 inclusive are tabulated in Table 1. Six of the barriers are on streams which flow into Whitefish Bay, the other two on streams which flow into Nipigon Bay. The totals given in Table 1 are regarded as good indices of the relative abundance of sea lampreys at the corresponding times and places. The Whitefish Bay subtotals indicate a relatively stable population from 1956 to 1961 inclusive, then a dramatic decrease in population size between 1961 and 1962. The decreased level of abundance persisted in 1963; no special significance is attached to the difference between counts in 1962 and in 1963. The decline from the 1956–61 level of abundance to the 1962–63 level is attributed to the treatment of Lake Superior streams with lampricide.

TABLE 1.—Number of sea lampreys collected annually at electrical barriers on eight Canadian tributaries to Lake Superior during the period May 15–July 31 between 1956 and 1963.

Tributary	1956	1957	1958	1959	1960	1961	1962	1963
Whitefish Bay								
Big Carp	23	23	11	15	20	6	5	2
Harmony	22	15	6	7	19	14	3	0
Chippewa	825	353	171	290	1,045	453	123	222
Batchawana	382	408	301	467	626	561	136	336
Sable	58	63	36	138	241	88	10	36
Pancake	657	1,051	750	804	1,286	931	187	387
Subtotal	1,967	1,913	1,275	1,721	3,237	2,053	464	983
Nipigon Bay								
Pays Plat	4	3	4	30	10	31	9	9
Big Gravel	8	101	152	537	626	799	315	64
Subtotal	12	104	156	567	636	830	324	73
Total	1,979	2,017	1,431	2,288	3,873	2,883	788	1,056

The Nipigon Bay totals indicate a rapid increase in the local lamprey population until 1961, followed by a dramatic decline between 1961 and 1962. The lower population level persisted in 1963; it is not clear whether the difference between 1962 and 1963 should be regarded as significant or as only part of a natural fluctuation at the lower level. In any case, the decline from the population level reached by 1961 is attributed to treatment with lampricide.

Stream surveys

A careful search for sea lamprey ammocoetes was made in each of 335 Lake Superior streams where none had previously been found. Sea lamprey ammocoetes were found for the first time in 7 of them: East Davignon Creek, Stillwater Creek, Otter Cove Creek, Cypress River, Little Gravel River, Cash Creek and Nipigon River. The discovery of sea lampreys where they had not been recorded previously is attributed to improved techniques and to a persistent search, rather than an invasion of streams that were lamprey-free when earlier surveys were made.

A preliminary survey, designed to find which Lake Huron streams are populated by sea lamprey ammocoetes, was completed several years ago. In most cases detailed surveys to map the distribution of ammocoetes within each stream, as a necessary preliminary to chemical treatment, have also been completed. In 1963, 66 Lake Huron streams were resurveyed to determine if lampreys had become established since the original surveys.

To facilitate any planning that may be required for lamprey work on Lake Ontario, preliminary surveys were made on 230 streams. Included in the survey was almost every stream along that part of the shoreline which stretches clockwise from Niagara River almost to Belleville. Young sea lampreys were found in 16 of the streams as follows: Bronte Creek, Credit River, Rouge River, Duffin Creek, Lynde Creek, Oshawa Creek, Harmony Creek, Bowmanville Creek, Wilmot Creek, Graham Creek, Cobourg Brook, Sheltered Valley Brook, Salem Creek, Butler Creek, and two other nameless rivulets, one between Graham Creek and Cobourg Brook, the other between Cobourg Brook and Sheltered Valley Brook. Because the time allotted was limited and because of unfavorable weather, it is likely that ammocoetes occur in several other streams where none were recorded during this survey.

Ammocoetes in lake and estuaries

An electrified trawl, based on a design developed by the U.S. Bureau of Commercial Fisheries, Marquette, Michigan, was used to collect sea lamprey ammocoetes in Batchawana Bay during August and September. The trawl was hauled 110 times for a total of 21 hours

and covered a total bottom area estimated at almost 100,000 square yards. All hauls were made within 1000 yards of the mouth of the Sable River in water ranging from 2 to 18 feet deep. Ammocoetes of 22 sea lampreys, of 106 American brook lampreys and of 5 of the genus *Ichthyomyzon* (i.e., either silver lamprey or Michigan brook lamprey) were collected. Two of the sea lamprey ammocoetes were partially transformed. Calculations based on these limited collections indicate about 1.7 ammocoetes per 1000 square yards inshore and about 0.15 per 1000 square yards offshore. The calculated inshore concentration is very close to the value derived by an earlier investigator, but the calculated offshore concentration is about one-tenth of the value calculated earlier. These results require further confirmation.

The three main lamprey-producing streams which are tributary to Batchawana Bay, namely, the Chippewa, Batchawana and Sable Rivers, have been treated with lampricide each year since 1961, and the Batchawana and Sable were also treated in 1959. Following each treatment, representative samples of ammocoetes that had been killed by lampricide were collected. In every case, ammocoetes were collected both in the main river (i.e., where the water always moves in one direction) and in its estuary. In some cases, lampricide-bearing river water remained undiluted for long enough to kill ammocoetes in the lake close to the river mouth, making it possible to collect from a limited area of the lake. As it is extremely difficult to find the smaller ammocoetes after a treatment, those collected were almost all more than one year old.

The number of ammocoetes collected was not necessarily related to their abundance, since the effort expended varied greatly as did physical conditions which influence ease of collection. However, samples can be used for roughly assessing sea lamprey abundance because of the following circumstances. The ammocoetes in the sample are predominantly Michigan brook lampreys and American brook lampreys; some silver lampreys, whose ammocoetes cannot be distinguished from those of Michigan brook lamprey, are presumed to occur also, probably rarely. Each of the three rivers in question has on it a natural barrier which prevents spawning-run sea lampreys from ascending more than a few miles. Before stream treatments, sea lamprey ammocoetes were found only as far upstream as these natural barriers, but the other species were at least as abundant above the natural barriers as below them. The rivers were treated only up to, or for a short distance above, the natural barriers. Since ammocoetes tend to drift downstream, all sizes of brook lamprey ammocoetes begin repopulating the treated area soon after treatment. On the other hand, until about 2 years after treatment the only source of sizeable sea lamprey ammocoetes is migration from the open lake, and sea lamprey

ammocoetes are unable to stem a perceptible current. Therefore, a decrease in percentage of sea lamprey ammocoetes can be regarded as evidence of a decrease in absolute numbers.

The percentage of sea lamprey ammocoetes in each collection is indicated in Table 2. Except in the Chippewa River where the distance from estuary to natural barrier is short, about one-half mile, these data indicate a many-fold decrease in abundance of sea lamprey ammocoetes in the main river. The data on abundance in the lake near these river mouths, though limited, suggest much less change in abundance, if any. In the estuarial areas the abundance declined substantially, but not as much as in the main rivers. A plausible explanation is that some sea lamprey ammocoetes migrate into estuaries from the open lake either actively or passively during the "upbound" phase of the reversing currents which are characteristic of the mouth of these rivers.

TABLE 2.—Percentage of sea lamprey ammocoetes in collections of various species of ammocoetes made during successive treatments of 3 Batchawana Bay streams with lampricide.

[Figures in parentheses indicate total numbers of ammocoetes of all species.]

	1959	1961	1962	1963
Chippewa				
Lake	Not	– (0)	4 (555)	– (0)
Estuary	treated	2 (664)	2 (838)	7 (997)
Main River		0 (72)	1 (692)	0 (173)
Batchawana				
Lake	– (0)	– (0)	40 (8)	33 (3)
Estuary	47 (652)	18 (864)	11 (89)	9 (166)
Main River	33 (1551)	15 (1352)	4 (1023)	0 (229)
Sable				
Lake	11 (59)	– (0)	– (0)	– (0)
Estuary	17 (78)	9 (2740)	6 (108)	10 (205)
Main River	15 (1295)	45 (529)	0 (12)	2 (114)

Chemical treatment

In 1963, 13 Lake Superior streams were treated with lampricide; standard techniques were used. Essential details of the treatments are summarized in Table 3. Note that the assessments of ammocoete abundance are subjective estimates. We are indebted to the Ontario Department of Lands and Forests for assistance with some of the treatments, particularly for air transportation of material.

TABLE 3.—Canadian streams treated with lampricide, Lake Superior, 1963.

Stream	Date of treatment	Discharge (cfs)	Stream miles treated	Pounds of active ingredient	Ammocoete abundance
W. Davignon	May 17–19	18	8.5	93	Scarce
E. Davignon	May 25–28	16	5.5	142	Scarce
Harmony	May 29	37	1.5	140	Scarce
Pearl	June 23–24	90	3.0	468	Scarce
Pays Plat	June 25–27	299	7.5	1,382	Scarce
Batchawana	July 11–14	174	10.0	1,399	Scarce
Chippewa	July 15–17	84	1.5	648	Scarce
Sable	July 18–20	16	14.5	149	Scarce
Dog	Aug. 1–2	200	2.0	921	Scarce
Big Pic	Sept. 1–16	1,155	94.0	13,144[a]	Abundant
White	Sept. 10–13	400*	3.0	5,680[b]	Moderate
Michipicoten	Sep. 29–30	1,500*	17.0	8,581[c]	Abundant
Otter Cove	Oct. 8	1	0.25	40	Scarce
Stillwater	Oct. 10–12	2	7.0	49	Scarce
Cypress	Oct. 12–13	14	4.0	89	Moderate
Total		4,006	179.25	32,925	

* Flow estimated.
a Plus 350 lbs. of Bayer-73.
b Plus 125 lbs. of Bayer-73.
c Plus 225 lbs. of Bayer-73.

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An innovation in 1963 was the use of a chemical, trade name "Bayer-73", as a synergist during three of the treatments. Laboratory tests had indicated that when a small quantity of Bayer-73 is mixed with the usual lampricide, 3-trifluormethyl-4-nitrophenol, the mixture kills ammocoetes at about half the concentration that would be required if the synergist were not added. Experience with the synergist during the Big Pic, White and Michipicoten treatments supports conclusions reached in the laboratory that with the synergist the amount of chemical required for a standard treatment can be appreciably reduced, thereby reducing the cost of each stream treatment.

Most Canadian streams have now been treated two or more times. During the second and subsequent treatments, ammocoete collections from several of them have included some sea lamprey ammocoetes which were too large to be the result of spawning since the previous treatment and which were too far upstream to be attributable to immigration from the lake. Obviously, although most ammocoetes are killed when streams are treated with lampricide, a small proportion of the sea lampreys in at least some of the streams survive the treatment. The results of numerous bioassays indicate little likelihood that any ammocoete which is exposed to lampricide-treated stream water for a reasonable time will survive. Therefore, those which survive the treatment must do so by evading exposure to the treated water. An ammocoete in a slough which is isolated from the treated river, or in the treated river but at the mouth of a tiny rivulet where there is local dilution of the lampricide, would evade a lethal exposure. But ammocoetes have apparently survived even when great care was taken to eliminate all such obvious ways by which they could evade exposure.

It was therefore considered desirable to investigate the possibility that some aspect of the ammocoete's burrowing habit enables it to evade exposure to a lethal concentration in a treated stream. A number of experiments were therefore conducted in the laboratory and in the field. Although the investigation is far from completed, several interesting observations have been made. For instance, sea lamprey ammocoetes burrow into the stream bottom as much as 20 inches. If the water level is dropped so that the stream bottom is exposed, they survive for many hours in burrows in the exposed substrate. A few ammocoetes tolerate as much as 72 hours exposure on the dried-up "stream bottom" and recover at the end of that time if given access to water.

LAMPREY CONTROL AND RESEARCH IN THE UNITED STATES

by

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Sea lamprey control made significant progress on the Great Lakes during 1963. The catch of adult lampreys (11,117) continued to be low at the assessment barriers on 26 south shore streams of Lake Superior. Although the number surpassed last year's low of 9,227 by 1,990 animals, it still represented a decline of 83 percent from the 1961 figure of 67,360.

The stream-treatment program advanced well until drought reduced stream flows in early autumn. Forty-eight tributaries discharging 4,504 cfs of water were treated with 63,729 pounds of the selective lampricide TFM (3-trifluormethyl-4-nitrophenol). Twenty-six of the streams were along the south shore of Lake Superior and 22 were tributaries of Lake Michigan. Six of the Lake Michigan streams were treated with a synergistic mixture (TFM-2B) containing 98 percent by weight of TFM and 2 percent 5,2′-dichloro-4′-nitrosalicylanilide. Surveys of Lake Huron streams located 48 that contain sea lamprey larvae.

Lake Superior surveys and bioassays

Surveys were completed on 187 streams. Of these 136 contained no larvae; 7 had small populations of larvae for the first time, which raised to 76 the number of lamprey-producing streams on the south shore; and 44 were treated streams examined in preparation for re-treatment. Posttreatment surveys to determine the success of recent treatments were completed on 10 streams. Residual populations of larvae were found in 3 of these streams: the Bad River, Deer Lake Outlet, and Traverse River. Only the latter river contained enough residual ammocetes to warrant early re-treatment. The streams and channels of Isle Royale, resurveyed after 4 years, were among those streams found to contain no larvae.

Bioassays were made on waters from 46 streams to determine TFM concentrations useable in treatment and to test the reliability of predictions of concentrations from alkalinity and conductivity measurements. Minimum lethal concentrations (100-percent lamprey mortality in 9 hours or less) were predicted within ± .5 ppm 41 times (89 percent) and the maximum allowable concentrations (25-percent fish mortality in 9 hours or less) were predicted within ± 1 ppm 28 times (61 percent).

Lake Superior chemical treatments

Treatment of 26 streams (discharge 3,043 cfs) along the south shore was accomplished between April and mid-September (Table 1). Nine of the streams were treated for the first time and 17 were re-treated (Table 2). Survivors from previous treatments were not found in significant numbers.

One of the initial treatments was on Trap Rock River, Houghton County, Michigan, which could not be surveyed with confidence because extremely high conductivity reduced the effectiveness of electrical shockers. No sea lamprey larvae were found. Unusually low water flows in early autumn forced postponement of treatments of 6 streams. Low flows also nullified the treatment of Traverse River.

Treatments with TFM killed sea lamprey ammocetes in 4 of 13 isolated oxbows on the Ontonagon River and in 3 of 16 ponds on the Sturgeon River. Two likely oxbow ponds in the Bad River system were partially treated with TFM but no ammocetes were present. Control of concentration in ponds is so difficult that sometimes fish are killed. Fortunately, no important fishes were involved.

The only serious fish kill during the 1963 treatments was in the Bad River. Conentrations of TFM near the maximum allowable level in a tributary of the river killed some walleyes and white suckers in spawning and postspawning condition. Approximately 400 dead walleyes and 4,000 white suckers were observed.

Lake Michigan surveys and bioassays

Surveys in 1963 disclosed sea lamprey larvae in 5 more tributaries of Lake Michigan, bringing the number of known infested streams to 99. The estimated discharge of the lamprey-producing tributaries is about 14,000 cfs. Posttreatment surveys of 29 streams on the north and west shores revealed residual sea lamprey ammocetes in 7. The Whitefish River and Beattie Creek were the only ones with significant numbers. Those in the Whitefish River system were present in 2 lake outlets that could not be treated. An untreated tributary to Beattie Creek had a small population of larvae.

Posttreatment surveys on 6 streams along the east shore that were treated experimentally with the synergistic mixture, TFM-2B, were conducted because of an unexpected kill of brown trout in 2 of the rivers. Brown trout were still abundant in Little Manistee River (9 areas sampled) in which approximately 2,000 were found dead after treatment, and common to abundant in 7 of 8 areas sampled in the Platte River, where an estimated 500 were killed. Pretreatment bioassays were completed on water from 40 tributaries of Lake Michigan.

TABLE 1.—Summary of chemical control in the United States waters of the Great Lakes, 1958–63.

Year	Number of streams	Discharge at mouth (cfs)	Stream miles treated	Amount of active ingredient (pounds)
Lake Superior				
1958	10	619	178	6,265
1959	29[1]	1,616	286	19,147
1960	16[1]	3,651	397	51,400
1961	9[2]	453	139	9,653
1962	19[3]	1,567	366	22,471
1963	26[4]	3,043	399	38,604
Total	109	10,949	1,765	147,540
Lake Michigan				
1960	7	140	70	1,751
1961	26	1,094	252	24,689
1962	8	422	342	15,173
1963	22	1,461	350	25,125
Total	63	3,117	1,014	71,738
Lake Huron				
1961	1	10	14	318
1962	2	81	38	3,114
1963	0	0	0	0
Total	3	91	52	3,432
Grand total	175	14,157	2,831	222,710

[1] Includes 1 re-treatment.
[2] Includes 8 re-treatments.
[3] Includes 14 re-treatments.
[4] Includes 9 initial treatments and 1 for survey.

Lake Michigan chemical treatments

Thirteen tributaries between the Door Peninsula in Wisconsin and the Garden Peninsula in Michigan were treated with TFM. One north shore and 8 east shore streams were also treated (Tables 1 and 3). Six of the streams were treated with the synergistic mixture (TFM-2B) which reduced lampricide requirements by 40 to 50 percent. Some difficulties arose in mixing and applying TFM-2B and these problems are being investigated. The actual costs of chemical for treatment with TFM-2B and the estimated cost for TFM alone were $25,997 and $53,091, respectively.

TABLE 2.—Details on the application of sea lamprey larvicide to 26 streams tributary to Lake Superior, 1963.

Stream	Date	Discharge at mouth (cfs)	Concentation (ppm)		Amount of active ingredient (pounds)
			Minimum effective	Maximum allowable	
Deer Creek[1]	April 24	34	1.5	2.0	162
Bad River	May 27	900	1.0	5.0	12,011
Fish Creek (Eileen T.)	June 1	80	2.0	8.0	882
Raspberry River[1]	June 1	2	1.5	6.0	108
Six Mile Creek[1]	June 20	24	3.0	9.0	240
Sturgeon River[2]	June 22	1,085	1.0	6.0	11,505
Ontonagon River	July 3	600	2.5	7.0	8,520
Seven Mile Creek	July 17	17	3.0	8.0	216
Mosquito River	July 18	10	4.0	13.0	288
Beaver Lake	July 19	34	5.0	7.0	312
Grants Creek	July 21	3	1.5	6.0	48
Galloway Creek	July 22	6	2.0	4.5	144
Naomikong Creek[1]	July 23	7	3.5	9.0	144
Ankodosh Creek	July 23	6	4.0	10.0	168
Pendills Creek	July 24	24	2.0	6.0	192
Carp River[1]	July 30	15	4.5	11.0	288
Traverse River	August 2	3	2.0	4.0	144
McCallum Creek[1]	August 4	1	2.0	5.0	8
Trap Rock River[3]	August 5	15	5.0	12.0	264
Eliza Creek	August 5	1	3.0	6.0	8
Salmon-Trout River	August 14	38	2.5	8.0	752
Pine River	August 14	19	1.5	3.0	120
Graveraet River[1]	August 28	15	3.0	9.0	288
Salmon-Trout River	August 28	26	3.0	6.0	432
Dead Sucker River[1]	September 11	28	3.5	8.0	312
Sucker River	September 12	50	2.5	7.0	1,048
Total		3,043			38,604

[1] Initial treatment.
[2] Sections above and below Otter Lake treated separately on September 4.
[3] Treatment of a negative stream to check survey results.

Treatments of east shore streams were halted in late September due to low water flows and the susceptibility of brown trout to the lampricide.

Lake Huron surveys

Surveys were completed of the Lake Huron tributaries not previously examined. Sea lamprey larvae have been found in 48 of 351 streams along the west and north shore of the lake. Ammocetes were taken also at 6 of 25 stations on the St. Marys River. Origin of these larvae is unknown and will have to be determined. In other respects

the surveys were complete. The locations of access roads to chemical applications sites also were determined. The total discharge of the 48 streams was estimated to be approximately 2,200 cfs at stages of reasonable minima for treatment.

Electric barrier operations

Electric barriers were operated on 26 streams along the south shore of Lake Superior (Table 4) as indices to the abundance of spawning sea lampreys. This number was a reduction of 3 barriers from the previous year. The structures functioned well and no difficulties were encountered. A total of 11,117 sea lampreys was taken during the season. This number is 1,990 above the comparable catch (9,127) for 1962, and 56,243 below the 1961 catch of 67,360.

TABLE 3.—Details on the application of sea lamprey larvicide (TFM) and the mixture of TFM and Bayluscide (5,2′-dichloro-4′-nitrosalicylanilide) to 22 streams tributary to Lake Michigan, 1963.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		Active TFM (pounds)	Bayluscide (pounds)
			Minimum effective	Maximum allowable		
Sugar Creek	Apr. 17	6	5.0	8.0	54	...
Johnson Creek	Apr. 17	5	5.0	8.0	63	...
Rochereau Creek	Apr. 18	6	4.0	8.0	72	...
Beattie Creek	Apr. 18	10	5.0	12.0	90	...
Springer Creek	Apr. 19	9	5.0	10.0	198	...
Bailey Creek	Apr. 21	8	4.0	8.0	378	...
Sunny Brook Creek	Apr. 21	17	4.0	8.0	252	...
Hibbards Creek	Apr. 22	15	7.0	19.0	445	...
Whitefish Bay Creek	Apr. 22	23	9.0	15.0	567	...
Lilly Bay Creek	Apr. 24	2	11.0	19.0	122	...
Ephraim Creek	Apr. 26	8	7.0	19.0	162	...
Bear Creek	Apr. 26	2	7.0	13.0	78	...
Sturgeon River	May 1–13	280	1.0	4.0	3,330	...
Davenport Creek	Aug. 7	10	4.5	8.0	249	...
Acme Creek	Aug. 11	12	8.0	16.0	411	...
Mitchell Creek	Aug. 12	35	5.0	12.0	162	4.5
Boardman River	Aug. 20	236	4.5	8.0	3,585	100.0
Good Harbor Creek	Aug. 24	12	3.5	7.0	180	5.0
Crystal River	Aug. 26	16	3.5	6.0	216	6.0
Platte River	Sept. 7	395	3.5	8.0	7,704	49.5
Betsie River	Sept. 20	170	3.5	7.0	2,559	68.5
Little Manistee R.	Sept. 26	184	5.0	15.0	4,014	...
Total		1,461			24,891	233.5

The first mature lamprey was taken April 2, in the Au Train River. The run increased slowly; the initial peak (29 percent of total run) appeared May 26 to June 4, and a second one (30 percent of total run) June 15 to 29. The migration declined gradually until only 482 sea lampreys were taken in the last 9 days of operation. Barriers in the 8 principal streams took 9,911 lampreys or 90 percent of the total catch. Three streams (Two Hearted, Sturgeon, and Brule Rivers) produced 7,298 lampreys or 65 percent of the total. The 18 barriers east of Keweenaw Peninsula contributed 66 percent (7,389) of the season's total and the 8 barriers to the west accounted for the remaining 34 percent (3,728). Wide annual variation of catch continued in some streams.

The 3 index barriers on streams tributary to northern Green Bay, Lake Michigan, were operated April 2 to July 2 (Table 4). The upstream migration developed slowly to an initial peak (17 percent of total catch) May 6–10. Migration decreased during a period of cold weather and then increased again to a peak on May 26–30 (25 percent of total catch). The run then declined rapidly and was practically over when operations were terminated. A total of 7,461 sea lampreys was captured; a decline of 8 percent from the 1962 catch. A decline of 55 percent from 1962 in the catch in the Bark and Sturgeon Rivers probably was due to the recent chemical treatment of these streams. The Cedar River, which has not been treated, had an increase of 12 percent.

The size of sea lampreys sampled from 11 Lake Superior streams (length 16.6 inches, weight 5.5 ounces) did not change significantly from last year. The sex ratio (expressed as number of males per 100 females), however, decreased to 204 from the all-time high of 229 in 1962. The sex ratio east of the Keweenaw Peninsula decreased from 200 in 1962 to 184 in 1963; west of the Keweenaw the decrease was from 268 males in 1962 to 225 in 1963.

Biological data from Lake Michigan were limited to those collected on the Bark River. Sea lampreys were 0.6 inch shorter and 1.0 ounce lighter in 1963 than in 1962. Males per 100 females increased from 178 in 1962 to 216 in 1963.

The numbers of the principal migratory fishes (rainbow trout, white suckers, and longnose suckers) ascending the rivers of Lake Superior blocked by barriers did not change significantly. Spawning-run rainbow trout captured totaled 1,390 compared to the 7-year average of 1,323. The incidence of sea lamprey wounds on rainbow trout declined to 2.2 percent, the lowest level since 1959. The catches of white and longnose suckers continued without trend.

Fyke net operations

Catch records of fyke nets continue to demonstrate major reductions in sea lamprey populations in treated streams of Lake Superior.

TABLE 4.—Catches of adult lampreys to mid-July at barriers on 26 Lake Superior streams and to the end of June on 3 Lake Michigan streams.

Streams	1958	1959	1960	1961	1962	1963
Lake Superior						
Waiska River	70	42	122	87	10	34
Pendills Creek	16	38	30	74	10	11
Betsy River	1,061	999	696	1,366	316	444
Two Hearted River	3,388	3,950	4,290	7,498	1,757	2,447
Sucker River	1,613	2,436	4,683	3,209	474	698
Hurricane River	29	63	80	96	6	36
Miners River	94	127	399	220	64	107
Furnace Creek	38	350	2,211	1,012	132	142
Au Train River	337	164	74	181	179	130
Rock River	1,403	1,170	2,598	3,660	399	353
Chocolay River	6,133	3,486	4,173	4,201	423	358
Harlow Creek	1	15	10	22	89	28
Iron River	391	250	317	2,430	1,161	110
Pine River	22	39	28	70	2	20
Huron River	3,447	1,408	1,237	4,825	70	201
Ravine River	4	12	4	6	2	3
Silver River	2,000	753	1,271	5,051	267	760
Sturgeon River	28	539	161	427	397	1,437
Elm River	1	2	7	9	0	0
Misery River	830	2,433	696	962	80	24
Firesteel River	1,532	2,044	250	1,118	70	178
Cranberry River	0	5	22	12	1	3
Brule River	22,637	19,156	9,539	22,478	2,026	3,414
Poplar River	575	8	57	103	2	0
Middle River	4,829	3,598	2,815	3,502	311	48
Amnicon River	7,622	968	1,094	4,741	879	131
Total	58,101	44,055	36,864	67,360	9,127	11,117
Lake Michigan						
Sturgeon River	1,280	733	910	2,378	1,650	751
Bark River	1,255	1,047	1,065	1,085	710	298
Cedar River	8,134	6,856	4,676	9,423	5,729	6,412
Total	10,669	8,636	6,651	12,886	8,089	7,461

Metamorphosing and larval sea lampreys were taken at a rate of 0.4 per 100 days of fishing through July and 4.5 per 100 days after July. These figures represent a 98-percent reduction from the average 3-year catch per 100 days fished in untreated streams of Lake Michigan. Multiple treatments of Lake Superior streams have reduced lamprey populations in some streams to a level where fyke nets are no longer productive.

The catches in 2 untreated northern tributaries of Lake Michigan continue to demonstrate a high rate of downstream movement. The catch per 100 days of fishing through July was 81.3 and after July, 128.7 transforming individuals.

The value of fyke netting in streams to measure the relative success of treatment was demonstrated by catches in Whitefish River. A catch of 2,085 newly metamorphosed sea lampreys per 100 days of fishing indicated conclusively that the treatment in sections of that river was unsuccessful. The Whitefish River will be re-treated after operational procedures of the first attempt are examined to find the sections of stream not adequately covered.

Fyke nets were fished in 6 streams tributary to the east shore of Lake Michigan, November 4 to December 16. Duplication of this operation during succeeding years will provide comparative information for judging success of treatments in this area.

A mechanical rotary screen on a water intake of an industrial firm that uses Pere Marquette River water has provided a novel device for collecting recently transformed sea lampreys. The screens have been inspected in the spring and autumn for the last 2 years. In 1962, 5,771 metamorphosed sea lampreys were removed from the screens and during the current year 20,321.

Reestablishment in treated streams

Populations of larvae established following chemical treatment are known to exist in 31 tributaries along the south shore of Lake Superior. Young-of-the-year larvae were found in 23 streams. The 1961 and 1962 year classes were present in 13 and 20 streams, respectively. Only 5 rivers are known to contain the 1960 year class.

The drastic reduction in the spawning run of sea lampreys in 1962 in Lake Superior was reflected by a corresponding decrease in production of larvae. Survey personnel observed significantly fewer larvae of the 1962 year class than of the 1961 year class. Ammocete collections made during re-treatments substantiated these observations. Data from these studies also indicate that the duration of the larval stage may reach or exceed 6 years in some rivers. No evidence of transformation has been observed among 3-year-old sea lamprey ammocetes.

Ammocetes in estuaries and lakes

The electric beam trawl was operated off the mouths of 28 Lake Superior streams from Pigeon Bay, Minnesota, to Whitefish Bay, Michigan. Thirty hours of trawling produced only 14 sea lamprey ammocetes at 3 locations. Two were captured in Pigeon Bay, 1 near the mouth of the Brule River, and the remaining 11 were taken off Furnace Creek. Eighty-six American brook lampreys were captured in 5 locations; of these 70 were taken in Munising Bay. One *Ichthyomyzon* larva was captured near the mouth of Tahquamenon River.

Trawling in Lake Michigan waters was limited to Traverse Bay, Lake Charlevoix, and Pere Marquette Lake. Four sea lamprey ammocetes were captured in the south arm of Lake Charlevoix and 1 in the west section of Traverse Bay.

Exploratory trawling also was tried among the Les Cheneaux Islands, Lake Huron, and in the St. Marys River. In 125 minutes of towing, 2 sea lamprey and 4 American brook lamprey ammocetes were captured among the islands. Sixteen American brook lamprey ammocetes and 1 *Ichthyomyzon* ammocete were taken in the St. Marys River in 67 minutes of towing.

Evaluation of the efficiency of the electric trawl in controlled experiments was inconclusive. However, experience indicated that in areas with relatively high concentrations of sea lamprey ammocetes, the trawl will take larvae at the rate of 1 or more per minute. The rate of capture in East Bay (Lake Superior) was 121 per 100 minutes prior to chemical treatment. No ammocetes were captured after the treatment. Loss of recruitment to West Bay from East Bay after treatment was reflected in the rate of capture from West Bay, where the catch fell from 14 ammocetes per 100 minutes of towing in 1961 to 6 in 1962 and to nil in 1963.

The rate of capture has increased off the mouth of Furnace Creek where the recruitment into lake waters is unimpeded. Ammocetes were captured at the rate of 15 per 100 minutes in 1962 and 17 in 1963.

Sea lamprey research

The search for new chemicals specifically toxic to sea lampreys and the investigation of the selective properties of salicylanilide compounds were major objectives of the research program. The various aspects of the toxicity of TFM (3-trifluormethyl-4-nitrophenol) continued to be explored, especially its action in synergism with Bayluscide (5,2′-dichloro-4′-nitrosalicylanilide). Quality-control assays also were conducted on all lots of TFM purchased by the Commission. In conformity with federal policy on pesticides, the Bureau began development of methods for detecting residues of TFM in the treated environment, including its aquatic inhabitants. Experiments were continued on the effects of fluctuating temperatures on the development of sea lamprey eggs. Other biological studies included experimental hybridization of several species of lampreys and the effect of nutrition on growth and metamorphosis. A project concerned with the history of one age group of sea lamprey ammocetes was continued.

Screening of new chemical compounds. Since the beginning of the second screening program, 616 compounds have been tested; 220 were toxic to ammocetes at concentrations of 10 ppm or less. Sixty-four of

86 compounds of the halo-nitro-salicylanilide group exhibited some degree of selective toxicity for sea lampreys.

The discovery that Bayluscide, a compound used to control snails, is highly toxic (0.08 ppm MLD) to sea lamprey larvae aroused interest in the salicylanilides. Although toxic to fish, its extreme toxicity to sea lamprey larvae resulted in 2 lines of investigation: possible enhancement of the selective properties of TFM by the addition of small amounts of the material and evaluation of related halo-nitro-salicylanilides.

Small amounts of Bayluscide improved the toxicity of TFM without affecting significantly its selectivity toward sea lampreys. A mixture containing 98 percent TFM and 2 percent Bayluscide (TFM-2B) by weight was assayed in waters from 27 different sources. Toxicity was consistently twice as great as for TFM alone. The laboratory tests were confirmed by simulated stream treatments at Hammond Bay and the treatment of 6 streams along the east shore of Lake Michigan.

Other salicylanilides were tested to relate chemical structure to toxicity and selectivity. Compounds exhibiting a high degree of selective toxicity were analyzed to determine structural relationship with biological activity. On the basis of these data additional salicylanilides are being synthesized in a search for more specific forms.

TFM residues in the environment. The effect of lampricidal concentrations of TFM on mammals was determined before the chemical was used in Lake Superior. When higher concentrations of TFM were required to treat Lake Michigan streams, the Wisconsin Alumni Research Foundation again determined that no harmful effects to mammals were attributable to the increased concentrations.

Concern over the persistence of TFM (a stable compound) in the environment and possible accretion of harmful residues in fishes and their food chain started a search for analytical methods to determine residue levels of TFM in natural waters, bottom sediments, fish, and aquatic invertebrates exposed to the lampricide. Initial study involved the use of activated carbon as an adsorptive agent to concentrate TFM from natural water. More recently, ion-exchange adsorption was investigated. Lampricide is adsorbed to an anion-exchange resin to the extent that original concentrations as low as 1.0 ppb have been measurable spectrophotometrically in the laboratory.

Methods are being sought for determining residue levels in fish tissue and bottom sediments. A solvent-extraction technique has been used successfully to remove adsorbed TFM from fresh-frozen tissue of yellow perch. Further research is necessary to refine the procedure.

Effects of TFM on certain aquatic organisms have been observed during stream treatments. Preliminary information indicates a reduction in the numbers of susceptible invertebrates immediately after

treatment and resurgence to pretreatment levels of abundance within a year. Several index streams are being studied to determine long-term effects as well as possible buildup of toxic residues in the stream fauna.

Water analysis. Periodic chemical analyses of water from selected tributaries of Lakes Superior and Michigan are providing information on chemical constituents of waters infested with sea lamprey ammocetes. Tests were made for: aluminum, barium, calcium, chloride, chromate, copper, fluoride, phenolphthalein and total alkalinity, total hardness, iron, manganese, nitrates, nitrites, oxygen, orthophosphate, metaphosphate, total phosphate, silica, sulfate, tannin, lignin, pH, and conductance.

Biological studies. The effects of fluctuating temperatures on sea lamprey embryology were measured again this year to complete a previous study interrupted by a water-supply failure. Batches of eggs were subjected to the same fluctuating temperatures with similar diurnal changes. The experiment verified previous findings and added an important conclusion—when the magnitude of the temperature fluctuations remains within 10°F of base temperatures used, viable burrowing-stage prolarvae are produced. Temperature variations greater than 10°F failed to produce significant numbers of burrowing prolarvae.

Attempts to hybridize the several species of lampreys in the Great Lakes showed that intrageneric crosses of the 3 species of *Ichthyomyzon* generally produced viable full-term larvae except when eggs of female chestnut lampreys (*I. castaneus*) were used. None of the intergeneric crosses produced full-term larvae.

Experimental population of ammocetes. Collections from the single year class of larval sea lampreys established in Big Garlic River in 1960 continue to provide data on length distribution and rate of growth. Lengths of ammocetes have increased each year as has the range of lengths. Changes noted in October of each year were:

Year	*Mean length*	*Length range*	*Length increment*
1960	13 mm	10–19 mm	13 mm
1961	39 mm	25–54 mm	26 mm
1962	63 mm	37–107 mm	24 mm
1963	80 mm	52–134 mm	17 mm

The ammocetes are beginning to drift downstream, usually in periods of high water. The downstream trap, installed at the dam, took 324 ammocetes in a 6-day period during the 1963 spring runoff; 382 larvae have been recovered thus far. During the spring runoff in 1964 the trap, which normally handles 10 to 18 cfs of stream flow, was subjected to and withstood flooding in excess of 100 cfs. Successful and economical winter operation was maintained by installing a heated enclosure over the inclined screens.

During the fall of 1962, 318 ammocetes were marked with a subcutaneous injection of insoluble dye and returned to the stream. An additional 700 larvae were marked in 1963. A combination of colors and location of marks will provide information on movements; recaptures also may provide data for estimating the size of populations and survival rates. Only 2 of the marked animals have been recaptured; both were taken in the area of release.

LAKE TROUT REHABILITATION

The task of rehabilitating lake trout in areas of the Great Lakes depleted by sea lamprey depredations has been undertaken by federal, state and provincial agencies. The planning and coordination of these activities is accomplished through the Commission's Committee on Lake Trout Rehabilitation. The Committee has been concerned principally with assessment of lake trout populations, particularly their response to reductions in sea lamprey, and the propagation and planting of hatchery trout where needed. These activities were concentrated in Lake Superior in 1963.

Information on the status of lake trout has come mainly from examination of commercial catches and experimental fishing by research vessels. Commercial fishing for lake trout has been restricted in Lake Superior in order to encourage recovery of the trout, but at the same time permitting continuation of biological studies.

A scarcity of large mature trout has resulted in negligible natural spawning by most inshore populations since 1959. Plantings of hatchery trout have therefore been made to offset, to some degree, the failure of natural reproduction. The propagation program has included the establishment of brood stocks in hatcheries, location of sources of lake trout eggs in inland lakes, expanded rearing facilities, and improved planting methods. Hatchery fish have been marked to distinguish them from naturally produced trout and to measure the relative success of various stocks and planting techniques.

In United States waters the lake trout fishery remained closed during 1963 and a controlled amount of fishing for biological data was allowed under contracts or special permits. A total of slightly more than 35,000 fish weighing about 100,000 pounds was taken and examined by the research agencies. In Canada, the commercial fishery was allowed to operate under a 100,000 pound quota applied by season and area. By the end of the year the Canadian production totalled about 112,000 pounds of which 62,700 pounds (about 25,800 fish) were examined.

In general, the information obtained from inshore waters indicated that a further increase in the size and abundance of marketable lake trout occurred on both sides of the lake in 1963. An increase in the abundance of the larger and older trout is apparently the result of improved survival first noted in 1962. However, reduction in the numbers of native fish in the smaller and mid-size ranges has continued due to the progressive decline of natural spawning after 1959. In many of the inshore areas of the lake the scarcity of young native fish has been offset by the introduction of substantial numbers of hatchery-reared fish. On certain offshore grounds in both United States and Canadian waters, however, native trout of all sizes both

mature and immature were well represented in the populations. These populations were still largely self-reproducing and judged capable of sustaining a moderate degree of exploitation.

In Wisconsin waters, where striking improvements were noted in 1962, the average size of marketable trout declined slightly to 2.7 pounds. The catch of 80 marketable trout (210 pounds) per 10,000 feet of gill net lifted showed little change from 1962, but the abundance index of trout over 25 inches in length increased by 28 percent. The improved survival of large and older trout apparently led to increased spawning in Wisconsin waters in the fall of 1963. Experimental netting on spawning reefs at spawning time yielded twice as many mature fish as were taken in 1962 and ten times as many females.

In the inshore waters of the State of Michigan, the average size of trout increased substantially in all areas except Whitefish Bay. The increases were not as large as in 1962, but the trend that began in the fall of 1961 continued. The catch of 38 marketable trout per 10,000 feet of gill net fished, was virtually the same as in 1962. This value was substantially below the Wisconsin figure, however, which presumably reflects the effects of the long continued planting program carried on in that state's waters since 1951. Larger trout were also taken in increasing numbers in Michigan waters. Trout over 25 inches in length showed a 60 percent increase in abundance over 1962 in most of the eastern waters. For the first time in several years, reports of mature female trout were obtained at all Michigan ports in September, and spent females were reported from one area.

Data were obtained for the first time since 1961 from a number of offshore Michigan fishing grounds. In all these areas, there was no shortage of young fish or evidence of a serious reduction in recruitment. The incidence of lamprey wounds was much reduced and hatchery-reared fish were virtually absent. Several of the populations were reported capable of sustaining a moderate degree of exploitation.

In Canadian waters, the improved survival especially of larger and older lake trout noted in 1962 appeared to continue. Over the entire lake and through the entire year the average weight of marketable trout was 2.43 pounds, just under one-tenth of a pound heavier than in 1962. The number of fish taken per 10,000 feet of gill net lifted increased from 37 in 1962 to 40 in 1963. There were scattered reports from the fall fishery of ripe males from several inshore areas in the western part of the lake, but none of ripe females.

Information obtained from certain offshore grounds in Canadian waters indicated that their trout populations had suffered relatively little from lamprey, were self-reproducing, and capable of withstanding a moderate degree of commercial fishing.

The incidence of lamprey-wounded lake trout in the catches on both sides of the lake remained, in general, close to the low levels

established in 1962. Wounding rates from fall-caught samples are of special interest, since the lamprey responsible are those that form the spawning runs the following spring. In Wisconsin waters, the incidence of wounds on trout remained at less than 1 percent during the entire fishing season. In Michigan waters, fresh wounds were generally higher than in 1962 during the spring, but were lower than in 1962 during the fall. In Canadian waters, wounding during the fall was considerably higher in certain western areas, but lower elsewhere. On a lake-wide basis, there appeared to be little significant change in wounding in 1963.

The percentage of hatchery-reared fish in the catches increased in 1963. In both Wisconsin and Michigan waters planted trout provided approximately 50 percent of the legal portion of the catch and 90 percent, or more, of the undersized portion. The contribution of hatchery-reared trout to the Canadian catches rose from 33 percent in 1962 to 58 percent in 1963.

In 1963, a total of 2,311,000 marked lake trout were planted into Lake Superior (Table 1). Approximately one-half million trout were planted in Canadian waters by the Ontario Department of Lands and Forests and over 1.8 million were planted in United States waters by the U. S. Bureau of Sport Fisheries and Wildlife and the conservation departments of Michigan, Wisconsin, and Minnesota. These plantings represented an increase of 458,000 fish over 1962 and brought the total plantings in Lake Superior since 1958 to 8.1 million fish.

TABLE 1.—Plantings of hatchery-reared lake trout in Lake Superior, 1963.

[Yearlings except as noted]

Agency	Location planted	Number	Fin-clip
Ontario Department of Lands and Forests	Rossport to St. Ignace Islands	247,000	both ventrals
	Whitefish Bay	190,000	adipose
	Mouth of Dog River	40,000	adipose
Wisconsin Conservation Department	Apostle Islands	311,000	left pectoral-right ventral
Michigan Department of Conservation	Ontonogan	88,000	dorsal-right pectoral
Minnesota Department of Conservation	Silver Bay	175,000[1]	left pectoral
U. S. Bureau of Sport Fisheries and Wildlife	Marquette to Shelter Bay	563,000	right pectoral-left ventral
	Keweenaw Bay (spring)	273,000	left ventral
	Keweenaw Bay (fall)	267,000	right ventral
	Whitefish Bay	162,000[1]	left pectoral
	Total	2,311,000	

[1] fingerlings

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A SUMMARY OF FISHERY RESEARCH ON THE GREAT LAKES IN 1963

Lake Ontario

The whitefish fishery of eastern Lake Ontario has been under continuous study since 1944, when an evaluation of plantings of whitefish fry was begun. During the last ten years investigation of the fluctuations in year class strength and their effect on the commercial fishery has been emphasized. Information has come mainly from regular sampling of the commercial catch augmented by experimental gill netting, trawling, and tagging.

The decline in the abundance of the whitefish population spawning in the Bay of Quinte and the predominance of whitefish spawning on the south shore of Prince Edward County, has led to experimental closure of the latter area during the fall. Approximately 700 mature whitefish taken from these grounds in experimental nets have been tagged and released at various points. The recovery of a high proportion by the fishery suggests that the loss of production due to the fall closure was not substantial and might well be offset by better prices received the following spring. Recaptures have shown extensive movement and an intermingling in the eastern basin with the population spawning in the Bay of Quinte. Morphological data are being collected from the two populations for comparison.

The experiment to re-establish lake trout by Ontario and New York entered a final phase in 1963, with a comparatively large planting of 108,000 yearling trout, the first of two such plantings proposed. The fish were successfully moved by aircraft from the U. S. Bureau of Sport Fisheries and Wildlife Hatchery at Charlevoix, Michigan to Glenora, Ontario. Although smaller plantings have been made each year since 1953, the small number of recoveries of older fish suggests that few are surviving to spawn. The larger plantings, in addition to increasing the chances of spawning, are expected to provide more adequate information on survival and growth.

Limnological data are recorded at six stations on Lake Ontario at 10-day intervals. Temperature, dissolved oxygen, pH measurements, and plankton samples are taken weekly at three sampling stations in the Bay of Quinte. Studies have been initiated to determine species of algae responsible for fouling gill nets and to find ways to clean nets.

The American eel is making a significant contribution to the fishery in Lake Ontario. A heavy run of elvers was reported at dams on the Ottawa and St. Lawrence Rivers in 1963. Some elvers, held at the Glenora Station of the Ontario Department of Lands and Forests, may be marked and released in 1964 to obtain information on growth and longevity of the species in Lake Ontario. Adults, tagged and released, have been taken both locally and in the St. Lawrence River.

The creel census of the angling fishery for walleyes in the Bay of Quinte in 1963 provided the lowest catch-per-unit-effort so far recorded. The major contribution of the catch was made by the 1959 year class which has dominated the fishery since 1961. Attempts to delineate various walleye populations were limited to tagging of fish taken in Hay Bay.

Lake Erie

Sampling of the commercial catch was carried out by the Ontario Department of Lands and Forests and the U. S. Bureau of Commercial Fisheries assisted by state agencies. The age composition of walleye catches in the western portion of the lake consisted mainly of the 1962 year class and at the end of 1963 it was estimated that it had made its major contribution to the fishery. Most males of the year class are expected to spawn in the spring of 1964, but females are not expected to spawn before 1965. Spring catches of yellow perch were composed largely of the 1959 year class. The weaker year classes of 1960 and 1961 began to dominate the catch in the fall.

A statistical analysis of data from 3 years of sampling with trawls by the Bureau has established the reliability of a procedure for estimating the relative abundance of young fish of most species. Trawl sampling has been extended to Canadian waters by the Ontario Department of Lands and Forests, but the number of stations and their location have not yet been fixed. Sampling in United States waters showed that the 1963 year class of walleyes was about as weak as those produced in 1960 and 1961, and far below the strength of year classes produced in 1959 and 1962. The hatch of yellow perch was also poor in 1963. Smelt, white bass, sheepshead, and several species of minnows were about as abundant as in other recent years. Trawling on Lake St. Clair indicated the presence of two distinct size groups of walleye of the 1962 year class, presumably of different origin. The larger fish, 10–11 inches long, were similar in size to yearling walleye from eastern Lake Erie. The smaller fish were 7–8 inches long.

The Ohio Division of Wildlife continued studies of walleye spawning and egg survival in western Lake Erie. Information was collected by the Division and Bureau of Commercial Fisheries on temperature, currents, and water chemistry at three sites. A laboratory study of the feeding habits of young-of-the-year walleye was completed and some progress made in determining the type and degree of parasitization of young walleye.

Data on the distribution of smelt throughout the year have been collected by various agencies since 1961 and are now being analyzed. Smelt spawning has been investigated on the north shore and infor-

mation collected on time of spawning, spawning sites, type of substrate preferred for egg deposition, and the sex and age composition of spawning groups. Food and growth studies have also been continued.

Special limnological investigations by the Bureau of Commercial Fisheries in 1963 included a test of airborne radiometers and infrared scanners to detect water masses and currents at the mouth of the Detroit River. Drift bottle studies of the outflow pattern of the Detroit River, oxygen demand of bottom sediments in the central and western basins, water chemistry and exchange with sediments, a test of a Hardy continuous plankton sampler, collection and analysis of bottom fauna with emphasis on the distribution of the polychaete *Manayunkia speciosa* and Japanese snail *Viviparus japonicus* were also carried out.

Lake Huron

Fishery investigations on Lake Huron were mainly in Canadian waters and were carried out by the Ontario Department of Lands and Forests. Commercial catches of whitefish were sampled at ports in the North Channel, Georgian Bay, and southern Lake Huron. Several small fisheries on the south shore of Manitoulin Island were also covered. Fishing for whitefish was generally heavier in 1963 due to the collapse of markets for chubs following outbreaks of botulism. The relatively good whitefish catch in southern Georgian Bay was based largely on fish of the 1958 year class. Elsewhere younger fish of the 1959 and 1960 year classes were the mainstay of the local fisheries.

A creel census was also continued in South Bay and at Parry Sound. The catch of smallmouth bass in South Bay was down from 1962 with the 1959 year class contributing 62 percent of the catch. Some 5,000 marked bass were released in South Bay in 1963 to assess their contribution to the fishery. Bass taken at Parry Sound continued to show the same dominant year classes as the South Bay catch.

Experimental fishing with a variety of gear was continued in South Bay. Alewife continued to dominate the fishery, although there was a decline in numbers from 1962. Yellow perch were taken in unusually small numbers and white suckers at about the same rate as in 1962. Catches of hybrid trout were down, reflecting the relatively small planting in recent years. Total mortality for smelt dropped from about 90 percent to about 70 percent, reflecting the termination of experimental fishing for this species. Smelt are maturing at about the same size but at a greater age than previously. Whitefish and hybrid trout taken in experimental gear have been tagged and released; some whitefish were first injected with tetracycline hydrochloride to put a time mark on their scales. Whitefish were also tagged in the North Channel and northern Georgian Bay.

Replies to monthly questionnaires issued by the Department of Lands and Forests indicated that lamprey scarring was up slightly for whitefish in both Lake Huron and Lake Superior and for lake trout in Lake Superior.

A report on the thermal regimen in South Bay, based on temperature records collected from 1953 to 1963, is being prepared for publication in 1964.

Lake Michigan

Investigations in Lake Michigan were concerned principally with coregonids, which have become the dominant group in the main lake. The bloater *C. hoyi* contributed 99.1 percent of the experimental trawl catches by the U. S. Bureau of Commercial Fisheries; *C. artedii* 0.7 percent; and *C. reighardi* 0.2 percent. *C. alpenae, C. kiyi* and *C. zenithicus* were taken in small numbers.

Trawls were fished throughout the year to follow the bathymetric distribution of these fish and associated species including alewife, yellow perch and smelt. The data confirmed the distributional pattern found in 1962. Meter and half-meter nets were fished during 1963 to obtain information on larval coregonids. Cisco larvae were taken in May, but were too small to be taken in numbers until June. They were found from the surface to the bottom, but were most abundant in deeper water approaching 60 fathoms. Few were taken in August, and were presumed to have grown large enough to avoid the nets.

Alewife larvae, which were taken in greatest numbers in August, were widely distributed close to the bottom, at depths from 3 to 40 fathoms, but were most abundant at 10 fathoms. Sculpin larvae were taken in May from the surface to the bottom in 15–50 fathoms of water. Yellow perch larvae were taken on only one occasion near Saugatuck in 3–7 fathoms.

The rearing of coregonids to study their developmental morphology was continued by the Bureau in 1963. Round whitefish, *Prosopium cylindraceum,* and a deep-water cisco, *C. reighardi,* were reared successfully for the first time. Observations were made of the swimming ability, feeding, and schooling behavior of the latter.

A comparison of blood serum of coregonid species and the distribution of their proteins by acrylamide electrophoresis has shown great promise for illustrating the differences and relationships—not only in Lake Michigan but in all the Great Lakes. Studies have shown that the Great Lakes coregonids fall into three distinct groups: five species of cisco, pygmy and round whitefish, and the lake whitefish. The relationship and identity of serum proteins are being studied immunologically. Further tests of the temperature tolerance of whitefish were carried out by the Bureau.

Two studies were undertaken by the Wisconsin Conservation Department in the Door Peninsula. Rainbow trout were planted in

tributaries and their survival and contribution to the sport fishery followed. Smallmouth bass populations were found from tagging to be quite discrete and scale studies detected an improvement in growth which coincided with the upsurge of alewife.

Lake Superior

Investigations on Lake Superior were concerned principally with lake trout. In the United States waters, where commercial fishing for lake trout is presently restricted, samples of lake trout were taken by commercial fishermen operating under contracts. In Ontario waters, where similar arrangements were impractical, the commercial fishery continued under a catch limit with quotas for various areas. In Wisconsin, five contract fishermen took 14,292 lake trout which were measured and checked for lamprey wounds and fin clips. Records of the catch-per-unit-effort were also compiled. The fishermen in the State of Michigan waters took 20,130 fish from which similar data were obtained by the Bureau of Commercial Fisheries. Four fishermen in Minnesota provided 735 fish for examination. An estimated catch of 46,000 trout was reported for Ontario waters, of which 56 percent were examined by staff of the Fisheries Research Board of Canada. Research vessels sampled with trawls and experimental gill nets for information on young trout. The results of these studies is summarized in the report on lake trout rehabilitation (page 42).

The study of the distribution of deepwater ciscoes and associated species in southeastern Lake Superior was completed by the Bureau in 1963. *C. hoyi,* although relatively abundant, did not dominate these populations as in Lake Michigan.

A study of the morphology of *C. reighardi* and *C. zenithicus* failed to reveal any distinguishing characteristics. The time of spawning appeared to be the only valid difference. On the other hand, *C. reighardi* from Lake Superior are so different in morphological characteristics from those in other lakes that it is difficult to accept it as the same species. A detailed study of *C. nigripinnus cyanopterus* suggests that they are large *C. zenithicus*. It is likely that *C. nigripinnus,* which disappeared in Lake Michigan and Lake Huron during the 1950's, is now extinct in the Great Lakes.

Studies of lake-run brown and rainbow trout which spawn in certain Lake Superior tributaries were continued by the Wisconsin Conservation Department on the Brule River and by the Minnesota Department of Conservation on several streams on the north shore. A two-way fish weir on the Brule has provided counts of brown and rainbow trout moving upstream and downstream. Supplementary information has been obtained by tagging fish and a voluntary creel census. A heavy mortality of large brown trout at spawning was observed again in 1963.

In Minnesota, information is being sought on life history of rainbow trout resident in certain Lake Superior tributaries or using them to spawn. Weirs are being used to provide counts of migrating fish and recovery of marked individuals. Movements of mature rainbows and their abundance in certain streams are also being studied.