ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1961

GREAT LAKES FISHERY COMMISSION

MEMBERS — 1961

CANADA	UNITED STATES
A. O. Blackhurst	D. L. McKernan
J. R. Dymond	Claude Ver Duin
A. L. Pritchard	Lester P. Voigt

SECRETARIAT

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

GREAT LAKES FISHERY COMMISSION

Established by Convention
between Canada and the United
States for the Conservation of
Great Lakes Fishery Resources.

ANNUAL REPORT

FOR THE YEAR

1961

NATURAL RESOURCES BUILDING
THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN,
U. S. A.

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 1961.

CLAUDE VER DUIN, *Chairman*

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1961 ANNUAL REPORT

INTRODUCTION

The annual catch of the Great Lakes commercial fishery has averaged 109 million pounds during the last 40 years. Approximately half has, until recently, consisted of whitefish, lake trout, walleye, blue pike, and yellow perch for which there is good demand and a relatively high price. However, the destruction of the lake trout by sea lamprey and more recent and hitherto unexplained declines in whitefish, walleye, and blue pike have made commercial fishing operations less profitable and angling less attractive.

Increasing concern regarding the spread of sea lamprey from Lake Ontario through the upper lakes and other problems facing the management of the fishery led to ratification of the Convention on Great Lakes Fisheries by the United States and Canada in 1955. The Convention established a Great Lakes Fishery Commission with the following responsibilities:

(*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.

When the Commission was organized in 1956, provincial, state and federal agencies were already at work studying the fishery and devoting much effort to reducing sea lamprey with electrical barriers on the spawning streams. Two federal agencies, the Bureau of Commercial Fisheries in the United States and the Fisheries Research Board of Canada became agents of the Commission in continuing a program to control lamprey. The province and states have continued to assist in this program but are directing more attention to the re-establishment of lake trout and investigation of other fishery problems.

In 1957, after five years of research, the Bureau of Commercial Fisheries treated a stream with a chemical which selectively destroyed the young lamprey ammocetes with negligible damage to game fish. Following this successful field test, barrier operations were gradually curtailed and funds and personnel shifted to the development and

application of this new control technique. Barriers were operated after 1960 on a reduced scale to follow changes in the number of adult lamprey spawning each year.

Seventy-two Lake Superior streams known to produce sea lamprey were treated chemically by the end of 1960, and operations were extended to Lake Michigan and Lake Huron where 7 streams were treated in each lake. In Lake Superior 3 newly discovered lamprey streams and a bay containing ammocetes from a tributary were treated in 1961. Second treatments were also carried out on 9 streams to destroy ammocetes surviving initial treatments and those newly established. In Lake Huron and Lake Michigan 14 and 26 streams, respectively, were treated.

Electrical barriers operated in 1961 continued to take large numbers of spawning lamprey, indicating that the population in the lake during 1960 was large in spite of stream treatments in 1958 and 1959. However, lake trout taken in the fall of 1961 showed fewer lamprey wounds, suggesting that adult lamprey had been reduced by treatment of the remaining lamprey streams in 1960 and that a reduction in the numbers spawning could be expected in 1962.

The Commission has given considerable attention to the task of restoring lake trout being undertaken by state, provincial, and federal agencies. Nearly 4 million marked lake trout have been planted in Lake Superior since 1958 in a program co-ordinated by a committee of the Commission. In order to facilitate recovery, the Commission recommended that the harvest of lake trout in Lake Superior in 1962 be limited to the catch necessary to provide biological information on changes in the population.

Although the problem of controlling sea lamprey and restoring the lake trout has attracted most attention, preliminary study has been given by the Commission to the need for research on other fishery problems. In 1959 and 1960, the Commission suggested that certain general investigations would be profitable and recommended that these be included in the research undertaken in both countries. In 1961, it began a more detailed study of research requirements.

The actions of the Commission, its committees, and the work of its agents and co-operating groups during 1961 are described in detail in various sections of this report.

1961

ANNUAL MEETING

AGENDA

1. Call to order.
2. Adoption of agenda.
3. Approval of past minutes.
4. Press relations.
5. Report of Chairman.
6. Preliminary report on inconsistencies in fishery regulations.
7. Progress reports on sea lamprey program.
8. Report of Lake Trout Rehabilitation Committee.
9. Observations made in spring of 1961 on lake trout stocks in Lake Superior.
10. Review of the 1961–62 program.
11. Consideration of 1962–63 program.
12. Consideration of administrative matters.
13. Functions of Scientific Advisory Committee.
14. Time and place of next meeting.
15. Adjournment.

ANNUAL MEETING

PROCEEDINGS

The Sixth Annual Meeting of the Great Lakes Fishery Commission was held at Ann Arbor, Michigan on June 22 and 23, 1961.

Call to order. The meeting was called to order by the Chairman, Mr. Claude Ver Duin. Following introductions of the Commissioners and Secretariat, advisors, observers, and governmental staff members were introduced. A list of participants appears on page 14.

Adoption of agenda. After minor changes in the order of business, the tentative agenda was adopted.

Approval of past minutes. The minutes of the Annual Meeting, held at Cleveland, Ohio on December 1–2, 1960, were approved.

Press relations. The Chairman appointed a committee to prepare news releases on the meeting to be issued by the University of Michigan News Service.

Report of the Chairman. The Chairman reviewed the major objectives of the Commission and its role in advocating measures to make possible a higher production of fish from the Great Lakes.

He drew attention to the completion in 1960, of initial lampricide treatments in all known lamprey-producing streams in Lake Superior and the extension of the chemical operations to Lake Huron and Lake Michigan.

The catches by electrical barriers on 37 Lake Superior streams, operated during the spring to follow changes in lamprey abundance, were of particular interest to the Commission for there was a possibility that treatments which began in 1958 would have some effect on the number of spawners in 1961. However, the spawning run underway appeared larger than in 1960. There were, however, indications that small lampreys in the lake, which would spawn in 1962, were less abundant. It would be necessary to rely on 1962 barriers catches to judge the effectiveness of chemical treatments and provision should therefore be made to continue operating assessment barriers. Studies of lake trout should also be encouraged to measure effects of reduced predation.

The Chairman stressed the need to consider more fully other measures to increase the productivity of the Great Lakes fishery. In 1959, the Commission submitted general recommendations on research to the two countries, but it was now necessary to examine additional information on the fishery with a view to recommending more specific measures.

Preliminary report on inconsistencies in fishery regulations. At its Annual Meeting in Cleveland, Ohio on December 1–2, 1960, the Commission was asked by the United States Section to explore the possibility of obtaining more uniform regulations in the various political jurisdictions. A proposal for studying the question was subsequently submitted by the Secretariat which recommended that each agency be asked to (1) examine its regulations in the light of present information and estimate their effectiveness, (2) recommend changes and estimate their effect, (3) suggest studies which would follow the effects of the recommended change, and (4) that the Commission assist in the evaluation by arranging for the preparation of working papers and other material.

After discussing the need for an evaluation of existing regulations and any adopted in the future, the Commission recommended that the suggestions made by the Secretariat be presented to the regulatory agencies and their opinions solicited before further action was taken.

Progress reports on sea lamprey program. The Commission received reports on the progress of the 1961 program from its agents and cooperating agencies and took special note of the barrier catch to June 17. *

Numbers of sea lamprey recovered at the 8 electrical barriers operated in Canada in 1961 had reached 1,555 compared with 2,479 in 1960, 1,448 in 1959, and 1,052 in 1958. Changes appeared to be analogous to fluctuations in a commercial fishery. The catch of spawning lamprey at 29 barriers in the United States on the south shore of Lake Superior reached 51,628, compared with 27,519 in 1960, 41,254 in 1959, 48,744 in 1958. A total catch of about 61,000 was expected by the end of the spawning run.

In discussing the reasons for the continued high catch of sea lamprey in Lake Superior, Bureau representatives reported that 62 percent of the total flow treated was not dealt with until 1960, after the downstream migration of newly transformed individuals had begun. These were now appearing at the barriers as sqawning adults. It was also probable that the counts at barriers in 1960 did not represent the true abundance of adults because of operating difficulties caused by severe flooding. Operating conditions were much more favorable in 1961 and therefore the catches in these two years were not strictly comparable.

The Scientific Advisory Committee presented, at the request of the Commission, the following statement regarding the significance of the large 1961 barrier catch:

> The Scientific Advisory Committee has considered the information on lamprey scarring and numbers of lamprey taken in barriers this spring. It has

* Final reports on operations carried out in 1961 are given on pages 26, 31, and 41.

found no general evidences of changes in predation, or numbers of adults, that could be attributed to chemical treatments on Lake Superior. The Committee wishes to point out that any evaluation of the experiment at this time is necessarily premature. The effects of 1958 and 1959 treatments would only be apparent if the lamprey returned to parent streams, and there is good reason to believe that they do not necessarily do so. Consequently, the lack of contribution to lake populations of these streams could easily be outweighed by the contributions from large streams not treated until 1960.

Report of Lake Trout Rehabilitation Committee. The Commission received a report from the Lake Trout Rehabilitation Committee on the progress of the 1961 operations.*

The Committee drew the attention of the Commission to the fact that native lake trout stocks in the upper Great Lakes would not product significant numbers of eggs for propagation for several years and that the inland waters of the adjacent states had limited potential. If lake trout eggs were to be obtained in the United States in numbers sufficient to meet propagation requirements, they would have to come mainly from hatchery brood stocks. Egg collections from inland waters in Canada, on the other hand, could meet the requirements of the propagation program being carried out by the Province of Ontario.

The Committee recommended that the State of Michigan be encouraged to continue and broaden its program of lake trout egg production from hatchery brood stocks to meet the egg requirements for the rehabilitation program in the United States. The major burden of hatching and rearing these fish should be borne by the U. S. Bureau of Sport Fisheries and Wildlife and state agencies with suitable facilities.

The Committee also reported that it had considered possible effects of the chub fishery in Lake Superior on the rehabilitation of lake trout. Information collected by assessment agencies studying the fishery indicated that the take of undersized trout in small mesh chub nets in both Canadian and United States waters of Lake Superior was not serious at the present time. The Committee believed that the present United States fishery was so constituted that it would be unrealistic to apply additional restrictions to reduce the catch of undersized trout. The chub fishery in Canadian waters consisted of small operations near the Sibley Peninsula. The Committee believed that the present assessment program in Lake Superior would detect areas where the catch of undersized trout might become serious. Moreover, most commercial fishermen in Lake Superior strongly supported the lake trout rehabilitation program and would avoid areas where undersized trout were abundant.

The Commission adopted the recommendation of the Committee on Lake Trout Rehabilitation and asked that it be transmitted to the two governments.

* Final report of the Lake Trout Rehabilitation Committee is given on page 44.

Observations made in spring of 1961 on lake trout stocks in Lake Superior.* The Fisheries Research Board reported that despite the increasing contribution of hatchery-reared trout, the availability of lake trout declined in Canadian waters. The decline was most pronounced in the western end where availability was now approaching the low level characteristic of the eastern fishery. Wounding and scarring rates had declined in eastern Lake Superior but increased in the west. However, it was highly probable that the wounding and scarring rates were dependent on both the abundance of trout and lamprey and the apparent decline in the east might well be the result of changes in trout numbers.

The Bureau of Commercial Fisheries reported a 50 percent increase in the incidence of fresh scars on legal-size trout in the United States waters of Lake Superior, in the spring of 1961. Average weight of trout taken commercially declined to an all time low. This decline had occurred later in the western end of the lake, but now the average weight was uniformly low along the entire south shore. The percentage of fin-clipped hatchery fish in the catch had risen more than threefold at all ports east of the Keweenaw Peninsula and was up more than twofold for the entire south shore. Hatchery fish were most prominent in Wisconsin waters where 44 percent of the trout taken under 17 inches and 86 percent of those under 11 inches were fin-clipped.

The catch per unit of effort was now only half of the 1959 value, and the lake trout fishery which existed as a full-time fishery until 1959 was now a source of income for only a few months a year for most fishermen.

Review of 1961–62 program. The Commission reviewed its 1961–62 program which called for the following activities:

Lake Superior. Operation of 18 electrical barriers to follow changes in lamprey abundance and effectiveness of chemical program; chemical treatment of the Chippewa River in which ammocetes had been recently discovered; examination of treated streams to determine from the composition of the re-established ammocete populations when re-treatments were required; re-treatment of the Pancake River.

Lake Michigan. Operation of 3 electrical barriers to follow changes in lamprey abundance in Green Bay and provide a comparison with Lake Superior; continuation of surveys to determine ammocete distribution in streams, and periodic bioassays to follow seasonal changes in the effectiveness of the lampricide; treatment of lamprey-producing tributaries of Green Bay and some streams on the east shore of Lake Michigan.

Lake Huron. Completion of treatments on Georgian Bay streams and disposal of about half the lamprey streams entering the North Channel; continuation of ammocete surveys and advance bioassays.

Research. Completion of laboratory studies of the effects of temperature on the survival of lamprey at all life history stages from egg to adult, and studies

* Observations covering 1961 are given on page 51.

of the distribution of ammocetes in the lake off spawning streams; testing of new chemicals with potential as lampricides; investigation of methods of applying toxicants to bottom areas in both streams and estuaries for control and to provide survey crews an additional method of locating ammocetes.

The Commission considered and approved a recommendation from the Scientific Advisory Committee that the 37 barriers operated in 1960–61 on Lake Superior be continued in 1961–62. Further testing of the mammalian toxicity of the lampricide used was also approved. The cost of the sea lamprey control and research program was maintained at $1,368,500 by reductions in other activities.

Consideration of the 1962–63 program. The Commission considered a program and budget for 1962–63 which proposed the following activities:

Lake Superior. Continuation of assessment barrier operations until the end of the 1962 spawning run; re-treatment of Lake Superior lamprey streams treated in 1958 and some of those treated in 1959; examination of streams to determine need for treatment.

Lake Michigan. Completion of treatments on west shore streams and half of the streams on east shore; completion of ammocete distribution surveys on east shore.

Lake Huron. Continuation of surveys to determine ammocete distribution and bioassays to learn the pattern of seasonal changes in lampricide effectiveness; completion of treatments in Canadian streams in the northern portion of the lake and adjacent U. S. streams.

Research. Continuation of search for less costly and more effective lampricide.

The Commission agreed that provision should be made for continuing operation of the 37 barriers on Lake Superior and the 3 on Lake Michigan in 1963. The cost of the program should be held at the current budget level of $1,368,500. Necessary reductions should be made in chemical treatments proposed on Lake Huron and Lake Michigan. The revised program would be considered for adoption by the Commission at its Interim Meeting in November.

Consideration of administrative matters. The Chairman stated that at past meetings of the Commission, the Scientific Advisory Committee had presented research recommendations based on prospectuses prepared by a number of individuals representing various agencies. The recommendations offered an excellent broad view of Great Lakes problems, but were limited almost exclusively to biological and oceanographic considerations.

The Commission believed that much more detailed recommendations were needed for each lake. It therefore called for the preparation of research programs for each of the Great Lakes indicating in detail the need for particular studies and method of attack. Programs were to cover the economic and technological as well as the biological problems and were to be prepared by groups broadly representative of the organizations concerned with the particular fishery. The task of developing the programs was assigned to the Secretariat.

Functions of the Scientific Advisory Committee. The Commission approved the following functions of the Scientific Advisory Committee:

(*a*) Advise the Commission of developing fishery problems before they become critical.

(*b*) Review the progress of research on the Great Lakes and advise the Commission of pertinent findings and possible applications.

(*c*) Review the research program on the Great Lakes and advise the Commission of neglected areas of study.

(*d*) Assist in the initial planning of the Commission's sea lamprey program and review the program, or program changes, before their adoption by the Commission.

Time and place of next meeting. The Commission agreed to hold its Interim Meeting at London, Ontario on November 29–30, 1961.

Adjournment. The Chairman adjourned the Sixth Annual Meeting at 2:30 p.m.

ANNUAL MEETING PARTICIPANTS

OFFICERS

Chairman: Claude Ver Duin, United States
Vice Chairman: A. L. Pritchard, Canada

MEMBER GOVERMENTS

Canada

Commissioners:	*Advisors:*	*Scientific Advisors:*
A. O. Blackhurst	H. V. Sutton	J. C. Budd
J. R. Dymond		T. Burridge
A. L. Pritchard		C. H. D. Clarke
		W. J. Christie
		J. Davies
		C. Douglas
		H. Frick
		F. E. J. Fry
		R. N. Johnston
		W. A. Kennedy
		K. H. Loftus*
		H. H. MacKay
		N. D. Patrick
		R. Rush
		G. F. M. Smith*
		J. J. Tibbles
		W. H. R. Werner

United States

Commissioners:	*Advisors:*	*Scientific Advisors:*
D. L. McKernan	T. Brown	R. Balkovic
Claude Ver Duin	W. J. Harth	K. Brouillard
L. P. Voigt	A. S. Hazzard	A. B. Cook
	A. S. Hill	G. P. Cooper
	R. A. Jensen	C. A. Dambach*
	J. H. Kitchel	L. F. Erkkila
	E. C. Koster	P. H. Eschmeyer
	W. M. Lawrence	Ralph Hile
	D. J. Leedy	J. H. Howell
	R. B. McClelland	W. Jones
	S. S. Sivertson	A. McLain
	H. O. Swenson	J. W. Moffett*
	G. A. Walker†	R. Personius
	H. M. Woods	R. Pycha
		E. Schneberger
		H. Seagren
		S. H. Smith
		H. Van Meter

Others: D. C. Chandler, Marvin Fast, S. G. Fontanna, Ray H. Full, and Alfred Ming.

SECRETARIAT:

Norman S. Baldwin,* Executive Secretary
Robert W. Saalfeld, Assistant Executive Secretary

* Member of Scientific Advisory Committee.
† Representing G. E. Eddy, Michigan Department of Conservation

INTERIM MEETING

The Commission's Interim Meeting was held in London, Ontario, November 29–30, 1961 to review the progress of the lamprey control and research programs, lake trout rehabilitation, and to consider the development of the trawl fishery on Lake Erie.

Development of the trawl fishery. A report on experimental trawling by commercial fishermen in Canadian waters of Lake Erie was presented by representatives from the Ontario Department of Lands and Forests. Fishing for smelt with trawls began in 1956, but had limited success until the introduction of "Biloxi trawls" in the summer of 1959. By the end of February, 1960, 20 fishermen had taken 1,320,000 pounds of smelt, 14,000 pounds of yellow perch, and minor catches of other species. Good catches during January and February, 1960 demonstrated the potential of the gear for winter fishing. During the period March 1 to December, 1961, 40 commercial fishermen using trawls took 5,960,000 pounds of smelt and 177,000 pounds of yellow perch. Some preliminary testing of the selectivity of codends of different mesh size were carried out in the fall of 1961. Mesh sizes (stretched measure) from 1 3/16 to 1 3/8-inch appeared to be most effective in taking sizes of smelt preferred by the market at that time.

Although trawling showed good potential, many questions regarding possible effects on young fish, conflicts with set gear, usefulness of quotas and economic soundness of trawling operations remained unanswered.

After discussing the need to improve the harvest of certain commercial species and at the same time prevent overexploitation of others, the Commission adopted a resolution urging the continuation and expansion of research needed to establish regulations which would insure an adequate safe harvest by the most efficient gear available.

Progress of sea lamprey program. Reports on the operations of the Bureau of Commercial Fisheries and the Fisheries Research Board of Canada were presented to the Commission. The presence of large ammocetes in treated streams reported by both agents was attributed to the movement of individuals from small tributaries, lagoons, and isolated pools overlooked in the first treatment. Particular concern was expressed regarding the lack of quantitative information on ammocete populations in the lake at mouths of streams, and the difficulty of obtaining this information. Tagging with radioactive isotopes and the development of an electrified bottom trawl to sample deep-water populations had shown promise and the Commission recommended that further investigation be undertaken.

Lake trout rehabilitation and assessment. A report on the lake trout rehabilitation program being carried out by federal, state and provincial agencies and coordinated through the Lake Trout Rehabilitation Committee is given on page 44.

Observations on the status of lake trout made by the Wisconsin Conservation Department, Bureau of Commercial Fisheries, and the Fisheries Research Board of Canada summarized on page 51 clearly indicated a reduction in incidence of lamprey wounds on lake trout during the fall of 1961. The reduction was most apparent in Wisconsin where a slight improvement in the catch per unit of effort had also been observed.

The Commission agreed that there was encouraging evidence of a reduction in sea lamprey and a relatively high survival of hatchery-reared fish to maturity could be anticipated. It reviewed the recommendation of an *Ad hoc* Committee on Regulation of the Lake Superior Lake Trout Fishery, submitted at the 1960 Annual Meeting, which proposed the adoption of a catch limit and quota system when success of sea lamprey control was evident. It then recommended *that the 1962 harvest of lake trout in Lake Superior be limited to the fishing effort required to support necessary biological studies and suggested that agencies act to accomplish this objective through appropriate procedures available to them.*

Consideration of 1962–63 program. The Commission considered and adopted a program for 1962–63 which provided for the following activities:

Lake Superior. Operation of 37 electrical barriers to follow changes in lamprey abundance and measure effectiveness of chemical program; re-treatment of 20 lamprey streams; examination of potential lamprey streams to detect newly established ammocete populations and re-established populations in previously treated streams to determine time for re-treatments.

Lake Michigan. Operation of 3 electrical barriers on Green Bay to follow changes in lamprey abundance; completion of treatments on Green Bay and west shore of Lake Michigan; treatment of several east shore streams; completion of ammocete-distribution surveys on streams tributary to southeast portion of lake.

Lake Huron. Surveys to determine ammocete distribution and bioassays to determine approximate chemical requirements throughout season.

Research. Testing of chemicals with potential as lampricides; further investigation for causes of seasonal changes in lampricide effectiveness; study of the effect of sublethal exposure on ammocetes.

ADMINISTRATIVE REPORT FOR 1961

Officers and Staff. No changes were made in Commission officers during 1961. Permanent staff consisted of the Executive Secretary, the Assistant Executive Secretary and a secretary-stenographer. A typist was employed half-time.

Accounts and Audit. The accounts of the Commission for fiscal year 1960–61 were audited by the Ann Arbor firm of Icerman, Johnson and Hoffman. The Auditors' Report appears on page 21.

Contributions to the 1960–61 program. The Commission's 1960–61 program and budget for Sea Lamprey Control and Research and Administration and General Research were approved by correspondence in July, 1959, but were subsequently reduced to meet a limitation in the United States contribution. A supplemental appropriation of $21,000 was made by the United States Government to meet a general salary increase given to employees of the U.S. Bureau of Commercial Fisheries at the beginning of the fiscal year.

Requests for funds, credits and contributions for fiscal year 1960–61 were as follows:

	United States	*Canada*	*Total*
Sea lamprey control and research			
Share of program costs	$923,287.00	$414,810.00	$1,338,097.00
Credits from 1958–59	1,665.02	748.06	2,413.08
Contributions	$921,621.98	$414,061.94	$1,335,638.92
Supplemental	21,000.00	—	21,000.00
	$942,621.98	$414,061.94	$1,356,683.92
Administration and general research			
Share of program costs	$ 23,000.00	$ 23,000.00	$ 46,000.00
Credits from 1959–60	7,356.01	7,356.01	14,712.02
Contributions	$ 15,643.99	$ 15,643.99	$ 31,287.98

Expenditures in 1960–61. Agreements to carry out the program of sea lamprey control and research were made with the Fisheries Research Board of Canada for $479,082 (Canadian) and the U.S. Bureau of Commercial Fisheries for $772,400 (U.S.). An amount of $86,615 was held to pay contract administration charges (6 percent) in both countries and exchange charges on funds supplied to the Board. In addition to the amount supplied under the terms of the agreement, the Board was permitted to carry forward $76,864.51 in unexpended funds to purchase lampricide in the first quarter of 1960–61.

Statements of expenditures by the Commission's agents appear on pages 24 and 25. The statement from the Fisheries Research Board shows an under-expenditure of $48,617.04 at the close of fiscal year 1960–61. This amount was obligated, however, in a purchase of lampri-

cide delivered after the close of the fiscal year. The Bureau of Commercial Fisheries had an under-expenditure of $27,402.08.

The programs outlined in the Memorandum of Agreement with the Fisheries Research Board were carried out essentially as specified although advance bioassays of representative streams were curtailed due to lack of staff. The Black Sturgeon River and Sawmill Creek, not listed in the Agreement, were treated when ammocetes were discovered in them.

The Bureau of Commercial Fisheries discontinued operation of barriers on White River and Fish Creek on grounds that they would not contribute useful information on lamprey abundance. The number of barriers operated on the south shore was therefore reduced from 31 to 29. The three large streams mentioned in the agreement and 8 streams not specified were treated with lampricide for the first time and a ninth stream re-treated when it became evident that the first treatment in 1960 had left survivors. Total flowage treated was 2,097 c.f.s. Twenty Lake Michigan streams with a total flow of 966 c.f.s. were treated on the north and east shore. Treatments of 5 of the 13 streams specified in the agreement were postponed to FY 1961–62 because of unfavorable operating conditions. Ammocete-distribution surveys on Lake Huron were not initiated as specified.

Expenditures for Administration and General Research, shown on page 23 in 1960–61 totaled $38,996.61. The under-expenditure of $7,003.39 occurred mainly in salaries, where the position of clerk-typist remained unfilled, and in general research, where no projects were charged against the $2,000 provided.

Contributions to 1961–62 program. A 1961–62 program was adopted by the Commission at its Interim Meeting, June 14–15, 1960. Some minor internal revisions were made subsequently to cover salary increases and the program and budget approved by correspondence. At the 1960 Annual Meeting on December 1-2, the Commission accepted a recommendation from the Fisheries Research Board to discontinue barrier operations on the Michipicoten and Goulais Rivers and revised its program accordingly. At the Annual Meeting on June 22–23, 1961, the Commission, on the advice of its Scientific Advisory Committee, increased the number of barriers to be operated on the U.S. shore of Lake Superior from 10 to 29, reducing operations elsewhere to remain within the approved budget. The estimated cost of lamprey control and research was $1,368,500, and administration and general research $46,000.

Agreements with agents in 1961–62. The Commission approved Memoranda of Agreement with the Fisheries Research Board of Canada and the U.S. Bureau of Commercial Fisheries to carry out the 1961–62 program of lamprey control and research. The Bureau subsequently proposed several revisions in its draft which were adopted at the Interim Meeting.

The costs of the two agreements were as follows:

U. S. Bureau of Commercial Fisheries		
Amount of contract	$693,100	(U. S.)
Provision for contract administration charge (6%)	41,536	(U. S.)
Total	$734,686	(U. S.)
Fisheries Research Board of Canada		
Amount of contract	$318,000	(Canadian)
Provision for contract administration charge (6%)	19,080	(Canadian)
Total	$337,080	(Canadian)

The Commission called for tenders on lampricide required in 1961 and received bids from four suppliers. One offered a quantity less than the minimum required and its bid was not considered. The Maumee Chemical Company of Toledo, Ohio was awarded a contract to supply 65,000 pounds of lampricide at $2.65 a pound to the Bureau of Commercial Fisheries, and the Hoechst Chemical Company of Montreal, P.Q., a contract to supply 46,000 pounds to the Fisheries Research Board at the same price.

Procedure for disposal of Commission equipment. During 1961, some Commission equipment was declared surplus to requirements by the Bureau of Commercial Fisheries and sold with Commission authorization. The Commission agreed that the funds realized from these sales in either country be retained by the federal governments and the Commission advised of the amount. The Commission would maintain a record of these amounts and from time to time adjust credits so that the net cost of operations would continue to be shared on a 69 to 31 basis.

Meetings. The Commission held two meetings in 1961, an Annual Meeting in Ann Arbor, Michigan, on June 22–23 and an Interim Meeting in London, Ontario, on November 29–30. The Scientific Advisory Committee held two meetings, on June 21 and November 1. The Lake Trout Rehabilitation Committee held its meeting in Milwaukee, Wisconsin, February 9–10.

Other meetings or conferences attended by Commission staff were as follows:

Annual Meeting of Ontario Council of Commercial Fishermen.
Annual Meeting of Michigan Fish Producers Association.
Conference on Great Lakes Research (University of Michigan).
Annual Meeting of Lake Ontario Fish Management Committee.
Annual Meeting of Lake Erie Fish Management Committee.
Tagging Symposium (ICNAF).
Experts Meeting on the Economic Effects of Fishery Regulations (FAO).

Lake Erie Research Advisory Committee (Ontario Dept. of Lands and Forests).
Lake Superior Advisory Committee (U. S. Section of GLFC).
"Resources for Tomorrow" Conference (Canada).

The Executive Secretary continued to serve as recording secretary for the Ontario and Lake Erie Fish Management Committees and proceedings for their meetings were prepared by the Commission's staff. The Executive Secretary also served as Chairman of a fisheries workshop at the "Resources for Tomorrow" Conference.

Reports and publications. The 1959 Annual Report was published in February and was followed by the first in a series of technical reports which will be issued from time to time by the Commission. Publications in this series and in journals during the year were as follows:

Vernon C. Applegate, John H. Howell, James W. Moffett and B. G. H. Johnson. Use of 3-trifluormethyl-4-nitrophenol as a selective sea lamprey larvicide. GLFC. Tech. Rep. No. 1, 35 p.

Stanford H. Smith, Howard J. Buettner and Ralph Hile. Fishery statistical districts of the Great Lakes. GLFC. Tech. Rep. No. 2, 24 p.

Robert A. Braem and W. J. Ebel. A back-pack shocker for collecting lamprey ammocoetes. Prog. Fish. Cult. Vol. 23, No. 2, p. 87–91.

Other activities. In September, the Commission moved from the converted residence at 1319 North University to new quarters provided by the University of Michigan in the Natural Resources Building on the Main Campus.

Auditors Report to Commission

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

September 25, 1961

Great Lakes Fishery Commission
Room 106
East University Avenue
Ann Arbor, Michigan

We have examined the cash accounts of the Great Lakes Fishery Commission Administration and General Research Fund and Lamprey Control Operation Fund for the year ended June 30, 1961.

Our examination included tracing of receipts to the depository, verification of the bank balance by direct confirmation, tracing of disbusements 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 cash receipts and disbursements present fairly the cash position of the designated funds of the Great Lakes Fishery Commission at June 30, 1961, and the results of operations for the year then ended.

/s/Icerman, Johnson & Hoffman

Great Lakes Fishery Commission

Lamprey Control Operation Fund
Statement of Receipts and Disbursements
Year Ended June 30, 1961

Receipts	*Actual*	*Budget*
Canadian Government	$ 414,811.00	$ 414,810.00
United States Government	920,015.97	923,287.00
Supplemental request for salary increase	21,000.00	21,000.00
Transfer from Administration Fund	1,606.01	-0-
Total	$1,357,432.98	$1,359,097.00

Disbursements		
Canadian Department of Fisheries	$ 507,826.00	$ 507,826.00
United States Fish and Wildlife Service	816,286.93	818,700.00
Bureau of Commercial Fisheries for salary increases	21,000.00	21,000.00
Currency exchange charges	9,944.24	11,571.00
Refund—Canadian Government for overpayment	748.06	-0-
Total	$1,355,805.23	$1,359,097.00
Excess of receipts over disbursements	$ 1,627.75	
Fund balance, July 1, 1960	-0-	
Fund balance, June 30, 1961	$ 1,627.75	

Great Lakes Fishery Commission

Administration and General Research Fund
Statement of Receipts and Disbursements
Year Ended June 30, 1961

Receipts			
Canadian Government	$23,000.00		
Less refund for overpayment	7.356.01	$15,643.99	$15,643.99
United States Government	$17,250.00		
Less transfer for lamprey operations	1,606.01	15,643.99	15,643.99
Sale of equipment		786.92	-0-
Total		$32,074.90	$31,287.98

Disbursements		
Communication	$ 1,043.72	$ 800.00
Equipment	1,923.22	1,500.00
Insurance, bonding, and audit	346.20	600.00
Rents and utilities	134.96	100.00
Reproduction and printing	2,294.76	1,500.00
Salaries (including F.I.C.A. and Pension)	29,444.15	33,200.00
Supplies and equipment maintenance	1,369.98	1,500.00
Transportation	8.72	300.00
Travel	2,430.90	4,500.00
General Research	-0-	2,000.00
Total	$38,996.61	$46,000.00A
Excess of disbursements over receipts	$ (6,921.71)	
Fund balance, July 1, 1960	14,712.02	
Fund balance, June 30, 1961	$ 7,790.31	

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

Cash balance, July 1, 1960	$14,712.02
Anticipated receipts	31,287.98
Total anticipated available funds	$46,000.00

Fisheries Research Board of Canada

Financial Report to Great Lakes Fishery Commission

April 1, 1960 to March 31, 1961

Administration in field (58.6% of cost of London Headquarters)	($100,333.02)	$ 58,795.15
Operations:		
1. Operation of Electric Barriers		73,361.17
2. Chemical Treatment Operations		
(a) Funds from 1960–61 contract	244,834.12	
(b) Funds carried over from 1959–60	76,864.51	321,698.63
3. Surveys		16,169.25
Research:		
4. Ammocete Studies		21,001.51
5. Temperature Tolerance Studies		2,819.70
		$493,845.41
Contributions to Superannuation:		
6% of permanent salaries to July 31, 1960	($ 40,267.50)	2,416.05
6½% of permanent salaries August 1, 1960 to March 31, 1961	(72,950.49)	4,741.78
	($113,217.99)	$501,003.24
Contract Administration:		
6% of total disbursements		35,070.23
		$536,073.47
Funds Provided by Commission:		
Carried over from 1959–60	76,864.51	
Payments under Contract 1960–61	507,826.00	
Total funds available	$584,690.51	
Cost applicable to 1960–61	536,073.47	
Carried over to 1961–62	$ 48,617.04	

Bureau of Commercial Fisheries
Sea Lamprey Control and Research Program

Report of Expenditures

July 1, 1960 through June 30, 1961

Activity	Funds programed	Obligations: Salaries	Obligations: Expenses	Total	Unobligated balance
Program Costs					
Washington, D.C. (supervision)	$ 21,500.00	$ 10,543.60	$ 8,185.01	$ 18,728.61	$ 2,771.39
Research	75,000.00	56,343.06	15,198.26	71,541.32	3,458.68
Control:					
Chemical	498,825.00	231,715.88	254,437.30	486,153.18	12,671.82
Electrical	211,700.00	150,616.36	52,735.31	203,351.67	8,348.33
General administration					
Central Office (Washington D.C.)	375.00		375.00	375.00	-0-
Regional Office (Ann Arbor)	32,300.00	30,864.79	1,283.35	32,148.14	151.86
Total	$839,700.00	$480,083.69	$332,214.23	$812,297.92	$ 27,402.08

Bureau of Commercial Fisheries
Sea Lamprey Control and Research Program

Report of Expenditures
July 1, 1960 through June 30, 1961

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		Salaries	Expenses	Total	
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Total	$839,700.00	$480,083.69	$332,214.23	$812,297.92	$ 27,402.08

LAMPREY CONTROL AND RESEARCH IN CANADA

by the Fisheries Research Board of Canada

Surveys

In 1961, 24 Lake Superior tributaries were re-surveyed for ammocetes and none were found to contain sea lamprey. Three Lake Superior and 22 Lake Huron streams were surveyed prior to chemical treatment.

Post-treatment surveys were made on 13 Lake Superior streams, treated since 1958, for surviving or newly established ammocetes. These were inconclusive in the western section, with the exception of the Kaministikwia, as streams were in flood. Large sea lamprey ammocetes found in 7 streams were presumed survivors of initial treatments because of their size. These ammocetes appear to have come from unmapped and undiscovered tributaries, lagoons and side channels which were isolated from the mainstream during treatment. Large ammocetes found near stream mouths within the influence of lake seiches are believed to have re-entered from the lake. A thorough investigation of the stream system for small tributaries, lagoons and isolated pools is proposed before subsequent treatments. Navigable sections of large streams can be checked by boat but small streams will have to be surveyed on foot.

Sixty-four bioassays were carried out during the year, to follow seasonal changes in the biological activity of the lampricide 3-trifluormethyl-4-nitrophenol (TFM) and determine the time when it would be most effective.

Chemical treatments

Five Lake Superior and 4 Lake Huron streams were treated in 1961. Details of the Lake Superior treatments are given in Table 1. The Chippewa and Wolf were treated for the first time and the latter re-treated a week later to see whether reducing flow and lowering the water level had allowed ammocetes to survive. No additional ammocetes were recovered in the second treatment. The Pancake, Batchawana, and Sable were re-treated, the latter two ahead of schedule because of the presence of large ammocetes and to reduce drift into Batchawana Bay.

In Lake Huron, 14 streams were treated with lampricide (Table 2). The Nottawasaga River presented many difficulties because of its large size and many branches. Although crews arrived May 23, a series of rainstorms delayed treatment until June 18. In the interval, 25 bioassays and numerous flow measurements were made. Spawning lamprey were found in nearby Lafontaine Creek and this stream was

TABLE 1.—Streams treated with lampricide in Lake Superior, 1958–1961.

Stream	Date of treatment	Discharge (cfs)	Stream miles treated	Concentration in ppm at		Pounds of active ingredient	Ammocete abundance
				feeder	mouth		
Pancake	Sept. 27, 1958	43	15	2.5	1.0	212	Very abundant
West Davignon	July 4, 1959	15	9	2.2	1.0	117	Moderately abundant
Big Carp	July 7, 1959	10	9	8.0	1.7	119	Abundant
Harmony	July 10, 1959	11	5	1.6	1.1	65	Moderately abundant
Sable	July 15, 1959	14	5	2.6	1.4	208	Abundant
Batchawana	July 20, 1959	126	7	2.6	1.4	1,567	Very abundant
Pays Plat	Aug. 26, 1959	132	7	4.3	1.0	1,580	Moderately abundant
Pearl	Sept. 1, 1959	12	4	5.0	1.8	191	Few
Big Gravel	Oct. 6, 1959	274	7	3.1	2.2	1,983	Few
Cranberry	April 29, 1960	37	5	6.5	4.0	567	Few
Stokeley	May 5, 1960	104	7	4.8	3.0	780	Few
Little Carp	May 12, 1960	28	7	4.0	2.5	205	Few
Kaministikwia	June 4, 1960	1,334	48	2.3	0.9	11,895	Very abundant
McIntyre	June 8, 1960	22	6	3.0	1.5	176	Few
Goulais	June 22, 1960	800	88	2.8	1.5	6,464	Very abundant
Michipicoten	July 2, 1960	2,594	17	1.7	1.5	16,322	Abundant
Jackfish	Sept. 23, 1960	26	9	4.5	3.5	741	Moderately abundant
Black Sturgeon	Oct. 12, 1960	684	49	8.0	5.0	15,239	Very abundant
Pigeon	Oct. 18, 1960	99	4	4.0	2.3	2,145	Few
Sawmill	Oct. 28, 1960	3		4.2	3.9	16	Few
Pancake[1]	July 9, 1961	39	15	2.3	1.5	456	Few
Chippewa	July 10, 1961	174	2	1.5	0.7	667	Abundant
Batchawana[1]	Sept. 7, 1961	154	10	2.3	1.0	3,151	Moderately abundant
Sable[1]	Sept. 16, 1961	100	15	2.0	1.5	502	Moderately abundant
Wolf	Oct. 5, 1961	75	9	4.5	3.0	1,134	Abundant
	Oct. 13, 1961[2]	200	9	3.0	2.0	2,360	None

[1] Second treatment.
[2] Experimental treatment.

TABLE 1.—Streams treated with lampricide in Lake Superior, 1958–1961.

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TABLE 2.—Streams treated with lampricide in Lake Huron, 1960–1961.

Stream	Date of treatment	Discharge (cfs)	Stream miles treated	Concentration in ppm at		Pounds of active ingredient	Ammocete abundance
				feeder	mouth		
Magnetawan	Aug. 11, 1960	718	6	1.0	0.5	1,570	Few
Still	Aug. 16, 1960	17	18	2.3	0.9	176	Very abundant
Naiscoot	Aug. 21, 1960	27	15	2.2	1.5	156	Abundant
Chickanishing	Sept. 9, 1960	6	4	1.5	0.8	29	Few
Boyne	Nov. 13, 1960	24	5	2.2	0.9	556	Few
Silver	Nov. 30, 1960	6	6	20.0	9.0	1,402	Moderately abundant
Sturgeon	Dec. 2, 1960	26	12	35.0	8.0	1,275	Very abundant
Gordons	Apr. 24, 1961	4	1	8.0	3.5	32	Moderately abundant
Gowas	Apr. 30, 1961	10	1	10.0	4.3	160	Few
Browns	Apr. 30, 1961	7	2	3.5	2.0	103	Moderately abundant
Richardsons	May 4, 1961	12	4	14.0	6.0	438	Abundant
Two Tree	May 7, 1961	30	15	14.0	5.0	1,334	Moderately abundant
Lafontaine	June 11, 1961	5	10	6.0	3.0	151	Few
Nottawasaga	June 18, 1961	400	131	12.0[2]	8.0	19,883	—[3]
Root	July 16, 1961	70	34	2.3	1.8	674	Moderately abundant
Serpent	Aug. 5, 1961	269	11	1.2	1.0	1,735	Moderately abundant
H 114[1]	Aug. 7, 1961	1				14	None
Livingstone	Aug. 10, 1961	1	3			45	Moderately abundant
McBeth	Aug. 10, 1961	1				50	Moderately abundant
Lauzon	Aug. 10, 1961	5	1	2.0	1.0	21	Moderately abundant
Mississagi	Aug. 16, 1961	1800	16	2.4	2.0	12,693	Abundant

[1] Unnamed tributary near Serpent River.
[2] Concentration at feeders on some tributaries as high as 18 ppm.
[3] Scarce in mainstream and Pine, Bear, Willow tributaries; moderately abundant in Noisy; abundant in Mad.

TABLE 2.—Streams treated with lampricide in Lake Huron, 1960–1961.

Stream	Date of treatment	Discharge (cfs)	Stream miles treated	Concentration in ppm at feeder	Concentration in ppm at mouth	Pounds of active ingredient	Ammocete abundance
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treated June 11. Treatments of tributaries entering the North Channel and the St. Mary's River, presented no serious problems.

Lake Superior barrier operations

Eight electrical barriers were operated during the 1961 spawning run, six on east shore streams near Sault Ste. Marie and two on north shore streams near Rossport. All were in operation by May 19 and although the Batchawana barrier was inoperative 48 hours there was little difficulty with high water or mechanical failures. Barriers were shut down July 29–30 after taking 2,895 sea lamprey, compared with 3,907 in 1960. No significance is attached to this decrease. Numbers of lamprey recovered at the barriers each year since 1955 are given in Table 3.

TABLE 3.—Sea lamprey recovered annually at assessment barriers on eight Lake Superior streams, 1955–1961.

Stream	Year 1955	1956	1957	1958	1959	1960	1961
Big Carp	5	27	28	19	15	20	6
Harmony	29	29	16	6	8	19	14
Chippewa	807	839	359	220	296	1051	453
Batchawana	608	421	427	358	482	629	561
Sable	43	65	76	47	142	246	100
Pancake	555	717	1073	809	816	1306	931
Pays Plat	.	6	3	4	32	10	31
Gravel	.	5	99	154	541	626	799
Total	2047	2109	2081	1617	2332	3907	2895

Ammocete studies

It has become apparent from studies just concluded that sea lamprey ammocetes are much more adaptable than was previously realized. They tend to remain in their burrows in the stream bottom during daylight and emerge, if they emerge at all, only during darkness and usually immediately after nightfall. They seldom leave their burrows, but do move a good deal within the stream bed. Freshets tend to dislodge them. Active emergence from the burrow or passive movement after being washed out of the stream bed results in a consistent drift downstream for ammocetes are not able to swim against even moderate currents. Consequently, ammocetes from comparatively short streams reach the open lake well before metamorphosis and seem to develop successfully in the open lake. Populations of sea lamprey ammocetes were found off the mouths of six of the eight

Lake Superior tributaries investigated. In the adequately sampled inshore areas approximately 17 individuals were found per 10,000 square yards, and the limited data available indicates a comparable density in offshore areas.

None of the conventional methods for determining fish ages are applicable to sea lamprey ammocetes, since they have no scales, fins, otoliths, etc. However, on the basis of length-frequency distribution and as a result of information recently published ammocetes from Big Creek (Lake Erie) are now tentatively regarded as 5½ or 6½ years old at metamorphosis, and it is tentatively concluded that ammocetes in other Great Lakes watersheds are of comparable age. There is also evidence to suggest that metamorphosis takes place at a specific age rather than at a specific size.

Temperature tolerance studies

The thermal tolerance of the sea lamprey has been studied during each stage in its life history. During most stages the responses of lampreys to lethal temperatures correspond to those shown by fish. Except in the egg stage, lampreys can, given time to acclimate, live at all temperatures between 0°C and 32.5°C. However, the temperature range within which eggs will develop is much narrower.

During 1961, experiments were concerned solely with temperature tolerance during the egg stage. In order to lengthen the period over which the eggs would be available, spawning of mature sea lampreys was delayed by holding them at low temperatures until required. Unfortunately, the fertilized eggs did not develop successfully. However, it was possible to demonstrate that, although eggs required temperatures between 15° and 25°C in the early stages, they would tolerate a wider range at later stages of development. This information would be useful for assessing whether lampreys could use certain streams for breeding.

Other activities

Reports of adult lamprey taken in the upper Niagara River above the falls, and near the city of Welland, led to an examination of sections of the Welland Canal while drained for repairs in December, 1961. Recess pools in locks and one large pondage were shocked and twelve species of fish collected. No sea lamprey or scarred fish were found. Further investigation is required however, before any conclusions regarding use of the canal by sea lamprey can be made.

LAMPREY CONTROL AND RESEARCH IN THE UNITED STATES

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

The chemical treatments of United States streams in 1961 began March 15 and continued until November 7. During this period, 36 stream systems, discharging 1,557 c.f.s., were treated with 34,660 pounds of 3-trifluormethyl-4-nitrophenol (TFM). Twenty-six of the streams were on the north and east shores of Lake Michigan, 9 on the south shore of Lake Superior, and 1 tributary to the St. Mary's River (Lake Huron). A summary of chemical treatments since 1958 is given in Table 1.

Lake Superior surveys and bioassays

Surveys were conducted on 43 streams that previously had not been found to contain sea lamprey larvae. Small ammocetes were collected in Three Mile Creek, Dead Sucker, Boston-Lily, and large ammocetes in the Laughing Whitefish, Pilgrim, Nemadji, and Arrowhead. Post-treatment surveys were completed on Ravine, Slate, Falls. East Sleeping, and Split Rock, treated in 1960. The East Sleeping was the only stream in which larvae appeared to have survived.

Since 1959, 229 bioassays have been completed in conjunction with chemical treatments on Lake Superior and Lake Michigan. Alkalinity readings and conductivity data from these bioassays indicated a relationship which may be used to predict approximate minimum lethal and maximum allowable treatment concentrations of TFM.

Lake Superior chemical treatments

A second round of chemical treatments of Lake Superior streams treated in 1958 was begun when residual populations of ammocetes and transforming sea lampreys were found in surveys and fyke-net catches. By the end of the season, 7 streams were treated for the second time. The Laughing Whitefish River and Chipmunk Creek, a tributary to East Bay, were found to contain small populations of sea lampreys and were also treated. Details of these treatments are given in Table 2.

In re-treating the Rock River, chemical was fed at the inlet to a small lake (Ginpole Lake) at the upper end to destroy sea lampreys in the lake as well as those in the stream. The concentration achieved in the lake, however, was below the minimum lethal concentration required and a small population was probably left.

TABLE 1.—Summary of chemical control operations in the United States waters of the Great Lakes, 1958–61.

Year	Number of streams treated	Discharge at mouth (cfs)	Stream miles treated	Amount of lampricide (pounds)
Lake Superior				
1958	10	619	178	6,265
1959[1]	29	1,616	286	19,147
1960[2]	16	3,651	397	51,400
1961[3]	9	453	139	9,653
Total	64	6,339	1,000	86,465
Lake Michigan				
1960	7	140	70	1,751
1961	26	1,094	252	24,689
Total	33	1,234	322	26,440
Lake Huron				
1961	1	10	14	318
Grand Total	98	7,583	1,336	113,223

[1] Includes re-treatment of Sucker River.
[2] Includes re-treatment of East Sleeping River.
[3] Includes 8 re-treatments.

Preliminary inspection of collections made during re-treatment of the Silver River revealed very few residual lampreys but a significant number were found in the Huron River. Only first and second year larvae were present in collections made during re-treatment of Big Garlic. Fyke nets fished in the Chocolay River took 8 transformed sea lampreys in October, and the stream was immediately treated. Collections of larvae indicated a small residual population in a mile section of stream.

No serious fish mortality resulted from any of the treatments in 1961. The Chocolay River was treated during the fall run of rainbow and brown trout; 24 dead adult brown trout were observed. A few highly susceptible fishes such as longnose dace, sculpin, and mudminnows were reduced in some streams. Freshwater scuds, burrowing mayflies, aquatic earthworms, and clams were the most susceptible invertebrates.

A large population of sea lamprey ammocetes (estimated at more than 100,000 by Michigan Department of Conservation personnel) was known to be in East Bay at the mouth of the Sucker River. High incidence of scarring of fishes in the vicinity indicated that the bay

might be contributing significantly to the adult population and a decision was made in late September to treat experimentally with a general toxicant. Treatment began October 24 when 85 gallons of toxaphene were distributed evenly over the surface to produce a concentration of 100 p.p.b. A small feeder was also operated for 14 days in the mouth of the Sucker River to provide a similar concentration at the inflow. Fish mortality reached a peak during the second and third days after application. An estimated 50-80 large migratory rainbow trout and 30-40 small ones were killed. Other fish killed included: northern pike, yellow perch, white suckers, and minnows. Thirteen

TABLE 2.—Details on the application of sea lamprey larvicide to nine United States streams tributary to Lake Superior, 1961.

Stream	Date of treatment	Discharge at mouth (cfs)	Concentration (ppm)		Amount of active ingredients (pounds)
			Minimum effective	Maximum allowable	
Rock	Sept. 18	31	5.0	12.0	732
Laughing Whitefish	Sept. 23	14	5.0	12.0	215
Big Garlic	Sept. 27	14	2.5	9.0	234
Huron	Oct. 3	67	2.0	6.0	946
Silver	Oct. 6	33	2.0	7.0	604
Sucker	Oct. 12	120	1.5	7.0	2,025
Carpenter's	Oct. 15	3	2.5	7.0	32
Chipmunk	Oct. 15	1	2.5	7.0	19
Chocolay	Oct. 23	170	3.0	9.0	4,848
Total		453			9,655

test cages, each containing 10 larval lampreys were placed in the bay before application of the toxaphene and the larvae were observed daily for 14 days. Thereafter, weekly examinations were made until ice formed. Two larvae were alive in four cages which remained undisturbed during the observation period.

Chemical treatments have been aided by the development during the year of a photoelectric detector for use with dyes in timing water movement in streams. A continuous record of time, duration, and intensity of fluorescein dye introduced in the streams is obtained on a recording milliammeter. The device will also detect changes in turbidity and furnishes information on the flow characteristics of the stream. Modifications that might increase the instrument's sensitivity and permit its use for recording concentrations of lampricide colorimetrically are being investigated.

Lake Michigan surveys and bioassays

The examination of streams tributary to Lake Michigan for sea lamprey ammocetes continued and 833 stations on 101 streams were checked. Approximately 130 streams on the west shore received preliminary examination. Tributaries on the east shore remaining to be surveyed (36) include 5 large rivers, the St. Joseph, Kalamazoo, Black, Grand, and Pere Marquette, all known to contain sea lamprey.

Post-treatment surveys were conducted on 25 streams treated in 1960 and 1961. Re-established sea lamprey populations were found in 12 and 12 others had small residual populations. Dilution of the chemical by rains and melting snow were believed to be responsible for the incomplete kill in the latter.

The mobile bioassay unit at Harrietta, Michigan, determined the seasonal activity of TFM in 13 representative east-shore streams, and thereby provided a basis for estimating chemical requirements and scheduling treatments. The bioassays indicated that streams tributary to the east shore of Lake Michigan will require approximately twice the concentration of chemical used in Lake Superior streams. A reduction of larvicide effectiveness occurred at various times from June through December on the streams tested. Preliminary chemical analyses indicate that the activity of TFM was strongly influenced by water hardness but the relationship obtained can not be relied upon for prediction of lethal levels for lamprey and fish.

Lake Michigan chemical treatments

A total of 26 Lake Michigan tributaries, with an aggregate flow of 1,094 c.f.s., was treated in 1961 (Table 3). No new problems were encountered, but higher concentrations of TFM were required to kill lampreys. The concentration that would cause excessive mortality of fish was also higher and the working ranges between maximum and minimum concentrations were therefore comparable to those for Lake Superior streams. No significant mortality of fishes occurred during treatment of Lake Michigan streams although some contained large populations of the more susceptible species.

Larvicide was used to test chemical treatment under winter conditions on Yuba Creek March 15. Excessive amounts of chemical were required and mechanical failures due largely to freezing were encountered during this treatment.

Lake Huron surveys and treatment

Ammocete-distribution surveys were completed on all tributaries to the St. Mary's River and the north shore of Lake Huron between Sault Ste. Marie and St. Ignace, including Sugar, Drummond, Mackinac, and Bois Blanc Islands. Of the 82 streams examined, 17 contained sea lamprey ammocetes. The Little Munuscong River, tributary to the

TABLE 3.—Details on the application of sea lamprey larvicide to 26 streams tributary to Lake Michigan, 1961.

Stream	Date of treatment	Discharge at mouth (cfs)	Concentration (ppm)		Amount of active ingredient (pounds)
			Minimum effective	Maximum allowable	
Yuba	March 15	10	6.0	14.0	642
Bulldog	April 6	35	3.0	9.0	619
Gulliver	April 8	7	4.0	7.0	128
Paquin	April 11	30	5.0	11.0	758
Mile	April 13	13	2.0	5.0	100
Big Stone	April 15	10	9.0	15.0	338
Big Sucker	April 17	32	7.0	14.0	1,251
Loeb	April 28	6	8.0	17.0	180
Porter	April 30	19	8.0	17.0	625
Brevort	May 1	162	2.5	7.0	1,802
Jordan	May 11	249	6.0	15.0	7,335
Boyne	May 17	126	7.0	16.0	3,720
Horton	May 18	17	6.0	11.0	709
McGeach	May 19	4	6.0	15.0	127
Millicoquin	June 4	189	2.0	9.0	2,924
Black	June 15	17	4.0	12.0	625
Sucker	June 18	1	1.5	7.0	11
Rock	June 19	5	7.0	15.0	137
Cataract	June 20	6	4.0	13.0	134
Valentine	July 6	4	2.0	4.0	79
Poodle Pete	July 7	3	2.0	7.0	54
Hudson	July 9	7	1.5	3.0	93
Pt. Patterson	July 9	24	4.0	9.0	318
Milakokia	July 10	83	4.0	7.0	1,284
Swan	July 10	2			51
Fishdam	July 30	33	3.5	8.0	648
Total		1,094			24,689

St. Mary's River, was treated August 11, 1961. Periodic bioassays were carried out in 18 streams to provide data on seasonal variation in the activity of TFM.

Barrier operations

Electrical barriers were operated on 29 streams of Lake Superior to measure the abundance of adult sea lampreys. Twenty-two were activated by the end of March and the remainder in April. Barriers on all streams except the Chocolay were shut down by July 12, at the end of the spawing run. The continuation of the Chocolay barrier until September 1 showed that few lamprey entered the streams after mid-July.

The catch of 68,197 sea lampreys to mid-July was 82 percent over that for the corresponding period in 1960 and 53 percent over the 1959 catch in the same streams (Table 4). The number of sea lampreys taken in 1961 increased 55 percent over 1960 in the same streams in the eastern half of the lake and 127 percent in the same streams in the western half.

Barriers on Lake Michigan were reduced to 3 index streams in northern Green Bay on the Sturgeon, Bark and Cedar Rivers. The catch of 12,886 sea lampreys represented an increase of 94 percent over the 1960 catch and interrupted the steady downward trend in the number taken from these streams since 1956 (Table 4).

The spawning run reached a peak the first week of June, and declined rapidly in early July; 91 percent of the run was taken from May 6 to June 30. The largest weekly catch (20.0 percent) was made June 3–9. The species composition and numbers of fish handled at the barriers were similar to those of previous years. Mortality below the barriers was small. The sex ratio east of the Keweenaw Peninsula declined drastically from 221 males per 100 females in 1960 to 187 males per 100 females, while west of the Keweenaw it increased from 228 males per 100 females in 1960 to a high of 254 males per 100 females in 1961.

The percentage of sea lamprey scars on mature rainbow trout entering 13 streams of Lake Superior was less than in the record year of 1960. However, no correlation exists between the size of the adult sea lamprey run and the incidence of scars on rainbow trout.

Adult sea lamprey from 11 index streams in Lake Superior averaged 16.1 inches in length and 4.8 ounces in weight—a decrease of 0.3 inch and 0.4 ounce from 1960 averages. The sea lampreys west of the Keweenaw Peninsula averaged 0.3 inch shorter and 0.1 ounce lighter than those to the east. The condition was the reverse of that in 1960.

Fyke net operations

Fyke nets were fished on representative streams along the south shore of Lake Superior and for comparative purposes in six tributaries (five untreated and one treated) to northern Green Bay to: (1) verify information collected by survey personnel on presence and abundance of ammocetes and transforming sea lamprey; (2) obtain information on the time of downstream movement of ammocetes, especially in streams where bays, lakes, and estuarine waters might make chemical control more difficult; and (3) collect additional information on the effectiveness of the chemical control in individual streams.

Preliminary data indicate only limited downstream movement of ammocetes in all streams except the Sucker River. A total of 85 newly transformed adult sea lamprey was taken in 9 of the 14 streams of

TABLE 4.—Numbers of sea lamprey taken at electrical barriers on United States tributaries of Lake Superior, 1956–1961, and Lake Michigan, 1957–1961.

[Totals as of July 12 in Lake Superior and June 30 in Lake Michigan].

Stream	1956	1957	1958	1959	1960	1961
Lake Superior:						
Waiska	66	55	70	42	122	87
Pendills	42	46	16	38	30	74
Betsy	1,552	768	1,061	999	696	1,366
Little Two Hearted		693	417	410	668	558
Two Hearted	1,596	7,570	3,388	3,950	4,290	7,498
Sucker	3,846	3,496	1,613	2,436	4,683	3,209
Hurricane	96	171	29	63	80	96
Miners	93	417	94	127	399	220
Furnace	197	246	38	350	2,211	1,012
AuTrain	408	709	337	164	74	181
Rock	3,230	2,510	1,403	1,170	2,598	3,660
Laughing Whitefish	16	37	9	18	37	267
Chocolay	6,731	8,088	6,133	3,486	4,173	4,201
Harlow	0	2	1	15	10	22
Iron	317	708	391	250	317	2,430
Salmon-Trout				40	5	12
Pine	15	28	22	39	28	70
Huron	1,583	2,809	3,447	1,408	1,237	4,825
Ravine	1	5	4	12	4	6
Silver	916	2,748	2,000	753	1,271	5,051
Sturgeon	4	31	28	539	161	427
Elm	0	1	1	2	7	9
Misery	474	758	830	2,433	696	962
Firesteel	167	1,003	1,532	2,044	250	1,118
Cranberry			0	5	22	12
Brule		3,969[1]	22,637	19,156	9,539	22,478
Poplar		126	575	8	57	103
Middle		4,273	4,829	3,598	2,815	3,502
Amnicon		11,024	7,622	968	1,094	4,741
Total	21,350	52,291	58,527	44,523	37,574	68,197
Lake Michigan:						
Sturgeon		3,503	1,271	731	903	2,378
Bark		2,478	1,238	1,041	1,063	1,085
Cedar		12,159	8,113	6,834	4,648	9,423
Total		18,140	10,622	8,606	6,614	12,836

1 Operated for part of run.

Lake Superior while nets on five untreated tributary streams of Lake Michigan captured 1,785.

The average fishing time in hours necessary to capture a newly transformed sea lamprey was much greater on treated than on untreated streams. A total of 311 hours of fishing was required to capture one recently transformed lamprey in treated streams of Lake Superior. compared with 6 hours in untreated streams of Lake Michigan.

Experimental population of ammocetes

The need for increased and accurate knowledge of the larval life history of the sea lamprey prompted the establishment of a single year class of sea lamprey ammocetes in the upper portion of the Big Garlic River where a dam and a series of falls prevent the upstream migration of spawning adults. Sexually mature adults were tagged and released in the upper part of the river where they nested, spawned, and established a population of known-age larvae. Growth rate, in this year class, has been highly variable. Ammocetes taken during October 1960, ranged in length from 10 to 19 mm. and had a mean of 13 mm. In October, 1961, the range in length was 25 to 54 mm. and the mean 39 mm. A downstream trap has been installed on a concrete dam at the lower end of the study area to capture the first individuals in the population to undergo metamorphosis. The trap will, also, furnish information on the downstream movement or drift of larvae.

Re-establishment in treated streams

Sea lamprey larvae which have become established in tributaries to Lake Superior following chemical treatment are being studied to provide information on variation in growth rate, duration of larval life, and relative success of year classes in the different streams. New populations have been found in 34 of the 52 treated streams. The 1960 year class is abundant and easily detected, however, progeny from the large spawning run in 1961 are poorly represented.

Fifteen streams with divergent physical characteristics (gradient. water temperature, volume, bottom composition, and geographical location) were selected for special study of the growth rate of the larvae in 1960. A wide variation in the growth rate of ammocetes in these streams also is clearly evident. The mean length of young-of-the-year in October, 1960 ranged from 16 mm. to 34 mm. One year later, the mean length of this age group ranged from 39 to 75 mm.

Ammocetes in estuaries and lakes.

Water depth has greatly limited the use and efficiency of electric shockers to locate and study ammocete populations in bays, estuaries, or inland lakes. Ammocetes can be captured in deep water with dredges, but the method is extremely time consuming and restricted to relatively soft bottom. A 5-foot beam trawl with an electrode array attached to a modified bridle and energized by a D.C. relaxing-pulse generator has recently been tested. The trawl is portable, can be handled by two men and is towed by a 16-foot boat, equipped with a 40-horsepower outboard motor. Trials were conducted in East Bay of the Sucker River where cooperative work by Michigan Department of Conservation personnel had provided considerable information on the abundance and distribution of sea lamprey larvae. The catch by individual tows indicated a density and distribution of larvae which corresponded to the earlier findings. Tows were also made in Huron Bay, Whitefish Bay, off the mouth of the Falls River in Keweenaw Bay, off the mouth of the Huron River, and in West Bay of the Sucker River. Larvae were taken in numbers only in West Bay within ¼ mile of the mouth of the Sucker River.

Sea lamprey research

Studies at the Hammond Bay laboratory in 1961 were concerned mainly with improving the use of chemical in the control program. Most of the 292 bioassays made during the year were to measure seasonal changes in the biological activity of TFM in 2 Lake Michigan streams and 16 Lake Huron streams and to determine the toxicity of a number of compounds which might be used as bottom poisons. The remaining bioassays were to test the quality of TFM supplied for treatments, determine toxicity of TFM to warm-water fish, check selective toxicity of new compounds, determine long-term effects of sublethal exposure, determine susceptibility of three genera of lamprey, and to determine effect of soluble organic materials on biological activity of TFM. Preliminary results are available for several of these studies.

Selectivity of TFM among larval lamprey. Preliminary tests to determine whether TFM is selective by size, species, or life-history stages of lampreys indicated considerable selectivity of TFM by size. Tests with larvae of the three genera also showed some differences in susceptibility which may, however, shift with changes in the basic biological activity.

Bottom poisons. Larval populations in bays, estuaries, sloughs, and lakes have prompted a search for materials to be used as bottom larvicides. Tests in 1961 were limited to chemicals toxic to aquatic organisms, such as chlorinated benzenes, copper sulphate, toxaphene, and various formulations of rotenone. None were selectivity toxic for lamprey. Rotenone formulations of high specific gravity seem to have the most advantageous physical characteristics.

Screening of new materials. Over 80 chemical manufacturers were asked to supply samples of chemicals which might supplement or replace TFM. One hundred samples have been received and a number of companies are preparing extensive lists of research chemicals for survey.

Artificial culture of ammocetes. Lamprey larvae from five species found in the upper Great Lakes are being reared for taxonomic studies. Rates of embryological development are being obtained and data collected on the development of secondary sexual characteristics and methods of holding ripening adults. Sorting and repeated anesthetization of large numbers of ammocetes are required in these studies. The anesthetic tricaine methane sulfanate (MS 222) proved too toxic to ammocetes under prolonged exposure, but 4-styrylpyridine, which showed some promise in the original screening in 1953–57, is now the standard anesthetic used.

LAMPREY CONTROL AND RESEARCH

by Co-operating Agencies

Michigan Department of Conservation

Michigan's sea lamprey research program in 1961 was concerned principally with the following: duration of ammocete stage; occurrence of ammocetes in lentic waters; estimates of abundance; an experimental barrier to prevent adult lampreys from reaching their spawning grounds; a method of marking ammocetes; and metamorphosis. The work was conducted from the Laboratory of the Institute of Fisheries Research at Marquette, Michigan.

Duration of ammocete stage. A paper on the duration of larvae life was accepted for publication in the Transactions of the American Fisheries Society.* At Carp Lake River, the main study area, duration of larval life almost certainly has been at least seven years.

Occurrence of ammocetes in lentic waters. A survey of ammocetes in certain lentic waters of the Upper Peninsula, was completed and sumbitted to the American Fisheries Society for publication.† Ammocetes were found in 13 of the 29 areas examined in sufficient numbers to indicate substantial total populations in lentic environment. Numerous ammocetes smaller than metamorphosing size (5.7 inches) were collected, suggesting that recruitment to sea lamprey populations would continue for some years after stream populations were exterminated.

Estimates of abundance. Estimates of ammocete population size were made in certain areas concurrently with the distribution surveys. Studies at Ogontz Bay and East Bay have been completed and accepted for publication by the Journal of Wildlife Management and the Michigan Academy of Science, Arts, and Letters (Vol. 47). A third study is now in progress at McKay Bay Creek and McKay Bay in northern Lake Huron. The population in McKay Bay Creek, excluding a beaver pond, was estimated as 20,000 in 1961. Estimates of the ammocete population in McKay Bay and the beaver pond on McKay Bay Creek will be made in 1962.

A new device for sampling deep-water areas was developed for the study in McKay Bay. The device consists of a metal drum with a funnel inside the open end. The drum is inserted into the substrate and larvicide introduced. The ammocetes confined in the substrate by the drum edge swim up through the funnel and are trapped. Tests

* Wagner, Wilbert C., and Thomas M. Stauffer. 1962. Sea lamprey larvae in lentic environments. Trans. Am. Fish. Soc., Vol. 91, No. 4, 384-387.

† Stauffer, Thomas M. 1962. Duration of larval life of sea lampreys in Carp Lake River, Michigan. Ibid., 422-423.

showed that the device caught 80 percent of the ammocetes trapped within the cylinder—a marked improvement over the orange-peel dredge formerly used for quantitative sampling.

Experimental barrier dam. An experimental barrier dam with an overhanging steel lip was operated on the Black River (Mackinac County) in 1950–1957. Lampreys, suckers, and smelt were blocked by the barrier at a head of 26 inches, but rainbow trout were not.

Method of marking ammocetes. Field studies of the usefulness of mercuric and cadmium sulfide (insoluble dyes) injected under the skin of ammocetes as a mark have been completed. Marks can be applied quickly, are easily recognized by trained personnel, and remain visible for at least 3 years on ammocetes. Some marks were concealed by pigmentation or were obliterated when metamorphosis occurred. There was minor mortality after marking, but it could not be determined that the mark caused mortality either during or after metamorphosis. There was no evidence that the mark affected growth or condition.

Metamorphosis of lampreys. Investigation of metamorphosis suggests that sea lamprey increase in length with the progress of transformation. This observation conflicts with findings of other investigators who have suggested an actual decrease in length with the progress of metamorphosis—they were unable to find newly transformed adults as long as the longest ammocetes. To resolve the question, ammocetes of known length and identity will be held through metamorphosis.

Wisconsin Conservation Department

The sea lamprey control program in Wisconsin waters of the Great Lakes was again a joint project of the Wisconsin Conservation Department and the Bureau of Commercial Fisheries. A total of 6 barriers was operated during the 1961 season in streams tributary to Lake Superior, and one on a stream tributary to Lake Michigan. The catches at the Lake Superior barriers are given in the report of the Bureau of Commeruial Fisheries (page 31).

The program on Lake Michigan, which during the past 6 years has been carried on in cooperation with the Bureau, was sharply curtailed in 1961. The department continued however to operate the barrier on Hibbards Creek where continuous records were available since 1946. A screen barrier has proved successful in this stream, but in 1958 an electrical device was placed 100 feet upstream from the screens to insure against escapement. The 1961 catch of 975 lampreys, when compared with the catch of 988 in 1960, would indicate that the population has remained fairly constant over the 2-year period.

The catches at the Hibbards Creek barrier for 1946–1961 were as follows:

1946	125	1954	7,279
1947	596	1955	6,395
1948	989	1956	5,325
1949	1,579	1957	6,525
1950	5,431	1958	2,563
1951	12,640	1959	2,330
1952	3,302	1960	988
1953	9,247	1961	975

LAKE TROUT REHABILITATION

The lake trout rehabilitation activities in 1961 again were devoted mainly to Lake Superior. Plantings of fin-clipped yearling trout by the Ontario Department of Lands and Forests, Bureau of Sport Fisheries and Wildlife, and the conservation departments of Wisconsin and Michigan reached a record total of 1.2 million—an increase of 150,000 over 1960. Investigations on the status of native lake trout and the survival and dispersal of planted lake trout were continued by the Bureau of Commercial Fisheries, the Wisconsin Conservation Department, and the Fisheries Research Board of Canada.

This section covers the present status of the lake trout fishery and the principal propagation activities in 1961. Changes in the incidence of lamprey wounds, size composition of catch, availability, and other data that may indicate changes in lamprey predation are reviewed by various agencies in an other section (page 51).

The commercial catch records of lake trout for 1950–1961 provided by the Province of Ontario and the Bureau of Commercial Fisheries for the States of Michigan, Wisconsin, and Minnesota show that the lake trout production in Lake Superior continued to decline in 1961 (Table 1). The take of 368,000 pounds was 27 percent lower than the 1960 catch. The decline was most severe in Canadian waters where production dropped nearly 64 percent.

The decrease in Canadian waters resulted from a continued drop

TABLE 1.—Commercial landings of lake trout in Lake Superior by states and province, 1950–1961.

	(thousands of pounds)				
Year	Michigan	Wisconsin	Minnesota	Ontario	Entire Lake
1950	2,400	591	202	1,506	4,699
1951	2,174	504	233	1,273	4,184
1952	2,074	521	243	1,389	4,227
1953	1,746	450	217	1,371	3,785
1954	1,609	436	211	1,266	3,522
1955	1,378	553	170	1,003	3,104
1956	1,224	479	109	527	2,340
1957	849	287	55	238	1,429
1958	767	259	33	366	1,426
1959	671	186	11	238	1,106
1960	269	109	2	122	503
1961	218	103	2	45	368

both in fishing intensity and the catch per unit effort (Tables 2 and 3). The total number of 10,000-foot gillnet units lifted in the Canadian waters decreased from 1,276 in 1960 to 782 in 1961. At the same time the catch per unit effort (unweighted average for individual fishing areas) dropped from 91 pounds in 1960 to 52 pounds in 1961.

The condition of the Canadian fishery is shown clearly by the fact that of the 69 Canadian fishermen that reported lake trout in 1961, 44 took less than 100 pounds and only one took more than 5,000 pounds.

The amount of gill net fished in the United States waters dropped from 4,356 units in 1960 to 3,831 in 1961. Although the catch per 10,000 feet lifted in 1961 was well below average, it was slightly greater than in 1960 (Tables 2 and 3).

Slightly over 5½ million lake trout eggs were collected by state, federal, and provincial agencies in 1961—nearly 80 percent from brood fish in hatcheries. The building of brood stocks has solved the egg shortage which has limited hatchery production of lake trout since 1958. Nearly 70,000 brood trout are available in various hatcheries; these fish include nine different year classes and cover an age range from 2 to 13 years. The brood fish have been selected from various stocks of lake trout in Lake Superior. In addition, hatchery-reared trout have been introduced into two inland lakes in Ontario to provide "wild" brood stocks of Lake Superior origin.

The greater production of eggs has allowed agencies to increase plantings of hatchery-reared trout in Lake Superior. Slightly over 1.2 million yearling trout were released in Lake Superior in 1961 (Table 4), bringing the total plantings since 1958 to nearly 4 million fish (Table 5).

Although plantings have been mainly in Lake Superior, four small test plantings of hatchery trout have been made in Lake Michigan to obtain information on their dispersion, growth, and ability to survive lamprey predation in the years immediately following introduction. Early returns from these plantings have shown wide dispersal and excellent growth. First generation hybrid trout (brook trout x lake trout) and the progeny of first generation hybrids backcrossed to lake trout have been planted in South Bay (Manitoulin Island) and northern Georgian Bay by the Ontario Department of Lands and Forests. Returns since 1958 have indicated major differences in behavior from both native and planted lake trout. The hybrids tend to remain in shallower water and some have been taken in 6 feet in July when water temperatures are normally well over 60°F. Later in the year they were found in the upper portion of the thermocline at depths less than 50 feet. There has been evidence of spawning in areas formerly used by lake trout and at the same time of the year. The hybrids appear to survive through at least one spawning and some

TABLE 2.—Quantities of large-mesh gill nets lifted in lake trout fishery in United States statistical districts of Lake Superior, 1950–1961, and Canadian districts, 1953–1961, in units of 10,000 linear feet.

State or province & district	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Minnesota	928	1,380	1,714	1,541	1,227	1,114	812	353	205	125	37	13
Wisconsin	2,989	2,723	2,903	2,707	2,721	3,218	3,195	2,396	1,770	1,397	1,086	1,045
Michigan:												
S–1	1,140	1,315	1,515	1,564	1,524	1,185	1,686	698	444	239	154	119
S–2	1,724	706	564	443	320	323	448	260	184	133	68	52
S–3	5,449	4,557	5,507	5,241	5,209	4,914	3,970	3,133	3,004	2,431	1,445	1,265
S–4	2,686	2,102	3,262	3,202	2,991	2,617	2,381	2,258	1,852	2,141	1,070	923
S–5	1,548	1,701	1,112	777	1,121	856	767	631	722	660	482	301
S–6	648	730	617	656	703	502	415	414	215	207	44	113
U. S. total	16,062	16,214	17,194	16,131	15,816	14,729	13,734	10,143	8,396	7,433	4,386	3,831
Ontario:												
OS–1				895	895	870	658	310	392	456	106	53
OS–2				364	408	408	242	283	266	191	96	56
OS–3				386	393	374	517	259	312	397	145	47
OS–4				967	908	893	819	699	463	357	255	129
OS–5				450	202	630	238	291	267	41	138	10
OS–6				2,102	1,602	1,362	520	436	126	213	137	194
OS–7				1,262	1,253	944	667	605	749	543	399	293
Canadian total				6,414	5,671	5,481	3,716	2,831	2,587	2,252	1,270	782

TABLE 3.—Catch of lake trout per lift of large-mesh gill nets (4½-inch and greater) in United States statistical districts of Lake Superior, 1950–1961, and Canadian districts, 1953–1961, in pounds per 10,000 linear feet.

State or province & district	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Minnesota	174	137	133	116	154	142	115	125	150	75	66	142
Wisconsin	154	158	152	154	145	162	142	112	136	110	84	87
Michigan:												
S–1	258	227	227	185	164	179	126	115	130	89	72	67
S–2	155	147	133	141	118	177	198	137	163	133	75	79
S–3	129	145	118	109	104	100	97	103	104	104	75	70
S–4	142	150	140	121	111	112	110	92	102	97	64	58
S–5	201	164	193	229	198	221	213	216	187	207	139	161
S–6	254	189	234	231	216	171	154	132	165	149	131	127
U.S. average [1]	183	165	166	161	151	158	144	129	142	121	88	99
Ontario:												
OS–1				191	237	209	158	126	234	133	137	77
OS–2				178	172	160	65	66	114	52	35	29
OS–3				222	254	184	115	69	96	37	71	54
OS–4				227	213	180	117	116	199	154	114	64
OS–5				328	355	241	239	137	103	96	139	30
OS–6				178	186	151	151	107	198	191	91	43
OS–7				187	189	140	99	111	107	94	49	64
Canadian average [1]				216	229	181	135	105	150	108	91	52

[1] Unweighted mean.

TABLE 4.—Plantings of hatchery-reared lake trout in Lake Superior, 1961.

Agency	Area planted	Number planted	Fin clip
Bureau of Sport Fisheries and Wildlife	Keweenaw Bay	171,730	left ventral
	Whitefish Bay	112,500	right ventral
	Bayfield (Apostle Islands)	108,175	dorsal-right ventral
	Munising	59,170	left pectoral-right maxillary
Wisconsin Conservation Department	Bayfield (Apostle Islands)	108,886	adipose
		96,960	adipose-left maxillary
Michigan Department of Conservation	Ontonogan	48,700	dorsal-right pectoral
Ontario Department of Lands and Forests	Rossport to St. Ignace Island	278,980	both ventrals
	Montreal River to Coldwater Creek	215,000	left pectoral-right ventral
	West end of Pie Island	60,200	adipose-right pectoral
Total		1,260,300	

spawn the second time before they are completely eliminated by the sea lamprey.

Information collected in 1961 supported earlier evidence that natural reproduction in Lake Superior has been negligible in recent years and that the lake trout population is approaching complete dependence on hatchery trout. In 1961 fin-clipped trout made up 21 percent of the total marketable catch in Wisconsin waters, 9 to 16 percent in Michigan waters, and 9 percent in Ontario waters. The

proportion of fin-clipped trout in the population takes on added significance when their contribution to the young age groups is taken into account. A minor part of the catch always consists of fish too small to be marketable; about 51 percent of these small trout in Wisconsin were planted trout, in Michigan 23-31 percent, and in Ontario 33 percent. Moreover, hatchery fish made up 94 percent of the total season's catch of small lake trout (17 inches and under) by the Bureau of Commercial Fisheries research vessel *Siscowet* in western Lake Superior.

Preliminary estimates of total recoveries of fin-clipped trout in 1955–1961 from plantings made earlier in Wisconsin have shown that the survival of lake trout planted in Wisconsin waters has been re-

TABLE 5.—Annual plantings of hatchery-reared lake trout in Lake Superior, 1958–1961.

Year	*Number planted*
1958	982,200
1959	672,100
1960	1,049,800
1961	1,260,300
Total	3,964,400

markably high. Estimated total returns from these plants have ranged from 2.8 to 37.7 percent. Recoveries of fin-clipped trout in 1959–1961, in Michigan waters east of the Keweenaw Peninsula, from plants made in Michigan waters in 1958 and 1959 (these fish still are not completely vulnerable to the fishery) have ranged from 0.2 to 5.7 percent. Fish planted as 2- and 3-year-olds showed a much higher return—2½ to 11 times greater than 1-year-olds. No explanation for the differences in percent recovery can be given.

A total of 1,614 fin-clipped lake trout were recovered from the Canadian catch in 1961. Seventy-five percent were from 10 plantings made by the Ontario Department of Lands and Forests between 1953 and 1960. The remaining 25 percent were from 13 plantings made during the same period in the United States waters by the Fish and Wildlife Service and the Wisconsin Conservation Department.

Plantings of marked lake trout have been made both in the open lake from boats and at suitable shoreline locations to compare survival. The experimental shoreline plants have contributed about the same number of recoveries as the conventional boat plants.

The Bureau's research vessel *Siscowet* followed the movements of planted lake trout by making experimental trawl hauls during and after the stocking of 23,500 fish by the Wisconsin Conservation Department at Frog Bay (Apostle Islands). The first planted trout were taken at a depth of 5 fathoms about 40 minutes after planting. They reached 10 fathoms in 2 hours and 15 fathoms in 3½ hours after planting. The depth of 15 fathoms in Frog Bay was considered suitable habitat since native and previously planted trout were captured in this area. Feeding apparently did not begin until 48 hours after planting although the bottom had an abundant supply of amphipods.

LAKE TROUT ASSESSMENT

Bureau of Commercial Fisheries

In 1961, the Bureau continued its assessment of the commercial fishery in Michigan and Wisconsin waters of Lake Superior, to detect changes in the lake trout population, a task which is becoming increasingly difficult with the progressive decline of the fishery.

In the spring of 1961, both the percentage of lake trout bearing fresh lamprey wounds and the number of adult lampreys killed at the assessment barriers were the highest on record. In the summer, however, the frequency of wounds dropped to a very low level in all areas. The rate of wounding in September was 75–100 percent lower than in September 1959 and 1960 in most areas and nowhere was the reduction less than 50 percent. The usual seasonal increase in wounding rates occurred towards the end of November and December, but levels reached were still substantially lower than in 1959 and 1960.

Other signs of an improvement in the lake trout population were first noted in the fall of 1961. The catch per unit of effort increased at the Apostle Islands, Marquette, Munising, and Traverse Bay. At the Apostle Islands the catch per unit effort was 2.5 times higher in November 1961 than November 1959. An increase in the number of larger trout was noted in the November and December catches, particularly among the 23- and 24-inch fish. The catch per unit effort of fish over 22.9 inches long was approximately double the 1960 figures for November and December in the Apostle Islands, Marquette, and Traverse Bay. Although the catch per unit effort of fish longer than 25 inches increased considerably over 1960 in Wisconsin waters, it was still below the 1959 level. A marked increase in the survival of hatchery fish during their sixth year in Wisconsin was also indicated by the relatively higher rate of recovery from plantings of yearling lake trout made in 1956 than from plantings made in 1955 (even though survival of fish from the 1955 planting was considered outstanding as compared to plantings of most other years).

Although the abundance of large trout apparently increased during the latter half of 1961, the abundance of smaller trout remained very low as the result of the serious reduction in natural reproduction during the past few years. In December the catch per unit effort of sublegal fish dropped 50 percent or more below the 1959 figures in the Apostle Islands, Marquette and Traverse Bay. Of the sublegal fish caught, the proportion of fin-clipped fish was 50 percent at Traverse Bay and 95 percent at the Apostle Islands. Since the increase in the number of large trout has been confined principally to large immature fish, a material increase in the number of mature female trout cannot be expected before the fall of 1963. The prospects for rapid recovery

of the lake trout population under present conditions, therefore, do not appear good.

The Bureau's research vessel *Siscowet* was mainly concerned in 1961 with studies of lake trout and its environment in western Lake Superior; during two cruises the observations were extended to Whitefish Bay, Keweenaw Bay, and Isle Royale. The operations in Whitefish Bay in August provided very small catches of young trout, due largely to poor weather and unfamiliarity with the area. Only 22 lake trout were taken, of which 16 were fin-clipped (all from the shore plant made in Whitefish Bay in 1961).

In Keweenaw Bay nine 10-minute trawl tows between Baraga and L'Anse and off Pequaming, at the end of August, took 167 small lake trout, of which 165 (99 percent) were fin-clipped. Of these, 127 had been planted from shore as yearlings in June 1961 and the remaining 38 had been planted in 1960. Lake trout from the 1961 plant had grown 0.7 inch since release in June; those from the plant in June 1960 had grown 2.9 inches. Trawling operations in Keweenaw Bay in 1961 yielded approximately twice as many trout per 10-minute tow as did trawling in the same area with identical gear by the *Cisco* in 1953. It would appear that the plant of 172,000 fish in June 1961 contributed more fish to this area of Keweenaw Bay than did natural reproduction in the years just prior to 1953.

Experimental gill nets set off Mott Island and Thompson Island near Isle Royale took 125 lake trout, of which only one was fin-clipped. Catches by the *Siscowet* in 1958, 1959, 1960, and 1961 suggested that the abundance of small trout in this area has not changed materially.

The annual assessment of spawning populations of lake trout in the Apostle Islands area was conducted on a cooperative basis with the Wisconsin Conservation Department's research vessel *Salmo*. The two vessels lifted over 64,000 feet of large-mesh gill nets set on main spawning grounds and took 32 spawning trout (all males; none fin-clipped; average age, 6 years).

During the entire season's activities in west Lake Superior, the *Siscowet* captured 536 lake trout less than 17 inches long, of which 94 percent were hatchery-reared. Ninety-eight percent of all the yearling trout captured were from the 1961 Bayfield plant and 77 percent of all the fish 2 years old or older were from the 1960 spring plant. Only 30 trout were recaptured from the 1959 plant and only 6 from the 1958 plant. It is still too early to evaluate the survival of the 1961 plant, but the survival of the 1960 plant appears to be excellent.

Fisheries Research Board of Canada

Lamprey-wounded lake trout were abundant in the 1961 spring catches in both U. S. and Canadian waters. The usual summer decline in the incidence of wounded fish occurred, presumably when adult lampreys entered streams to spawn, but in the fall wounded lake trout were significantly less abundant than in 1960.

A decline in the proportion of wounded lake trout caught in eastern Lake Superior was reported in 1960. A further decline from 1960 to 1961 was observed for spring and fall catches and may be reasonably assumed for the summer catches despite the lack of statistically significant differences. The spring catches in 1961 from western Lake Superior showed no significant change in the proportion of wounded lake trout when compared to those from 1960. Summer catches were too small to permit a comparison. A significant decline, however, was apparent in the fall catches in both eastern and western areas.

There has been no evidence of a significant change in mean weight of marketable fish from 1960 to 1961 in areas where comparable data exist.

In Divisions IV and VII planted fish provided the great majority of the 2- and 3-year-old lake trout captured. The contribution of hatchery-reared fish in Division I was smaller but still significant. Divisions IV and VII have been the sites of three successive plantings, whereas Division I has received its share of planted fish solely by immigration.

The program of experimental fishing and tagging on Superior Shoal was continued in 1961. Of 1,021 lake trout captured in 12 lifts between June 20 and September 22, 361 were tagged and released. Only two percent of these fish bore lamprey wounds, although 20 percent were scarred. A total of 358 of 671 fish examined were judged mature and 75 of them were taken ripe or spent while spawning or immediately after.

In summary, the lake trout stocks in Canadian waters have continued to decline under the effects of sea lamprey predation. The continuing decline in the incidence of wounded trout in eastern Lake Superior and the spread of this trend to western divisions for the first time is encouraging. Confirmation of the fact that this is an effect of the efforts to control sea lampreys will, however, have to come from the lamprey spawning runs of 1962.

Planted fish have increased their representation in the Canadian catch tenfold within the last year and have provided the great majority of the 2- and 3-year-old fish captured by the industry. As there is no evidence to suggest any increase in natural reproduction, this trend may be expected to intensify in 1962, and to lead within three years to a situation in which any fishery will depend virtually exclusively on planted fish. Further, it seems likely that this condition will persist for several years thereafter, even should lamprey control prove successful and natural reproduction be restored.

Wisconsin Conservation Department

A rapid decline in the average size and weight of the lake trout taken in Wisconsin waters occurred from 1959 to mid-1961. This trend toward smaller fish was accompanied by an increase in the incidence of sea lamprey wounds.

In July 1961, sea lamprey wounding suddenly dropped 95 percent below the level for July 1960. This low incidence of wounds continued through November and increased slightly in December 1961, to a level 75 percent below that of December 1960. The sharp drop in sea lamprey wounding was accompanied by a noticeable improvement in the average size and weight of lake trout taken commercially.

A rapid increase in the percentage of fin-clipped lake trout in the sublegal (under 17.0 inches) sample was noted in 1961. Net-run samples of sublegal lake trout during November and December, 1961, were composed mainly (78 percent) of hatchery trout and indicated that the fishery would soon become almost totally dependent on planted fish.

An improvement in availability of lake trout in Wisconsin waters was first noticed in the fall of 1961. During this period the catch per unit effort of lake trout in the 21.0 to 24.9-inch group essentially doubled the 1960 figure for the same period. The improvement appeared to be due to increased survival and growth.

A SUMMARY OF FISHERY RESEARCH IN THE GREAT LAKES IN 1961

Lake Ontario

Research in Lake Ontario in 1961 was concerned primarily with fisheries for walleye and whitefish and the success of a cooperative program to re-establish lake trout by plantings and study their survival.

The Canadian fishery for whitefish in the eastern end of Lake Ontario has been under continuous study since 1944. Recent analysis of the composition of the catch has indicated that fry plantings were of no value to the fishery in years when conditions were favorable for natural reproduction. It has also been shown that cool spawning periods followed by warm hatching periods produced larger year classes. The increasing amplitude of annual fluctuations in the commercial catch is believed to be due to a recent reduction in the reservoir of parent whitefish and measures to increase the spawning stock have been recommended.

Walleye from the Bay of Quinte have supported an attractive sport fishery and a commercial fishery for some years. Both fisheries have been under study by the Ontario Department of Lands and Forests since 1957. The sport fishery is mainly dependent on the young fish (2-year-olds in 1961) and is relatively sensitive to changes in year class strength. The commercial fishery, on the other hand, takes older fish of several ages, probably as a result of the low rate of exploitation, and production has been steady at a relatively high level. An earlier opening for angling has been recommended to increase the catch of older fish by the sport fishery. Catches of young walleye made while seining for white perch have reflected the strength of year classes before they enter the fishery. It is proposed to include seining in the routine sampling program.

A continued decline of lake trout production and evidence that recruitment to the fishery had ended led the Ontario Department of Lands and Forests and the New York Conservation Department to begin a cooperative project to re-establish the population. Marked trout have been planted annually since 1953 at various locations in eastern Lake Ontario and recoveries made mainly in commercial nets set for whitefish.

The number of recaptured planted trout has increased to the point where the purchase of all sublegal fish for examination is no longer practical and a sample is now being taken. Almost 8,000 planted trout of legal size were caught in 1961, the majority in U.S.

waters. It now appears that nets are being set specifically for lake trout by some fishermen. The age composition of the catch in 1961 indicates a reservoir of older fish in U.S. waters which may, if it persists, produce spawn in 1962.

Other investigations included: (1) a creel census and sampling of fish populations in Lake St. Lawrence; (2) studies of the American eel population for possible effects of the St. Lawrence Seaway; (3) feeding habits of white perch, recently established in Lake Ontario; and (4) laboratory studies of coregonine hybridization.

Lake Erie

Research in Lake Erie in 1961 was concerned mainly with the rapid changes occurring in the fish populations and environment. These were studied by limnological observations and standardized fishing, mainly with trawls, at established stations. Additional material was obtained by sampling the commercial catch.

The Ontario Department of Lands and Forests continued monthly sampling of catches in trawls and gillnets. Pound nets and trapnets, which were not used extensively, received minor attention. Smelt in trawl catches from the western end of the central basin early in the season were predominantly females from the 1958 year class. This year class was dominant also in the catches made in the eastern end of the lake. Yearling smelt entered the fishery in considerable numbers late in 1961. A total of 9,563 fish, including 4,300 yellow perch, 3,800 smelt, 1,000 walleye and 300 white bass, were examined. Catch sampling in U.S. ports in the spring and again in the fall was carried out by the Bureau of Commercial Fisheries with assistance from state agencies.

Trawl sampling of the fish population was continued by the Bureau of Commercial Fisheries in the western basin and consisted of 3-day series of trawl hauls off Bono and East Harbor in spring, summer and fall, and biological sampling at seven stations. Data are being analysed to determine variability.

The hatch and survival for most species in Lake Erie appeared much better in 1961 than in 1960, although not as successful as in 1959. Cooler water temperatures in 1961 may have slowed the growth of young-of-the-year fish. The growth of older yellow perch of the 1959 year class was noticeably retarded.

Ten limnological cruises were made in 1961, to study dissolved oxygen conditions. Several hundred square miles of the central basin had less than 1 p.p.m dissolved oxygen in bottom waters when thermal stratification was present. Bottom organisms were taken at 60 stations, 40 previously sampled in 1930, to provide information on changes in the benthic community. About half of the samples were examined by the end of 1961.

A study of walleye spawning sites, which began in 1960, was continued in 1961 by the Ohio Division of Wildlife. A pumping device was used to collect eggs on spawning sites and measurements made of the dissolved oxygen, alkalinity, pH, transparency and temperature of the water, during April and May. Water samples were taken for chemical analyses and plankton. Fry tows were begun in early May an continued to mid-June. Collections at 20 stations in 1961 provided slightly more than 54,000 walleye eggs. Examination of more than half showed that approximately 20 percent were viable as compared with 50 percent in 1960. Fry tows, however, indicated that young fish were more abundant than in 1960, a fact confirmed by subsequent sampling with trawls. No conclusion can be drawn yet as to the specific factors influencing the hatch. Attempts were also made in 1961 by the Ontario Department of Lands and Forests to sample blue pike eggs on spawning grounds off Long Point but only 27 eggs were taken.

Some information was obtained on the movements of walleye (1959 year class), tagged in 1960 by the Bureau of Commercial Fisheries. Recoveries in the tagging year were mainly from U.S. waters of the western basin. Recoveries in 1961 indicated a westward dispersion with some fish reaching Lake St. Clair. Returns from 600 yearling walleye tagged in Lake St. Clair in the fall of 1960 by the Ontario Department of Lands and Forests showed some moving to Lake Huron, others to Lake Erie, while most remained for their second year in Lake St. Clair. These observations are not consistent with earlier tagging data which suggested a migration to Lake Erie.

Smelt, which are increasing in commercial importance in Canadian waters, were the subject of special studies by the Ontario Department of Lands and Forests. Sampling of the spawning population in the vicinity of Pt. Pelee has been carried out each year since 1954. During this period, the even year classes have predominated in the spawning populations. Experimental trawling showed that by late August smelt were rare in the western part of the central basin. Preliminary tests of the selectivity of trawl cod-ends for sizes of smelt were carried out.

Lake Huron

In the United States the routine collection of scales from the commercial catch in Saginaw Bay was continued by the Bureau of Commercial Fisheries. Determination of the micro-organic constituents of the lake water using carbon filters was carried out at Hammond Bay. The use of discriminant analysis in studying coregonid morphology was tested and found satisfactory in distinguishing five species of Lake Huron ciscoes. Studies of coregonid serology and chromosome content to aid in identification of stocks were continued.

Periodic sampling of the commercial whitefish catch, was continued by the Ontario Department of Lands and Forests. In southern

Georgian Bay samples the 1957 year class was best represented. In the Parry Sound area 90 percent of the fish examined were from the 1958 year class, which had earlier contributed substantially to the fishery in southern Lake Huron. The absence of older fish was most noticeable. In the past six years, only 3.4 percent of the fish examined have been 5 years of age or older. Similar observations have been made in southern Lake Huron where the whitefish catch has been relatively high in recent years. Here 2-year-old fish predominate and in 1961 only 4.6 percent of the catch was 4 years of age or older.

Whitefish tagging in Georgian Bay continued to indicate that fish in the south form a discrete population which spawns near the southeast end of Wasaga Beach.

Experimental fishing was continued in 1961 in South Bay and Georgian Bay to systematically follow changes in abundance of principal species and the success of plantings of hybrid trout. Alewife were abundant and cisco declined for the fifth consecutive year in South Bay. No lake trout were taken, indicating that no significant numbers of the 1954 year class, which had been the most successful of the six established by planting, survived to reach 7 years of age. The catch in experimental nets in Georgian Bay consisted mainly of coregonids. Only 11 whitefish and no lake trout or hybrid trout were taken.

Creel census of the bass fisheries in South Bay and Parry Sound was continued. During the census in South Bay 10 year classes have contributed from 193 to 4022 fish. The quality of the bass fishing has been closely related to the strength of year classes largely determined by temperature conditions in their first year.

The monthly questionnaire survey of the incidence of lamprey wounds and scars in the commercial whitefish catch showed essentially no change.

Three hydrographic studies were carried out in 1961. A detailed analysis was made of the South Bay water temperature data and a paper prepared for publication. A calculation of the water exchange between South Bay and Lake Huron was made on the basis of heat storage and transfer. Attempts to check the results by direct measurement of currents at the mouth of South Bay were begun. A synoptic survey and a release of drift bottles in Georgian Bay was also made.

Lake Michigan

The Bureau of Commercial Fisheries completed its third inventory of the Lake Michigan chub populations. The second inventory in 1955 revealed a drastic change in species composition since the first survey in 1932. In the recent survey the bloaters (*C. hoyi*) were even more abundant in 1961 and other species were generally less numerous. Additional nylon gillnets of graded mesh size and trawls were fished in several areas to provide a broader basis for future comparisons of

fish populations. Hydrographic data were routinely collected during these operations.

Walleye tagging in northern Green Bay was continued by the Bureau and the Michigan Department of Conservation during the spawning run. As in past years most of the recaptures of tagged fish were made in northern Green Bay. No tagged fish released in this area were taken in Lake Michigan proper. The year class composition of spawning populations differed significantly. A report is being prepared for publication.

The commercial catch was sampled in the spring and fall as in past years. Reports are being prepared on the contribution of year classes of yellow perch and whitefish to fisheries in south and central Green Bay.

Lake Superior

Routine sampling of fish populations and observations of environmental conditions in United States waters were continued in 1961 by the Bureau of Commercial Fisheries research vessel *Siscowet*. Collection of information on the distribution and abundance of native and planted lake trout was emphasized. The latter were dominant in the trawl catches along the south shore, but scarce in the vicinity of Isle Royale where the abundance of small trout has not changed materially in the last four years. During the trout spawning season the *Siscowet* and *Salmo* (Wisconsin Conservation Dept.) set and lifted gillnets on spawning grounds and took some mature trout, all males. Other activities of the *Siscowet* included: (1) the collection of blood samples for electrophoretic studies; (2) experimental fishing with mid-water trawl; (3) collection of pelagic fish larvae with tow nets; (4) annual assessment of spawning whitefish in western Lake Superior; (5) studies of spawning of various coregonids; (6) assistance in sediment studies.

A major activity in which the Bureau of Commercial Fisheries, the Fisheries Research Board of Canada, and the Wisconsin Conservation Department participated in was the assessment of the lake trout fishery. The 1961 observations are summarized on page 51.

The Fisheries Research Board of Canada extended their investigations on Lake Superior in 1961 to include: (1) net-run sampling of the commercial whitefish catch; (2) examination of the brief but intense fall fishery for lake herring; and (3) the distribution and abundance of other species of current or potential value.

A study of the migration of brown and rainbow trout from Lake Superior into the Brule River was begun by the Wisconsin Conservation Department. A mechanical two-way trap, operated from August 9 to December 5, took 1426 brown and 328 rainbow trout. Fish were measured, weighed, sexed, and scale samples taken. Eleven hundred and five brown and 167 rainbow trout were tagged. Lamprey scars

were noted on 15.6 percent of the brown trout and about 1 percent of the rainbow trout. Only 3 fish bore wounds. While migrating spawners were in the river, an outbreak of furunculosis caused significant mortality. Data on age and growth are being analysed.

Study of the life history of lake-run rainbow trout in Lake Superior tributaries was continued in 1961 by the Minnesota Department of Conservation. Trapping operations on three streams took 75 mature trout which were then tagged and 197 immature trout which were fin-clipped. Subsequent recovery of tagged fish and observation of dead trout upstream indicated a high mortality of spawning fish. Young-of-the-year were first noticed in late June and appeared in traps two weeks later. High catches were made in late July, following rains and increased stream flow. Fall surveys on five streams indicated a high proportion of young-of-the-year fish remaining in streams. Fish larger than 8 inches and more than 2 years old were rare. Additional fish were marked in the course of the surveys, removing different fins to determine if mature fish returned to parent streams. A creel census during the spring and fall seasons showed that angling pressure was highest in the Baptism River and streams to the west.