ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1977

GREAT LAKES FISHERY COMMISSION

MEMBERS — 1977

CANADA	UNITED STATES
E. W. Burridge	W. M. Lawrence
F. E. J. Fry	N. P. Reed
C. J. Kerswill	Claude Ver Duin
K. H. Loftus	L. P. Voigt

SECRETARIAT

C. M. Fetterolf, Jr., Executive Secretary
A. K. Lamsa, Assistant Executive Secretary
J. Herbert, Fishery Biologist
T. C. Woods, Secretary

GREAT LAKES FISHERY COMMISSION

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

ANNUAL REPORT
for the year
1977

1451 Green Road
Ann Arbor, Michigan,
U. S. A.
1980

LETTER OF TRANSMITTAL

In accordance with Article IX of the Convention on Great Lakes Fisheries, I take pleasure in submitting to the Contracting Parties an Annual Report of the activities of the Great Lakes Fishery Commission in 1977.

Respectfully,

L. P. Voigt, *Chairman*

CONTENTS

ANNUAL REPORT FOR 1977

INTRODUCTION

A Convention on Great Lakes Fisheries, ratified by the Governments of the United States and Canada in 1955 provided for the establishment of the Great Lakes Fishery Commission.

The Commission was given the responsibilities of formulating and coordinating fishery research and management programs, advising governments on measures to improve the fisheries, and implementing a program to control the sea lamprey.

In accordance with Article VI of the Convention, the Commission pursues much of its program through cooperation with existing agencies. Sea lamprey control, a direct Commission responsibility, is carried out under contract with federal agencies in each country.

The Commission has now been in existence for 22 years. Its efforts to control the sea lamprey and reestablish lake trout have, in the main, been very successful although inherent problems remain. Residual populations of sea lampreys continue to be a source of mortality. Operational costs and costs of the chemicals used in the sea lamprey control program continue to rise. The need to develop and test alternative and supplementary control methods is urgent. Also, because of environmental considerations, the Commission is obligated to continue its support of research on the immediate and long-term effects of the chemicals being used. Self-sustaining populations of lake trout have not been widely reestablished, and efforts to encourage natural reproduction by lake trout must be intensified.

Through the years of its existence, the Commission has encouraged close cooperation among state, provincial, and federal fisheries agencies on the Great Lakes. Many, and probably most, of the fisheries problems are of concern to all agencies. The development of integrated and mutually acceptable management programs, supported by adequate biological and statistical information is vital. The Commission is gratified with the spirit of interagency cooperation that has developed and anticipates continued cooperation for the benefit of the fishery resource and its users.

Further, recognizing that ultimately the welfare of the fishery resource of the basin depends upon maintaining an environment of the highest possible quality, the Commission, with the support of other fishery agencies, is developing close liaison with those governmental agencies who have direct responsibility for water quality, pollution abatement, and land use.

The Commission's Annual Meeting was held at Sault Ste. Marie, Ontario, June 14-16, 1977 and its Interim Meeting was convened in Ann Arbor, Michigan, December 1-2, 1977.

ANNUAL MEETING

PROCEEDINGS

The twenty-second Annual Meeting of the Great Lakes Fishery Commission was held in Sault Ste. Marie, Ontario, June 14-16, 1977.

Chairman Lester P. Voigt convened the meeting at 0900 hours and announced the impending appointment of Robert Herbst, Assistant Secretary of the Interior for Fish and Wildlife and Parks, as the new U.S. federal representative on the Commission.

Dr. Murray Johnson, Ontario Region, Director General, Canada Department of Fisheries and the Environment, welcomed the Great Lakes Fishery Commission to Sault Ste. Marie on behalf of Mr. Ken Lucas, Senior Assistant Deputy Minister, Canada Department of Fisheries and the Environment, exhorting the Commission to assume a position of leadership in all aspects of fisheries management as stated on its letterhead, "Established by Convention between Canada and the United States to improve and perpetuate fishery resources."

In his report to the Commission, Chairman Voigt was an enthusiastic proponent of Lucas's theme, and recognized the need for re-evaluation of Commission goals and objectives in light of the problems and possibilities arising from previous successes. He expressed his hope that through cooperation of not only the two countries but of the academic and the management communities, the new goals and objectives of the Great Lakes Fishery Commission will someday be realized.

Sea Lamprey Control and Research

The Commission accepted reports on sea lamprey control and research during 1977 from its two agents, represented by Dr. Tibbles and Mr. Dustin, Canada Department of Fisheries and the Environment, and Mr. Braem, United States Fish and Wildlife Service (Appendices C and D). Dustin and Tibbles explained that high sea lamprey counts in localized areas, such as certain upper lakes tributaries and the Humber River in Lake Ontario, may be attributable to the transportation and support of adult sea lamprey by migratory salmon, thus concentrating them in the vicinity of the streams. These localized counts did not necessarily indicate an increase in sea lamprey numbers. Braem cited low flows in some major sea lamprey streams and unseasonally high water temperatures in all streams in May of 1977 as combining to cause a concentration of spawning sea lamprey into certain tributaries of Lake Superior. The latter condition attracts sea lampreys while the former repels them.

The Annual Report of the Hammond Bay Biological Station, summarizing progress since January 1977, was submitted by Dr. Joseph Hunn, Station Chief, USFWS (Appendix E).

Dr. Fred Meyer (USFWS) summarized the activities of the La Crosse Fish Control Laboratory on registration-oriented research on lampricide (Appendix F). Mr. Bernard Berger, USFWS Liaison Officer to the various regulatory agencies, reported on the status of registration of TFM, Bayer 73 and their combined use. There remains some uncertainty as to whether additional information is required for mixtures of Bayer 73 and TFM, and whether additional studies will be necessary after registration, which is reviewed every five years.

Commissioner Lawrence, Chairman of the Task Force on Barrier Dams, submitted the draft document, "Barrier Dam Program for Sea Lamprey Control," for amendment and adoption by the Commission. The Task Force on Barrier Dams met 18 May 1977, to develop guidelines for obtaining Commission funds for construction of barrier dams on selected streams.

The Commission approved both 1978 and 1979 Sea Lamprey Control and Research appropriations, giving tentative approval to Administration and General Research allocations for the two years:

	1978	1979
Sea Lamprey Control and Research	$4,423,000	$4,891,000
Administration and General Research	206,000	246,400
	$4,629,000	$5,137,400

Management and Research

Management and Research Committee (MRC)

Commissioner Kerswill, MRC Chairman, advised attendees of the 12 April 1977 reactivation of the MRC, noting the attendees and the topics discussed, the recommendations which evolved, and the Commission's response to the MRC's recommendations. He also summarized the deliberations of his ad hoc committee (W. Pearce, N.Y.; A. Holder, Ontario; H. Vondett, Michigan) on the role of the MRC, its terms of reference and future direction.

Lake Committee Meetings

Mr. Russell Scholl (Ohio Department of Natural Resources) reported on the proceedings and recommendations generated at the annual 1977 Lake Erie Committee meeting and the Joint Lake Erie and Lake Ontario Committees Meeting, generating a discussion on the fortunes of Lake Erie walleye, sauger and blue pike.

Mr. Pearce (NYDEC) summarized the 1977 deliberations and recommendations of the Lake Ontario Committee, emphasizing the function of the lake committees as a strong arm to the MRC and the Commission.

Mr. Asa Wright, Michigan Department of Natural Resources, reported on the activities and recommendations of the Lake Huron Committee, Lake Superior Committee and the Upper Lakes Plenary Session. Mr. Ron Poff, Wisconsin Department of Natural Resources, reported for the Lake Michigan Committee, noting the annual report of the Lake Michigan Lake Trout Technical Committee. There were inquiries on the results of the purse seine feasibility project, the specifics of Wisconsin's limited entry legislation, the assessment of lake trout egg loss on Lake Michigan reefs to perch and burbot, and the progress of the 1976 Green Lake strain lake trout plant on Wisconsin's Sheboygan Reef.

Great Lakes Fish Disease Control Committee

Advances in fish disease control in hatcheries around the Great Lakes were related to the Commission by Mr. James Warren (USFWS), Chairman of the Fish Disease Control Committee.

Scientific Advisory Committee (SAC)

Mr. Andrew Lawrie (OMNR), Convenor, reviewed the SAC recommendations to the Commission, making a commitment to work toward the realization of the Commission's wishes, and, to this end introducing Drs. Henry Regier's (University of Toronto) and George Francis's (University of Waterloo) "Proposal to Establish a Reference Group on Great Lakes Rehabilitation and Restoration."

National Sections Meetings

Commissioner Claude Ver Duin, U.S. Section Chairman, reported those topics which came under discussion during the U.S. Section Meeting, which included the Eastland Fisheries Survey, stock assessment, and the FDA proposal to lower the PCB tolerance level in fish to 2 ppm and its effects on the fishing industry, and increasing the role of U.S. Advisors.

Commissioner Burridge, who chaired the Canadian Section Meeting, summarized the deliberations of Canadian attendees. The International Joint Commission (IJC) was the major topic of discussion and new references were considered in relation to IJC, along with fishery representation on those reference groups. Other topics of discussion included barrier dams for sea lamprey control and remedial work for the St. Marys Rapids.

International Joint Commission Water Quality Report

The IJC Liaison Officer to the Great Lakes Fishery Commission updated the Commission on items of concern to fishery interests with particular reference to the ongoing review of the 1972 Canada-U.S. Water Quality Agreement soon to be renegotiated and progress of the Upper Great Lakes Reference Group, the Pollution from Land Use Activities Reference Group, and the Fish Contaminant Surveillance Program which has two phases, inshore and offshore.

Quotas - Their Establishment, Allocation, Auditing and Enforcement

The four participants in the panel on quota management, arranged at the request of the Management and Research Committee, shared some thoughts on the subject with Annual Meeting attendees. Mr. William Straight (Ontario Ministry of Natural Resources) considered the benefits and difficulties inherent in the application of quota management techniques. Mr. Ron Poff (Wisconsin Department of Natural Resources) felt that fishery managers should be concerned with biological rather than social or economic impacts and Straight agreed, recognizing, however, that the socio-economic aspects of the industry must be dealt with in order to achieve control over biological impacts. Attendees noted that recreational and Indian fisheries, as well as the commercial fishery must be considered when limiting fishing pressure.

Mr. B. Skud, Executive Director of the International Pacific Halibut Commission (IPHC), summarized his agency's experience with quota management, making some observations and recommendations about the regulation of commercial fisheries.

Dr. M. Shepard, Deputy Director General of the Fishing Services Directorate of Canada Fisheries and Marine Service, addressed the question "Why quotas?" and made some comparisons between management of fish stocks in the oceans and on the Great Lakes, emphasizing the biologically conservative approach Canada is initiating.

Mr. R. Hodgins, Special Agent in Charge of Law Enforcement, Region III, USFWS, described five essential elements for the successful implementation of a scientifically defensible quota system: 1) the system must be equitable, 2) contracts must have value, 3) contracts must be clear and enforceable, 4) the support of the judicial system must be obtained if criminal sanctions are to imposed, and 5) adequate enforcement resources should be available at the onset of a quota system proportional to the fishery's value.

Extension of Winter Navigation Season

Informational reports on the Corps of Engineers (COE) planning process, the progress of the Winter Navigation Season Extension Environmental Planning Task Force, and Canadian reservations, were given by Mr. Alfred P. Behm (Assistant Chief of Planning, Chicago District, COE), Mr. Herb Hyatt (Coastal Ecosystems Activity Leader, Region III, USFWS) and Mr. Derek Foulds (Director, Ontario Region, Inland Waters Directorate, DFE). A representative of the New York Department of Environmental Conservation relayed his concern over the COE's plans to proceed with construction and implementation of the winter navigation program, monitoring environmental effects for the first ten to fifteen years of the program. Other questions related to U.S. and Canadian economic justifications for the program and whether the harshness of the 1977 winter had altered any agency's perception of the project. Although the COE and the U.S. House Committee were not deterred by the severity of the 1977 winter, Hydro Quebec is refusing to consider winter navigation any further.

Administrative and Executive Decisions

Chairman Voigt highlighted the major decisions made during the three-part Executive Session.

General

1. The Commission approved the fiscal year 1978 budget of $4.4 million for Sea Lamprey Control and Research and made tentative changes in the budget for Administration and General Research pending adjustments in staff and appropriation levels. The fiscal year 1979 budget

for Sea Lamprey Control and Research was approved at $4.9 million—Administration and General Research was tentatively approved at $246,400. The Commission also authorized the purchase of an additional 30,000 pounds of TFM with available funds.

2. As a replacement for Mr. McLain on the Sea Lamprey Control and Research Committee, the Commission appointed Mr. Patrick Manion, USFWS.

3. Concerning the Barrier Dam Proposal, the Sea Lamprey Control and Research Committee was charged with seeing that recommendations of the proposal are carried out, and with making a progress report to the Commission at its September 1977 quarterly meeting.

4. The Commission authorized the publication of Schneider and Leach's PERCIS paper entitled, "Walleye Fluctuations in the Great Lakes and Possible Causes" and Shuter and Koonce's paper entitled, "A Dynamic Model of Western Lake Erie Walleye Populations," in the Technical Report Series.

5. Transfer of funds for use by the Sea Lamprey International Symposium Steering Committee was approved.

6. The Commission authorized the Hammond Bay Biological Station to fill outside requests for live sea lamprey for research purposes on a cost basis, if the Commission has a supply of sea lamprey surplus to its own needs. Efforts to capture or culture extra sea lamprey will not be authorized.

7. The Commission will prepare a position statement on the need for continued sea lamprey control, stocking, and efforts to rehabilitate Great Lakes fish stocks in the face of contamination problems.

8. The quota management panel discussion will be distributed separately from the minutes of the Annual Meeting and will be made available to Commission cooperators.

9. The Commission will meet with the International Joint Commission sometime after the Great Lakes Fishery Commission September Executive Meeting.

Responses to the Management and Research Committee

1. The Commission endorses the Lake Committees' efforts towards "common management goals, and objectives" and urges them to actively pursue such development in advance of the 1978 Annual Meeting.

2. The Commission encourages its state cooperators to continue working cooperatively with the USFWS towards completion of the inventory of Great Lakes fish stock assessment programs, with a complementary effort by the Province of Ontario.

3. The Commission feels that the Secretariat lacks the manpower resources to develop a summary dealing with the effects of contaminants on fish stocks, as requested by the Management and Research Committee.

Responses to the Fish Disease Committee

1. The Commission expressed its support of the Resolution on Availability of Therapeutics and Prophylactics Used to Control Fish Diseases, which stated the need for minor use drugs in the Great Lakes rehabilitation effort.

Responses to the Scientific Advisory Committee (SAC)

1. The Commission forwards "Feasibility of Modelling Walleye Populations of Western Lake Erie" to the Lake Erie Committee with encouragement that their Standing Technical Committee work with members of the SAC and others as appropriate to prepare a report on the prospects for expansion of joint research employing dynamic models and shared data bases as an adjunct to traditional approaches of stock assessment.

2. The Commission requests that the final report on the feasibility of modelling walleye populations of western Lake Erie be used as one basis for discussion by the Standing Technical Committee and their advisors.

3. The Commission returned SAC recommendation entitled "Great Lakes Carrying Capacity of Large Piscivores" for clarification, reorganization and possible division into separate recommendations.

4. The Commission did not accept SAC recommendation "Habitat Modification as a Means to Sea Lamprey Control" as a feasible proposal.

5. In response to SAC recommendation "Bi-National Storage and Retrieval System for Great Lakes Fishery Data," the Commission encourages the U.S. Fish and Wildlife Service and the Ontario Ministry of Natural Resources to work together towards further system capability, such as increased compatibility of catch statistics handled by Ontario Fisheries Information System (OFIS) and the Great Lakes Fishery Laboratory terminal in Ann Arbor.

6. The Commission solicited the services of Dr. H. T. Booke who convenened a session on "Fish Genetics-Fundamentals and Implications to Fish Management" at the International Association for Great Lakes Research 1977 annual meeting. The SAC was charged to investigate the ways and means, time frame and subject matter for a bi-national workshop on the "stock concept."

7. The Commission agreed to reaffirm its position favoring a reversal of environmental degradation, and its support of the International Joint Commission and the Canada-U.S. Water Quality Agreement. The Commission seeks to retain an effective voice in environmental matters by avoiding extremist positions.

8. The Commission received with appreciation the timely SAC memo "Rehabilitation of Great Lakes Fisheries" and encourages the SAC to further consideration of rehabilitation in the context of present industrial and urban influences.

9. The Commission forwarded SAC comments on the draft document "The Role of the U.S. Fish and Wildlife Service in a National Program for the Enhancement of the Fishery Resources of the Great Lakes" to the U.S. Fish and Wildlife Service.

Other Business

Dr. Tibbles advised the Commission of an issue concerning the proposed development of the Whitefish Island-St. Marys River rapids area (Sault Ste. Marie), agreeing to submit a written suggestion for Commission action at the September 1977 Executive Meeting.

Mr. Daugherty gave a brief progress report on the Iron River National Fish Hatchery and pointed out that the Service is still in the process of land acquisition and the desired site should be available by next spring (1978). Plans are "on track and progressing well."

Dr. David Stuiber (University of Wisconsin, Madison) discussed activities in removing organic chlorinated hydrocarbons from fish, noting that most investigations are concerned with identifying and monitoring contaminants.

Dr. Will Hartman (USFWS) reported on the status of the fish stock assessment program inventory, expected to be complete in September of 1977.

Adjournment

The quarterly Executive Meeting was scheduled for 29 September 1977 in Ann Arbor, Michigan. The 1978 Annual Meeting was scheduled for 12-15 June 1978, to be convened in Rochester, New York.

Chairman Voigt expressed appreciation on behalf of the Commission for the fine hospitality of the Sea Lamprey Control Centre and of the Ontario Ministry of Natural Resources over the past week. The field trip, luncheon, and cruise arranged by Dr. Tibbles and his staff, and the steak fry and picnic sponsored by the OMNR had made the 1977 Annual Meeting a most enjoyable and memorable one. He thanked the attendees for their participation in a most productive meeting, and the Annual Meeting of the Great Lakes Fishery Commission was adjourned at 1300 hours, June 16, 1977.

INTERIM MEETING

PROCEEDINGS

The Commission's Interim Meeting was convened in Ann Arbor, Michigan on December 1-2, 1977 to consider the sea lamprey control and research program, to review budgets for fiscal years 1978 and 1979, to consider reports of internal committees, to receive updates on status of contaminants, to receive a report on an inventory of fish stock assessment programs, and to hear the U.S. Comptroller General's Report to Congress on "The U.S. Great Lakes Commercial Fishing Industry: Past, Present, and Potential."

In addition to introducing the present Commissioners, the Chairman of the Commission also welcomed Mr. R. L. Herbst as U.S. federal alternate Commissioner in lieu of Mr. Reed who had resigned. Mr. Herbst is Assistant Secretary, Fish and Wildlife and Parks, Department of the Interior.

Sea Lamprey Control and Research

The Commission heard reports on the incidence of sea lamprey wounding on lake trout, salmon, and lake whitefish in the Great Lakes.

The sea lamprey control agents presented progress reports on sea lamprey control operations in the United States (June-November 1977) and Canada (April-November 1977).

Progress reports covering sea lamprey research at Hammond Bay Biological Station, Michigan (USFWS) included: progress relative to development of methods to sterilize adult sea lamprey; development of uniform criteria for classifying sea lamprey wounds; and chemical sensing in sea lamprey and development of attractants and repellents. Registration-oriented research on lampricides at the Fish Control Laboratory, La Crosse, Wisconsin (USFWS) was also summarized.

Commissioner Lawrence, Chairman of the Commission's Sea Lamprey Control and Research Committee, presented a progress report on the development of the sea lamprey barrier dam program, which will improve control of sea lamprey in streams that are difficult to treat with lampricides and will reduce control costs over the years. Application and Project Agreement forms have been completed and are being distributed to agencies. Further, the Regional Office of the U.S. Fish and Wildlife Service is assisting the Commission in developing a draft "Environmental Assessment of the Barrier Dam Program for Sea Lamprey Control."

The Commission also received its first application for barrier dam funding; that of the Wisconsin Department of Natural Resources for repairs to a dam on the East Twin River, tributary to Lake Michigan.

The Commission considered programs and budgets for fiscal years 1978 and 1979. At the Annual Meeting in June 1976, the Commission adopted a budget for fiscal year 1978 in the amount of $4,555,600 as follows:

	U.S.	*Canada*	*Total*
Sea Lamprey Control and Research	$3,001,170	$1,348,370	$4,349,540
Administration and General Research	103,030	103,030	206,060
Total	$3,104,200	$1,451,400	$4,555,600

The budget request for fiscal year 1979 ($5,137,400) endorsed at the Annual Meeting in June 1977, called for continuation of sea lamprey control on Lakes Ontario, Huron, Michigan and Superior, stream surveys for larval lampreys, operation of electric assessment weirs on Lake Superior and Huron, continuing, although almost completed, research to assess immediate and long-term effects of lampricides in the environment, research to improve present control techniques, and continuation of barrier dam construction on selected streams to prevent sea lamprey access to problem areas and reduce application costs and use of expensive lampricides.

Sea Lamprey International Symposium (SLIS)

The Chairman of SLIS presented a progress report which announced deferral of the symposium from August 1978 to August 1979 because of unavoidable delays in programming. He also reported on arrangements to publish the proceedings in the Journal of the Fisheries Research Board of Canada.

Scientific Advisory Committee (SAC)

The Convenor of the SAC reviewed the report of the SAC September 1977 meeting which had been presented to the Commission at its September Executive Meeting. The report addressed the role of the SAC and its terms of reference; included recommendations on the feasibility study for rehabilitating degraded Great Lakes fish communities, and on deferring lampricide treatments of sea lamprey-infested tributaries in the Oswego River drainage pending further evaluation of their contribution to Lake Ontario lamprey populations; and considered plans for the Stock Concept Workshop and barrier dams for sea lamprey control.

The Convenor also reported on the SAC deliberations emanating from the SAC meeting immediately preceeding the Interim Meeting which included information from the work group on the feasibility of rehabilitation in the Great Lakes and on the suggested organization for the Stock Concept Workshop. He also reported on the ad hoc meeting of personnel from sea lamprey control agents, New York Department of Environmental Conservation, SAC, and Secretariat to review and discuss potential sea lamprey contribution from the Oneida-Oswego system to Lake Ontario and make recommendations for further studies.

Management and Research

A representative of the Great Lakes Basin Commission presented a progress report on it plans for development of a comprehensive fisheries management plan for the Great Lakes.

The Commission accepted with thanks the completed report of the inventory of Great Lakes fish stock assessment programs.

The U.S. Fish and Wildlife Service presented a progress report on the Iron River National Fish Hatchery which will be located in northern Wisconsin. It will be a multipurpose lake trout hatchery incorporating brood stock facilities, genetic strain maintenance, egg and yearling production.

The Chairman of the Lake Erie Committee reported on minimum size restrictions on commerically-caught yellow perch, walleye quotas, and activities of the new Standing Technical Committee, which has two mandates--determine walleye quota estimates for the coming year and examine management consideration for Lake Erie fish communities.

The Chairman of the Lake Michigan Committee summarized activities of the Lake Committee's three technical committees: Lake Trout Technical Committee, Sport Fishing Statistics Committee, and Chub Technical Committee.

The Chairman of the Lake Huron Committee apprised the Commission that the Province's major splake rearing facility for Lake Huron, which had a history of disease problems, was to be cleaned and disinfected, with the result that no splake would be available for planting in 1978.

The Chairman of the Lake Ontario Committee briefly summarized ongoing activities which included fish stock assessment and monitoring, contaminant sampling, groundbreaking for New York's lake trout hatchery, and collection of chinook and coho salmon spawn for future planting. New York expressed special concern over effects of increased diversions of water from Great Lakes system at Chicago and effects of winter navigation.

The Lake Superior Committee made no report, but alternate Commissioner Herbst reported on Minnesota's new French River Hatchery.

The U.S. Section of the Commission also received seven recommendations from the Lake Superior Advisory Committee concerning construction of barrier dams to block spawning runs of sea lamprey, Indian representation on the Advisory Committee, catch fees, marketing Great Lakes species either suspected of being contaminated or considered underutilized, support for Minnesota's efforts to rehabilitate lake herring, identification of successful strains of lake trout for retention as brood stock at the Iron River National Fish Hatchery, and resubmitted a recommendation requesting the U.S. Section to "petition Congress to investigate the stipulations of the various Indian treaties as negotiated with the U.S. government and Indian organizations with respect to the provisions of those treaties and the present management and utilization of the fishery resources of the Great Lakes."

Contaminants

The contaminant problem in New York waters of Lake Ontario concerning Mirex and PCB's was described. It has led to a ban on possession of certain species, particularly salmonids, except that a limited number of trophy-sized fish may be kept if tagged with non-reuseable tags. In addition, planting rates for restricted species have been reduced or eliminated.

The Commission was also apprised that dieldrin residues in Lake Michigan chub stocks sampled in State of Michigan waters often exceed the U.S. Food and Drug Administration action level of 0.3 µg/g. No explanation is available since use of this pesticide was banned in the early 1970's.

A representative of the International Joint Commission Great Lakes Regional Office, Windsor, Ontario, presented an update on the Great Lakes international fish contaminant surveillance program. The whole lake program emphasizes long-term trends of known, problem contaminants and identification of new contaminants. Additional objectives relate to the relative conditions of the lakes to each other, protection of fish stocks, transboundary movements of contaminants, impact of nearshore regulatory controls on the whole lake, and evaluation of non-point source and particularly atmospheric contaminants.

U.S. Comptroller General's Report to the Congress on "The U.S. Great Lakes Commercial Fishing Industry: Past, Present, and Potential"

A representative of the General Accounting Office (GAO) presented the above report, which stated that "various complex issues severely limit the potential for expanding the U.S. Great Lakes commercial fishing." The report cites such factors as depleted stocks of important commercial species, development of a recreational fishery for traditional commercial species, states' preference for recreational fisheries, restriction on commercial gear and a limited entry program, contaminants, and absence of reliable data on volume of fish that can be harvested. The report noted the future of the U.S. commercial fishermen may depend upon an increase in harvest of high valued species if improved stock assessments will convince states to allocate quotas of such species to the commercial industry, and harvesting and marketing of currently underutilized species. The report also dwelt briefly upon prospects for the Canadian commercial fisheries.

A representative of the National Marine Fisheries Service agreed the report is factual and comprehensive but felt the conclusions were unduly pessimistic. Using the factual statements of the GAO report which predicted a dismal future for Great Lakes commercial fisheries, he turned them around to show an improved position for commercial fisheries assuming continued advances in management, restoration of the environment, and rehabilitation of the fish stocks.

A representative of the U.S. Fish and Wildlife Service also responded to the GAO report finding it "a fair, factual, comprehensive, and straight forward assessment of the Great Lakes fishing industry " and expected the report to add support for increased state-federal assessment of fish stocks. He also viewed the "report optimistically as a vehicle that could lead the industry to a brighter future more quickly than otherwise might be the case."

Executive and Administrative Action by the Commission

Chairman Voigt reported on action taken by the Commission since the annual meeting in June. He drew attention to the second joint meeting between the Great Lakes Fishery Commission (GLFC) and the International Joint Commission (IJC) held October 20, 1977 in Ann Arbor, Michigan, quoting from the news release,

> On October 20, 1977 in Ann Arbor, Michigan, the Great Lakes Fishery Commission, charged to control sea lamprey and improve and perpetuate fishery resources under the 1954 Canada-U.S. Convention on Great Lakes Fisheries, hosted a meeting with the International Joint Commission (IJC), charged with assisting the governments in the implementation of the 1972 Canada-U.S. Great Lakes Water Quality Agreement. The purpose of the meeting was to discuss improved consultative and working mechanisms among the Commissions and their cooperators to accelerate the rate of progress towards attaining improved ecosystem quality in the Great Lakes.
>
> Issues discussed included the ongoing five-year review by the two federal governments of the Water Quality Agreement; construction of remedial works to improve the habitat which sustains the fishery in the St. Marys Rapids at the outlet of Lake Superior; procedures governing decisions on the introduction of new fish species into the Great Lakes; mutual benefits to be derived from coordinated monitoring programs combining water quality measurements with the requirements for thriving fish populations; new research and regulatory programs applied to contaminants; and initiation under the IJC of new studies on Lake Erie water level regulation and diversions into and out of the Great Lakes basin.
>
> The issues of greatest importance discussed by the two international bodies were establishment of improving Great Lakes ecosystem quality for the benefit of society as the shared goal of the Commissions and the state, provincial, and federal natural resources agencies which are their cooperators; coordination of efforts by the Commission's top level advisory scientists to produce a book detailing a feasible plan for the further rehabilitation and restoration of the Great Lakes to reattain lost values; and development of a series of environmental maps to provide a historical perspective leading to better understanding of today's Great Lakes ecosystem as an aid to resource management decision-making.

The Chairman's elaboration on the five major topics of discussion is included in Appendix A, Summary of Management and Research, which focuses on the relationship between the quality of the aquatic environment and fisheries.

Chairman Voigt also reported on other actions taken by the Commission since the Annual Meeting:

Hired Mr. William J. Maxon as Chief Administrative Officer in a move to free Fetterolf and Lamsa to work more closely with the Commission's cooperators to achieve our shared objectives;

Established ad hoc committees and charged them to clarify the need for sea lamprey control in the Oswego River system tributary to Lake Ontario and define the feasibility of sea lamprey control research programs in the Finger Lakes;

Combined the 1977 Management and Research Committee and Lake Committee recommendations and Commission responses into a document usable by all our cooperators;

Charged the Scientific Advisory Committee (SAC) to create an ad hoc committee to report on the feasibility of holding a symposium on the applications of the stock concept to Great Lakes fishery management;

Produced "Fish Genetics - Fundamentals and Implications to Fish Management" as an information package for the design of a stock concept symposium;

Activated SAC's initiative to produce a book on the feasibility of rehabilitating and restoring the Great Lakes ecosystem;

Engaged a Technical and Managing Editor for two Technical Reports, full length versions of the PERCIS papers by Shuter and Koonce, "A Dynamic Model of the Western Lake Erie Wallege Population," and Schneider and Leach, "Walleye Fluctuations in the Great Lakes and Possible Causes, 1880-1975." Abbreviated versions are being published in the PERCIS volume of the Journal of the Fisheries Research Board of Canada;

Laid all the groundwork for getting the long-awaited barrier dam program underway;

Transmitted to the FDA the resolution on the need for more approved therapeutics and prophylactics for use in hatchery production, and stimulated support from the American Fisheries Society;

Commented at length to FDA on the ramifications and justification for the proposed lowering of the PCB tolerance in fish from 5 ppm to 2 ppm;

Provided a review of as yet unresolved international Great Lakes issues for the Canada-U.S. Interparliamentary discussions;

Provided background and need to amend the Great Lakes Fishery Act of 1956 by HR 2203, the long-awaited enabling legislation to increase the number of U.S. Commissioners from 3 to 4;

Briefed the Conference of Great Lakes Congressmen on the Commission's programs and fishery needs in the Great Lakes;

Contracted with Dr. F. W. H. Beamish for further compilation of the Cyclostomata bibliography; and

Accepted the master's thesis of Tom Whillans, University of Toronto, entitled, "Fish Community Transformation in Three Bays within the Lower Great Lakes" as a completion report on a contract, and stipulated that a version of the thesis be submitted for publication in a peer-review journal widely read by our cooperators.

The Chairman also enumerated action taken by the Commission during the Interim Meeting:

Accepted the December 2, 1977 report of the ad hoc committee on Oswego River and Oneida Lake sea lamprey control;

Received the December 2, 1977 report of the ad hoc committee on an integrated program of sea lamprey control and research in the Finger Lakes;

Accepted the SAC subcommittees' progress reports on: production of a book on feasibility of rehabilitation and restoration of the Great Lakes ecosystem; and the proposed symposium on application of the stock concept to Great Lakes fishery management;

Received letters from Northeast Wisconsin Consumer Fisheries Association protesting restrictions on Lake Michigan lake trout and chub commercial fisheries, and referred the chub matter to the Lake Michigan Committee;

Authorized the Secretariat to present a statement on behalf of the U.S. Commissioners January 13, 1978 at the Congressional Oversight Hearings at Petoskey, Michigan which will deal with Indian fisheries;

Instructed the Secretariat to recommend to the Commission the most efficient and effective way to pull Great Lakes fish contaminant data into a package usable by fishery managers;

Approved application of Wisconsin DNR for funding repair of Michicot Dam under the barrier dam program, pending review of plans by U.S. Fish and Wildlife Service;

Received the recommendations of the Lake Superior Advisory Committee to the U.S. Section, and referred the appropriate ones to the Lake Superior Committee; and

Instructed the Secretariat to distribute to cooperators the Chairman's report, the briefing by the U.S. Commissioners to the Conference of Great Lakes Congressmen, and the news release covering this meeting.

Adjournment

Chairman Voigt announced the retirement of Commissioner E. W. Burridge from the Canadian Department of Fisheries and the Environment and noted that this would be Commissioner Burridge's last meeting as a Commissioner. On behalf of the Commission, Chairman Voigt expressed appreciation to Commissioner Burridge for his outstanding contribution and service to the Commission since his appointment in 1967. The Chairman stated that Commissioner Burridge will be sorely missed, not only as a Commissioner, but as a scientist and administrator whose contribution to the Great Lakes program has been significant.

He also thanked those in attendance for their fine participation and adjourned the 1977 Interim Meeting of the Great Lakes Fishery Commission at 1230 h on 2 December 1977.

APPENDIX A

SUMMARY OF MANAGEMENT AND RESEARCH

The 1977 annual summary will focus on the Great Lakes Fishery Commission's (GLFC) long-standing concern and growing involvement with the relationship between the quality of the aquatic environment and fisheries. In the late 1960's and early 1970's the Scientific Advisory Committee (SAC), the Lake Committees, and the Commission found that an increasing part of their deliberations dealt with matters of habitat quality and quantity and its relation to fisheries. The Lake Committees, in particular, kept bringing ecosystem quality concerns before the Commission, pointing out that management objectives could not be reached unless acceptable water and habitat quality were available. While regulation of various aspects of environmental quality rests with the state, provincial and federal governments, the International Joint Commission (IJC) is charged to assist the governments in the implementation of the 1972 Canada-U.S. Great Lakes Water Quality Agreement in which the governments stated their determination "to restore and enhance water quality in the Great Lakes system." Combined with the GLFC's commitment to fishery resource rehabilitation and improvement, it is obvious that a working relationship between the two commissions is desirable.

The Commission made several moves in 1975 and 1976 to become more involved in water quality and habitat issues. In early 1975 the Commission requested the SAC to develop a statement on environmental quality in the Great Lakes. SAC member Dr. Murray G. Johnson, Director, Great Lakes Biolimnology Laboratory, Fisheries and Environment Canada, lead this effort. He received much technical review and suggestions from Lake Committee and other SAC members, Commissioners, and other environmental scientists and administrators knowledgeable in Great Lakes matters. The GLFC endorsed the statement in September 1975.

The Commission invited Kenneth A. Oakley, Director of IJC's Great Lakes Regional Office, to address the 1975 Annual Meeting in Toronto. He provided an overview of the IJC's responsibilities under the Boundary Waters Treaty of 1909, gave the highlights of the 1972 Great Lakes Water Quality Agreement, and a discussion of the international mechanisms (boards, committees, and reference groups) created by the Agreement to assist the IJC in meeting its responsibilities.

In June 1975, the GLFC announced the appointment of Carlos M. Fetterolf, Jr. as Executive Secretary to replace Robert W. Saalfeld, who had died. Mr. Fetterolf, formerly a fishery biologist, had been most active in recent years in water quality and environmental matters with the Michigan Department of Natural Resources and the National Academy of Sciences. He had served as Chairman of IJC's Water Quality Objectives Subcommittee and was a member of IJC's Research Advisory Board representing the Great Lakes state agencies. Upon Mr. Fetterolf's appointment, to further the working relationship between the Commissions, the IJC created an ex-officio position on its Research Advisory Board for the Executive Secretary of the GLFC.

The number of interagency, interdisciplinary actions of the Commission and its cooperators seemed to accelerate about this time.

GLFC Chairman Loftus had been an active member of IJC's Water Quality Board since its inception in 1972. In 1976 the GLFC added Dr. Alfred Beeton, Director, Great Lakes Research Division, University of Michigan, a nationally recognized expert in water quality, and Dr. George Francis, University of Waterloo, a political scientist specializing in institutional arrangements for the management of natural resources to the SAC. Both of these scientists were also active in IJC affairs. Dr. Johnson of SAC was very active in IJC's Upper Lakes Reference Group and later became Canadian co-chairman of a major IJC reference on Pollution from Land Use Activities (PLUARG).

In November 1975, Executive Secretary Fetterolf, in addressing the United States National Symposium on Polychlorinated Biphenyls (PCB) in Chicago, stated,

"The U.S. Food and Drug Administration guideline of 5 μg/g (ppm) in edible tissue of fish has been exceeded in numerous species in Lakes Michigan, Huron, Erie, and Ontario and their connecting waters. Several important sport and commercial species are included with those that exceed the guideline. This situation casts a pall over the social and economic aspects of Great Lakes fisheries. It creates a very real problem for commercial fishermen, processors, and retailers; a shadow of doubt in the minds of every consumer and sport fisherman; an added question for the fishery manager; a symbol of defeat for the water pollution control agencies; and a mark for every environmental management critic to flaunt as an example of the failure of the 'system.' It denies full use of the Great Lakes fishery resource."

Mr. Fetterolf explained that the GLFC is not a regulatory agency and that fishery agencies must depend on legislative action to pass the laws, and enforcement agencies to furnish the muscle which will provide an aquatic environment which will produce useable fishery products. He commented that foot dragging has been going on, emphasized that a serious problem existed, and asked how to get adequate response from a regulatory agency. The same question had been asked repeatedly throughout the symposium.

Mr. Fetterolf criticized the U.S. Environmental Protection Agency's (EPA) proposed criterion for PCBs, "0.001 μg/L for freshwater and marine aquatic life and for consumers thereof." He stated that a water concentration alone may not be adequate to provide a usable resource, and continued,

"I don't believe the concentration of PCB in the waters of Lake Superior is known accurately enough that it appears in the refereed literature. It is generally believed to be 0.001 μg/L, the concentration recommended in EPA's proposed Quality Criteria for Water. An analytical chemist of EPA's National Water Quality Laboratory at Duluth on the shores of Lake Superior estimates the PCB concentration in Lake Superior water at 0.0004 µg/L, 0.4 parts per trillion. The total PCB body burden of whole Lake Superior adult siscowets, a race of lake trout with a high fat content, is greater than 5 µg/g. Depending on which water concentration one chooses, we have a bioconcentration factor of at least 500,000 times. I don't believe the proposed EPA water concentration is going to do the job necessary so that Great Lakes fishery resources can be fully used. Canada shares the Great Lakes with us. The November 17, 1975 announcement by their Department of Health and Welfare, lowering their PCB regulatory level to 2 µg/g in edible tissue, is going to further restrict the full use of the Great Lakes fishery resources."

Although the Canadian Sections of the GLFC and IJC had met informally on a prior occasion, the two commissions had never met formally. GLFC Chairman Loftus and IJC Co-chairman Maxwell Cohen initiated arrangements for the first formal joint meeting, which was held in Fort Erie, Ontario, 3 March 1976. The GLFC suggested to IJC that the GLFC's recently developed statement on environmental quality become the focal point of discussions at the Fort Erie meeting. Upon acceptance of that proposal, the statement was titled "Environmental Quality and Fishery Resources of the Great Lakes, a Brief to the International Joint Commission from the Great Lakes Fishery Commission." The letter of transmittal outlined GLFC's objectives for the joint meeting,

"The brief incorporates the findings and opinions of the Great Lakes Fishery Commission's five Lake Management and Research Committees and Scientific Advisory Committee. The Commission recognizes that the International Joint Commission, through its various boards, committees, and advisory groups, currently is considering many of the environmental issues identified in the brief. Nonetheless, the Commission wishes to describe and bring together under one cover the spectrum of aquatic environmental issues, stressing the inter-relationships among them and emphasizing ecological considerations relevant to problems of common concern.

The brief is considered of secondary importance to early development of a mutually-productive consultative mechanism between the two commissions. The International Joint Commission is in a most influential position to ensure that environmental quality will be improved where needed and safe-guarded elsewhere so that the integrity of Great Lakes biological systems can be sustained and that rational demands for commercial and recreational fishing can be met.

The Great Lakes Fishery Commission recognizes an interdependence of goals of the two commissions. Hopefully, this brief will lead to further development of mutual understanding and a closer relationship between the two."

Unfortunately, on 3 March 1976 the Fort Erie-Buffalo area experienced a widespread, severe ice storm. Of six IJC Commissioners, four were able to attend. Of eight GLFC Commissioners, four were able to attend. Electric power lines were down, therefore the meeting was held in candlelight with all attendees in overcoats.

Chairman Loftus, in opening the meeting, traced the development of scientific awareness that environmental quality improvement was necessary for full rehabilitation and usability of fish stocks. He stated that fish are integrators of stress, and as such reflect water and habitat quality.

After discussion of the different roles and philosophies among Great Lakes agencies with responsibilities for natural resource management, the discussion focused on the environmental quality brief.

The introduction to the brief traced the deterioration of the Great Lakes ecosystem since settlement by non-Indians, and explained,

"Two major responsibilities of the international Great Lakes Fishery Commission are to control the parasitic sea lamprey and to improve the quality, abundance, and productivity of the fishery resources of the Great Lakes. By 1975 sea lamprey had been reduced sufficiently in Lakes Superior, Michigan, Huron, and Ontario where its destruction was the greatest, to permit establishment of large stocks of various species of salmon and trout by stocking of hatchery-reared fish. Other species, such as whitefish, suckers, and burbot, have, to varying degrees, recovered without hatchery assistance.

The degree to which these rehabilitation efforts and their associated economic benefits may be developed depends in part on the quality of the aquatic environment. Changes in water chemistry, plankton, and bottom fauna accompanied by changes in populations of unexploited fish species are evidence that environmental quality is a major factor in limiting certain fish stocks. Some species which have disappeared or whose abundance has been reduced because the chemical or physical environment is no longer suitable for their reproduction may be maintained by hatchery introduction. However, where changes in environmental quality have reduced or changed food organisms, fish stocks will be limited by the quantity and quality of food available. Even for species that can be maintained naturally or by stocking, their use as human and animal food has, and continues to be, threatened or eliminated by environmental contaminants.

Improvement of the quality of the aquatic environment will greatly enhance the benefits derived from the work of the Great Lakes Fishery Commission and its cooperating agencies. Protection of benefits already gained will require continued vigilance to prevent erosion of the fishery resource from such factors as additions of toxic substances, destruction of young fish in pumping and cooling systems, discharge of heated water by steam electric generating stations, and dredging and disposal of spoils. Our understanding of these and other factors as influences on aquatic populations or communities is incomplete. Nevertheless, careful review of events within the Great Lakes and their drainage is providing information important to the formulation of environmental criteria and elaboration of management plans that can be implemented to reverse undesirable trends and restore much of the value of the Great Lakes and their fisheries. Closer consultation and cooperation than has previously existed between the International Joint Commission and the Great Lakes Fishery Commission can accelerate the development and implementation rates."

The brief, always focusing on the relationship with fishery resources, delved into the issues of eutrophication and nutrient controls; power plants, waste heat, entrainment and impingment, and the often associated problems of "before and after studies" aimed at "local" effects; the piecemeal environmental impact statement process; mixing zone limitations; dredging and spoils disposal; shoreline and nearshore modifications; present trouble-making contaminants such as DDT, dieldrin, PCBs, and mercury, and then touched on future contaminant problems; and water level and flow regulation.

The summary and recommendations of the brief state,

"Habitat degradation and impaired water quality in the Great Lakes, invasions by undesirable fish species, resultant population changes, and intensive, selective fishing have been responsible for declines in quality and value of Great Lakes fisheries. The explicit goal of the Great Lakes Fishery Commission and also an implicit goal of the International Joint Commission is to restore and sustain healthy, useful biological systems. Closer consultation and cooperation between the two Commissions is required.

Progress has been made in controlling nutrient inputs to combat cultural eutrophication, but measures aimed at controlling other contributing factors are also needed. Controls on waste heat discharges, sediment from erosion and dredged spoils are complementary requirements.

Power plants and their waste heat discharges have various effects on aquatic resources. The development of specific water quality objectives under terms of the Canada-U.S. Agreement on Water Quality in the Great Lakes will not minimize all effects. Better criteria for site selection, intake and discharge design, plant operation, and mixing zones are of equal importance. Additional short-term studies are required on power plants, on dredged spoils disposal, and on other shoreline and nearshore modifications, but longer-term research must emphasize the effects on desirable fish communities of multiple environmental perturbations together with all other effects, including fishing. Similarly, the environmental impact review process must be changed from the usual piecemeal approach, in both time and space, to a process well-founded on thorough resource-oriented studies from which critieria for ecological protection can be developed in a holistic framework emphasizing the water body as a system.

Environmental toxicology presents an exceptionally difficult challenge because of the large number of substances, their complex limnological and biological behavior, and possible joint effects. Energetic programs are needed to control inputs of toxic substances generally, and a review of effects and use of PCBs is needed urgently. Surveillance programs must be designed carefully for the examination of the trend-through-time data on toxic substances and contaminant residues in fish. For adequate interpretation of the latter, ancillary factors such as age, season, feeding interrelationships, and large-scale movements of fish populations must be accounted for. Greater effort is needed in assessing effects of toxic substances on aquatic resources. Fishery agencies will require additional support if this work is to be done satisfactorily.

The GLFC commends the IJC for establishing the St. Marys Rapids Task Force which developed recommendations to alleviate dewatering of the St. Marys Rapids and consequent loss of spawning area and forage base whenever the outflow of Lake Superior was curtailed significantly. The GLFC now urges the IJC to implement the recommendations of the Task Force. The GLFC also recommends that the IJC establish study teams to review the problems and investigate possible remedial measures in other connecting channels where water level fluctuations have had deleterious effects on fish and fish habitat. Moreover, if the IJC proposes to control water levels on Lakes Ontario and Superior with existing structures and on Lake Erie with minimal modifications to control outflow through the Niagara River by implementation of SEO Regulations, it is important that studies be funded to predict effects of these measures on fisheries."

Discussion among the Commissioners focused mainly on the St. Marys Rapids remedial works, the PCB problem and long-term solutions and long-term effects, whether a public hearing series on waste heat problems was timely, effects of water level fluctuations on fisheries, effects of shoreline modifications in Lake St. Clair on fisheries, future format of joint meetings, and whether GLFC and IJC were the proper institutions to develop long range planning for the Great Lakes. Do the IJC and GLFC accept that role? If not, who does?

IJC Commissioner Beaupré summarized by pointing out that there is inadequate screening of toxic material and both institutions should impress on EPA and FDA in the U.S. and sister agencies in Canada the necessity of screening programs; that there must be greater definition of thermal and intake problems before policy and criteria can be established and designs improved; and that the commissions should meet on a more formal, regular basis.

Following the meeting, the secretariats drafted a meeting protocol agreement. It was not acted on by the commissions from a lack of concern that a formal agreement was needed. The GLFC had a strong desire not to commit to regular meetings, preferring an "as necessary or desirable basis."

At the 1976 GLFC Annual Meeting, IJC's Great Lakes Regional Office Director Oakley addressed the Commission again and highlighted developments and accomplishments of remedial programs; development and implementation of water quality objectives to protect the most sensitive uses of water (most often aquatic life); water quality monitoring results; and surveillance and remedial plans for areas of significance to fisheries.

In the discussion which followed, William Pearce (New York Department of Environmental Conservation) advocated preparation of a base-line inventory or atlas of Great Lakes resources as a management aid. Mr. Oakley stated a scheme for biological allocation has been proposed and that a seminar to develop basin-wide criteria for biological-environmental value mapping would be held in the fall of 1976. He recognized that such a project was a tremendous undertaking, but essential. W. Jack Christie (Ontario Ministry of Natural Resources) commented that the philosophy of allocating areas of water use is not entirely compatible with the objective of rehabilitation of fish stocks. Mr. Oakley responded that this was one of the problems to be brought out at the seminar and stated that Mr. Fetterolf was one of the leaders in organizing the seminar. Mr. Fetterolf, responding primarily to Christie's expressed concern, noted the seminar would not be designed to consider biological allocation, but on how to construct environmental-value maps to provide a basis for management decisions; that this is a necessary step towards development of a mechanism to limit areas of non-compliance in the Great Lakes; and that such a mechanism is missing from the Canada-U.S. Water Quality Agreement.

Chairman Loftus reiterated that Mr. Oakley's presence at the meeting was indicative of the developing close liaison between IJC and GLFC, and added that the GLFC cannot achieve its objectives without successful water management programs by IJC. Further, IJC will not reach its objectives without support and input by fishery agencies.

Chairman Loftus noted that the organizers of the Percid International Symposium (PERCIS), endorsed and partially funded by GLFC, had sought funds through IJC's Research Advisory Board. The Board recommended such support to the IJC and it was granted.

Later in 1976 Mr. David Rosenberger, Biologist on IJC's Great Lakes Regional Secretariat, was named as IJC's first liaison officer to the GLFC. As liaison officer he attends interim and annual meetings of the GLFC and many of the Lake Committee meetings. He often addresses the groups, providing updates on IJC activities and serving as a resource to attendees in much the same way the GLFC's Executive Secretary does at IJC meetings.

During the spring and summer of 1977 the commissions planned for their second joint meeting, 20 October 1977 in Ann Arbor, Michigan. The format was to emphasize shared initiatives and dialogue on subjects of mutual concern. The major subjects discussed were ecosystem quality, rehabilitation and restoration, environmental mapping, surveillance, contaminants, and exotic fish introductions.

1. *Ecosystem Quality.* Following the IJC Secretariat's summary of the portion of the IJC Research Advisory Board's (RAB) 1976 Annual Report on the subject, the Great Lakes Fishery Commission responded in part as follows:

This Commission viewed the Section of the Research Advisory Board's 1977 Annual Report devoted to "Water Quality and the Great Lakes Ecosystem" with great interest. We have long recognized that to achieve rehabilitation of the Great Lakes ecosystem to the benefit of society there must be simultaneous restoration of chemical, physical and biological quality.

We applaud RAB's recommendation that the IJC, "Recognize that the degradation of the Great Lakes must not be evaluated on just water quality, but also on all aspects on the lakes' ecology." We agree with the Research Advisory Board's opinion that continued emphasis on water quality alone will be to the detriment of the eventual restoration of the lakes and, therefore, urge the IJC to adopt the broader concept of ecosystem quality.

We hope ecosystem quality becomes the basic philosophy of IJC and its cooperators' programs. The concept of ecosystem quality is interwoven with our intitiatives, and the success of our rehabilitative efforts is dependent on an ecosystem of high quality.

We are not concerned with overlap of areas of responsibility between the commissions. We feel the resource of the Great Lakes and the people of the Great Lakes region will be the beneficiaries if attainment of desirable ecosystem quality becomes the identified and shared philosophy of the two Great Lakes international commissions. Such a sharing should increase cooperative achievement in the future.

2. *Great Lakes Ecosystems Rehabilitation and Restoration: A Feasibility Study.* GLFC described its recent initiation of the study under the leadership of Scientific Advisory Committee (SAC) members Dr. Henry Regier (University of Toronto) and Dr. John Magnuson (University of Wisconsin-Madison), and encouragement to the SAC to work collaboratively with RAB's Expert Committees on Ecosystems, Technology, and Socio-Economics. The IJC reacted favorable towards cooperative consultative arrangements with its Expert Committees.

3. *Environmental Mapping.* The IJC Research Advisory Board has formed a task force to develop a plan of study for Great Lakes Environmental Mapping. The plan of study defined:

-Those dimensions which lend themselves to mapping;
-The scope of future mapping efforts;
-The agencies which should participate; and
-The anticipated costs vs. benefits and liabilities.

Commissioners Johnson and Loftus (and his task force alternate, W. Jack Christie, OMNR) and Executive Secretary Fetterolf represent fishery interests on the task force.

The Commission endorsed the concept of environmental mapping of the Great Lakes, but pointed out that fishery interests would be very uncomfortable with an environmental map depicting Great Lakes resources as they stand today unless that map is accompanied by a map or series of maps showing the resources as they were in the past. Environmental maps of today's resources depict major losses, and without means of comparison today's map may be interpreted as the baseline from which to measure future gains or losses. The Commission commented that the baseline for those measurements should be historical and that the task force should examine this point and recommend what time periods should be represented for comparison or baseline purposes.

The Commission stated it is committed to rehabilitation of Great Lakes fishery resources and believes that today's resource manager and the public should know what has been lost in order to know what might be regained through rehabilitative initiatives. It would be an injustice to the resource, today's resource manager, and the public if only today's snapshot was used to depict an environmental situation which must be viewed as part of a time series.

4. *Surveillance.* After IJC outlined its surveillance program as conducted by its cooperating agencies, GLFC commented in part, that until very recently, IJC surveillance efforts in the Great Lakes have been largely confined to traditional water quality parameters, but that in recent years the identification of contaminants such as Hg and PCBs in waters, sediments, microorgainisms, and fish have tended to broaden the surveillance base. Even more recently the "ecosystem quality" concept has emerged, in contrast to water quality concept, as a philosophical base

for IJC's programs, and there has been increased emphasis on rehabilitation as contrasted to non-degradation. Both of these developments will have the effect of broadening the base of parameters in the ecosystem that should be monitored in IJC's surveillance programs.

The Commission's statement continued,

"It seems, if the foregoing is true, that our two commissions are looking towards monitoring and surveillance programs in which there will be a growing degree of common ground. It may be appropriate for both to take steps to ensure that the total surveillance programs are adequate and that they are jointly planned to ensure maximum benefits to clients for dollars spent."

5. *Contaminants.* After IJC described the Research Advisory Board's initiative, GLFC stated that the planned intensive studies to identify organic chemical residues in human and fish tissues would most likely result in finding the same contaminants in both materials. The GLFC expressed concern that the public would draw the unwarranted conclusion that people get the residue solely or mainly from eating fish. IJC was encouraged to present their findings in a manner which would not lead to unwarranted conclusions which could unjustifiably further discourage consumption of Great Lakes fish.

6. *Exotic Fish Introductions.* IJC requested discussion of this subject because such introductions had been pointed out as a form of "biological pollution" at one of their public hearings. The GLFC emphasized that the days of purposeful introductions without adequate forethought and consultation among jurisdictions have essentially come to an end. Using Pennsylvania's recent proposal to introduce sterile striped bass on an experimental basis, the Commisssion pointed out that any such agency proposal is subject to serious review and comment by the rest of the fishery agencies around the Great Lakes, with responses coordinated through the GLFC.

Chairman Voigt explained that neither the GLFC, nor any other Great Lakes agency, would have the authority to prevent an agency from introducing an exotic. He advised that the GLFC and its Lake Committees provide the forums in which interagency cooperation on such matters can be achieved. Within these forums, an agency would be subject to a great deal of peer pressure and professional criticism if it were to introduce an exotic species against the judgment of its sister agencies.

The GLFC believes that through the further opening of communication between the GLFC and the IJC that the ecosystem approach to management of the Great Lakes has been advanced. The GLFC looks forward to continued progress in drawing water quality and fishery managers together into shared initiatives and goals.

APPENDIX B

SUMMARY OF TROUT, SPLAKE, AND SALMON PLANTINGS

Intensive annual plantings of hatchery-reared salmonids continue to be the principal method employed to rehabilitate Great Lakes fisheries. In 1977, about 25 million trout and salmon were planted.

In Lakes Superior, Michigan, Huron and Ontario, salmon and trout survival is dependent upon sea lamprey control since experience has shown that planting of these species where sea lamprey are abundant results in high mortality of fish and heavy lamprey wounding on survivors. In Lake Erie there is no clear evidence that the sea lamprey population causes high mortality of planted salmon and trout.

Most of the rainbow and brown trout and all of the Pacific salmon plantings are aimed at the recreational fishery. On the other hand, a substantial part of the lake trout and the Province of Ontario's splake plantings are intended to develop self-sustaining stocks. With anglers pursuing a wide variety of species ranging from salmon and trout to yellow perch and walleye to pan fish and bass, it was estimated that Great Lakes recreational fishermen spent $350 million on fishing expenses in 1975.

Lake trout have been planted annually in Lake Superior since 1958 and in Lake Michigan since 1965. These programs have been carried out cooperatively by the U.S. Fish and Wildlife Service, the states of Michigan, Wisconsin and Minnesota and the Province of Ontario. Lake trout eggs are obtained from brood fish in hatcheries or from mature lake trout from inland lakes. Nearly all trout are reared to yearlings (ca. 30/pound) and planted during the spring and early summer. In the fall of 1971, 1972, and 1973, however, the U.S. Fish and Wildlife Service made experimental plants of fall fingerlings to compare survival and growth of regular-size fall fingerlings (about 80/pound) with fingerlings whose growth was accelerated to about 30/pound through diet and the use of heated rearing water. Data collected through assessment fishing to compare the survival and growth of the paired plants has shown considerable variation in the comparative performance over the years, but in general the accelerated-growth fingerlings have out-performed the normal-growth fish. Better information on the comparative survival of the two groups may emerge when the fish become vulnerable to large mesh assessment gillnets. If fall plants of accelerated-growth fingerlings are advantageous, production in U.S. Federal hatcheries could be increased at minimum costs.

To rehabilitate fish stocks in Lake Huron, the Province of Ontario and the State of Michigan originally agreed to plant highly-selected splake. These fish were developed in Ontario through an intensive breeding program in which male brook trout were crossed with female lake trout to produce a fast growing fish similar to lake trout in behavior and appearance and to the brook trout in fast growth and early maturity.

Following several generations of selective breeding a splake was developed which grows rapidly, matures at an early age, and inhabits deep water. First plantings were made in 1969 in Ontario waters (mostly yearlings) and in 1970 in Michigan waters (mostly fingerlings). Because of a shortage of highly-selected splake brood fish and the need to expand rehabilitation efforts in U.S. waters of Lake Huron, splake sperm also was used to fertilize lake trout eggs to produce backcrosses. It was believed these fish would retain the advantages of early maturity and fast growth. The first backcrosses were produced in the fall of 1971 and planted in Lake Huron as yearlings in the spring of 1973 and the program was continued. Because of fish disease problems in the U.S. brood stock of splake (chronicled in Annual Reports for 1975 and 1976, Appendix B), lake trout plants were initiated in U.S. waters of Lake Huron in 1973 and continued through 1977. The Province of Ontario continued to plant highly-selected splake through 1977 but also made small plantings of lake trout and lake trout x splake backcrosses in 1977 for comparative studies. Michigan also planted backcrosses in 1977 for evaluation purposes.

In Lake Erie, Pennsylvania made small experimental plants of lake trout fingerlings in 1969 and yearlings in 1974, 1975, and 1976. New York initiated lake trout plants in Lake Erie in 1975.

Plants of yearling splake in Lake Ontario were initiated in 1972 and continued through 1974 by the Province of Ontario, but none were planted in 1975. In 1976, the Province planted a few splake and initiated lake trout planting. In addition, plants of lake trout were made by New York State in 1973 and through a cooperative arrangement between New York and U.S. Fish and Wildlife Service in 1974 to 1976.

Table 1 summarizes annual plantings of lake trout and hybrids in the Great Lakes and Table 2 details the 1975 plants in each of the Great Lakes. Other small experimental plants of first generation splake have been made by Wisconsin and Michigan in Lake Superior (Table 3).

Coho salmon, usually stocked in the spring as yearlings, have been planted annually in Lakes Superior and Michigan since 1966, and in Lakes Huron, Erie, and Ontario since 1968. Table 4 summarizes annual plantings in each of the Great Lakes, and Table 5 details the 1975 plantings in each of the Great Lakes.

Annual plantings of chinook salmon, usually stocked in the spring as fingerlings, have been made in Lakes Superior and Michigan since 1967, in Lake Huron since 1968, in Lake Erie since 1970, and in Lake Ontario since 1969. Table 6 summarizes annual plantings of chinook salmon in the Great Lakes and Table 7 details the 1975 plantings in each of the Great Lakes.

In 1972, Michigan and Wisconsin inaugurated plants of Atlantic salmon in the Upper Great Lakes. In 1972, Wisconsin planted 8,000 3-year-old and 12,000 2-year-old fish in Lake Superior; in 1973 the entire plant was 2-year-old fish. After 1972, Michigan discontinued its plants in Lake Huron but continued them in Lake Michigan. Table 8 summarizes Atlantic salmon plantings in the Great Lakes 1972-1976.

Plantings of rainbow and steelhead trout, brown trout, and brook trout have been continued in the Great Lakes over the years, but have not been included in these records because of the variability in reporting and difficulty in separating "inland" plantings from "Great Lakes" plantings. Nevertheless, the need for stocking information on these species prompted

recent inclusion of rainbow and steelhead trout and brown trout plantings in the Annual Report. Table 9 summarizes the annual plantings of rainbow and steelhead trout for 1975 and 1976, and Table 10 details the 1976 plantings. Table 11 summarizes annual plantings of brown trout for 1975 and 1976, and Table 12 details the 1976 plantings. For 1976, brook trout plantings are included for the first time (Table 13).

Table 1. Annual plantings (in thousands) of lake trout, splake[1,2] and backcrosses[3] in the Great Lakes, 1958-1977.

LAKE SUPERIOR

Year	Michigan	Wisconsin	Minnesota	Ontario	Total
1958	298	184	-	505	987
1959	44	151	-	473	668
1960	393	211	-	446	1,050
1961	392	314	-	554	1,260
1962	775	493	77	508	1,853
1963	1,348	311	175	477	2,311
1964	1,196	743	220	472	2,631
1965	780	448	251	468	1,947
1966	2,218	352	259	450	3,279
1967	2,059	349	382	500	3,290
1968	2,260	239	377	500	3,376
1969	1,860	251	216	500	2,827
1970	1,944	204	226	500	2,874
1971	1,055	207	280	475	2,017
1972	1,063	259	293	491	2,106
1973	894	227	284	500	1,905
1974	888	436	304	465	2,093
1975	872	493	337	510	2,212
1976	789	814	345	1,062	3,010
1977	803	551	350	677	2,381
Subtotal	21,931	7,237	4,376	10,533	44,077

LAKE MICHIGAN

Year	Michigan	Wisconsin	Illinois	Indiana	Total
1965	1,069	205	-	-	1,272
1966	956	761	-	-	1,717
1967	1,118	1,129	90	87	2,424
1968	855	817	104	100	1,876
1969	877	884	121	119	2,001
1970	875	900	100	85	1,960
1971	1,195	945	100	103	2,343
1972	1,422	1,284	110	110	2,926
1973	1,129	1,170	105	105	2,509
1974	1,070	971	176	180	2,397
1975	1,151	1,055	186	186	2,577
1976	1,255	1,045	160	164	2,624
1977	1,057	970	166	177	2,369
Subtotal	14,029	12,136	1,418	1,416	28,998

Table 1 -- (Cont'd)

LAKE HURON

Year	Michigan Splake	Michigan Lake trout	Michigan Backcrosses	Ontario Lake trout	Ontario Splake	Ontario Backcrosses	Total
1969	-	-	-	-	35	-	35
1970	43	-	-	-	247	-	290
1971	74	-	-	-	468	-	542
1972	215	-	-	-	333	-	548
1973	-	629	486	-	412	-	1,527
1974	-	793	-	-	299	-	1,092
1975	-	1,053	-	-	523	-	1,576
1976	-	1,024	-	-	658	-	1,682
1977	-	1,033	250	15	879	61	2,238
Subtotal	332	4,532	736	15	3,854	61	9,530

LAKE ERIE

Year	Pennsylvania	New York	Total
1969	17	-	17
1974	26	-	26
1975	34	150	184
1976	16	186	202
1977	-	125	125
Subtotal	93	461	554

LAKE ONTARIO

Year	Ontario Splake	Ontario Lake trout	New York Lake trout	Total
1972	48	-	-	48
1973	39	-	66	105
1974	26	-	644	670
1975	-	-	514	514
1976	6	194	337	537
1977	-	288	298	586
Subtotal	119	482	1,859	2,460

Great Lakes Total, lake trout	80,517
Great Lakes Total, splake and backcrosses	5,128
Great Lakes Total, lake trout, splake and backcrosses, 1958-1977	85,645

Table 1 -- (Cont'd)

[1]Lake trout x brook trout hybrid.

[2]Excludes small experimental splake plants by Michigan and Wisconsin in Lake Superior (see Table 3).

[3]Lake trout x splake hybrid, (see text).

Table 2. Planting of lake trout, splake[1,2] and backcrosses[3] in the Great Lakes, 1977.

Location	Numbers	Fin clip
LAKE SUPERIOR-LAKE TROUT		
Michigan waters		
Partridge Island	87,500[3]	adipose-left pectoral
Marquette	31,000	adipose-left pectoral
Tahquamenon Island, Whitefish Bay	50,000[3]	adipose-right ventral
Iroquois Island, Whitefish Bay	51,200[3]	adipose-right ventral
Marquette Power Dock	55,300	right ventral
Laughing Fish Point	28,000[3]	right ventral
Laughing Fish Point	28,000	right ventral
Shot Point	28,000	right ventral
Loma Farms	20,663	right ventral
Copper Harbor	27,700	right ventral
Copper Harbor	33,200[3]	right ventral
Manitou Island	84,000[3]	right ventral
Salmon Trout Bay	28,000[3]	right ventral
Huron Island Area	28,000[3]	right ventral
Big Traverse Bay	28,000	right ventral
Big Bay	28,000	right ventral
Porcupine Reef	28,000[3]	right ventral
Porcupine Mountains Reef	27,000[3]	right ventral
Munising City Dock	28,000	right ventral
Black River	27,000	right ventral
Ontonagon River	28,000	right ventral
Grand Marais	28,000	right ventral
Subtotal	802,563	
Wisconsin waters		
Devils Island Shoal	182,830[3]	dorsal
Superior Entry	265,000	right ventral
Cornucopia	35,250	right ventral
Squaw Bay	67,560	right ventral
Subtotal	550,640	

Table 2 -- (Cont'd)

Location	Numbers	Fin clip
Minnesota waters		
Cannon Ball Bay	50,211	right ventral
Palmers	80,151	right ventral
Split Rock River	85,005	right ventral
Good Harbor Bay	50,001	right ventral
Tofte	84,993	right ventral
Subtotal	350,361	
Ontario waters		
La Pointe Point	125,000	right ventral
Montreal River	26,000	right ventral
Lizzard Island	50,000[3]	right ventral
Montreal River	74,000	right ventral
Michipicoten Bay	100,000	right ventral
Mamainse Point	37,400	right ventral
Mamainse Harbor	90,000	right ventral
Old Woman Bay	90,000	right ventral
Pancake Bay	50,000[3]	right ventral
Sinclair Cove	35,000	right ventral
Subtotal	677,400	
Total, Lake Superior	2,380,964	

[Note: 727,730 (31%) of total 2,380,964 were planted offshore.]

Table 2 — (Cont'd)

Location	Numbers	Fin clip
LAKE MICHIGAN-LAKE TROUT		
Michigan waters		
Ford River	25,000	both ventrals
Boulder Reef	25,000[3]	both ventrals
Ille Aux Galets	25,000	right ventral
Kipling Reef	25,000	right ventral
Trout Island Shoal	25,000[3]	right ventral
Charlevoix	50,000[3]	right ventral
Round Island	25,000	right ventral
South Fox Island Shoal	25,000	right ventral
Good Harbor Bay Reef	25,000	right ventral
Gull Island Reef	25,000[3]	right ventral
Pentwater	68,000	right ventral
Frankfort	66,000	right ventral
Petoskey	77,000	right ventral
Old Mission Point	26,000[3]	right ventral
Montague	68,000	right ventral
Acme	52,000	right ventral
Greilickville	53,000	right ventral
St. Joseph	68,000	right ventral
South Haven	67,000	right ventral
Holland	68,000	right ventral
Grand Haven	52,000	right ventral
Stonington	25,000	right ventral
Fishermans Island	26,000[3]	right ventral
Manistee	66,000	right ventral
Subtotal	1,057,000	
Wisconsin waters		
Gills Rock	52,500[3]	both ventrals
Larsens Reef	45,000	both ventrals
Kewaunee	47,500[3]	dorsal-both ventrals
Milwaukee	102,600[3]	right ventral
Sheboygan	105,000	right ventral
Larsens Reef	55,000	right ventral
Port Washington	50,000	right ventral
Manitowoc	100,000	right ventral
Algoma	104,000[3]	right ventral
Racine	104,000	right ventral
Sturgeon Bay	100,000	right ventral
Kewaunee	104,000[3]	right ventral
Subtotal	969,600	

Table 2 -- (Cont'd)

Location	Numbers	Fin clip
Illinois waters		
Waukegan Harbor Area	70,800	right ventral
Glencoe Reef	52,100[3]	right ventral
Waukegan Reef	43,100[3]	right ventral
Subtotal	166,000	
Indiana waters		
East Chicago	28,000	none
Burns Harbor	121,000	none
Michigan City	28,000	none
Subtotal	177,000	
Total, Lake Michigan	2,369,600	

[Note: 682,800 (29%) of total 2,368,600 were planted offshore.]

LAKE HURON-LAKE TROUT, BACKCROSSES, AND SPLAKE

Location	Numbers	Fin clip
Michigan waters (lake trout)		
Black River Island	76,000[3]	left pectoral-left ventral
Middle Island	50,000[3]	left pectoral-left ventral
Scarecrow Island	76,000[3]	left pectoral-left ventral
Zela Shoal	50,000[3]	left pectoral-left ventral
Adams Point	78,000	left pectoral-left ventral
Greenbush	75,000	left pectoral-left ventral
Tawas Point	105,000	left pectoral-left ventral
Grindstone City	156,000	left pectoral-left ventral
Port Sanilac	25,000	left pectoral-left ventral
Raynolds Reef	25,000[3]	left pectoral-left ventral
Round Island Shoal	51,000[3]	left pectoral-left ventral
Hammond Bay	109,000	left pectoral-left ventral
Goose Island Shoal	28,000[3]	left pectoral-left ventral
Martin Reef	53,000[3]	left pectoral-left ventral
Little Trout Island	50,000[3]	left pectoral-left ventral
Middle Entrance Reef	26,000[3]	left pectoral-left ventral
Subtotal	1,033,000	
Michigan waters (backcross)		
Grindstone City	125,000	left pectoral-right ventral
Harrisville	125,000	left pectoral-right ventral
Subtotal	250,000	

Table 2 -- (Cont'd)

Location	Numbers	Fin clip
Ontario waters (lake trout)		
South Bay	15,000[3]	none
Ontario waters (splake)		
Penetanguishene	100,000	none
Heywood Island	140,772	right pectoral-right ventral
Jackson Shoal	28,020[3]	right pectoral-right ventral
Meaford Range	21,553	right pectoral-right ventral
Lora Bay (Meaford)	55,914	right pectoral-right ventral
Surprise Shoal	34,534[3]	right pectoral-right ventral
Vails Point (Range)	3,180	right pectoral-right ventral
Jackson Shoal	29,208[3]	right pectoral-right ventral
Jackson Shoal	7,770	right pectoral-right ventral
Kiawana Beach	65,372	right pectoral-right ventral
Lora Bay	392,563	tetracycline
Colpoys Bay	14	external tag
Lions Head	104	external tag
Subtotal	879,004	
Ontario waters (backcross)		
Perseverance Island	18,000	adipose
South Bay	12,000	adipose
South Bay	3,000[3]	adipose
Lora Bay	27,819	tetracycline
Subtotal	60,819	
Subtotal, lake trout	1,048,000	
Subtotal, splake	879,004	
Subtotal, backcross	310,819	
Total, Lake Huron	2,237,823	

[Note: 594,762 (27%) of total 2,237,823 were planted offshore.]

LAKE ERIE-LAKE TROUT

Location	Numbers	Fin clip
New York waters		
Barcelona	125,000[3]	left ventral-left maxillary
Total lake trout, Lake Erie	125,000	

[Note: All 125,000 (100%) were planted offshore.]

Table 2 — (Cont'd)

Location	Numbers	Fin clip
LAKE ONTARIO-LAKE TROUT		
New York waters		
Stoney Island	117,600	left ventral-left maxillary
Sodus Point	75,693	left ventral-left maxillary
Hamlin Beach	105,000	left ventral-left maxillary
Subtotal	298,293	
Ontario waters		
Clarkson	87,600[3]	adipose-right pectoral
Eastern Basin	180,000[3]	right pectoral
Charity Shoal	20,000[3]	right pectoral
Subtotal	287,600	
Total, Lake Ontario	585,893	

[Note: 200,000 (34%) of total 585,893 were planted offshore.]

Footnotes as in Table 1.

Table 3. Plantings of F_1 splake in Lake Superior, 1971, 1973, 1974, 1975, 1976, and 1977.

Year	State	Location	Numbers	Fin clip
1971	Michigan	Copper Harbor	13,199	none
1973	Wisconsin	Bayfield Area	5,000	dorsal-left ventral
1974	Wisconsin	Washburn	10,316	dorsal
		Houghton Point	9,782	dorsal
1975	Wisconsin	Pikes Bay	15,000	dorsal-right ventral
1976	Wisconsin	Pikes Bay	18,360	dorsal-left pectoral
1977	Michigan	Copper Harbor	26,100	left pectoral-right ventral
	Total, Lake Superior		97,757	

Table 4. Annual plantings (in thousands) of coho salmon in the Great Lakes, 1966-1977.

LAKE SUPERIOR

Year	Michigan	Minnesota	Ontario	Total
1966	192	-	-	192
1967	467	-	-	467
1968	382	-	-	382
1969	526	110	20	656
1970	507	111	31	649
1971	402	188	27	617
1972	152	145	-	297
1973	100	35	-	135
1974	455	74	-	529
1975	275	-	-	275
1976	400	-	-	400
1977	627	-	-	627
Subtotal	4,485	663	78	5,226

LAKE MICHIGAN

Year	Michigan	Wisconsin	Indiana	Illinois	Total
1966	660	-	-	-	660
1967	1,732	-	-	-	1,732
1968	1,176	25	-	-	1,201
1969	3,054	217	-	9	3,280
1970	3,155	340	48	-	3,543
1971	2,411	267	68	5	2,751
1972	2,269	258	96	-	2,623
1973	2,003	257	-	5	2,265
1974	2,788	318	125	-	3,231
1975	2,026	433	46	-	2,505
1976	2,270	648	179	80	3,177
1977	2,314	491	179	103	3,087
Subtotal	25,858	3,254	741	202	30,055

LAKE HURON

Year	Michigan	Total
1968	402	402
1969	667	667
1970	571	571
1971	975	975
1972	249	249
1973	100	100

Table 4 — (Cont'd)

1974	500	500
1975	627	627
1976	690	690
1977	416	416
Subtotal	5,197	5,197

LAKE ERIE

Year	Michigan	Ohio	Pennsylvania	New York	Total
1968	-	20	86	5	111
1969	-	92	134	10	236
1970	-	253	197	74	525
1971	-	122	152	95	369
1972	-	38	131	50	219
1973	-	96	315	-	411
1974	200	188	366	29	783
1975	101	231	363	125	819
1976	199	568	248	477	1,491
1977	645	282	636	269	1,832
Subtotal	1,145	1,890	2,628	1,134	6,797

LAKE ONTARIO

Year	Ontario	New York	Total
1968	-	40	40
1969	130	109	239
1970	145	294	439
1971	160	122	282
1972	122	230	352
1973	272	240	512
1974	438	217	655
1975	226	812	1,038
1976	166	178	343
1977	313	39	352
Subtotal	1,972	2,281	4,252
Great Lakes Total, coho salmon, 1966-1977			51,527

Table 5. Plantings of coho salmon in the Great Lakes, 1977.

Location	Numbers	Fin clip
LAKE SUPERIOR-COHO SALMON		
Michigan waters		
Huron River	75,000	none
Dead River	202,000	none
Falls River	100,000	none
Black River	75,000	none
Sucker River	75,000	none
Big Iron River	75,000	none
Presque Isle River	25,000	none
Total, Lake Superior	627,000	
LAKE MICHIGAN-COHO SALMON		
Illinois waters		
Waukegan Harbor Area	99,742	none
Waukegan River Mouth	3,000	none
Subtotal	102,742	
Indiana waters		
Trail Creek	106,000	none
Little Calumet River	73,000	none
Subtotal	179,000	
Michigan waters		
Brewery Creek	100,142	none
Grand River	210,231	none
Little Manistee River	358,832	none
St. Joseph River	200, 308	none
Platte River	606,814	none
Portage Lake	138,809	none
Big Sauble River	200,728	none
Muskegon River	176,252	none
Black River	100,811	none
Thompson Creek	111,203	none
Cedar River	110,000	none
Subtotal	2,314,130	

Table 5 -- (Cont'd)

Location	Numbers	Fin clip
Wisconsin waters		
Little River	42,000	none
Ahnapee River	55,916	none
Manitowoc	44,700	none
East Twin River	22,100	none
West Twin River	20,000	none
Sheboygan	50,000	none
Port Washington	69,200	none
Milwaukee	62,360	none
Racine	50,070	none
Kenosha	75,000	none
Subtotal	491,346	
Total, Lake Michigan	3,087,218	
LAKE HURON-COHO SALMON		
Michigan waters		
Diamond Creek	110,450	none
Elk Creek	40,136	none
Carp River	38,976	none
Cass River	75,129	none
Au Sable River	100,349	none
Tawas River	50,528	
Total, Lake Huron	415,568	
LAKE ERIE-COHO SALMON		
Michigan waters		
Raisin River	120,376	none
Detroit River	299,824	none
Huron River	225,233	none
Subtotal	645,433	
Ohio waters		
Huron River	138,448	left pectoral
Chagrin River	143,717	right pectoral
Subtotal	282,165	

Table 5 — (Cont'd)

Location	Numbers	Fin clip
Pennsylvania waters		
Pear Creek	11,360	none
Elk Creek	51,640	none
Godfrey Run	87,100	none
Presque Isle Bay	140,000	none
Trout Run	278,000	none
Sixteenmile Creek	67,855	
Subtotal	635,955	
New York waters		
Cattaraugus Creek	50,000	adipose
Cattaraugus Creek	99,600	right ventral
Cattaraugus Creek	40,000	none
Chautaugua County	29,500	none
Eighteen Mile Creek	50,000	none
Subtotal	269,100	
Total, Lake Erie	1,719,489	
LAKE ONTARIO-COHO SALMON		
New York waters		
Salmon River	10,078	adipose-left pectoral
Salmon River	9, 858	adipose-left ventral
Salmon River	9,588	left pectoral
Salmon River	9,116	left ventral
Subtotal	38,640	
Ontario waters		
Niagara River (on-the-lake)	25,812	right pectoral
Niagara River (Queenston)	52,182	right pectoral
Credit River	158,629	right pectoral
Bronte Creek	76,278	right pectoral
Subtotal	312,901	
Total, Lake Ontario	351,541	

Table 6. Annual plantings (in thousands) of chinook salmon in the Great Lakes, 1967-1977.

LAKE SUPERIOR

Year	Michigan	Wisconsin	Minnesota	Total
1967	33	-	-	33
1968	50	-	-	50
1969	50	-	-	50
1970	150	-	-	150
1971	252	-	-	252
1972	472	-	-	472
1973	509	-	-	509
1974	295	-	228	523
1975	253	-	-	253
1976	201	-	291	493
1977	116	35	103	254
Subtotal	2,381	35	622	3,038

LAKE MICHIGAN

Year	Michigan	Wisconsin	Indiana	Illinois	Total
1967	802	-	-	-	802
1968	687	-	-	-	687
1969	652	66	-	-	718
1970	1,675	119	100	10	1,904
1971	1,865	264	180	8	2,317
1972	1,691	317	107	24	2,139
1973	2,115	697	-	174	2,986
1974	2,046	616	159	757	3,578
1975	2,816	927	156	381	4,280
1976	1,947	1,276	38	142	3,403
1977	1,576	913	141	347	2,977
Subtotal	17,872	5,195	881	1,843	25,791

LAKE HURON

Table 6 -- (Cont'd)

Year	Michigan	Total
1968	274	274
1969	255	255
1970	643	643
1971	894	894
1972	515	515
1973	967	967
1974	776	776
1975	655	655
1976	831	831
1977	733	733
Subtotal	6,543	6,543

LAKE ERIE

Year	Michigan	Ohio	Pennsylvania	New York	Total
1970	-	150	-	-	150
1971	-	180	129	-	309
1972	-	-	150	-	150
1973	305	-	155	125	585
1974	502	-	189	125	816
1975	401	-	483	85	969
1976	300	246	769	65	1,381
1977	302	428	979	362	2,072
Subtotal	1,810	1,004	2,854	762	6,432

LAKE ONTARIO

Year	Ontario	New York	Total
1969	-	70	70
1970	-	141	141
1971	89	149	238
1972	190	427	617
1973	-	696	696
1974	225	963	1,188
1975	-	920	920
1976	-	593	593
1977	-	-	-
Subtotal	504	3,959	4,463

Great Lakes Total, chinook salmon, 1967-1977. 43,264

Table 7. Plantings of chinook salmon in the Great Lakes, 1977.

Location	Numbers	Fin clip
LAKE SUPERIOR-CHINOOK SALMON		
Minnesota waters		
Baptism River	11,000	none
French River	40,573	none
Cascade River	11,000	none
Grand Portage Creek	40,336[1]	right ventral
Subtotal	102,909	
Michigan waters		
Black River	25,186	none
Dead River	90,400	none
Subtotal	115,586	
Wisconsin waters		
Black River	35,000	
Total, Lake Superior	253,495	
LAKE MICHIGAN-CHINOOK SALMON		
Illinois waters		
Kellogg Creek	25,000	left ventral
Waukegan Harbor Area	40,354	none
Jackson Harbor	50,042	none
Diversey Harbor	206,300	none
Calumet Harbor	25,000	right ventral
Subtotal	346,696	
Indiana waters		
South Lake Michigan	72,250	left pectoral
South Lake Michigan	68,750	none
Subtotal	141,000	
Michigan waters		
St. Joseph River	319,150	none
Escanaba River	102,340	none
Grand River	302,807	none
Brewery Creek	25,095	none
Big Manistee River	100,800	none
Portage Lake	25,200	none

Table 7 -- (Cont'd)

Location	Numbers	Fin clip
Little Manistee River	250,200	none
Muskegon River	250,372	none
Big Sauble River	150,048	none
Kalamazoo River	50,190	none
Subtotal	1,576,202	
Wisconsin waters		
Little River	75,000	none
Pennsaukee River	40,000	none
Sturgeon Bay	150,000	none
De Pere Dam	30,000	none
Kewaunee River	75,000	none
Little Manitowoc River	70,000	none
East Twin River	25,000	none
West Twin River	25,000	none
Sheboygan River	80,000	none
Port Washington	90,000	none
Milwaukee	100,000	none
Racine	15,000	right pectoral
Racine	4,745	none
Kenosha	82,863	none
Ahnapee River	50,000	none
Subtotal	912,608	
Total, Lake Michigan	2,976,506	
LAKE HURON-CHINOOK SALMON		
Michigan waters		
Cass River	90,125	none
Au Sable River	200,200	none
Flint River	126,896	none
St. Marys River	90,064	none
Au Gres River	50,666	none
Mill Creek	150,174	none
Nagle Creek	25,305	none
Subtotal	733,430	
Total, Lake Huron	733,430	

Table 7 -- (Cont'd)

Location	Numbers	Fin clip
LAKE ERIE-CHINOOK SALMON		
Michigan waters		
Huron River	100,464	none
Detroit River	201,874	none
Subtotal	302,338	
Ohio waters		
Chagrin River	201,705	none
Huron River	226,695	none
Subtotal	428,400	
Pennsylvania waters		
Walnut Creek	460,000	none
Elk Creek	518,925	none
Subtotal	978,925	
New York waters		
Cattaraugus Creek	362,000	none
Total, Lake Erie	2,071,663	

[1] Federal plant.

Table 8. Plantings of Atlantic salmon in the Great Lakes, 1972-1977.

Year	State	Location	Numbers	Fin clip
LAKE SUPERIOR				
1972	Wisconsin	Bayfield	20,000	adipose-left ventral
1973	Wisconsin	Bayfield	20,000	right ventral
1976	Michigan	Cherry Creek	9,106	none
Total			49,106	

Table 8 -- (Cont'd)

Year	State	Location	Numbers	Fin clip
LAKE MICHIGAN				
1972	Michigan	Boyne River	10,000	none
1973	Michigan	Boyne River	15,000	none
1974	Michigan	Platte River	7,308	adipose
		Boyne River	14,555	none
1975	Michigan	Boyne River	9,005	none
			13,167[1]	none
1976	Michigan	Boyne River	20,438	none
			162[1]	none
1977	Michigan	Pere Marquette River	7,131	left ventral
		Little Manistee River	4,500	left ventral
		Pere Marquette River	3,961	right ventral
		Little Manistee River	2,997	right ventral
Total			108,224	
LAKE HURON				
1972	Michigan	Au Sable River	9,000	none
Great Lakes Total, Atlantic salmon, 1972-1977			166,330	

[1] Atlantic salmon cross.

Table 9. Annual plantings (in thousands) of rainbow, steelhead, and palomino[1] trout in the Great Lakes, 1975-1977.[2]

Year	Michigan	Wisconsin	Minnesota	Total
LAKE SUPERIOR				
1975	25	61	228	314
1976	36	400	9	445
1977	31	73	211	315
Subtotal	92	534	448	1,074

Table 9 -- (Cont'd)

LAKE MICHIGAN

Year	Michigan	Wisconsin	Indiana	Illinois	Total
1975	701	397	217	253	1,568
1976	601	964	217	45	1,827
1977	305	683	48	276	1,312
Subtotal	1,607	2,044	482	574	4,707

LAKE HURON

Year	Michigan	Ontario	Total
1975	425	62	484
1976	333	33	366
1977	168	119	287
Subtotal	926	214	1,140

LAKE ERIE

Year	Michigan	Ontario	New York	Ohio	Pennsylvania	Total
1975	10	223	-	277	19	529
1976	60	250	25	196	113	644
1977	10	287	13	247	181	737
Subtotal	80	776	38	720	313	1,910

LAKE ONTARIO

Year	New York	Ontario	Total
1975	252	29	281
1976	186	108	295
1977	144	110	254
Subtotal	582	247	830
Great Lakes Total, rainbow, steelhead, and palomino trout, 1975-1977			9,661

[1]Rainbow x W. Virginia Golden hydrid.
[2]Excluding eggs.

Table 10. Plantings of rainbow, steelhead, and palomino[1] trout in the Great Lakes, 1977.

Location	Numbers	Fin Clip
LAKE SUPERIOR-RAINBOW AND STEELHEAD TROUT		
Michigan waters (rainbow trout)		
Cross River	5,040	none
French River	50,819	adipose
Cascade River	5,040	none
Stewart River	17,550	none
Gooseberry River	17,496	none
Split Rock River	17,515	none
Brule River	35,005	none
Baptism River	17,503	none
Onion River	5,040	none
Subtotal	171,008	
Minnesota waters (steelhead trout)		
Brule River	5,496	none
Gooseberry River	1,008	none
Stewart River	4,068	none
Knife River	2,988	none
Baptism River	4,860	none
Kimball Creek	504	none
Cascade River	1,001	none
French River	5,004	none
Cross River	1,001	none
Kadunce Creek	1,001	none
Temperance River	2,002	none
Devil Track River	1,001	none
Split Rock River	3,240	none
Beaver River	900	none
Sucker River	6,012	none
Subtotal	40,086	
Wisconsin waters (rainbow trout)		
Herbster	24,525	none
Cranberry River	2,350	none
Superior Entry	40,000	none
Flag River	2,000	none
Sioux River	2,000	none
Fish Creek	2,500	none
Subtotal	73,375	

Table 10 -- (Cont'd)

Location	Numbers	Fin clip
Michigan waters (rainbow trout)		
Dead River	11,914	none
Michigan waters (steelhead trout)		
Black River	4,640	none
Presque Isle River	4,680	none
Two-Hearted River	10,101	none
Subtotal	19,421	
Subtotal, rainbow trout	256,297	
Subtotal, steelhead trout	59,507	
Total, Lake Superior	315,804	
LAKE MICHIGAN-RAINBOW AND STEELHEAD TROUT		
Wisconsin waters (rainbow trout)		
Oconto	15,000	none
Marinette	30,000	none
Gills Rock	5,000	none
Ellison Bay	5,000	none
Coast Guard Station	13,500	none
Egg Harbour	4,600	none
Ephraim	8,500	none
Fish Creek	8,500	none
Braunsdorf Beach	9,400	none
Sister Bay	5,000	none
Whitefish Bay	10,000	none
Bailey's Harbour	10,000	none
Moonlight Bay	5,000	none
Wester's	10,000	none
Stone Quarry	6,000	none
Schauer Park	20,500	none
DNR Office	15,000	none
Algoma Harbour	48,500	none
Kewaunee Harbour	32,750	none
Manitowoc	73,500	none
Two Rivers	21,000	none
Cleveland	8,500	none
Sheboygan	81,000	none
Port Washington	44,614	none
Milwaukee	39,190	none
Racine	61,647	none
Kenosha	91,210	none
Subtotal	682,911	

Table 10 — (Cont'd)

Location	Numbers	Fin clip
Illinois waters (rainbow trout)		
Waukegan Harbour Area	29,000	none
Wilmette Harbor	25,000	none
Belmont Harbor	217,660	none
Calumet Harbor	4,504	none
Subtotal	276,164	
Indiana waters (steelhead trout)		
Trail Creek	25,270	none
Little Calumet River	22,461	none
Subtotal	47,731	
Michigan waters (rainbow trout)		
Grand Haven	10,000	none
South Haven	10,710	none
Thompson Creek	10,000	none
Galien River	10,670	none
Menominee River	20,000	none
Montague	10,000	none
West Grand Traverse Bay	16,610	none
Bear River	11,132	none
Pigeon Lake	10,000	none
Subtotal	109,122	
Michigan waters (steelhead trout)		
Fish Creek	10,360	none
Black River	10,119	none
Crockery Creek	10,570	none
Muskegon River	10,138	none
Ruby Creek	5,250	none
Pentwater Creek	5,250	none
Cedar River	9,080	none
Paw Paw River	10,200	none
St. Joseph River	35,242	none
Betsie River	12,170	none
Bear River	23,910	none
Boardman River	14,910	none
Big Manistee River	24,620	none
Menominee River	9,120	none
Prairie Creek	5,161	none
Subtotal	196,100	

Table 10 -- (Cont'd)

Location	Numbers	Fin clip
Subtotal, rainbow trout	1,068,197	
Subtotal, steelhead trout	243,831	
Total, Lake Michigan	1,312,028	
LAKE HURON-RAINBOW AND STEELHEAD TROUT		
Michigan waters (rainbow trout)		
Port Austin	5,000	none
Caseville	5,000	none
Harbor Beach	10,000	none
Tawas Bay	11,000	none
Harrisville Harbor	20,125	none
Post Sanilac	15,005	none
Rogers City	10,000	none
Lexington	10,000	none
Subtotal	86,130	
Michigan waters (steelhead trout)		
St. Marys River	10,010	none
Carp River	10,175	none
Au Sable River	20,240	none
Thunder Bay River	7,560	none
Rifle River	10,082	none
Whitney River	8,200	none
Cheboygan River	7,560	none
Ocqueoc River	7,560	none
Subtotal	81,387	
Ontario waters (rainbow trout)		
Saugeen River	7,500	adipose
Saugeen River	10,000	adipose-right ventral
Saugeen River	47,650	none
Boyne River	20,000	none
Pinery Park	3,500	none
Beaver River	15,000	right ventral
Colpoy Bay	5,000	right ventral
Deer Creek	10,000	right ventral
Subtotal	118,650	

Table 10 -- (Cont'd)

Location	Numbers	Fin clip
Ontario waters (rainbow trout eggs)		
Saugeen River	401,000	none
Styx River	1,000	none
Hamilton Creek	3,000	none
Otter Creek	9,758	none
Camp Creek	11,000	none
Subtotal	425,758	
Subtotal, rainbow trout	204,780	
Subtotal, steelhead trout	81,387	
Subtotal, rainbow trout eggs	425,758	
Total, Lake Huron	286,167[2]	
LAKE ERIE-RAINBOW, STEELHEAD AND PALOMINO TROUT		
Michigan waters (rainbow trout)		
Detroit River	10,000	none
Ohio waters (rainbow trout)		
Rocky River	104,088	none
Chagrin River	102,306	none
Beaver Creek	5,000	none
Arcola Creek	3,000	none
Turkey Creek	3,000	none
Subtotal	217,394	
Ohio waters (steelhead trout)		
Conneaut Creek	29,151	left pectoral
Pennsylvania waters (rainbow trout)		
Seven Mile Creek	134	none
Twenty Mile Creek	27,900	none
Elk Creek	34,150	none
Walnut Creek	20,718	none
Bear Creek	100	none
Crooked Creek	1,300	none
Little Elk Creek	200	none
Orchard Beach Run	300	none
Twelve Mile Creek	494	none
Taylor Run	1,944	none
Camp Notre Dame	220	none
Temple Run	2,526	none

Table 10 -- (Cont'd)

Location	Numbers	Fin clip
Sixteen Mile Creek	20,000	none
Godfrey Run	10,350	none
Conneaut Creek	410	none
Six Mile Creek	1,851	none
Trout Run	8,270	none
Subtotal	130,867	
Pennsylvania waters (steelhead trout)		
Trout Run	12,000	left ventral
Lake Erie	13,000	left ventral
Godfrey Run	7,000	none
Trout Run	7,500	none
Subtotal	39,500	
Pennsylvania waters (palomino trout)		
Lake Erie	10,000	left ventral
Crooked Creek	50	none
Elk Creek	200	none
Twenty Mile Creek	200	none
Six Mile Creek	5	none
Seven Mile Creek	4	none
Twelve Mile Creek	7	none
Subtotal	10,466	
New York waters (rainbow trout)		
Buffalo Small Boat Harbor	12,500	none
Ontario waters (rainbow trout)		
Young's Creek	4,000	adipose
Big Creek	223[5]	none
Big Creek	24,200[3]	none
Venison Creek	213[5]	none
Venison Creek	9,860[3]	none
Windham Creek	2,750	none
Otter Creek Tributary	12,000	none
Young's Creek	25,810	none
Stony Creek	27,460	none
Tobacco Creek	2,610	none
Stream E	1,450	none
Lynn River	118	none
South Creek	27,830	none
Silver Creek	30,000	none
North Creek	15,080	none

Table 10 -- (Cont'd)

Location	Numbers	Fin clip
Pirrie Creek	15,000	none
Brockton Creek	3,700	none
Trout Creek	8,600	none
Dedrick's Creek	10,580	none
Dace Creek	1,160	none
Cranberry Creek	7,540	none
Chapman Creek	2,900	none
Lyndock Creek	5,790	none
Mosquito Creek	3,540	none
Stable Creek	2,610	none
South Otter Creek	18,000	none
Saul Creek	1,470	none
Lee's Mill Creek	1,450	none
Earl Creek	5,700	none
Deerlick Creek	12,470	none
Burnt Mill Creek	300	right ventral
Silver Creek	200	right ventral
Wardsville Pond	300	right ventral
Bloomfield Creek	200	right ventral
Little Otter Creek	1,500	right ventral
Komoko Creek	300	right ventral
Harrington Pond	500	right ventral
Subtotal	287,414	
Subtotal, rainbow trout	658,175	
Subtotal, steelhead trout	68,651	
Subtotal, palomino trout	10,466	
Total, Lake Erie	737,292	

LAKE ONTARIO-RAINBOW AND STEELHEAD TROUT

Location	Numbers	Fin clip
New York waters (rainbow trout)		
Wilson	7,500	adipose-left pectoral
Cloett	7,500	adipose-left pectoral
Selkirk St. Park Pier	14,250	adipose-left ventral
Selkirk St. Park Pier	4,863	dorsal
Sodus Point	62,477	left pectoral
Sodus Point	20,660	right ventral-left ventral
Subtotal	117,250	
New York waters (steelhead trout)		
Irondequdit Creek	7,000	left ventral
Salmon River	19,779	left ventral
Subtotal	26,779	

Table 10 -- (Cont'd)

Location	Numbers	Fin clip
Ontario waters (rainbow trout)		
Credit River	104,710	adipose
Duffin's Creek	5,000	adipose
Subtotal	109,710	
Subtotal, rainbow trout	226,960	
Subtotal, steelhead trout	26,779	
Total, Lake Ontario	253,739	

[1] Rainbow x W. Virgina Golden hybrid.
[2] Excluding eggs.
[3] Fingerlings.
[4] Yearlings.
[5] Adults.

Table 11. Annual plantings (in thousands) of brown trout in the Great Lakes, 1975-1977.

LAKE SUPERIOR

Year	Michigan	Wisconsin	Minnesota	Total
1975	35	103	108	246
1976	35	43	10	88
1977	40	62	31	133
Subtotal	110	208	149	467

LAKE MICHIGAN

Year	Michigan	Wisconsin	Illinois	Indiana	Total
1975	279	356	10	20	665
1976	666	292	94	199	1,251
1977	226	802	42	109	1,180
Subtotal	1,171	1,450	146	328	3,096

Table 11 — (Cont'd)

LAKE HURON

Year	Michigan	Total
1975	155	155
1976	447	447
1977	210	210
Subtotal	812	812

LAKE ERIE

Year	Pennsylvania	New York	Total
1975	7	26	33
1976	11	67	78
1977	49	125	174
Subtotal	67	218	285

LAKE ONTARIO

Year	New York	Total
1975	371	371
1976	311	311
1977	353	353
Subtotal	1,035	1,035
Great Lakes Total, brown trout, 1975-1977		5,695

Table 12. Plantings of brown trout in the Great Lakes, 1977.

Location	Numbers	Fin clip
LAKE SUPERIOR - BROWN TROUT		
Minnesota waters		
Baptism River	21,109	none
Blackhoof River	800	none
Big Nett River	599	none
Temperance River	5,548	none
Cascade River	3,329	none
Subtotal	31,385	
Michigan waters		
Marquette Bay	30,012	none
Munising	10,000	none
Subtotal	40,012	
Wisconsin waters		
Cornucopia	5,000	none
Superior Entry	15,000	none
Port Wing	10,000	none
Sioux River	1,000	none
Long Bridge	20,000	none
Saxon Harbor	10,948	none
Subtotal	61,948	
Total, Lake Superior	133,345	
LAKE MICHIGAN - BROWN TROUT		
Wisconsin waters		
Marinette	75,200	none
Oconto	11,000	left maxillary
Oconto	55,650	none
Coast Guard Station	18,550	none
Fish Creek	10,000	none
Braunsdorf Beach	12,400	none
Ephraim	10,000	none
Egg Harbour	15,800	none
Westers	16,800	dorsal
Westers	10,420	adipose-left ventral
Bailey's Harbour	21,000	dorsal
Bailey's Harbour	10,800	adipose-left ventral
Schauer Park	16,800	dorsal
Schauer Park	13,100	dorsal-left ventral

Table 12 -- (Cont'd)

Location	Numbers	Fin clip
Stone Quarry	13,000	none
Moonlight Bay	25,000	none
DNR Office	28,600	none
Algoma Harbor	35,000	none
Kewaunee Harbor	48,000	none
Manitowoc	27,000	none
Two Rivers	53,000	none
Two Creeks	10,000	none
Cleveland	15,000	none
Port Washington	41,050	none
Milwaukee	42,435	none
Racine	47,240	none
Sheboygan	83,500	none
Kenosha	35,848	none
Subtotal	802,193	
Illinois waters		
Wilmette Harbor	14,500	none
Calumet Harbor	27,700	none
Subtotal	42,200	
Indiana waters		
East Chicago	34,000	left pectoral
Burns Harbor	35,000	left pectoral
Michigan City	40,000	none
Subtotal	109,000	
Michigan waters		
Little Bay de Noc	30,012	none
Manistee	20,000	none
West Grand Traverse Bay	10,000	none
Lake Michigan	100,000	none
Benton Harbor	10,000	none
Frankfort	20,000	none
Little Traverse Bay	16,350	none
East Grand Traverse Bay	20,000	none
Subtotal	226,362	
Total, Lake Michigan	1,179,755	

Table 12 -- (Cont'd)

Location	Numbers	Fin clip
LAKE HURON - BROWN TROUT		
Michigan waters		
Carp River	10,000	none
Thunder Bay	75,013	none
Brulee Point	10,000	none
Port Sanilac	10,000	none
Lexington	10,000	none
Tawas Bay	20,001	none
Grindstone City	15,000	none
Caseville	10,000	none
Habor Beach	30,000	none
Harrisville	20,000	none
Subtotal	210,014	
Total, Lake Huron	210,014	
LAKE ERIE - BROWN TROUT		
Pennsylvania waters		
Lake Erie	12,000	left ventral
Twenty Mile Creek	1,650	none
Bear Creek	50	none
Conneaut Creek	920	none
Lake Erie	26,000	none
Taylor Run	258	none
Temple Run	2,167	none
Crooked Creek	1,650	none
Elk Creek	4,400	none
Subtotal	49,095	
New York waters		
Fisherman Park	15,000	adipose
Dunkirk Harbor	32,425	none
Hamburg Town Park	125	none
Buffalo Small Boat Harbor	34,800	none
Dunkirk Harbor	21,125	external tag
Hamburg Town Park	21,125	external tag
Subtotal	124,600	
Total, Lake Erie	173,695	

Table 12 -- (Cont'd)

Location	Numbers	Fin clip
LAKE ONTARIO - BROWN TROUT		
New York waters		
Hamlin Beach State Park	55,980	adipose
Selkirk Street Park Pier	17,000	adipose-left ventral
Oswego Harbor	17,000	left pectoral
Hamlin Beach State Park	74,491	left ventral
Selkirk Street Park Pier	45,950	none
Olcott-Wilson	71,500	none
Hamlin Beach State Park	33,259	none
Stoney Point Beach	37,500	right pectoral
Subtotal	352,680	
Total, Lake Ontario	352,680	

Table 13. Annual plantings (in thousands) of brook trout in the Great Lakes, 1976-1977.

LAKE SUPERIOR

Year	Wisconsin	Minnesota	Total
1976	25	7	32
1977	123	66	188
Subtotal	148	73	221

LAKE MICHIGAN

Year	Michigan	Wisconsin	Illinois	Total
1976	61	12	6	79
1977	-	643	-	643
Subtotal	61	655	6	722

Table 14 — (Cont'd)

Location	Numbers	Fin clip
Stewart River	1,074	none
Baptism River	650	none
Lake Superior (Pumping Station)	3,600	none
Subtotal	65,571	
Wisconsin waters		
Cornucopia	14,400	none
Stockton Island	150	none
Madeline Island	26,443	none
Onion River	14,400	none
Washburn Harbor	65,420	none
Unknown location	2,044	none
Subtotal	122,857	
Total, Lake Superior	188,428	
LAKE MICHIGAN - BROOK TROUT		
Wisconsin waters		
Oconto	7,500	none
Marinette	22,500	none
Sturgeon Bay	162,800	none
Fish Creek	100,000	none
Egg Harbour	100,000	none
Ephraim	100,000	none
Bailey's Harbor	10,330	none
Moonlight Bay	46,972	none
Westers	10,000	none
Whitefish Bay	9,000	none
Schauer Park	10,000	none
Cleveland	8,000	none
Two Rivers	13,250	none
Manitowoc	25,000	none
Sheboygan	18,000	none
Subtotal	643,352	
Total, Lake Michigan	643,352	

Table 14 -- (Cont'd)

Location	Numbers	Fin clip
LAKE ERIE - BROOK TROUT		
Pennsylvania waters		
Seven Mile Creek	30	none
Six Mile Creek	480	none
Twelve Mile Creek	36	none
Walnut Creek	1,232	none
Subtotal	1,778	
Total, Lake Erie	1,778	
LAKE ONTARIO - BROOK TROUT		
New York waters		
Selkirk State Park Pier	7,944	adipose
Total, Lake Ontario	7,944	

Table 13 -- (Cont'd)

LAKE ERIE

Year	Pennsylvania	Total
1976	6	6
1977	2	2
Subtotal	8	8

LAKE ONTARIO

Year	New York	Total
1976	-	-
1977	8	8
Subtotal	8	8

Table 14. Plantings of brook trout in the Great Lakes, 1977.

Location	Numbers	Fin clip
LAKE SUPERIOR - BROOK TROUT		
Minnesota waters		
Two Harbors	5,004	none
Kadunce Creek	1,175	none
Deer Yard Creek	100	none
Encampment River	276	none
Poplar River	300	none
Sucker River	2,002	none
Blackhoof River	800	none
French River	1,677	none
Devil Track River	2,925	none
Grand Marais Harbor	29,648	none
Portage Brook	1,075	none
Lester River	1,661	none
Cascade River	2,550	none
Kimball Creek	1,075	none
Gooseberry River	1,074	none
Knife River	2,676	none
Stoney Point	6,229	none

APPENDIX C

SEA LAMPREY CONTROL IN THE UNITED STATES

Robert A. Braem and Harry H. Moore
U.S. Fish and Wildlife Service

Progress in sea lamprey control was exceptionally good in 1977. Although the extreme low water experienced in 1976 continued into mid summer 1977, late summer and fall rains brought stream flows back to normal levels, and mild fall weather allowed an extension of treatments into November. The total of 77 stream treatments completed in the United States during the field season (Table 1) included 15 streams postponed from 1976 due to drought.

Table 1. Summary of chemical treatments in United States waters of the Great Lakes in 1977.
[Lampricides used are in pounds of active ingredient.]

Lake	Number of streams	Discharge at mouth (cfs)	TFM	Bayer 73	
				Powder	Granules
Superior	24	1,376	15,378	10.5	169.3
Michigan	37	4,056	56,804	218.8	90.0
Huron	14	423	10,538	0.0	0.0
Ontario[a]	2	85	716	0.0	0.0
Total	77	5,940	83,436	229.3	259.3

[a]Treated by crew from the Sea Lamprey Control Centre, Department of Fisheries and the Environment, Canada.

Surveys to assess sea lamprey populations were conducted on 310 streams tributary to the Great Lakes. Sea lamprey ammocetes were found for the first time in seven streams--one tributary of Lake Superior, one of Lake Michigan, two of Lake Huron, and three of Lake Ontario (Fig. 1).

Presented at: Great Lakes Fishery Commission
Annual Meeting
Rochester, New York
June 13-15, 1978

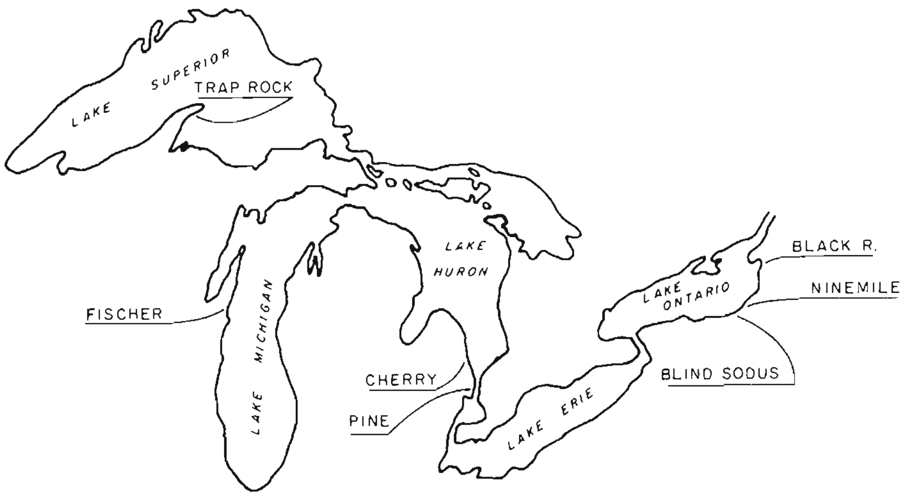

Figure 1. Streams tributary to the Great Lakes in which sea lampreys were collected for the first time in 1977.

Fyke nets fished in the Oswego River system at Caughdenoy, New York, captured one adult and six transformed sea lampreys. The nets were fished from March 26 to April 6 under poor fyke netting conditions (the river was at or near flood stage throughout the period).

The number of adult sea lampreys captured at the eight index barriers on Lake Superior increased from 2,098 in 1976 to 4,796 in 1977. The increase was lakewide, although the Brule River accounted for 54% of the total catch. The average size (length, 433 mm; weight, 180 g) of sea lampreys captured at the barriers did not change appreciably from that in 1976. The percentage of males was 29, the same as in 1976.

The number of parasitic-phase sea lampreys collected from fishermen increased 53% on Lake Superior, 192% on Lake Michigan, and 102% on Lake Huron, over the numbers collected in 1976.

The value of small, mechancial traps as a means of monitoring adult sea lamprey populations was proven during the field season. A total of 10,178 sea lampreys were captured in 13 of the 31 tributaries of the upper Great Lakes in which the traps were fished.

Surveys and Chemical Treatments

Lake Superior Surveys

Pretreatment surveys were conducted on 16 Lake Superior tributaries, of which 13 were treated during 1977. Moderate sized larval populations were present in the three streams not treated--the Betsy, Huron, and Ontonagon rivers.

Seven of 15 streams examined for reestablished sea lamprey populations contained ammocetes. Moderate numbers of reestablished larvae were taken in the Traverse and Misery rivers, but were scarce elsewhere. No significant numbers of residual larvae were found.

The Trap Rock River, Houghton County, Michigan, was the only stream that contained sea lamprey ammocetes (1, 19 mm long), of 13 examined where sea lamprey larvae had not been found before.

Surveys with Bayer 73 granules were conducted on deltas associated with six inland lakes in the Rock, Au Train, Sturgeon, and Big Garlic rivers and Deer Lake Outlet and Harlow Creek. Sea lamprey larvae were collected at three of these deltas: Harlow Lake, 30 larvae (75-175 mm long); Saux Head Lake, 12 (25-123 mm); and Otter Lake 45 (34-101 mm). All streams and the three delta areas were later treated.

Annual treatments with TFM of the Silver River and Eliza Creek have reduced recruitment to offshore areas of these streams. Survey crews collected no larvae off the Silver River and only six (92-134 mm long) in Eagle Harbor off Eliza Creek.

Surveys of 12 estuaries with Bayer 73 granules revealed reestablished populations of sea lampreys in Deer Lake Outlet and the East Sleeping and Ontonagon rivers. Residual larvae were found in the lower Otter River, a tributary of the Sturgeon River, which was later treated.

Lake Superior Chemical Treatments

Twenty-four streams, with a combined flow of 1,376 cfs (measured just before treatment), were treated during the season (Table 2, Fig. 2).

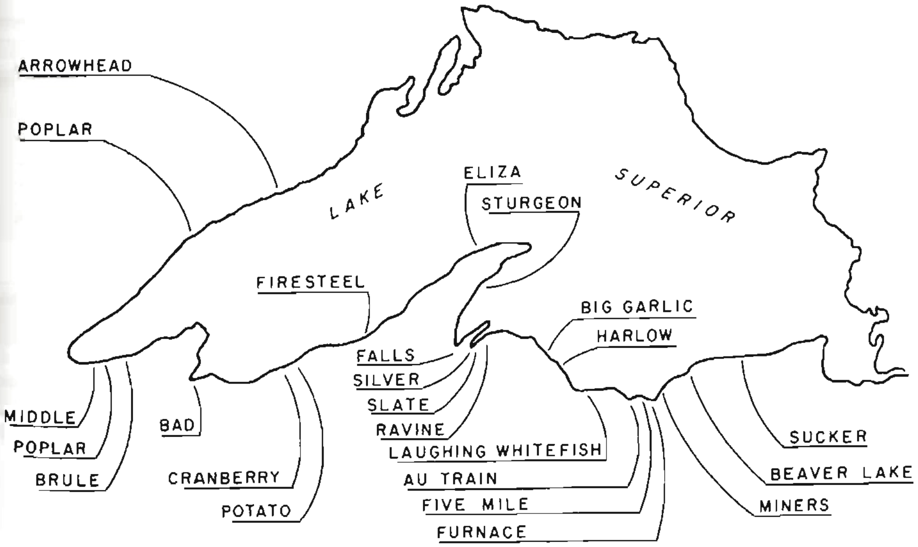

Figure 2. Lake Superior streams that were treated with lampricides in 1977.

Table 2. Details on the application of lampricides to tributaries of Lake Superior in 1977.
[Lampricides used are in pounds of active ingredient.]

Stream	Date	Discharge at mouth (cfs)	TFM: Concentration (ppm): Minimum effective	TFM: Concentration (ppm): Maximum allowable	TFM: Pounds used	TFM: Hours applied	Bayer 73: Pounds of powder used	Bayer 73: Granules: Pounds used	Bayer 73: Granules: Acres surveyed
Poplar River (Wis.)	July 7	18	1.7	5.0	242	16	-	-	-
Middle River	July 7	37	1.4	4.1	330	16	-	-	-
Arrowhead River	July 7	90	0.8	1.9	286	11	-	-	-
Brule River	July 9	230	1.5	5.0	1,716	16	-	-	-
Poplar River (Minn.)	July 9	45	1.0	2.8	110	8	-	-	-
Bad River	July 22	280	2.5	7.0	5,962	16	1.4	-	-
Five Mile Creek	Aug. 31	2	2.3	7.1	22	10	-	-	-
Au Train River	Sept. 1	127	2.1	5.0	770	9	7.7	40.5	8.1
Furnace Creek	Sept. 2	14	2.5	7.0	110	12	-	18.3	3.7
Beaver Lake Outlet	Sept. 3	2	2.4	6.8	22	6	-	14.0	2.8
Laughing Whitefish R.	Sept. 3	84	2.2	6.6	770	13	-	5.0	1.0
Miners River	Sept. 5	23	3.5	10.6	484	12	-	5.0	1.0
Sturgeon River									
Otter River	Sept. 15	110	2.6	7.8	990	12	-	20.0	4.0
Potato River	Sept. 15	1	3.0	9.5	352	36	-	-	-
Cranberry River	Sept. 16	1	2.5	7.6	220	24	-	-	-
Silver River	Sept. 17	20	1.8	5.4	308	18	-	-	-
Ravine River	Sept. 18	3	1.6	4.5	44	17	-	15.0	3.0
Firesteel River	Sept. 18	30	2.6	7.8	594	14	1.4	-	-
Slate River	Sept. 20	15	2.0	5.8	88	6	-	27.5	5.5
Falls River	Sept. 21	85	2.2	6.6	396	7	-	8.0	1.6
Sucker River	Sept. 29	110	1.7	5.0	1,056	12	-	15.0	3.0
Eliza Creek	Oct. 27	3	1.4	4.1	22	9	-	1.0	0.2
Harlow Creek	Nov. 1	19	1.3	3.7	176	12	-	-	-
Big Garlic River	Nov. 3	27	1.4	4.1	308	12	-	-	-
Total	...	1,376	...	...	15,378	...	10.5	169.3	33.9

Table 2. Details on the application of lampricides to tributaries of Lake Superior in 1977.
[Lampricides used are in pounds of active ingredient.]

Stream	Date	Discharge at mouth (cfs)	TFM: Concentration (ppm) Minimum effective	TFM: Concentration (ppm) Maximum allowable	TFM: Pounds used	TFM: Hours applied	Bayer 73: Pounds of powder used	Bayer 73: Granules Pounds used	Bayer 73: Granules Acres surveyed
Poplar River (Wis.)	July 7	18	1.7	5.0	242	16	-	-	-
Middle River	July 7	37	1.4	4.1	330	16	-	-	-
Arrowhead River	July 7	90	0.8	1.9	286	11	-	-	-
Brule River	July 9	230	1.5	5.0	1,716	16	-	-	-
Poplar River (Minn.)	July 9	45	1.0	2.8	110	8	-	-	-
Bad River	July 22	280	2.5	7.0	5,962	16	1.4	-	-
Five Mile Creek	Aug. 31	2	2.3	7.1	22	10	-	-	-
Au Train River	Sept. 1	127	2.1	5.0	770	9	7.7	40.5	8.1
Furnace Creek	Sept. 2	14	2.5	7.0	110	12	-	18.3	3.7
Beaver Lake Outlet	Sept. 3	2	2.4	6.8	22	6	-	14.0	2.8
Laughing Whitefish R.	Sept. 3	84	2.2	6.6	770	13	-	5.0	1.0
Miners River	Sept. 5	23	3.5	10.6	484	12	-	5.0	1.0
Sturgeon River									
Otter River	Sept. 15	110	2.6	7.8	990	12	-	20.0	4.0
Potato River	Sept. 15	1	3.0	9.5	352	36	-	-	-
Cranberry River	Sept. 16	1	2.5	7.6	220	24	-	-	-
Silver River	Sept. 17	20	1.8	5.4	308	18	-	-	-
Ravine River	Sept. 18	3	1.6	4.5	44	17	-	15.0	3.0
Firesteel River	Sept. 18	30	2.6	7.8	594	14	1.4	-	-
Slate River	Sept. 20	15	2.0	5.8	88	6	-	27.5	5.5
Falls River	Sept. 21	85	2.2	6.6	396	7	-	8.0	1.6
Sucker River	Sept. 29	110	1.7	5.0	1,056	12	-	15.0	3.0
Eliza Creek	Oct. 27	3	1.4	4.1	22	9	-	1.0	0.2
Harlow Creek	Nov. 1	19	1.3	3.7	176	12	-	-	-
Big Garlic River	Nov. 3	27	1.4	4.1	308	12	-	-	-
Total	...	1,376	...	...	15,378	...	10.5	169.3	33.9

No significant residual ammocete populations were detected, but the major sea lamprey-producing streams still contained moderate to abundant populations of reestablished ammocetes. No important fish mortality occurred.

Sea lamprey ammocetes were discovered in the Poplar River in Minnesota in 1976, and the river was treated for the first time in 1977. Few ammocetes were collected. A falls 200 yards above the mouth limited lamprey spawning migrations and the potential of this stream for ammocete production.

An experimental treatment with Fintrol 5, a formulation of antimycin coated on sand granules, was conducted in an oxbow of the Firesteel River. Though the stream was treated with TFM in 1976, large residual larvae were discovered in early summer surveys in the oxbow and in the river below it. The oxbow afforded two diverse habitat types. The downstream half is a 4-foot deep, 25-foot wide channel created by a beaver dam and the upper portion consists of many small pools in an otherwise dry stream channel.

Four cages, each containing 20 *Ichthyomyzon* ammocetes, were spaced throughout the oxbow. The quantities of Fintrol 5 required to treat each section were so small that beach sand was added at a ratio of 3:1 to increase the volume. The formulation was then sprayed with a solo blower over deeper areas and sprinkled from a salt shaker into the smaller pools.

Minnows died within a few hours of application. Caged larvae showed no reaction in the first 5 hours, but all were dead after 24 hours, and 48 dead larvae surviving from the previous treatment were collected from the oxbow. Turbidity hampered collecting from deeper sections of the oxbow. No larvae or fish were collected in the Firesteel River and its oxbow, which were treated with TFM and powdered Bayer 73 a month after the antimycin treatment.

Lake Michigan Surveys

Pretreatment surveys were completed on 31 streams in 1977. Twenty-three were treated and the remaining eight are scheduled for treatment in 1978. Sea lamprey populations are small in five of the eight streams scheduled for treatment in 1978, but the Manistee River contains a large population, and moderate populations are indicated in the Milakokia River and Hudson Creek. Treatment of the Manistee, originally planned for 1977, was rescheduled for 1978 when ammocetes did not reach a length at which metamorphosis would be expected.

Sixty-nine streams were examined for reestablished sea lamprey populations or the presence of young-of-the-year larvae. Reestablished sea lampreys were found in 37 streams and young-of-the-year ammocetes in 24. The 1977 year class was established above the Union Street dam on the Boardman River. One transforming sea lamprey was collected from the Elk River, 1 from the Manistee River, and 17 from Crockery Creek, a tributary of the Grand River.

In surveys to evaluate the success of recent chemical treatments on 13 streams, residual larvae were found in 7. The largest numbers were collected in four rivers—the Muskegon, Black, Whitefish, and Ford—in sections where physical characteristics such as oxbows, groundwater, and

Table 3. Details on the application of lampricides to tributaries of Lake Michigan in 1977.
[Lampricides used are in pounds of active ingredient.]

			TFM				Bayer 73		
			Concentration (ppm)					Granules	
Stream	Date	Discharge at mouth (cfs)	Minimum effective	Maximum allowable	Pounds used	Hours applied	Pounds of powder used	Powder used	Acres surveyed
Ford River	May 12	200	3.0	13.0	6,226	18	7.4	-	-
Burns Ditch	May 14	39	9.0	16.0	770	12	-	-	-
St. Joseph River									
Paw Paw River	May 26	250	7.0	14.0	3,740	10	-	-	-
Blue Creek	June 3	18	6.0	15.0	396	15	-	-	-
Pipestone Creek	June 5	20	6.5	15.0	572	16	-	-	-
Bulldog Creek	June 9	2	2.3	6.7	66	14	-	-	-
Marblehead Creek	June 11	2	4.4	13.7	44	12	-	-	-
Gulliver Lake Outlet	June 12	2	2.9	8.9	44	18	-	-	-
Southtown Creek	June 13	9	2.3	6.7	220	7	-	-	-
Johnson Creek	June 13	1	2.9	8.9	22	12	-	-	-
Black River (Van Buren County)	June 18	187	3.5	8.0	2,112	16	-	-	-
Millecoquins River	June 23	70	1.7	4.0	1,584	12	9.8	-	-
Ogontz River	June 23	40	2.0	5.1	198	12	-	40.0	8.0
Brevort River	June 24	21	2.3	7.0	242	12	-	-	-
Valentine Creek	June 26	8	2.3	6.7	110	12	-	-	-
Rock River	June 27	11	3.5	10.3	66	10	-	-	-
Deadhorse Creek	June 28	15	1.9	5.4	154	12	-	-	-
Kalamazoo River									
Bear Creek	June 29	7	7.0	15.0	176	15	-	-	-
Sand Creek	June 30	5	6.0	12.0	66	10	-	-	-
Swan Creek	July 7	35	5.5	13.5	682	15	-	-	-

(continued)

Table 3. Continued

			TFM				Bayer 73		
			Concentration (ppm)					Granules	
Stream	Date	Discharge at mouth (cfs)	Minimum effective	Maximum allowable	Pounds used	Hours applied	Pounds of powder used	Pounds used	Acres surveyed
Rogers Creek	July 8	2	3.0	7.0	44	12	-	-	-
Platte River	July 23	235	7.0	14.0	4,356	16	9.1	-	-
Rapid River	Aug. 4	250	2.5	7.5	4,070	12	-	7.5	1.5
Little River	Aug. 4	2	3.5	10.7	66	12	-	-	-
Horton Creek	Aug. 6	18	9.0	16.0	286	7	-	-	-
McGeach Creek	Aug. 7	8	9.0	18.0	198	12	-	-	-
Portage Creek	Aug. 8	5	3.0	10.0	66	10	-	-	-
Peshtigo River	Aug. 8	222	2.5	4.5	2,178	12	31.9	35.0	7.0
Boyne River	Aug. 18	90	9.0	14.0	2,398	13	-	-	-
Bailey Creek	Aug. 18	1	5.5	17.1	44	12	-	-	-
Beattie Creek	Aug. 19	1	5.3	16.7	22	2	-	-	-
Menominee River	Aug. 21	1,367	2.0	4.5	11,066	12	160.6	7.5	1.5
Jordan River	Aug. 22	400	8.0	14.0	8,162	13	-	-	-
Springer Creek	Aug. 23	1	5.4	15.9	44	12	-	-	-
Sugar Creek	Aug. 24	1	5.6	17.8	22	2	-	-	-
Lincoln River	Sept. 9	35	6.0	15.0	330	16	-	-	-
Duck Creek	Sept. 14	8	3.0	6.0	110	16	-	-	-
Bark River	Oct. 4	28	3.5	10.5	572	12	-	-	-
Sturgeon River	Oct. 14	380	1.3	3.7	2,992	12	-	-	-
Pensaukee River	Nov. 8	20	7.0	21.0	924	12	-	-	-
Grand River									
Crockery Creek	Nov. 8	40	7.0	14.0	1,364	16	-	-	-
Total	...	4,056	...	...	56,804	...	218.8	90.0	18.0

wide channels limited treatment effectiveness during the chemical treatment.

Bowen and Allegan 5 creeks contained small sea lamprey populations in 1975 but survey results this year were negative. The two streams have not been treated.

Nine streams along the west shore of Lake Michigan where sea lampreys had not been found were reexamined as possible sources of the large parasitic population that has persisted in the area in recent years. Only one sea lamprey was collected, a 115-mm long ammocete from Fischer Creek in Manitowoc County, Wisconsin. Only the Fox River system above Lake Winnebago now appears to have a potential for significant lamprey production. Tributaries in that part of the system support large numbers of native lampreys and seem well-suited for sea lamprey larvae if the adults are able to pass through the polluted section and the series of locks in the lower Fox River.

Sea lamprey larvae were recovered off the mouths of 11 of 21 Lake Michigan streams in which surveys with Bayer 73 granules and backpack shockers were conducted in 1977. The largest numbers were found off the Boyne and Bear rivers where 180 and 158 ammocetes, respectively, were collected. Somewhat smaller populations were indicated in Loon Lake of the Platte River (56 larvae) and in Lake Michigan off the Jordan River (17) and Portage (39) and Porter (18) creeks. Few ammocetes were found associated with the remaining five streams (Menominee, Cedar, Ford, Manistique, and Milakokia rivers).

Surveys of the deltas of the Boyne and Jordan rivers before and after treatment indicated significant reductions in the sea lamprey populations. Off the mouth of the Boyne, 180 sea lampreys were found before treatment but none after treatment; off the mouth of the Jordan, these numbers were 16 before treatment and 1 after treatment.

Estuaries of 15 streams tributary to northern Lake Michigan were surveyed with Bayer 73 granules. Sea lampreys were found in the Bark, Manistique, Menominee, and Rapid rivers. The Bark, Menominee, and Rapid rivers were later treated, and the Manistique River is scheduled for treatment in 1978. No ammocetes were found in the estuary of the Peshtigo River before treatment, but during the posttreatment survey, residual lampreys were found in several small oxbows and at the mouths of small, spring-fed tributaries. A relatively large population of ammocetes found in the marshy estuary of the Rapid River was eliminated during chemical treatment in 1977.

Lake Michigan Chemical Treatments

A total of 37 streams, with a combined flow of 4,056 cfs (measured just before treatment), were treated in 1977 (Table 3, Fig. 3). Ammocetes were abundant in the Platte, Boyne, Jordan, Sturgeon, and Peshtigo rivers but their numbers were moderate to low in the remaining streams.

Treatment problems were minor, except in the Jordan River and Valentine Creek. Heavy rains diluted chemical banks below minimum lethal concentrations and both streams were retreated after stream flow returned to more seasonable levels.

No significant fish mortalities occurred.

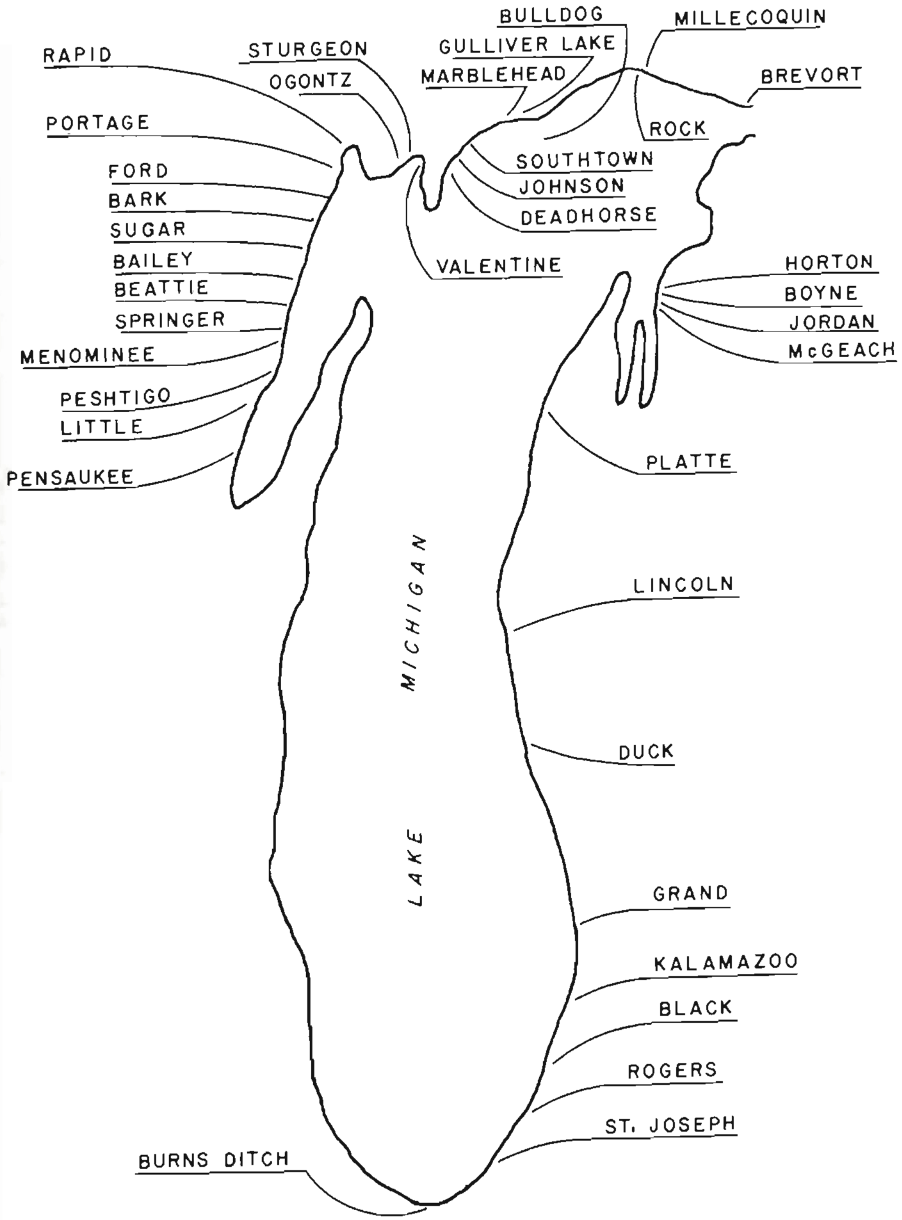

Figure 3. Lake Michigan streams that were treated with lampricides in 1977.

Initial treatments were conducted on Southtown and Duck creeks and the Menominee, Peshtigo, and Paw Paw rivers. Southtown and Duck creeks, which are small, and the Menominee River contained few sea lamprey ammocetes. The Peshtigo River, by comparison, had a large population, of which an estimated 60% were in various stages of transformation. The Paw Paw River, a major tributary of the St. Joseph River, contained a moderate number of ammocetes.

Sea lampreys have spawned in the Peshtigo and Paw Paw rivers for many years, but only since recent pollution control measures became effective have sea lamprey ammocetes managed to survive. The Menominee River has contained sea lamprey ammocetes for many years but survey crews did not consider the population to be large enough to warrant treatment. However, continued high lamprey scarring in Green Bay and nearby areas in Lake Michigan cast doubt on the validity of survey's measure of the sea lamprey population. When the river was treated, ammocete collections substantiated the findings of the survey: very few sea lamprey larvae were collected.

During the treatment of the Peshtigo and Menominee rivers, personnel from the Service's National Fishery Research Laboratory, La Crosse, Wisconsin, gave valuable assistance by installing a new gas chromatograph in an analysis trailer and the subsequent analyses of Bayer 73. They also monitored Bayer 73 concentrations during the treatment of the Peshtigo and Menominee rivers and provided instruction to the treatment crew on analysis techniques. The increased accuracy of the chromatograph will prove valuable in detecting lampricides and preventing them from entering public water supplies.

Lake Huron Surveys

Distributional surveys were completed on 15 Lake Huron tributaries in preparation for chemical treatments. Five were later treated. One of the streams remaining to be treated, the Carp River, contains a large population of sea lamprey larvae.

In surveys for reestablished populations, sea lamprey were found in 32 of the 44 streams examined. Very small numbers of transforming sea lampreys were found in eight streams, of which three—Devils River and Mulligan and Schmidt creeks—were later treated. Young-of-the-year sea lampreys were collected in 14 streams.

In posttreatment surveys on eight streams, residual sea lampreys were found in seven. The residual larvae were most numerous in the East Au Gres, Au Sable, and Ocqueoc rivers, where low water levels, groundwater seepage, and backwater areas created problems during chemical treatments. The Au Sable and Ocqueoc rivers are expected to produce transformed lampreys from these residual populations, although the numbers from each stream should be small.

In resurveys of six untreated streams in the southeastern Lower Peninsula of Michigan which had previously contained sea lampreys, ammocetes were found in three—the Saginaw and St. Clair rivers and Mill Creek. Although adult sea lampreys spawned below Dow Chemical Company's dam at Midland in the Saginaw River system, no sea lamprey ammocetes were found in a survey there. No sea lampreys of the 1977 year class were taken in Bluff Creek or the Chippewa River, which are positive tributaries of the Tittabawassee River above the dam at Midland. Sea lampreys gained access to these tributaries during overtopping of the dam or through a fishway in the dam at Midland. The fishway was closed during the 1977 spawning migration of sea lampreys.

In resurveys of 68 Lake Huron tributaries where sea lampreys had not been taken in the past, larvae were found for the first time in two. A total of 20 ammocetes were taken at 7 of 67 stations on the Pine River in St. Clair County, and 1 was found in Cherry Creek in Sanilac County. The larval distribution in the Pine River is limited to a small portion of the main stream and a tributary. The single ammocete in Cherry Creek came from a beach pool.

In surveys of the deltas of four Lower Peninsula streams, only one sea lamprey ammocete was found (off the mouth of the Ocqueoc River in Hammond Bay).

Sandy, wave-swept, offshore areas in the Upper Peninsula afforded limited larval habitat off most northern Lake Huron streams. However, a substantial number (69) of yearling larvae (41-87 mm long) were collected from the mouth of Albany Creek to a point 150 feet into the lake. Because entremely cold water prevented adequate surveys of the area with Bayer 73 granules, additional surveys will be made to define ammocete distribution. Two age-II larvae (45-59 mm) were also collected off McKay Creek in McKay Bay.

Lake Huron Chemical Treatments

Fourteen streams totaling 423 cfs measured just before treatment) were treated in 1977 (Table 4, Fig. 4). Substantial numbers of large ammocetes and transforming sea lampreys were found in Grace and Mulligan creeks and Swan, Devils, Au Gres, and Pine rivers. These streams were scheduled for treatment in 1976, but the treatments were deferred because the water level was extremely low.

Lake Erie Surveys

Investigations in Lake Erie in 1977 were designed to update information on the distribution and abundance of sea lamprey larvae in streams already known to be infested, and to check for populations in other streams with potential for production of larvae. Of 19 streams examined, sea lampreys were found in 4 (Cattaraugus, Crooked, Raccoon, and Conneaut Creeks), all of which had been positive in past surveys.

Only Conneaut Creek now appears to have a population of any consequence. A total of 127 sea lampreys (38-179 mm long), including 10 recently transformed individuals, were collected from 15 of 28 stations. The upstream limit of distribution on the main stem is about 55 miles above the mouth, and short sections of two tributaries are also infested. Small numbers of larvae were found in Crooked, Raccoon, and Cattaraugus Creeks. The survey on Cattaraugus Creek, however, was cut short by heavy rains and flooding; additional work there is essential.

No sea lampreys were found in the Grand or Sandusky Rivers, although both are classified as positive streams. Ammocetes were found in the lower reaches of the Grand River in 1973, but 25 stations on the main stream and tributaries in 1977 were negative. In the Sandusky River, a single transforming lamprey was captured in a fyke net in 1964, and small numbers of young parasitic-phase lampreys have been taken in

Table 4. Details on the application of lampricide to tributaries of Lake Huron in 1977. [Lampricide used is in pounds of active ingredient.]

			TFM			
			Concentration (ppm)			
Stream	Date	Discharge at mouth (cfs)	Minimum effective	Maximum allowable	Pounds used	Hours applied
Pine River	May 27	120	2.7	8.0	4,004	16
Little Munuscong River	June 9	12	2.5	7.7	330	18
Carlton Creek	June 10	1	5.0	14.0	44	9
Bear Lake Outlet	June 13	1	2.8	8.5	22	10
Prentis Creek	June 13	4	5.2	18.0	110	19
Martineau Creek	June 14	1	4.3	13.2	44	12
Ocqueoc River	Sept. 23	109	5.0	12.0	1,716	12
Grace Creek	Sept. 25	13	3.0	9.0	154	10
Mulligan Creek	Sept. 26	13	3.0	7.0	220	14
Schmidt Creek	Oct. 7	12	5.5	10.0	154	8
Swan River	Oct. 8	61	6.0	13.0	1,342	15
Devils River	Oct. 11	31	8.0	16.0	1,232	16
Au Gres River	Oct. 21	40	7.0	14.0	946	16
Saginaw River						
Bluff Creek	Oct. 25	5	8.0	16.0	220	16
Total	...	423	...	...	10,538	...

Table 4. Details on the application of lampricide to tributaries of Lake Huron in 1977. [Lampricide used is in pounds of active ingredient.]

Stream	Date	Discharge at mouth (cfs)	TFM Concentration (ppm) Minimum effective	Maximum allowable	Pounds used	Hours applied
Pine River	May 27	120	2.7	8.0	4,004	16
Little Munuscong River	June 9	12	2.5	7.7	330	18
Carlton Creek	June 10	1	5.0	14.0	44	9
Bear Lake Outlet	June 13	1	2.8	8.5	22	10
Prentis Creek	June 13	4	5.2	18.0	110	19
Martineau Creek	June 14	1	4.3	13.2	44	12
Ocqueoc River	Sept. 23	109	5.0	12.0	1,716	12
Grace Creek	Sept. 25	13	3.0	9.0	154	10
Mulligan Creek	Sept. 26	13	3.0	7.0	220	14
Schmidt Creek	Oct. 7	12	5.5	10.0	154	8
Swan River	Oct. 8	61	6.0	13.0	1,342	15
Devils River	Oct. 11	31	8.0	16.0	1,232	16
Au Gres River	Oct. 21	40	7.0	14.0	946	16
Saginaw River						
Bluff Creek	Oct. 25	5	8.0	16.0	220	16
Total	...	423	...	...	10,538	...

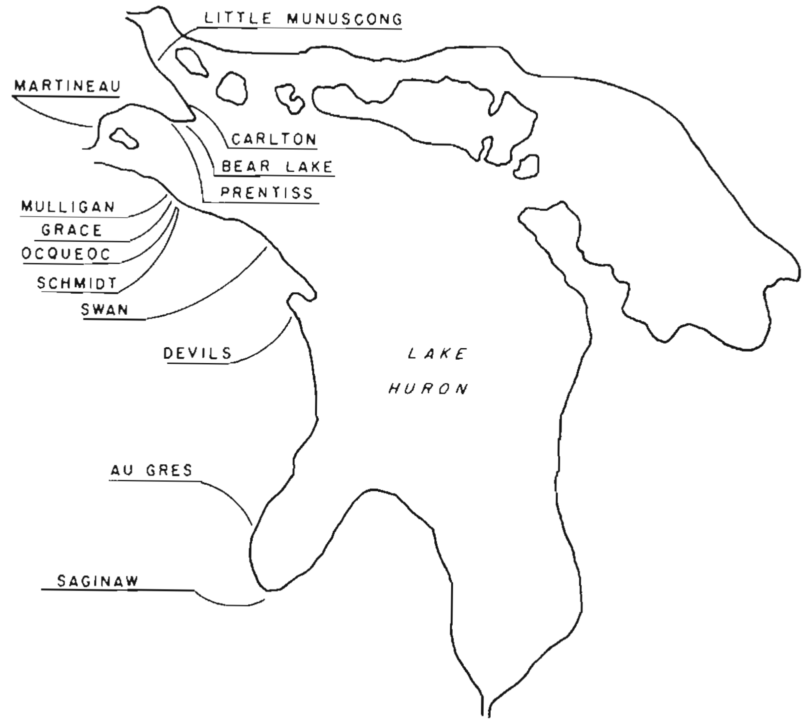

Figure 4. Lake Huron streams that were treated with lampricides in 1977.

recent years by commercial fishermen in Sandusky Bay. Despite these indications of a stream population, no larvae have been collected in the stream by survey crews.

High water forced the cancellation of surveys on several streams, among which were the Buffalo, Ashtabula, Sandusky, and Maumee rivers and Walnut, Elk, and Cattaraugus creeks. These surveys will be given first priority in 1978.

Lake Ontario Surveys

Larval surveys were conducted on streams directly tributary to Lake Ontario and on various parts of the Oswego River system. Fyke nets were also operated at two locations on the Oswego River in the spring to assess the downstream movement of recently transformed lampreys.

In the reexamination of 22 Lake Ontario streams that from previous surveys appeared to have potential for sea lamprey production, larvae were found for the first time in 3. Seventeen larvae (63-91 mm long) were found in the Black River, Jefferson County; 150 larvae and 2 transforming lampreys (24-142 mm) in Ninemile Creek, Oswego County; and 21 larvae (57-141 mm) in Blind Sodus Creek, Cayuga County. On the Black River, a dam about 1-1/4 miles upstream limits the potential in the river itself, but a large protected bay off the mouth may be a problem area and will need to be thoroughly examined. A moderate to large ammocete population is indicated in Ninemile Creek; about 12 miles of the stream will require treatment. The number of larvae in Blind Sodus Creek is relatively small and the upstream limit of distribution is about 5 miles above the mouth.

In the Oswego River drainage, the Oneida River immediately above the dam at Caughdenoy, New York, was checked with Bayer 73 granules and backpack shockers as a possible source for transforming sea lampreys taken in fyke nets at Caughdenoy in 1976-77. However, no larvae were found.

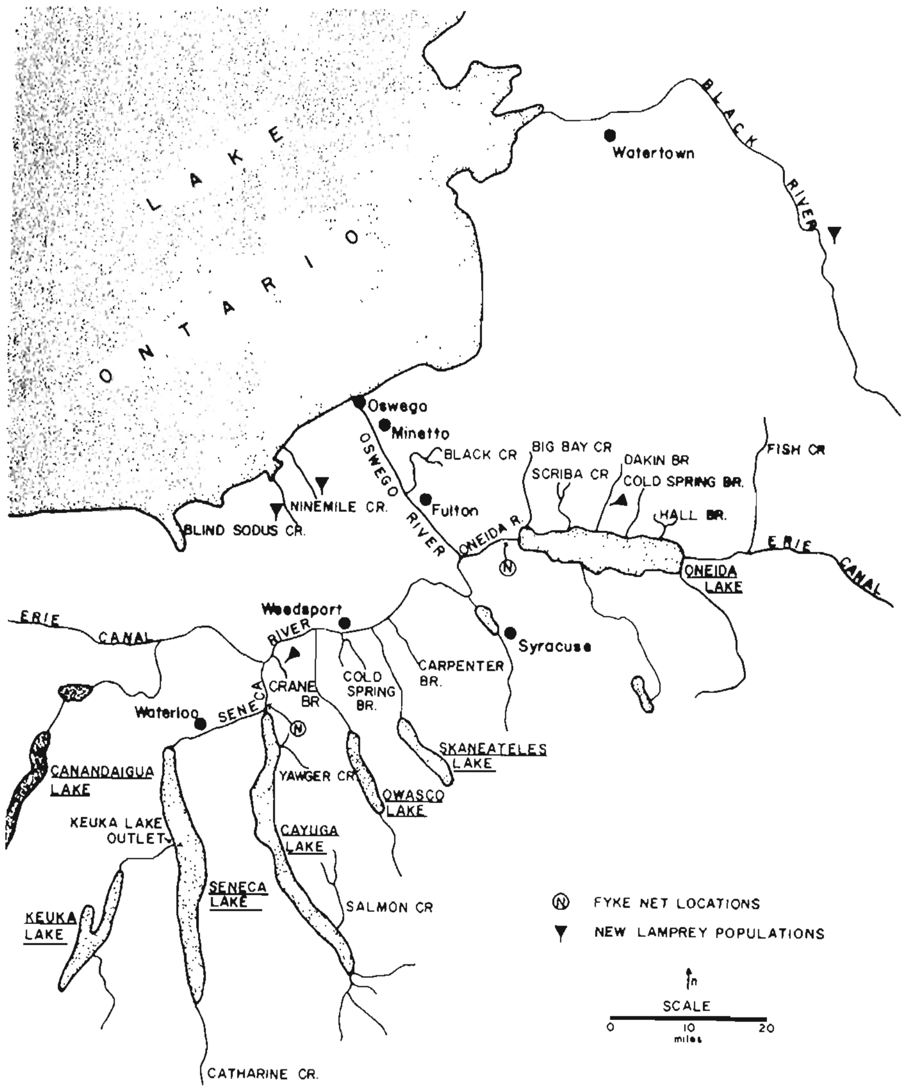

Figure 5. Oswego River system, showing locations of fyke nets in 1977.

Fyke net operations were resumed in the spring at two locations on the Oswego River system to determine if sea lamprey larvae produced in tributaries of Oneida, Cayuga, and Seneca lakes contribute to adult stocks in Lake Ontario (Fig. 5). The nets were fished from March 24 to April 25 at Caughdenoy, which is about 4 miles below the outlet of Oneida Lake, and at Mud Lock, which is at the outlet of the Cayuga-Seneca Lake complex. These two sites had been similarly netted in the fall of 1976.

At Caughdenoy, one adult and six transformed sea lampreys were captured between March 26 and April 6. The Oneida River at this site was at or near flood stage throughout the period and collecting conditions were considered poor. Considering the unfavorable conditions and the fact that only four nets were fished, the six transformed lampreys that were captured may indicate the movement of a significant number of young parasitic-phase lampreys out of Oneida Lake.

No lampreys were taken in seven nets at the outlet of Cayuga Lake, although stream conditions were much more favorable than at Caughdenoy. It appears that the number of young lampreys migrating from Cayuga and Seneca lakes is small.

Pretreatment surveys were completed on five tributaries of the north shore of Oneida Lake, one of the lower Oswego River, and three of the Seneca River. In two streams, Dakin Brook on Oneida Lake and Crane Brook on the Seneca River, sea lamprey larvae had not been found before. Populations in all streams are relatively small except in Big Bay Creek on Oneida Lake, where ammocetes and transforming lampreys are abundant.

No sea lampreys were found in the surveys of eight other Oneida Lake tributaries, including Cold Spring Brook where two transforming lampreys were found in 1973.

Studies of Adult Sea Lampreys

Migrant Sea Lampreys

The number of sea lampreys captured at the eight index barriers on Lake Superior increased in 1977 (Table 5). The total catch was 4,796, compared with 2,098 in 1976 and 4,487 in 1975. The major producer was the weir on the Brule River, which captured 2,572 (54% of the total).

During the past 5 years (1973-77) during which intensified control measures have been in effect, an average of 3,200 sea lampreys were trapped each year at the barriers (Fig. 6). During the previous 5-year period (1968-72), the average was 7,900. These data show about a 60% reduction in the lamprey population since intensification began. For both 5-year periods, the Brule River contributed an average of 30% to the total run; the Amnicon River, 20%; and the Two Hearted River about 18%. The average catch for the 1973-77 period represents a 94% reduction from the 51,000 taken in the eight barriers in 1961.

The assessment weir on the Ocqueoc River on Lake Huron captured 503 adult sea lampreys, compared with 6,937 in 1976 and 1,901 in 1975. Low water levels may have hampered lamprey trapping.

The average length and weight of Lake Superior adults for 1977 were nearly identical with the average length and weight in 1976 (Table 6). For 1977 the figures were 433 mm and 180 g and in 1976, 430 mm and 181 g.

Table 5. Number of adult sea lampreys taken at electric barriers operated in eight tributaries of Lake Superior through July 13, 1961-77.

Year	Betsy	Two Hearted	Sucker	Chocolay	Iron	Silver	Brule	Amnicon	Total
1961	1,366	7,498	3,209	4,201	2,430	5,052	22,478	4,741	50,975
1962	316	1,757	474	423	1,161	267	2,026	879	7,303
1963	444	2,447	698	358	110	760	3,418	131	8,366
1964	272	1,425	386	445	178	593	6,718	232	10,249
1965	187	1,265	532	563	283	847	6,163	700	10,540
1966	65	878	223	260	491	1,010	226	938	4,091
1967	57	796	166	65	643	339	364	200	2,630
1968	78	2,132	658	122	82	1,032	2,657	148	6,909
1969	120	1,104	494	142	556	1,147	3,374	1,576	8,513
1970	87	1,132	337	291	713	321	167	1,733	4,781
1971	104	1,035	485	53	1,518	340	1,754	4,324	9,613
1972	146	1,507	642	294	280	2,574	4,121	132	9,696
1973	294	894	468	270	16	495	261	149	2,847
1974	201	489	249	17	1	117	568	270	1,912
1975	197	683	478	24	8	206	285	2,606	4,487
1976	148	229	314	10	33	199	1,085	80	2,098
1977	162	654	533	4	66	312	2,572	493	4,796

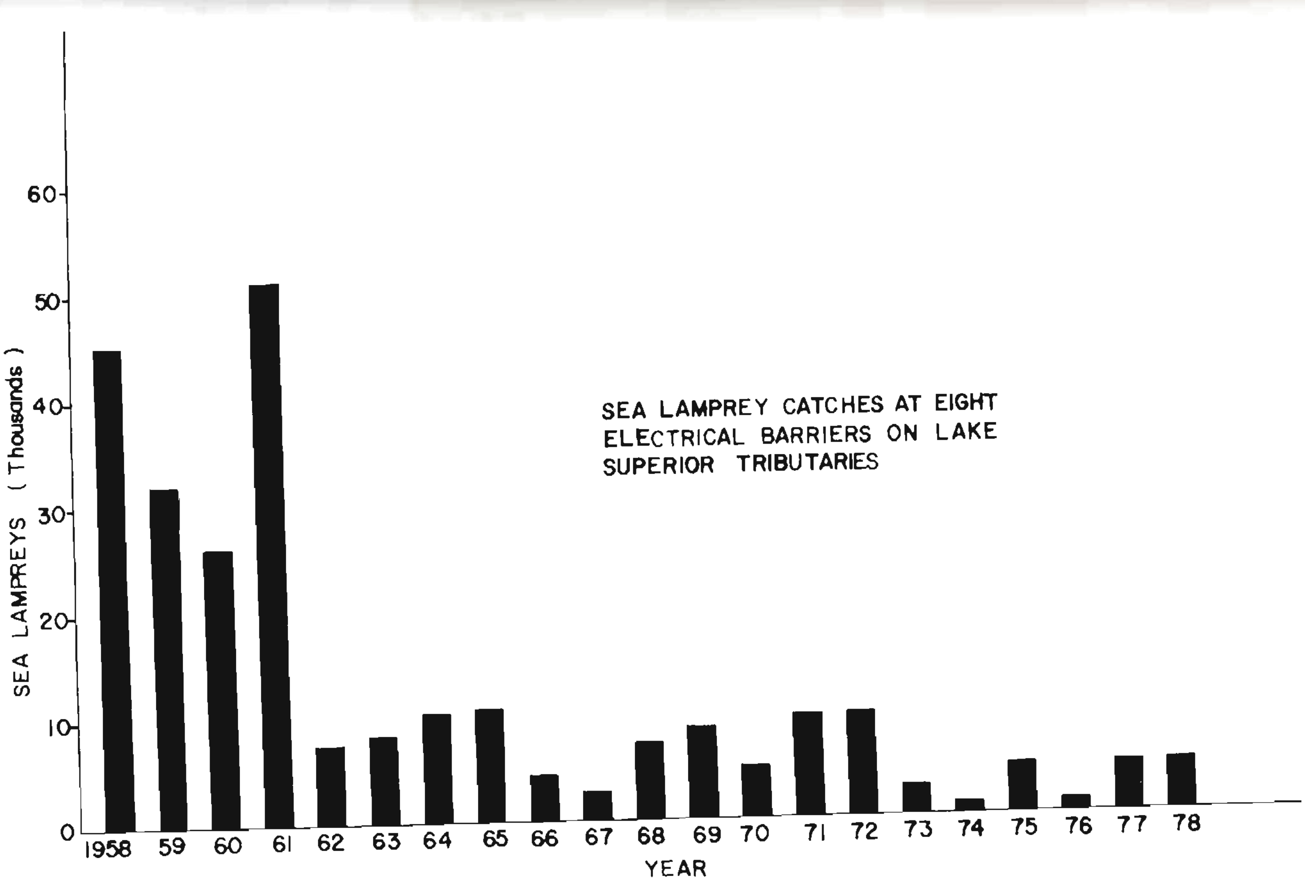

Figure 6. Reduction of sea lamprey catches at eight electrical barriers in Lake Superior tributaries.

Table 6. Average lengths and weights of sea lampreys and percentage of males from index streams of Lake Superior, 1954-77.

Year	Number in sample	Average length (mm)	Average weight (g)	Percentage males
1954	2,381	458	220	57
1955	5,736	438	195	53
1956	9,265	451	202	56
1957	10,305	433	174	66
1958	12,542	426	165	57
1959	14,421	431	167	58
1960	11,906	414	147	68
1961	18,201	409	136	67
1962	6,581	431	159	69
1963	7,221	426	160	66
1964	6,706	422	155	56
1965	7,680	431	164	52
1966	3,797	410	146	42
1967	2,217	421	168	33
1968	5,874	421	161	32
1969	6,498	419	164	27
1970	4,009	431	176	35
1971	7,060	449	190	31
1972	8,032	443	192	31
1973	2,663	421	161	31
1974	1,749	432	170	30
1975	3,407	436	186	31
1976	1,904	430	181	29
1977	4,065	433	180	29

The percentage of male sea lampreys in Lake Superior has stabilized between 29 and 31% for the past 7 years (1971-77). In 1977, the sex ratio was 29% males (Table 6).

The percentage of spawning-run rainbow trout bearing scars or wounds increased from 1.1 in 1976 to 3.4 in 1977. The number of rainbow trout examined also increased from 1,089 in 1976 to 1,404 in 1977, approximating the 1971-76 average of 1,430.

The number of white suckers handled at the index weirs was 9,471 which is above the 1971-1976 average of 8,203. The number of longnose suckers taken--5,006--is less than half the 1971-76 average of 10,155.

Preliminary testing in 1975-76 demonstrated that hardware cloth traps, 2 feet wide, 4 feet long, and 1-1/2 feet high, are effective in capturing adult lampreys when placed in strategic locations below dams and natural barriers where the adults congregate during their spawning migration. A program to determine the feasibility of small, mechanical traps as a means of assessing spawning sea lamprey populations and to locate suitable areas for their operation was continued by fishing 43 traps on 32 tributary rivers of the upper Great Lakes (Fig. 7). Lampreys were captured in 13 of the rivers (Table 7).

Traps in 11 Lake Superior tributaries caught 710 sea lampreys from 4 streams. Catches from the Rock River were 477 in 1977 compared with

498 in 1976 and 377 in 1975. However, population estimates (based on the capture of marked lampreys) indicate that the numbers of lampreys have increased in the past 2 years. The population estimate was 566 ± 112 for 1975, 635 ± 121 in 1976, and 876 ± 56 in 1977. This information agrees with data collected from three of the four nearest assessment barriers. The size of 218 lampreys captured in the traps in 1977 averaged 415 mm and 168 g, and 30.7% were males, as compared with 412 mm, 170 g, and 36.1% for 307 lampreys from three rivers of central Lake Superior with electrical assessment barriers (Chocolay, Iron, and Silver). Capture of sea lampreys in the Big Garlic River (30) was substantially lower than in 1976 (90). Population estimates for the river show a corresponding decrease from 261 ± in 1976 to 105 ± 23 in 1977. The catch below the falls on the Tahquamenon River (170) indicated that this is a usable assessment site. Although capture of lampreys on the Otter River (33) nearly doubled over 1976 (18), problems with a fishway require further experimentation to increase the recovery rate.

Traps were also operated below barriers above the electrical weirs on five of the eight assessment rivers on Lake Superior (Table 8). To determine the trapping effectiveness at each site, a portion of the lampreys taken in the weirs were fin-clipped and released upstream. Continuing assessment with mechanical traps appears favorable for the Iron and Betsy rivers, where 83 and 15%, respectively, of the sea lampreys released above the weirs were recaptured.

Figure 7. Location of streams tributary to the Upper Great Lakes in which small, mechanical traps were fished to assess populations of spawning sea lampreys in 1977.

Table 7. Number of adult sea lampreys captured in experimental mechanical traps, and the number fin-clipped, released, and recaptured in rivers tributary to the upper Great Lakes in 1977.

Lake and river	Dates of operation of traps	Number of sea lampreys captured	Fin-clipped sea lampreys		
			Number released	Total recaptured	Percentage recaptured
Lake Superior					
Tahquamenon	5/17-8/11	170	169	24	14
Rock	5/11-8/30	477	384	209	54
Big Garlic	5/13-8/19	30	28	8	29
Sturgeon Otter	5/19-7/1	33	25	2	8
Total		710	606	243	40
Lake Michigan					
Manistique	5/23-6/21	3,273	1,424	215	15
Menominee	5/5-5/20	714	375	128	34
Peshtigo	4/28-5/20	644	488	179	37
Oconto	4/28-5/17	7	6	0	0
Ahnapee	4/27-5/18	1	1	1	100
East Twin	4/26-5/18	21	21	3	14
Total		4,660	2,315	526	23
Lake Huron					
St. Marys	7/5-8/17	[a]1,419	1,229	258	21
Cheboygan	5/17-6/6	3,360	1,064	435	41
Trout	4/25-6/24	39	39	2	5
Total		4,818	2,332	695	30

[a]Includes 52 sea lampreys captured in dip nets.

Mechanical traps on western Lake Michigan tributaries from Sheboygan, Wisconsin, to Manistique, Michigan, collected 4,660 adult sea lampreys from 6 of 12 rivers. Sizable runs entered the Peshtigo, Menominee and Manistique rivers; respective population estimates were 1,755 ± 132, 2,092 ± 194, and 19,425 ± 3,153 lampreys. Males made up about 45% of the population in these rivers. The three rivers all have sites which lend themselves to efficient trapping and, with few minor alterations, will be established as assessment sites. Although 21 lampreys were captured from the East Twin River, completion of the barrier at Mishicot, Wisconsin, is essential before the location can be given further consideration as an assessment site.

Traps on Lake Huron were limited to the Cheboygan and Trout rivers (maintained through assistance by personnel of the Hammond Bay Biological Station) and the St. Marys River. Operations on the Cheboygan River were conducted during four evenings (dusk to dawn) during which the mechanical trap was serviced every 15 minutes. Average capture rates for an evening ranged from 1.1 to 9.2 lampreys per minute; 1,890 were collected in one evening during the peak run. Average lengths and weights of 392 of the lampreys were 462 mm and 210 g; 32.1% were

Table 8. Number of adult sea lampreys captured at electrical barriers that were fin-clipped and released, and the total number (marked and unmarked) recaptured in experimental mechanical traps in tributaries of Lake Superior in 1977.

River	Dates of operation of traps	Fin-clipped sea lampreys			Unmarked sea lampreys captured	Total in collection
		Number released	Total recaptured	Percentage recaptured		
Betsy	5/16-6/10	31	25	83	24	49
Iron	6/4-7/11	46	7	15	0	7
Silver	6/22-7/22	27	0	0	1	1
Brule	5/23-7/26	100	0	0	0	0
Amnicon	6/7-7/26	39	1	3	0	1

males. Based on a mark-recapture study, the spawning population was estimated at 8,218 ± 436 animals.

Traps below the U.S. Army Corps of Engineers No. 10 powerhouse on the St. Marys River captured 1,367 lampreys, and 52 were dip-netted after dark. All lampreys were marked with consecutively numbered Floy tags and released. Although the total number captured (1,419) was larger than in 1976 (1,198), population estimates (considering the relation between time of tagging and time recovery) were 10,964 ± 1,081 for 1976 as opposed to 7,104 ± 792 for 1977--a decrease of 35%. Average lengths and weights of 348 lampreys in 1977 were 468 mm and 231 g (55.2% males) compared with 465 mm and 258 g (42.4% males for 332 lampreys in 1976.

Parasitic Sea Lampreys

The collection of parasitic-phase sea lampreys taken by fishermen from Lakes Superior, Michigan, Huron, and Erie continued in 1977 (Table 9). Collections were discontinued in Lake Michigan statistical districts MM-5, MM-6, MM-7, and MM-8 and Lake Huron district MH-4 because commercial fishing activity had decreased and few sea lampreys had been collected in these districts in past years. The 1977 collections are incomplete because records of lampreys taken during the late fall are usually not available until fishing resumes in the spring.

A total of 257 sea lampreys were taken by Lake Superior commercial and sport fishermen, of which 133 (52%) were taken in Wisconsin. The collections included only 19 recently metamorphosed parasitic-phase sea lampreys (which are usually less than about 200 mm long). A smelt fishery at the mouth of the Pigeon River collected 38 spawning-phase sea lampreys in the spring. The barrier catch and the catch per unit of effort of parasitic-phase sea lampreys captured in gill nets were significantly correlated at the 5% level of probability (r=0.829).

Lake Michigan fishermen collected 1,485 sea lampreys in 1977, of which 68% were taken from the three statistical districts in Green Bay: the Garden, Michigan, area (MM-1) produced 248; the Gills Rock, Wisconsin, area (WM-2), 515; and the Pensaukee, Wisconsin, area (WM-1), 252. Fishermen of the Gills Rock area contibuted 225 (79%) of the parasitic-phase sea lampreys 200 mm long or less. Sea lampreys captured from the Algoma, Wisconsin, area (WM-4) were 78% spawning-phase

Table 9. Number of parasitic-phase sea lampreys and (in parentheses) the number of spawning-phase sea lampreys collected in commercial and sport fisheries, by lake statistical district, 1972-77. Collections for 1977 are incomplete. A zero (0) indicates sampling effort with negative results and a dash (-) indicates no effort.

District[1] and length (mm)	1972		1973		1974		1975		1976		1977		Total 1972-77	
LAKE SUPERIOR														
M-1														
200 or less	0		0		-		-		-		-		0	
> 200	3	(2)	3		-		-		-		-		6	(2)
M-2														
200 or less	0		0		0		0		0		0		0	
> 200	16	(7)	13	(16)	3	(1)	14		8		6		60	(24)
M-3														
200 or less	1		0		0		0		1		0		2	
> 200	7		9	(1)	7		12		13		5	(38)	53	(39)
Wisc.														
200 or less	3		4		6		0		2		2		17	
> 200	232	(2)	199	(1)	117		97	(2)	81	(1)	126	(5)	852	(11)
MS-2														
200 or less	0		0		1		0		1		2		4	
> 200	8	(2)	5	(1)	4	(1)	11	(1)	1		2		31	(5)
MS-3														
200 or less	11		6		8		12		4		6		47	
> 200	29		61		17		27		16		22		172	
MS-4														
200 or less	1		1		3		1		2		2		10	
> 200	121	(3)	74	(1)	45		13		20		12	(1)	285	(5)
MS-5														
200 or less	0		0		0		0		0		0		0	
> 200	5		2		2		0		2		1		12	
MS-6														
200 or less	2		6		3		1		0		7		19	
> 200	13		7		9		7		16		20		72	
Total														
200 or less	18		17		21		14		10		19		99	
> 200	434	(16)	373	(20)	204	(2)	181	(3)	157	(1)	194	(44)	1,543	(86)
LAKE MICHIGAN														
MM-1														
200 or less	1		12		7		2		15		35		72	
> 200	46		99	(1)	40	(4)	37	(9)	94	(11)	201	(12)	517	(37)
MM-2														
200 or less	1		7		12		1		2		0		23	
> 200	9		3		5		19	(1)	12	(1)	0		48	(2)
MM-3														
200 or less	22		13		4		10		4		7		60	
> 200	104	(2)	71		59		68		35	(2)	40		377	(4)
MM-5														
200 or less	10		4		7		1		1		-		23	
> 200	8	(4)	6	(2)	7		4		3		-		28	(6)
MM-6														
200 or less	0		0		1		0		0		-		1	
> 200	0		1		0		2		0		-		3	
MM-7														
200 or less	0		0		0		0		0		-		0	
> 200	0		1		1		0		0		-		2	

District[1] and length (mm)	1972	1973	1974	1975	1976	1977	Total 1972-77
MM-8							
200 or less	2	0	1	1	0	-	4
> 200	1	1	1	1	0	-	4
WM-1							
200 or less	5	1	1	0	1	8	16
> 200	31 (40)	37 (8)	38 (14)	33 (8)	41 (4)	233 (11)	413 (85)
WM-2							
200 or less	144	91	107	15	24	225	606
> 200	432	258	250	187	98	290	1,515
WM-3							
200 or less	6	3	1	0	3	6	19
> 200	108	47	29	20	38	116	358
WM-4							
200 or less	3	1	1	1	1	4	11
> 200	27 (160)	56 (42)	54 (80)	77 (107)	25 (86)	61 (235)	300 (710)
WM-5							
200 or less	5	5	2	0	0	0	12
> 200	11	13	19	3	7	0 (1)	53 (1)
WM-6							
200 or less	2	-	-	-	-	-	2
> 200	0	-	-	-	-	-	0
Total							
200 or less	201	137	144	31	51	285	849
> 200	777 (206)	593 (53)	503 (98)	451 (125)	353 (104)	941 (259)	3,618 (845)

LAKE HURON

MH-1							
200 or less	2	0	0	5	3	48	58
> 200	88	31	10	111	120	220	580
MH-3							
200 or less	4	-	-	-	-	-	4
> 200	5	-	-	-	-	-	5
MH-4							
200 or less	0	0	0	0	1	-	1
> 200	21	8	12	24 (3)	6 (3)	-	71 (6)
Total							
200 or less	6	0	0	5	4	48	63
> 200	114	39	22	135 (3)	126 (3)	220	656 (6)

[1] Boundaries are defined in "Fishery Statistical Districts of the Great Lakes," by S. H. Smith, H. J. Buettner and R. Hile, Great Lakes Fishery Commission Technical Report No. 2, 1961. Lampreys were not collected from the fishermen in Lake Superior district MS-1; Lake Michigan districts MM-4, Illinois, or Indiana; or Lake Huron districts MH-2, MH-5, or MH-6.

Table 10. Tributaries of Lake Superior with reestablished populations of sea lampreys and the number collected per hour with an electric shocker. B indicates the presence of a year class recovered with Bayer 73.

Stream	Date of last treatment	Year classes present			
		1974	1975	1976	1977
Pendills Creek	7/27/73	0	4	2	0
Grants Creek	7/21/63	0	0	1	0
Ankodosh Creek	7/26/73	3	0	0	0
Tahquamenon River	10/3/76				4
Betsy River	8/22/74		41	24	21
Little Two Hearted River	7/24/75			1	0
Two Hearted River	7/26/75			42	1
Sable River	9/7/73	0	0	0	32
Seven Mile Creek	7/19/67	0	0	2	0
Beaver Lake Outlet	9/3/77				[a]1
Deer Lake Outlet	8/13/70	0	0	1	0
Little Garlic River	10/3/74		66	19	4
Iron River	8/9/72	B	B	2	0
Salmon Trout River (Marquette County)	6/11/75		60	105	48
Huron River	9/21/74		25	43	46
Sturgeon River	8/13/76			20	46
Traverse River	10/1/75			46	1
Little Gratiot River	8/6/72	2	0	0	0
Big Gratiot River	10/7/75			0	2
Salmon Trout River (Houghton County)	10/17/74		95	163	46
Elm River	9/10/64	0	0	2	0
Misery River	10/17/74		14	31	2
East Sleeping River	9/17/75			3	10
Ontonagon River	6/26/75			18	0
Potato River	9/15/77				[a]4
Sand River	10/16/64	8	0	0	0
Brule River	7/9/77				[a]1
Amnicon River	6/15/75		6	0	6
Nemadji River	7/29/76		11	11	24
Number of streams		4	10	19	18

[a]Residual lampreys.

Table 11. Percentage of sea lamprey ammocetes of the 1960 year class that transformed while confined in a cage or aquarium at three locations. [Average water temperature (°C) from mid-May to July 31 shown in parentheses.]

Location	1974	1975	1976	1977
Lake Superior	5	10	8	10
	(7)	(11)	(11)	(10)
Big Garlic River	46	51	76	63
	(14)	(16)	(14)	(16)
Aquarium	75	84	100	95
	(20)	(21)	(20)	(21)

adults. The Peshtigo River may have been the source of the parasitic-phase sea lampreys that caused a significant increase in the number collected in Green Bay in 1977. A high percentage of the lampreys collected during the chemical treatment of the Peshtigo River were in various stages of transformation. Sea lamprey production began in the Peshtigo River in the early 1970's, when the water treatment plant at Peshtigo, Wisconsin, began operation.

Lake Huron fishermen captured 268 sea lampreys in 1977 from the De Tour, Michigan, area (MH-1), including 48 parasitic-phase sea lampreys 200 mm long or less. The number of parasitic-phase sea lampreys collected in 1977 is a significant increase over that of the past two years and probably reflects the lack of lamprey control in the St. Marys River.

One Lake Erie commercial fisherman collected three sea lampreys from Sandusky Bay (Ohio statistical district O-1, not shown in Table 9).

Ammocete Studies

Studies have been conducted each fall since 1960 at selected index stations in Lake Superior tributaries to determine the presence of young-of-the-year sea lampreys. The number of infested streams declined from 42 in 1973 to 37 in 1974 and remained at 36 the following two years. Lampreys of the 1977 year class have been recovered from 23 streams, but 10 streams had not yet been surveyed. This year class was later eliminated, by chemical treatments, from five streams (Sucker, Big Garlic, and Bad rivers and Furnace and Harlow creeks), but survived treatment in the resistant stage of their embryonic development in three streams (Potato and Brule rivers and Beaver Lake Outlet). Table 10 shows the status of the remaining reestablished populations in Lake Superior tributaries. Yearling larvae collected in the Elm River and Deer Lake Outlet represented the first infestation since 1964 and 1968, respectively.

A study of the rate of transformation of larvae in three locations was continued for the fourth year (Table 11). Known-age ammocetes of the 1960 year class collected in the downstream trap of the Big Garlic River each spring were used as test animals at each location.

Ammocetes were caged in Lake Superior at a depth of 35 feet, in a backwater area of the Big Garlic River, and in an aquarium at the Marquette Station. Results of the 1977 study, as in previous years, show the lowest transformation rate (10%) in Lake Superior (approximately 11°C) and the highest (95%) in the aquarium (approximately 20°C).

Of 18 larvae that were introduced in Lake Superior in 1976 and failed to metamorphose, 6 (33%) transformed in 1977. The group introduced in 1975 that failed to metamorphose and were observed an additional year, transformed at a rate of 44% (16 of 36). These data suggest that ammocetes that migrate into Lake Superior in the spring transform at low rates during their first summer, but acclimatization for a year results in much higher transformation rates. These data further show that the transformation rates of ammocetes retained in aquaria at water temperatures of 20°C transform at higher rates than those held at lower temperatures in a stream or lake.

APPENDIX D

SEA LAMPREY CONTROL IN CANADA

J. J. Tibbles, S. M. Dustin and B. G. H. Johnson
Fisheries and Marine Service
Department of Fisheries and Environment

This report summarizes the activities of the Canadian sea lamprey control program during the period April 1, 1977 to March 31, 1978, in compliance with a Memorandum of Agreement between the Department of Fisheries and Environment and the Great Lakes Fishery Commission. The Department acts as agent for the Commission with respect to the Canadian portion of the sea lamprey control program, which is conducted by the Department's Sea Lamprey Control Centre located at Sault Ste. Marie, Ontario. In addition to treating the Canadian tributaries of the Great Lakes, this Centre has accepted responsibility for treating streams on the United States side of Lake Ontario.

The sea lamprey control program consists essentially of four types of activity: assessment, treatment, survey and biological investigation. The assessment of sea lamprey runs is accomplished by means of electrical barriers, mechanical weirs and traps; treatments of streams and other bodies of water require the controlled application of selective toxicants; surveys for larval lampreys (ammocetes) are carried out with the use of electricity or chemicals; while biological studies are focused upon the distribution, movement, abundance, and growth of sea lamprey.

Electrical Barrier, Weir and Trap Operations

The electrical barriers operated on five Canadian tributaries of Lake Huron to assess their sea lamprey runs captured a total of 1,020 sea lamprey—more than double the figure for the previous year (see Table 1). Because the increase is mainly attributable to the Blue Jay River, there appears to be no widespread increase in sea lamprey abundance in Lake Huron as a whole. Examination of specimens for size, sex and maturity revealed no significant differences from the values obtained in the previous year.

Mechanical weirs were installed and operated on Cypress and Sable rivers (Lake Superior) and Graham Creek (Lake Ontario). They captured 13, 14 and 90 spawning-phase sea lamprey respectively. Box traps made of metal framing covered with hardware cloth were set in two Lake Huron tributaries (including St. Marys River) and in five Lake Ontario streams. In total, the first two captured 44, and the last five captured 319 spawning-phase sea lamprey.

Table 1. Numbers of sea lamprey taken at electrical assessment barriers, Lake Huron, from 1972 to 1977 inclusive.

Stream	Count for the season					
	1972	1973	1974	1975	1976	1977
North Channel Area						
Kaskawong	207	135	146	168	187	184
Georgian Bay Area						
Still	426	14	10	28	48	1
Naiscoot	2	0	0	0	0	0
Harris	472	8	1	8	13	31
Subtotal	900	22	11	36	61	32
Lake Huron Area						
Blue Jay	380	22	61	127	213	804
Total	1,487	179	218	331	461	1,020

Stream Surveys

In total, 65 streams and embayments in the Lake Superior drainage were surveyed by means of electro-shocking or granular Bayer 73. Routine surveys of 34 streams revealed no new sources of sea lamprey larvae. In addition, there were 15 reestablishment, 4 distribution, and 11 treatment-evaluation surveys, and one population study carried out on Lake Superior streams.

On Lake Huron 39 tributaries were surveyed; some of them more than once. These included 14 routine surveys (in which no new sources of sea lamprey larvae were found), 11 reestablishment surveys, 10 distribution surveys, 6 treatment-evaluation surveys and 4 population studies.

On the Canadian side of Lake Ontario 18 streams were surveyed. The single routine survey performed gave negative results. Re-establishment surveys were made on four streams, distribution surveys on seven, and treatment-evaluation surveys on six streams. Population studies were conducted on five streams.

On the United States side of Lake Ontario 16 reestablishment surveys, two distribution surveys and two treatment-evaluation surveys were carried out.

Five streams, previously known to have contained sea lamprey, on the Canadian side of Lake Erie were surveyed. Sea lamprey were found in all except the Grand River, although in some cases their numbers were small.

In addition to the foregoing, granular Bayer 73 was applied to selected portions of tributary systems and embayments of Lake Superior. These included the mouths of Mackenzie River and Stillwater Creek, the estuary of Nipigon River, and parts of the Steel River and Mountain Bay off the Gravel River. Applications were also made in Batchawana Bay off the mouths of several sea lamprey streams.

Lampricide Treatments

On Lake Superior all of the nine streams scheduled were treated. These were West Davignon, Goulais, Chippewa, Stokely, Batchawana, Pancake, Big Carp, Jackfish and Kaministikwia rivers.

On Lake Huron six of the eight streams scheduled were treated. These were Root, Garden, Echo, Mindemoya, Blue Jay and Manitou rivers. Silver Lake Creek was postponed indefinitely due to an absence of sea lamprey, and Kaboni Creek was postponed due to low flow.

On the Canadian side of Lake Ontario seven of the nine schedule treatments were completed. These were Ancaster, Bronte, Farewell, Wilmot, Graham and Shelter Valley creeks and Credit River. Bowmanville Creek and Cobourg Brook were postponed because of insufficient time.

On the United States side of Lake Ontario two of the four scheduled stream treatments were completed. These were on South Sandy and Sodus creeks. Excessive rainfall forced the postponement of treatments of Sage Creek and Little Salmon River.

Details of the above-mentioned treatments are summarized in Tables 2, 3, 4 and 5.

Sea Lamprey from Commercial Fishermen

In response to the offer of a reward payable to commercial fishermen on the Great Lakes for the collection of predatory sea lamprey and related catch information, we received 264 specimens caught in 1976 and 178 caught in 1977. The incidental catch of sea lamprey in offshore fishing gear continues to be characterized by a predominance of females. The tendency for smaller lamprey to be associated with small mesh nets, and larger lamprey with large mesh nets, remains in evidence.

Sea Lamprey from Humber River, Lake Ontario

For the second consecutive year the number of sea lamprey captured by the individual who nets sea lamprey under contract in the Humber River has declined significantly. The 1977 catch of 1,601 sea lamprey was less than half of the 1976 catch. Examination of the specimens for length, weight and sex ratios revealed no significant changes in these statistics from those of previous years.

Trawling for Adult Sea Lamprey in St. Marys River and in Lake Ontario

The annual assessment of the adult sea lamprey population in St. Marys River by trawling at the outflow of the Edison Sault Electric Company hydropower plant in Sault Ste. Marie, Michigan, was repeated in the fall of 1977. A total of 44 sea lamprey was taken. This is not significantly different from the catch rates observed in the two previous years (Table 6).

Table 2. Summary of streams treated with lampricide, Lake Superior, 1977.

Stream No.	Stream Name	Date	Flow cms	Flow cfs	TFM lbs.act. ingr.	Bayer 73 lbs.act. ingr.	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream treated km	Approx. stream treated miles
S-2	West Davignon	May 25-27	0.2	7	125	-	-	Moderate	9.7	6.0
S-24	Goulais	June 1-10	11.2	400	2,653	24	107	Abundant	137.6	85.5
S-48	Chippewa	June 14-15	2.5	91	415	7	-	Scarce	2.9	1.8
S-36	Stokely	June 16-18	0.2	7	141	-	-	Moderate	10.9	6.8
S-52	Batchawana	June 20-23	7.7	275	1,458	21	95	Scarce	14.5	9.0
S-56	Pancake	June 27-29	1.6	57	405	-	-	Moderate	14.3	8.9
S-5	Big Carp	July 5-6, Aug. 3-6	0.22	8	260	-	-	Moderate	10.0	6.2
S-385	Jackfish	July 11-12	6.2	222	1,211	15	18	Moderate	10.6	6.6
S-572	Kaministikwia	July 18-20	34.7	1,240	8,026	124	20	Moderate	38.6	23.8
Total			64.5	2,307	14,694	191	240		248.9	154.6

Table 3. Summary of streams treated with lampricide, Lake Huron, 1977.

Stream No.	Stream Name	Date	Flow cms	Flow cfs	TFM lbs. act. ingr.	Bayer 73 lbs. act. ingr.	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream treated km	Approx. stream treated miles
H-4	Garden	June 10-13	6.9	246	1,779	15	57	Moderate	59	36.7
H-10	Echo	June 8-12,20-24	0.68	24	469	-	3	Moderate	40.7	25.3
H-305	Mindemoya	June 7, 8	0.96	34	425	3	2	Scarce	8.5	5.3
H-314	Blue Jay	July 9-11	0.42	15	286	2	4	Moderate	10.1	6.3
H-313	Manitou	July 11	1.41	50	537	4	-	Scarce	3.2	2.0
H-3	Root	July 18-20	2.28	84	406	-	-	Moderate	30.6	19.0
Total			12.7	453	3,902	24	66		152.1	94.6

Table 2. Summary of streams treated with lampricide, Lake Superior, 1977.

Stream No.	Stream Name	Date	Flow cms	Flow cfs	TFM lbs.act. ingr.	Bayer 73 lbs.act. ingr.	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream treated km	Approx. stream treated miles
S-2	West Davignon	May 25-27	0.2	7	125	-	-	Moderate	9.7	6.0
S-24	Goulais	June 1-10	11.2	400	2,653	24	107	Abundant	137.6	85.5
S-48	Chippewa	June 14-15	2.5	91	415	7	-	Scarce	2.9	1.8
S-36	Stokely	June 16-18	0.2	7	141	-	-	Moderate	10.9	6.8
S-52	Batchawana	June 20-23	7.7	275	1,458	21	95	Scarce	14.5	9.0
S-56	Pancake	June 27-29	1.6	57	405	-	-	Moderate	14.3	8.9
S-5	Big Carp	July 5-6, Aug. 3-6	0.22	8	260	-	-	Moderate	10.0	6.2
S-385	Jackfish	July 11-12	6.2	222	1,211	15	18	Moderate	10.6	6.6
S-572	Kaministikwia	July 18-20	34.7	1,240	8,026	124	20	Moderate	38.6	23.8
Total			64.5	2,307	14,694	191	240		248.9	154.6

Table 3. Summary of streams treated with lampricide, Lake Huron, 1977.

Stream No.	Stream Name	Date	Flow cms	Flow cfs	TFM lbs. act. ingr.	Bayer 73 lbs. act. ingr.	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream treated km	Approx. stream treated miles
H-4	Garden	June 10-13	6.9	246	1,779	15	57	Moderate	59	36.7
H-10	Echo	June 8-12,20-24	0.68	24	469	-	3	Moderate	40.7	25.3
H-305	Mindemoya	June 7, 8	0.96	34	425	3	2	Scarce	8.5	5.3
H-314	Blue Jay	July 9-11	0.42	15	286	2	4	Moderate	10.1	6.3
H-313	Manitou	July 11	1.41	50	537	4	-	Scarce	3.2	2.0
H-3	Root	July 18-20	2.28	84	406	-	-	Moderate	30.6	19.0
Total			12.7	453	3,902	24	66		152.1	94.6

Table 4. Summary of streams treated with lampricide on the Canadian side of Lake Ontario, 1977.

Stream No.	Stream Name	Date	Flow cms	Flow cfs	TFM lbs. act. ingr.	Bayer 73 lbs. act. ingr.	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream km treated	Approx. stream miles treated
0-60	Ancaster	April 29-30	0.40	14	389	-	-	Scarce	12.1	7.5
0-125	Farewell	May 2-4	0.51	18	397	-	-	Moderate	15.4	9.6
0-76	Bronte	May 3-5	3.68	130	2,192	15	4	Moderate	35.6	22.1
0-133	Graham	May 5-7	0.51	18	408	-	21	Moderate	19.3	12.0
0-92	Credit	May 6-7	6.22	220	2,463	18	-	Moderate	15.4	9.6
0-132	Wilmot	May 10-11	0.79	28	687	-	14	Moderate	19.3	12.0
0-157	Shelter Valley	May 10-12	0.65	23	776	-	15	Abundant	18.1	11.2
Total			12.8	451	7,312	33	54		84.0	135.0

Table 5. Summary of streams treated with lampricide, Lake Ontario, New York State, 1977.

Stream No.	Stream Name	Date	Flow cms	Flow cfs	TFM lbs. act. ingr.	Bayer 73 lbs. act. ingr.	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream km treated	Approx. stream miles treated
NY-0-45	South Sandy	Sept. 12-14	2.1	75	485	-	-	Moderate	10.9	6.8
NY-0-84	Sodus	Sept. 16,18-19	0.28	10	231	-	-	Moderate	4.1	2.5
Total			2.4	85	716	-	-		15.0	9.3

Table 4. Summary of streams treated with lampricide on the Canadian side of Lake Ontario, 1977.

Stream No.	Stream Name	Date	Flow cms	Flow cfs	TFM lbs. act. ingr.	Bayer 73 lbs. act. ingr.	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream km treated	Approx. stream miles treated
0-60	Ancaster	April 29-30	0.40	14	389	-	-	Scarce	12.1	7.5
0-125	Farewell	May 2-4	0.51	18	397	-	-	Moderate	15.4	9.6
0-76	Bronte	May 3-5	3.68	130	2,192	15	4	Moderate	35.6	22.1
0-133	Graham	May 5-7	0.51	18	408	-	21	Moderate	19.3	12.0
0-92	Credit	May 6-7	6.22	220	2,463	18	-	Moderate	15.4	9.6
0-132	Wilmot	May 10-11	0.79	28	687	-	14	Moderate	19.3	12.0
0-157	Shelter Valley	May 10-12	0.65	23	776	-	15	Abundant	18.1	11.2
Total			12.8	451	7,312	33	54		84.0	135.0

Table 5. Summary of streams treated with lampricide, Lake Ontario, New York State, 1977.

Stream No.	Stream Name	Date	Flow cms	Flow cfs	TFM lbs. act. ingr.	Bayer 73 lbs. act. ingr.	Granular Bayer 73 lbs.	Sea lamprey abundance	Approx. stream km treated	Approx. stream miles treated
NY-0-45	South Sandy	Sept. 12-14	2.1	75	485	-	-	Moderate	10.9	6.8
NY-0-84	Sodus	Sept. 16,18-19	0.28	10	231	-	-	Moderate	4.1	2.5
Total			2.4	85	716	-	-		15.0	9.3

Table 6. Numbers of sea lamprey caught per hour of trawling at the Edison Sault Electric Company plant in St. Marys River in 1975, 1976 and 1977.

Week ending			Trawling time (hours)			No. of lamprey			No. of lamprey per hour		
1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
		Oct. 22			30.0			1			0.3
		Oct. 29			29.5			3			0.1
	Nov. 6	Nov. 5		31.2	30.1		3	11		0.1	0.4
	Nov. 13	Nov. 12		25.0	18.8		7	12		0.3	0.6
Nov. 22	Nov. 20	Nov. 19	24.0	31.8	30.3	23	0	2	1.0	0.0	0.1
Nov. 29	Nov. 27	Nov. 26	24.5	20.0	23.0	4	3	8	0.2	0.2	0.4
Dec. 6		Dec. 3	28.2		30.1	7		6	0.2		0.2
		Dec. 10			19.0			1			0.1
Totals and/or averages			76.7	108.0	210.8	34	13	44	0.4	0.1	0.2

Trawling off the mouth of the Credit River (Lake Ontario) was repeated in the fall of 1977. Only two sea lamprey were captured, compared with 11 in 1976, and 40 in 1975.

Modifications to Barrier Dams

The dam on the Echo River has been improved structurally to enhance its effectiveness as a barrier to sea lamprey. Arrangements with the Ontario Ministry of Natural Resources have been undertaken to develop a cooperative barrier dam program. Plans have been started to modify existing structures on two streams to make them lamprey proof, and to obtain access to a third site.

APPENDIX E

ALTERNATIVE METHODS OF SEA LAMPREY CONTROL

Thomas A. Edsall
Great Lakes Fishery Laboratory
Ann Arbor, Michigan 48105

and

Joseph B. Hunn
Great Lakes Fishery Laboratory
Hammond Bay Biological Station
Millersburg, Michigan 49759

Introduction

The Great Lakes Fishery Commission (GLFC) is committed to a continuing program of assessing the impact of residual sea lamprey populations on Great Lakes fish stocks. Its main charge is to develop an integrated, cost-effective lamprey control program that will include the continued use of chemical toxicant where appropriate, but that will also include the use of repellents, attractants, sterilants, physical barriers, and other methods as may prove useful, economical, and ecologically safe.

The Great Lakes Fishery Laboratory (GLFL), under contract with GLFC, performs research on the development of alternative methods for control of the sea lamprey. This research is conducted at the Hammond Bay Biological Station (HBBS) located on Lake Huron near Rogers City, Michigan, and at the Monell Chemical Senses Center at the University of Pennsylvania, Philadelphia, Pennsylvania.

Integrated Production of Sea Lamprey for Research

A total of 503 spawning-run sea was obtained from the electrical weir on the Ocqueoc River April 4-July 1, 1977 (compared with 6,947 in 1976), and an additional 2,000 spawning-run adults were taken from experimental traps in the Cheboygan River during May. We also obtained 100 late-run animals that were captured in the St. Marys River during July by the staff of Marquette Sea Lamprey Control Station.

They also provided us with about 300 large larvae and 200 transforming sea lamprey from the Peshtigo River, Wisconsin; the Oneida Lake drainage, New York; and the Big Garlic River, Michigan.

A total of 42 feeding-stage lampreys was purchased from a local commercial fisherman in the Hammond Bay area.

Three riffle-type fyke nets fished at the weir site on the Ocqueoc River in the spring (March 3-April 22) provided us with 48 transformers, averaging 173 mm and 6.87 g. In the fall (October 24 through December), the nets provided 26 transformers. A total of only three transformers was taken in these nets over a similar regimen in 1976.

Development of Methods to Sterilize Sea Lamprey

Chemosterilant Studies

A preliminary study was conducted to determine if male, spawning-run sea lampreys could be sterilized by immersion in an aqueous solution of *P*, *P*-Bis (1-aziridinyl)-*N*-methylphosphinothioic amide (bisazir). Twenty males were placed in a 10.0 mg/l solution of bisazir for 4 hours and ten other males were placed in a 100.0 mg/l solution for 2 hours. All treated individuals were fin clipped for later identification. The 30 treated males, 20 normal males, and 25 normal females were then placed in an artificial spawning stream that had been constructed in the laboratory. The lampreys were observed periodically and those seen spawning were removed from the stream and artificially spawned. Each female spawned with a treated male was also spawned with a normal male to provide a control for the fertility of the female. Batches of eggs from the different spawnings were held in glass battery jars partially immersed in constant-temperature troughs at 18 C. Dead (disintegrating) embryos were periodically removed, and all embryos were removed and preserved after 16 days. The results of this study are summarized in Table 1.

Table 1. Mortality of eggs and embryos and production of live, abnormal embryos in groups of eggs stripped from normal (untreated) females, and fertilized with sperm from bisazir-treated and untreated males. [Tabular values (for eggs and embryos) are averages; ranges are given in parenthesis.]

Treatment of males	Total number of males spawned artificially	Number of eggs in test group	Percentage mortality of eggs and embryos	Percentage live, abnormal embryos
10 mg/l bisazir	10	816 (154-1,880)	64.1 (40.9-97.4)	15.4 (2.0-29.9)
None (controls)	7	689 (258-1,469)	20.8 (14.1-43.0)	4.1 (0.7-14.3)
100 mg/l bisazir	6	1,077 (294-2,707)	99.7 (98.9-100.0)	0.25 (0.0-0.8)
None (controls)	6	919 (265-1,873)	28.0 (20.0-39.8)	3.2 (0.6-4.9)

Of the 20 males exposed to 10 mg/l bisazir, 10 were observed spawning and were artificially spawned; 6 of the 10 males treated with 100 mg/l bisazir and 13 of the 20 normal males were also seen spawning and were artificially spawned. About 64% of the eggs stripped from normal females and fertilized with sperm from males exposed to 10 mg/l bisazir died within 16 days, and 15% produced abnormal embryos that were so grossly deformed that their survival was considered highly unlikely; the remaining eggs (20.5%) produced embryos that were normal in appearance and survived for the duration of the study. In contrast, eggs from the paired controls (the same females spawned with normal males) had only 20.8% mortality, and a 4.1% incidence of abnormalities; 75.1% of these control eggs produced normal embryos.

Eggs from females spawned with males exposed to 100 mg/l bisazir had 99.7% mortality in 16 days; and only three (0.05%) of the surviving embryos appeared normal, whereas mortality and the production of normal embryos among the paired controls was 28.0 and 68.8% respectively.

These preliminary studies strongly suggest that adult male sea lampreys can be sterilized by immersion for 2 hours in an aqueous solution of 100 mg/l bisazir.

Immunological Studies

The initial approach to development of immunological sterility is to prepare antigens from spawning-stage sea lamprey gonadal material. These antigens, mixed with Freund's adjuvant, are injected intramuscularly into domestic rabbits. The initial injection is followed in seven days by a booster shot and the rabbit is bled 21 days later. Rabbits produced antibodies to four of seven antigens when injected with 1.0 ml of antigen mixed with 0.5 ml of adjuvant. The antigens producing positive response in rabbits are:

Antigen	Derived from
♂ 2	Sea lamprey sperm
♂ 4	Homogenized gonad
♀ 2	Homogenized eggs
♀ 3	Homogenized eggs (wash)

These positive antisera were used in an attempt to sterilize spawning lampreys. Antiserum against either male or female sex products were injected intraperitoneally so that the antisera would come into direct contact with the lamprey's gonadal tissue. Antiserum against female sex products was injected only into females and antiserum against male only into males. The spawning lampreys were injected with 1-5 ml of antisera, held for 25 hours, and spawned. If the injected lamprey was a female, a small portion of her eggs was collected and fertilized with sperm from an uninjected male. If the injected lamprey was a male, it was used to fertilize eggs from an uninjected female. As a control, eggs from this female were also fertilized with sperm from an uninjected male.

Evaluation of the results of this pilot study (Table 2) was difficult because of the inherently large variation in the viability of embryos obtained from different pairs of lampreys, and because limited numbers of experimental animals did not allow replication. Nevertheless, our data suggest: (1) the injection of Anti ♂ 2-1 resulted in steadily diminishing production (from 93.9 to 1.9%) of stage-15 embryos as the dose rate increased from 1ml to 4 ml (the high production of stage-15 embryos at the 5 ml dose rate may have resulted from an antibody excess which prevented the antigen-antibody reaction); (2) Anti ♂ 4-1 apparently had no effect on the production of stage-15 embryos; and (3) both Anti ♀ 2-1 and ♀ 3-1 injected into female spawners may have reduced production at the 5 ml dose rate. Anti ♀ 3-1 also has reduced production at the 4 ml dose

Table 2. Effect of intraperitoneal injection of various antisera on development of sea lamprey embryos.

Dose rate (ml)	Eggs observed		Number of stage 15 embryos produced		Percentage production of stage 15 embryos	
	Control	Experimental	Control	Experimental	Control	Experimental
Anti ♂ 2-1						
1	559	1700	472	1596	84.4	93.9
2	1376	1069	1127	309	81.9	28.9
3	1074	674	813	49	75.7	7.3
4	550	941	352	17	64.0	1.9
5	1731	1003	987	698	57.0	69.6
Anti ♂ 4-1						
1	1998	1164	1507	258	75.4	22.2
2	658	631	502	393	76.3	62.3
3	1481	1572	963	1108	65.0	70.5
4	892	785	591	79	58.2	10.1
5	1090	1574	786	621	72.0	39.5
Anti ♀ 2-1						
1	717	1003	115	8	16.0	0.8
2	686	1804	297	3	43.3	0.2
3[1]	2255	1438	898	815	39.8	56.7
4[1]	295	1068	206	593	69.8	55.5
5	960	814	529	0	55.1	0.0
Anti ♀ 3-1						
1	907	724	29	0	3.2	0.0
2	1402	1164	519	561	37.0	48.2
3[2]	691	1009	354	940	51.2	93.2
4[2]	1288	1090	7	0	0.5	0.0
5	1377	1036	803	0	58.3	0.0

[1] Anti ♀ 2-2 (made to same antigen but in different rabbit)
[2] Anti ♀ 3-2 (made to same antigen but in different rabbit)

Table 2. Effect of intraperitoneal injection of various antisera on development of sea lamprey embryos.

Dose rate (ml)	Eggs observed		Number of stage 15 embryos produced		Percentage production of stage 15 embryos	
	Control	Experimental	Control	Experimental	Control	Experimental
Anti ♂ 2-1						
1	559	1700	472	1596	84.4	93.9
2	1376	1069	1127	309	81.9	28.9
3	1074	674	813	49	75.7	7.3
4	550	941	352	17	64.0	1.9
5	1731	1003	987	698	57.0	69.6
Anti ♂ 4-1						
1	1998	1164	1507	258	75.4	22.2
2	658	631	502	393	76.3	62.3
3	1481	1572	963	1108	65.0	70.5
4	892	785	591	79	58.2	10.1
5	1090	1574	786	621	72.0	39.5
Anti ♀ 2-1						
1	717	1003	115	8	16.0	0.8
2	686	1804	297	3	43.3	0.2
3	2255	1438	898	815	39.8	56.7
4[1]	295	1068	206	593	69.8	55.5
5[1]	960	814	529	0	55.1	0.0
Anti ♀ 3-1						
1	907	724	29	0	3.2	0.0
2	1402	1164	519	561	37.0	48.2
3	691	1009	354	940	51.2	93.2
4[2]	1288	1090	7	0	0.5	0.0
5	1377	1036	803	0	58.3	0.0

[1] Anti ♀ 2-2 (made to same antigen but in different rabbit)
[2] Anti ♀ 3-2 (made to same antigen but in different rabbit)

rate, but the poor survival of control embryos makes this interpretation somewhat tenuous.

Further refinement of the antigens and the injection regime are necessary if this research is continued.

Development of Criteria to Specify the Age of Lamprey-inflicted Wounds and Scars on Lake Trout

Laboratory studies designed to describe the stages and chronology of healing of lamprey-inflicted wounds on Great Lakes salmonids at 10 C are nearing completion. In these studies we placed sea lamprey and lake trout of known size together in a tank at 10 C and recorded the location and duration of lamprey attachment on the fish. We allowed the lamprey to detach voluntarily from the fish. Immediately after detachment the size of the lamprey and the host fish were determined, and the wound on the fish was photographed. The wound was photographed frequently thereafter to illustrate the wound healing process and determine the rate of healing.

Case histories describing the healing of sea lamprey-inflicted wounds on 15 lake trout at 10 C have been compiled and are now available in a draft report for review by interested agencies. The report contains standard criteria that can be applied to determine the age of wounds and scars observed on lake trout under field conditions. We plan to publish a limited number of copies of this report in "handbook" form, and to distribute these handbooks to the agencies that have the responsibility for determining the incidence of sea lamprey-inflicted wounds and scars on lake trout in the Great Lakes. A more detailed scientific report describing the results of these and other ongoing wounding and wound healing studies at Hammond Bay Biological Station will be submitted for publication in the open literature.

We termed the two types of wounds observed in this study as type A and type B wounds. In a type A wound the skin is broken, exposing the underlying musculature. The wound usually has a central wound pit area which may be inflamed. The type A wound is usually caused by an attachment of long duration by a small lamprey which grows larger as it feeds, or by large, feeding lamprey. The type B wound is more of an abrasion, usually with a loss of scales (if on a scaled area). It can appear as an elongated scrape. The integument is not visibly broken and there is no wound pit. The type B wound is usually caused by an attachment of short duration. We observed no bleeding from either type A or B wounds in this study.

The four stages of healing are described below.

Type A Wounds

Stage I--The integument is broken with a fresh open wound. Rough, white, dead epidermal tissue usually surrounds the excavated area or pit. The wound pit can be deep into the underlying tissue. The exposed underlying tissue is usually raw and inflamed.

Stage II--Dead tissue over and around the wound pit is sloughed off. Margin around the wound pit is smoothed off. The wound site is generally smooth to touch due to the formation of a membrame-like covering. The wound pit may be partially filled with slightly opaque, mucous-like material. The underlying tissue, usually pink in color, is still visible.

Stage III--The entire area is smooth to touch, with the wound pit nearly filled with new tissue. An indentation can still be felt, however. The key characteristic for this stage is the reappearance of pigmentation in the damaged area. Pigment spots usually can be seen around edge of wound pit area. Pigmentation intensifies with time and usually covers the entire wound site.

Stage IV--The wound site appears as a roughly circular area, somewhat faded and recognizable by the absence of normal scalation. A slight indentation can sometimes be felt, but the wound site has taken on more normal appearing pigmentation and epidermal characteristics.

Type B Wounds

Stage I--The attachment site may be raw or inflamed. It is usually abraded and rough to the touch. Some swelling may be evident and scales are usually absent. The integument is not visibly broken and a wound pit is not present.

Stage II--The inflamed or raw area has reduced in size and is usually confined to central portion of the wound site. A transparent membrane has formed and the entire wound site is smooth to the touch.

Stage III--Pigmentation and epidermal features at the wound site have become generally normal in character.

Stage IV--Repigmentation is essentially complete. Scales, if regenerated, are arranged irregularly. Wound site might go undetected during field observations unless fish was subjected to very close examination.

Additional wounding and wound healing studies are underway at HBBS to provide field criteria that will permit assignment of sea lamprey wounds on lake trout to distinct feeding year classes of sea lampreys. Specifically, these studies are designed to produce criteria that will: 1) enable assessment personnel to distinguish wounds produced by newly metamorphosed sea lampreys that have just begun to feed parasitically from wounds left by lampreys nearing the end of their parasitic-feeding life stage; 2) describe the overwinter healing rate of wounds produced in the fall, so that wounds observed on lake trout in the spring could be attributed with greater certainty to either fall or spring feeding by lampreys; and 3) determine whether lamprey-inflicted scars on lake trout are identifiable for more than one annual assessment period.

Chemical Sensing in the Sea Lamprey

Studies supported by GLFC and GLFL are underway at the Monell Chemical Senses Center, the University of Pennsylvania, to identify and characterize nontoxic chemical substances, including sea lamprey pheromones, that will attract or repel sexually mature sea lampreys. If attractants and repellents can be developed they will be used to facilitate capture of sea lampreys during their spawning migration.

Project personnel conducted 73 tests in the attraction-avoidance apparatus (described in earlier reports) to determine if water in which spawning-run sea lampreys resided would serve as an attractant for other spawning-run sea lampreys. In one set of tests, 18 of 32 females spent a significantly greater amount of time in the end of the test trough receiving "rinse" water from male lampreys than in the end receiving fresh well water; 5 other females appeared to prefer the end of the trough receiving fresh well water; and 9 showed no preference. In a second set of tests, 21 of 26 males showed a preference for the female rinse water, 3 showed a preference for well water, and 7 showed no preference. A third set of tests, in which 6 males were exposed to male rinse water and 9 females were exposed to female rinse water, failed to yield evidence that lampreys were either attracted or repelled by rinse water from lampreys of the same sex. Thus, it appears that spawning-run lampreys may release a substance that is attractive to the opposite sex (a sex attractant) but not to both sexes (a general aggregation substance).

Also being investigated is the possibility that adult lampreys are attracted to a spawning stream by odors emanating from the population of lamprey ammocetes present in that stream. The two spawning-stage males and three females tested to date in the attraction-avoidance apparatus failed to exhibit a preference for water that had contained six ammocetes for 10 days.

APPENDIX F

REGISTRATION-ORIENTED RESEARCH ON LAMPRICIDES

Fred P. Meyer, Director
Fish Control Laboratory
U..S. Fish and Wildlife Service
La Crosse, Wisconsin 54601

Registration Activities

Comments were submitted to the U.S. Environmental Protection Agency in response to questions concerning a submitted petition for an exemption from tolerance and an amendment of registration for the use of the sodium salt of 3-trifluoromethyl-4-nitrophenol (TFM) as a lampricide. Areas still being negotiated include an exemption for the application of dimethylformamide (DMF) in streams as a part of TFM formulations, residue information in potable waters, possible restrictions in irrigation waters, and possible soil binding effects.

Technical Information Services

A computer check was run to determine if any positive results were encountered in teratology or mutagenicity studies on Bayer 73. None was found. This search was done following a German publication which reportedly showed teratology in fish.

A special report on the degradation of TFM was completed in response to a request from the Executive Secretary of the Great Lakes Fishery Commission. The Commission had received a letter expressing concern that TFM might be accumulating in the Great Lakes to the extent of presenting an environmental health hazard.

Distribution of TFM Residues in Largemouth Bass

Studies to define the distribution of TFM in a warmwater species of fish show no point of major bioconcentration of the lampricide other than gallbladder bile. These studies compare well with earlier studies on distribution of TFM in salmonid fishes.

Largemouth bass were exposed to a 1 µg/mL concentration of ^{14}C-TFM for up to 24 h. Muscle tissue was extracted in a column with hexane:ether and extracts were then quantified by radiometric and GLC methods. At 2, 4, 8, 12, and 24 h, radiometric residues were 0.20, 0.25, 0.37, 0.28, and 0.27 µg/g, respectively, while GLC residues were 0.13, 0.18, 0.35, 0.19, and 0.19 µg/g for the same time periods. It was also found that hexane:ether was extracting only about 50% of the total radioactivity from the column. Methanol was used to elute the remainder of the material from the column. Some free TFM was found in the methanol extract along with several other unidentified metabolites of TFM. A glucuronide of TFM was found in the head-viscera tissue. After 24 h exposure, concentrations of ^{14}C-materials in selected tissues were brain 1.46, liver 18.03, and kidney 13.04 µg/g, and in fluids were blood 1.29, and bile 1,497.26 µg/mL.

A second set of bass was exposed to ^{14}CTFM for 12 h and then placed in lampricide-free water for up to 72 h. During the 72 h, concentrations of ^{14}C-materials declined in blood from 1.71 to 0.14 µg/mL, in brain from 2.47 to 0.17 µg/g, in bile from 823.60 to 251.36 µg/mL, in liver from 14.22 to 0.83 µg/g, and in kidney from 17.38 to 0.59 µg/g. ^{14}C-residues declined in muscle tissue from 0.82 µg/g immediately after removing the fish from the treatment solution to 0.04 µg/g 72 h later. ^{14}C-materials decreased from 1.62 to 0.77 µg/g in the head-viscera over the same time period. Free TFM was found in the bile of exposed bass after treatment with β-glucuronidase indicating the presence of a glucuronide in the bile.

Uptake and Distribution of ^{14}C-labeled Bayer 2353

The rate of uptake and the distribution of residues of Bayer 73 by fish is part of the information needed for registration of the lampricide.

Residues of ^{14}C-labeled Bayer 2353 (Bayer 73 less the ethanolamine) were measured in rainbow trout and carp after exposure to 0.05 mg/L of the compound. Rainbow trout were exposed to the compound for up to 12 h and carp for 24 h. Highest residues were found in gallbladder bile (189 µg/mL in rainbow trout and 91.8 µg/mL in carp). Blood residues were 0.80 and 1.14 µg/mL for rainbow trout and carp, respectively. Brain and muscle residues in rainbow trout were 0.15 and 0.12 µg/g and in carp were 0.07 and 0.09 µg/g, respectively (Table 1).

A glucuronide conjugate of Bayer 73 was found in the gallbladder bile. Some free chloronitroaniline (CNA) and possibly some acetylated CNA in the bile were also detected. This indicates that fish metabolize the compound by hydrolysis and acetylation of the free amine as well as by conjugation of the salicylic acid portion of the molecule with glucuronic acid.

Cleanup Procedures for Analysis of Bayer 73 Residues

Procedures have been developed for the analysis of Bayer 73 residues in water and in fish plasma, bile, and urine. However, analyses for Bayer 73 residues in fish muscle tissue, invertebrates, and mud were complicated by the lack of an effective cleanup procedure.

An adequate cleanup procedure for the analysis of fish muscle tissue was developed. It involves incubation of sample extracts with oxidizing agents such as 30% H^2O^2 and $KMnO^4$ followed by acid/base partitioning and hexane/acetonitrile partitioning. The cleaned up sample then undergoes base hydrolysis in the presence of 30% H^2O^2 and the hydrolysis product, 2-chloro-4-nitroaniline (CNA) is partitioned into hexane:ethyl

Table 1. Concentration (average ± SE) of ^{14}C-materials (Bayer 2353) in bile and tissues from rainbow trout and carp exposed to a 0.05 µg/L solution of ^{14}C-Bayer 73 for up to 24 h.[a]

Exposure time (h)	µg/mL Blood	µg/g Brain	µg/mL Bile	µg/g Liver	µg/g Muscle
			Rainbow trout		
1	0.860	0.692	2.067	4.374	0.124
	(0.068)	(0.163)	(0.473)	(1.052)	--
2	0.997	0.504	6.017	6.819	0.139
	(0.174)	(0.048)	(2.757)	(0.380)	--
3	1.462	0.387	4.269	7.330	0.149
	(0.488)	(0.032)	(3.731)	--	--
4.5	1.164	0.282	99.366	10.342	0.183
	(0.262)	(0.024)	(43.338)	0.425)	--
8	2.116	0.124	153.161	6.439	0.120
	(0.960)	(0.013)	(16.940)	(0.978)	--
12	0.800	0.150	188.709	6.800	0.116
	(0.260)	(0.016)	(14.510)	(0.900)	--
			Carp		
24	1.141	0.066	91.751	2.979	0.088
	(0.080)	(0.006)	(13.172)	(0.521)	(0.007)

[a]Average of two to six fish.

ether (70:30). The CNA is then quantified by gas chromatography. Recovery of Bayer 73 spiked into bass, trout, catfish, and carp tissues averaged better than 80%.

The cleanup procedure for invertebrates and mud involves extraction with acetonitrile, partitioning with hexane, addition of acid to the acetonitrile, partitioning into hexane, and final partitioning into sodium hydroxide. Bayer 73 in the sodium hydroxide is then hydrolyzed as in the procedure for fish muscle tissue and quantified by gas chromatography. Recovery of Bayer 73 from spiked caddis fly larvae, glass shrimp, and mud averaged about 80%.

Renal Excretion of Bayer 73 in Rainbow Trout

Rainbow trout exposed to Bayer 73 are capable of rapidly excreting the lampricide in their urine. Most of the chemical is converted to a water-soluble glucuronide conjugate before being excreted.

Within 1 h of the start of exposure residues of Bayer 73 were found in the urine of fish exposed in water to 0.05 mg/L of Bayer 73 for 12 h. The largest amount of Bayer 73 residues was excreted during the 12 h exposure. They continued to excrete residues of Bayer 73 in the urine until 72 h postexposure (Table 2).

Table 2. Residues of Bayer 73 in bile, plasma, and urine of rainbow trout before, during, and up to 72 h of withdrawal following a 12 h exposure to 0.05 mg/L of Bayer 73.

Collection period postexposure (h)	Total Bayer 73 excreted (μg)	
-24 to -12		0.1
-12 to 1	2.54	2.20 [a]
1 to 12	82.2	7.12
12 to 24	17.4	6.32
24 to 36	5.79	2.09
36 to 48	5.19	1.58
48 to 60	2.41	1.03
60 to 72	3.43	1.86
Bile (72 h)	273	28.7
Plasma (72 h)	0.80	0.632 [b]

[a]Mean ± SD; N = 3.

[b]μg/mL.

Rainbow trout that received injections (IP) of 200 μg of Bayer 73 in corn oil also excreted residues of lampricide in the urine. The rate of elimination of Bayer 73 was slower in injected fish than in those exposed in water, possibly because of slower absorption of the chemical from the corn oil. Of the 200 μg of Bayer 73 injected, 25% was recovered in the urine, and another 20% was recovered in the bile at the termination of the study (Table 3).

Table 3. Residues of Bayer 73 in bile, plasma, and urine of rainbow trout with up to 72 h of withdrawal following an IP injection of 200 μg of Bayer 73 suspended in corn oil.

Collection period	Total Bayer 73 excreted (μg)		
postinjection (h)	Fish #1	Fish #2	Average
0-12	21.6	25.6	23.6
12-24	5.44	13.1	9.27
24-36	2.00	2.87	2.44
36-48	1.02	1.31	1.17
48-60	0.720	0.702	0.711
60-72	0.950	0.431	0.691
Bile (72 h)	49.2	69.5	59.4
Plasma (72 h)	0.260	0.140	0.200 [a]

[a]μg/mL.

Urine from fish in the water exposure study was cleaned up and concentrated on XAD-4 resin. A portion of the cleaned up sample was incubated with β-glucuronidase. Unincubated and incubated samples of urine were then chromatographed on silica gel TLC. The incubated portion showed a major spot with the same R_f as Bayer 73, whereas the unincubated portion showed the major spot near the origin. This indicates that most of the renal excretion of Bayer 73 was as the glucuronide conjugate.

Analysis of Municipal Water of Menominee, Michigan and Marinette, Wisconsin for TFM After Treatment of the Menominee River for Sea Lamprey Control

The Menominee River flows between the cities of Menominee and Marinette and enters Lake Michigan. Intakes for the municipal water supplies of both cities lie to the north of the mouth of the river and could possibly receive lampricide from treatment of the river.

Concentrations of TFM in the river were checked colorimetrically during treatment to ascertain the accuracy of computations of the amount of chemical needed to produce the desired treatment. Sensitivity of the colorimetric method is 0.1 mg/L (ppm).

TFM was applied beginning at 7:35 a.m. on 22 August and the leading edge of the chemical bolt reached the mouth of the river at 4:00 p.m. on that day. The trailing edge of the bolt reached the mouth sometime before 10:30 a.m. on 23 August.

Raw lake water was sampled from the inlet pipe to the Menominee Water Plant at selected intervals beginning at 8:00 a.m. on 22 August. Using the colorimetric method (sensitive to 0.1 mg/L), no TFM was detected in any of the samples taken between 8:00 a.m. 22 August and 10:00 a.m. 24 August, or on 9 September and 3 October. Samples were also collected for later analysis in the laboratory.

Aliquots of the various water samples were retained for subsequent analysis at the Fish Control Laboratory using gas chromatography. Gas chromatographic procedures used in the laboratory were sensitive to 0.02 μg/L (ppb) or roughly 5,000 times as sensitive as the colorimetric procedure. These analyses revealed that low amounts of TFM (μg range) were present in raw water samples from both water plant intakes.

Water samples were also taken from the municipal tap after the raw water had passed through the treatment plants. No TFM was found in the municipal water supply systems using either colorimetric or gas chromatographic procedures.

Both cities utilize activated charcoal filtration or the addition of a charcoal slurry to remove taste and odor problems associated with the use of lake water. Earlier studies at the Fish Control Laboratory had shown that activated charcoal will effectively remove both TFM and Bayer 73 lampricides so the absence of TFM was expected.

Sequential monitoring of the Menominee intake was ended at 10:00 a.m. on 24 August because colorimetric methods had indicated no evidence of TFM. Subsequent samples were collected only on 12 September and 3 October.

The highest level recorded at the Menominee plant (3.2 µg/L) was found in the 10:00 a.m. sample of 24 August. This level is equal to 1/1,560 of the peak applied.

One sample was received from the Marinette plant, and it consisted of a composite of six samples taken between 5:00 p.m. and 10:00 p.m. on 22 August.

The single pooled sample from Marinette contained 32 µg/L or 1/156 of the peak level applied and was found during the time the chemical was being discharged into Lake Michigan.

In both cases, the levels were so low they could only be detected using gas chromatographic methods. At three weeks no TFM was found, but at six weeks (3 October) a trace (0.033 µg/L) was detected. These observations are consistent with existing information on the degradation of TFM in natural environs.

Analysis of River Water for Bayer 73 During Lamprey Control Treatment

Water samples were analyzed for Bayer 73 residues during treatment of the Peshtigo River, Wisconsin with the lampricides TFM and Bayer 73. Analyses were run by the colorimetric method of Dawson, Harman, Schultz, and Allen. Stream concentrations were monitored to assist the sea lamprey treatment crew. Concentrations of Bayer 73 detected in the stream were very close to those calculated on the basis of chemical application and stream flow rates.

Ultraviolet Decomposition of ^{14}C-labeled Bayer 2353

Ultraviolet radiation from sunlight effectively decomposes Bayer 73. The products formed during ultraviolet decomposition and the stability of these products are important in determining the persistence of the lampricide in the environment.

Some degradation products of ^{14}C-labeled Bayer 2353 during exposure to UV light have been separated. The separation involves sequential elution from a silica gel column using various solvents. When sufficient quantities are obtained, they will be purified by preparative TLC and subjected to further analysis for identification.

Investigation of Liquid-liquid and Gel Permeation Chromatography for Bayer 73 Residue Analysis

Analytical BioChemistry Laboratories, Inc. completed work under contract on the feasibility of liquid-liquid and gel permeation chromatography for Bayer 73 residue analysis. The contract was completed on 4 February 1977. The investigation indicated that these procedures would not give adequate cleanup or sensitivity for Bayer 73 residue analysis at the present state of the art.

Radioimmune Assay for Bayer 73 Residue

Dr. Roa of Endocrine Labs is working on development of a radioimmune assay as a part of Dr. John Lech's contract. The feasibility of radioimmune assay for the analysis of Bayer 73 residues has been shown. However, the development of a usable method would depend on obtaining labeled Bayer 73 with a very high specific activity.

LITERATURE ON TFM AND BAYER 73

Allen, J. L., and J. B. Hunn. 1977. Renal excretion in channel catfish following injection of quinaldine sulfate or 3-trifluoromethyl-4-nitrophenol. Journal of Fish Biology 10(5):473-480.

Dawson, V. K., K. B. Cumming, and P. A. Gilderhus. 1977. Efficacy of 3-trifluoromethyl-4-nitrophenol (TFM), 2',5-dichloro-4'-nitrosalicylanilide (Bayer 73) and a 98:2 mixture as lampricides in laboratory studies. U.S. Fish and Wildlife Service, Investigations in Fish Control 77. 11 pp.

Kawatski, J. A., and A. E. Zittel. 1977. Accumulation, elimination, and biotransformation of the lampricide 2',5-dichloro-4'-nitrosalicylanilide by *Chironomus tentans*. U.S. Fish and Wildlife Service, Investigations in Fish Control 79. 8 pp.

Maki, A. W., and H. E. Johnson. 1977. The influence of larval lampricide (TFM:3-trifluoromethyl-4-nitrophenol) on growth and production of two species of aquatic macrophytes, *Elodea canadensis* (Michx.) *planchon* and *Myriophyllum spicatum* L. Bulletin of Environmental Contaminantion and Toxicology 17(1):49-56.

Maki, A. W., and H. E. Johnson. 1977. Kinetics of lampricide (TFM, 3-trifluoromethyl-4-nitrophenol) residues in model stream communities. Journal of the Fisheries Research Board of Canada 34(2):276-281.

Sanders, H. O. 1977. Toxicity of the molluscicide Bayer 73 and residue dynamics of Bayer 2353 in aquatic invertebrates. U.S. Fish and Wildlife Service, Investigations in Fish Control 78. 7 pp.

APPENDIX G

ADMINISTRATIVE REPORT FOR 1977

Meetings

The Commission held its Annual Meeting in Sault Ste. Marie, Ontario on 14-16 June 1977, and its Interim Meeting in Ann Arbor, Michigan on 1-2 December 1977. The Commission also held executive meetings of Commissioners and staff as follows: 14 April (Ann Arbor, Michigan), 13-16 June (Sault Ste. Marie, Ontario), 29 September (Ann Arbor, Michigan), 19 October (Ann Arbor, Michigan), and 1 November, 2 December (Ann Arbor, Michigan), and 12 December (Madison, Wisconsin). In addition, both the U.S. and Canadian Section met in a plenary session on 16 June in conjunction with the Annual Meeting in Sault Ste. Marie.

The Great Lakes Fishery Commission also met with the International Joint Commission at Ann Arbor, Michigan on 20 October 1977 to discuss items of mutual interest. Meetings of Standing Committees during 1977 were:

Lake Huron Committee, Milwaukee, Wisconsin, 22 February
Lake Superior Committee, Milwaukee, Wisconsin, 23 February
Combined Upper Great Lakes Committee, Milwaukee, Wisconsin, 23 February
Lake Michigan Committee, Milwaukee, Wisconsin, 24 February
Lake Ontario Committee, Columbus, Ohio, 8-9 March
Lake Erie Committee, Columbus, Ohio, 10 March
Management and Research Committee, Ann Arbor, Michigan, 12 April
Sea Lamprey Control and Research Committee, Ann Arbor, Michigan, 13 April
Great Lakes Fish Disease Control Committee, Ann Arbor, Michigan, 21-23 April
Finance and Administration Committee, Sault Ste. Marie, Ontario, 12 June
Scientific Advisory Committee, Sault Ste. Marie, Ontario, 13 June
Scientific Advisory Committee, Ann Arbor, Michigan, 28 September
Scientific Advisory Committee, Ann Arbor, Michigan, 1 December

Attendance at other Commission-related meetings included Sea Lamprey International Symposium Steering Committee, Lake Michigan Chub Technical Committee, Lake Michigan Lake Trout Technical Committee, Lake Michigan Sports Fishing Statistics Committee, and Lake Erie Standing Technical Committee.

Officers and Staff

The Chairman, Mr. L. P. Voigt, and the Vice-Chairman, Dr. C. J. Kerswill, continued their terms of office through 1977. Internal committee assignments established in June 1974 remained unchanged through 1977 and were as follows:

Scientific Advisory Committee (SAC)
F. E. J. Fry, Chairman
W. M. Lawrence

Finance and Administration Committee (F&A)
L. P. Voigt, Chairman
N. P. Reed
E. W. Burridge
K. H. Loftus

Sea Lamprey Control and Research Committee (SLCR)
W. M. Lawrence, Chairman
L. P. Voigt
C. J. Kerswill
K. H. Loftus

Management and Research Committee (SLCR)
C. J. Kerswill, Chairman
F. E. J. Fry
N. P. Reed
C. Ver Duin

Mr. J. H. Hemphill, Region III Director, U.S. Fish and Wildlife Service, represented Commissioner Reed at several Commission meetings. Following Mr. Reed's resignation in June 1977, Mr. R. L. Herbst, Assistant Secretary, Fish and Wildlife and Parks, Department of the Interior, was appointed U.S. federal alternate Commissioner pending official appointment as a Commissioner.

Staff Activities

The Commission's staff (Secretariat) performs several major functions. The Secretariat provides assistance to the standing committees for all phases of the Commission's program. On behalf of the Commission it provides liaison with agencies and individuals with whom the Commission deals, including assistance in coordinating fishery programs, planning meetings, arranging the presentation of reports, and preparation of minutes. The Secretariat provides direct assistance to the Commission in program development and acts on behalf of the Commission as circumstances may require. The only change in staff was the hiring of William J. Maxon in November as the Chief Administrative Officer. During 1977 the staff participated in conferences, meetings, and activities sponsored by:

Lake Superior Advisory Committee
Great Lakes Commission
State Fish and Game Directors and National Marine Fisheries Service Meeting
American Fisheries Society
Michigan Sea Grant
Wisconsin Sea Grant
Conference of Great Lakes Congressmen
U.S. Environmental Protection Agency - Advisory Panel Toxic Substances Control Act
Michigan Fish Producers
National Symposium on Classification, Inventory, and Analysis of Habitat

International Joint Commission (IJC) Annual Meeting
IJC Research Advisory Board
IJC Water Quality Objectives Subcommittee
IJC Water Quality Board
American Institute of Biological Sciences
American Society of Limnology and Oceanography
American Institute of Fishery Research Biologists, Great Lakes Division
Midwest Fish and Wildlife Conference
International Association for Great Lakes Research
Environmental Planning Task Force - Winter Navigation
Sea Lamprey Conference
Great Lakes Basin Commission
International Fishery Commissions Pension Society
Canada-U.S. University Seminar on Improving Management of the Great Lakes

Accounts and Audit

The Commission's accounts for the fiscal year ending September 30, 1977 were audited by Icerman, Johnson, and Hoffman of Ann Arbor. The firm's reports are appended.

Program and Budget for Fiscal Year 1977

At the 1975 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research in fiscal year 1977 estimated to cost $4,375,400. The program calls for continuation of sea lamprey control on Lakes Ontario, Huron, Michigan, and Superior, stream surveys to locate sea lamprey infested streams on Lake Erie, the operation of assessment weirs on Lakes Superior and Huron, continuing research to improve present control techniques, including biological controls, a new project to build barrier dams on selected streams to prevent sea lamprey access to problem areas, improving lamprey control and reducing the use of expensive lampricides and application costs. A budget of $150,000 was adopted for administration and general research for a total program cost of $4,525,400.

Following several revisions to adjust to changes in proposed contributions by the governments, including deferral of the proposed construction of barrier dams, the Commission proceeded with a program for sea lamprey control and research on a budget of $4,300,300. Final funding for fiscal year 1977 was as follows:

	U.S.	*Canada*	*Total*
Sea Lamprey Control and Research	$2,982,700	$1,317,600	$4,300,300
Administration and General Research	75,000	75,000	150,000
Total	$3,057,700	$3,392,600	$4,450,300

Sea lamprey control and research in Canada in fiscal year 1977 was carried out under agreement with the Canadian Department of Environment ($1,355,400) and in the United States with the U.S. Fish and Wildlife Service ($2,944,900) including lampricides and contingency funding for registration-oriented research. At the end of the fiscal year the Canadian agent refunded $3,250 and the U.S. agent $30,519. These monies and unused contingency funds were used to purchase supplemental lampricides.

Program and Budget for Fiscal Year 1978

At the 1976 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research in fiscal year 1978 estimated to cost $4,349,540. The program calls for continuation of sea lamprey control on Lakes Ontario, Huron, Michigan, and Superior, streams surveys to locate and monitor sea lamprey populations, continuing field research in direct support of control operations, the operation of assessment weirs on Lakes Superior and Huron, continuing research to assess immediate and long-term effects of lampricides in the environment, research to improve present control techniques, including biological controls, and another effort to initiate building of barrier dams on selected streams to prevent sea lamprey access to problem areas, thus reducing the use of expensive lampricides and application costs. A budget of $206,060 was adopted for administration and general research for a total program cost of $4,555,600.

The Canadian agent has scheduled treatments to 26 tributaries in their waters of the Great Lakes and 4 tributaries in the State of New York. Several problem areas involving major applications of granular Bayer 73 also are scheduled. In addition, an assessment barrier network of 5 units will be operated on selected Lake Huron tributaries and stream surveys to monitor larval lamprey populations will be continued.

The U.S. agent has scheduled 40 lampricide treatments; 10 tributaries to Lake Superior, 19 to Lake Michigan, and 11 to Lake Huron. The continued operation of the eight assessment barriers on Lake Superior tributaries and the device on the Ocqueoc River, a tributary to Lake Huron, is planned. The U.S. agent also will maintain stream surveys to monitor larval lamprey populations, will maintain studies on the growth and time to metamorphosis of selected larval populations, and also will continue the project initiated in fiscal year 1976 to assess the possible contribution of sea lampreys from the Oswego River-Finger Lakes system to the parasitic stocks of Lake Ontario.

The current sea lamprey research program at the Hammond Bay Biological Station and the registration-oriented work at the Fish Control Laboratories, La Crosse, Wisconsin, are to continue through fiscal year 1978.

The Commission negotiated a Memorandum of Agreement with its U.S. agent, the U.S. Fish and Wildlife Service, for work involving $2,250,840 and expects to provide lampricides valued at $534,500. A Memorandum of Agreement has also been executed which provides the Commission's Canadian agent, the Department of Environment, with $1,364,200 which includes lampricides valued at $153,500. The Commission also held $50,000 in reserve for contingency funding for registration-oriented research on lampricides. Funding was also approved for the construction of barrier dams on carefully selected streams to prevent sea lamprey access to hard-to-treat areas and to reduce costs of control: $150,000 was approved for use on the U.S. side and $100,000 on the Canadian side. In addition, the Commission reviewed its administration and general research budget for fiscal year 1978. The funding by government for fiscal year 1978 is as follows:

	U.S.	*Canada*	*Total*
Sea Lamprey Control and Research	$3,001,170	$1,348,370	$4,349,540
Administration and General Research	103,030	103,030	206,060
Total	$3,104,200	$1,452,400	$4,555,600

Program and Budget for Fiscal Year 1979

At the 1977 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research in fiscal year 1979 estimated to cost $4,891,000. The program calls for continuation of sea lamprey control on Lakes Ontario, Huron, Michigan, and Superior, stream surveys to locate and monitor sea lamprey populations, continuing field research in direct support of control operations, the operation of assessment weirs on Lakes Superior and Huron, some required research to assess immediate and long-term effects of lampricides in the environment, research to improve present control techniques, including biological controls, and construction of barrier dams on selected streams to prevent sea lamprey access to problem areas, thus improving control and reducing the use of expensive lampricides and application costs. A budget of $246,400 was adopted for administration and general research for a total program cost of $5,137,400 of which $3,498,700 is being requested from the U.S. Government and $1,638,700 from Canada.

ICERMAN, JOHNSON & HOFFMAN
Certified Public Accountants
303 NATIONAL BANK AND TRUST BUILDING
ANN ARBOR, MICHIGAN 48104
(313) 769 6200

R. L. JOHNSON, C.P.A.
C. A. HOFFMAN, C.P.A.
J. B. BURTT, C.P.A.
C. J. MOREHOUSE, C.P.A.
D. B. BOOTH, JR., C.P.A.
J. H. SUITS, C.P.A.
D. L. KREDERNITZ, C.P.A.
H. P. WAGNER, JR., C.P.A.
C. W. DUNBAR, C.P.A.

OFFICES
ANN ARBOR, MICHIGAN
HOWELL, MICHIGAN
ALLEGAN, MICHIGAN

Great Lakes Fishery Commission
Ann Arbor, Michigan

We have examined the accompanying balance sheets of Great Lakes Fishery Commission as of September 30, 1977, and the related statements of revenues and expenditures and encumbrances, changes in encumbrances and fund balances, and source and application of funds for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the financial statements mentioned above present fairly the financial position of Great Lakes Fishery Commission at September 30, 1977, and the results of its operations and changes in its financial position for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with the preceding year.

Icerman, Johnson & Hoffman

Ann Arbor, Michigan
January 16, 1978

Great Lakes Fishery Commission
Statement of Revenues and Expenditures and Encumbrances
Year Ended September 30, 1977

Sea Lamprey Control and Research Fund

	Budget	Actual	Over or (Under) Budget
Revenues			
Canadian government (Note 1)			
Operating revenues	$1,317,600	$1,686,745	$ 369,145
Receipt of unexpended funds	-0-	3,250	3,250
United States government:			
Operating revenues	2,932,700	2,982,700	50,000
Refund for unexpended funds	-0-	30,519	30,519
Interest	-0-	84,981	84,981
	$4,250,300	$4,788,195	$ 537,895
Expenditures and Encumbrances			
Canadian Department of the Environment (Note 1)	$ 955,000	$1,392,000	$ 437,000
United States Fish and Wildlife Service	2,127,830	2,127,830	-0-
Lampricide purchases (Note 2)	1,092,470	1,555,949	463,479
Special studies (Note 2)	75,000	12,495	(62,505)
	$4,250,300	$5,088,274	$ 837,974
Excess of expenditures and encumbrances over revenues	$ -0-	$ 300,079	$ 300,079

Great Lakes Fishery Commission
Statement of Revenues and Expenditures and Encumbrances
Year Ended September 30, 1977

Administration and General Research Fund

	Budget	Actual	Over or (Under) Budget
Revenues			
Canadian government (Note 1)	$ 75,000	$ 75,000	-0-
United States government	75,000	75,000	-0-
Miscellaneous	-0-	17	17
	$150,000	$150,017	17
Expenditures and Encumbrances			
Salaries	$ 90,700	$ 84,553	$ (6,147)
Fringe benefits	23,150	22,168	(982)
Research and other contractual services	15,700	17,381	1,681
Travel	8,000	11,981	3,981
Communications	1,250	1,778	528
Printing and reproduction	6,500	2,860	(3,640)
Supplies	3,000	4,170	1,170
Equipment	1,700	2,067	367
Expenses - Sea Lamprey International Symposium	-0-	10,000	10,000
	$150,000	$156,958	$ 6,958
Excess of expenditures and encumbrances over revenues	$ -0-	$ 6,941	$ 6,941

See notes to financial statements.

Great Lakes Fishery Commission
Statements of Changes in Encumbrances and Fund Balances

Administration and General Research Fund

	Encumbrances	*Fund Balance*
Balances, October 1, 1976	$ -0-	$ 15,130
Excess of expenditures and encumbrances over revenues	-0-	6,941
Balances, September 30, 1977	$ -0-	$ 8,189

Sea Lamprey Control and Research Fund

	Encumbrances	*Fund Balance*
Balances, October 1, 1976	$219,932	$1,186,083
Excess of expenditures and encumbrances over revenues	-0-	300,079
Correction of prior year encumbrances	(88,539)	-0-
Prior year encumbrances paid	(131,393)	-0-
Outstanding encumbrances applicable to the 9-30-76 budget	12,589	-0-
Outstanding encumbrances applicable to the 9-30-77 budget	21,180	-0-
Balances, September 30, 1977	$ 33,769	$ 886,004

See notes to financial statements.

Great Lakes Fishery Commission
Balance Sheet
September 30, 1977

	Administration and General Research Fund	*Sea Lamprey Control and Research Fund*	*Total*
Assets			
Cash in bank	$ 15,990	$886,004	$901,994
Accounts receivable	-0-	33,769	33,769
	$ 15,990	$919,773	$935,763
Liabilities and Fund Balance			
Current Liabilities			
Accounts payable	$ 5,273	-0-	$ 5,273
Accrued wages	2,528	-0-	2,528
	$ 7,801	-0-	$ 7,801
Encumbances (Note 2)	$ -0-	$ 33,769	$ 33,769
Fund Balance	$ 8,189	$886,004	$894,193
	$ 15,990	$919,773	$935,763

See notes to financial statements.

Great Lakes Fishery Commission
Statements of Source and Application of Funds
Year Ended September 30, 1977

	Administration and General Research Fund	*Sea Lamprey Control and Research Fund*	*Total*
Source of Commission Funds			
Revenues:			
Actual	$ 150,017	$4,788,194	$4,938,211
From reduction in assets:			
Cash	1,393	300,079	301,472
Encumbrances at September 30, 1977	-0-	33,769	33,769
	$ 151,410	$5,122,042	$5,273,452
Application of Commission Funds			
Expenditures:			
Budget	$ 156,960	$5,088,273	$5,245,233
To increase in assets:			
Accounts receivable	-0-	33,769	33,769
To reduction in liabilities:			
Accrued wages	(746)	-0-	(746)
Accounts payable	(4,804)	-0-	(4,804)
	$ 151,410	$5,122,042	$5,273,452

See notes to financial statements.

Great Lakes Fishery Commission

Notes to Financial Statements
September 30, 1977

Note 1. Significant Accounting Policies

The Commission has adopted a September 30 fiscal year end which corresponds with the United States government fiscal year.

The Canadian agency has not changed its fiscal year, so amounts budgeted for Canadian revenue and expenses represent approximately 71% of the 1977-78 fiscal year budget and amounts of the 1976-1977 fiscal year budget not previously recognized. This per cent was used because as of September 30, 1977, the Commission had received 71% of the total amount budgeted from the Canadian government for the 1977-78 fiscal year.

All amounts appearing on the financial statements are in United States dollars.

The books of account for the Commission are maintained on a modified accrual basis of accounting. Revenues are recognized when received except that balances of budgeted receipts that have been promised by the Canadian or United States governments are set up as receivables at September 30, 1977.

Inventories, equipment and related property items are expensed as they are purchased.

The cash balances for both funds operate from two bank accounts, one checking account and one savings account. Therefore, at any point in time, the bank accounts are each composed of monies from the Administration and General Research Fund and the Sea Lamprey Control and Research Fund.

Note 2. Budgeted Encumbrances

Unused funds at year-end are set up as encumbrances and charged to expenses. At September 30, 1977, these funds from the United States and Canadian Governments amounted to $33,769 which were encumbered for lampricide purchases and research in the Sea Lamprey Control and Research Fund.

Note 3. Federal Income Taxes

The Great Lakes Fishery Commission is exempt from federal income taxes under Sec. 501(c)(1) of the Internal Revenue Code.

COMMITTEE MEMBERS — 1977

Commissioners in Italics

SCIENTIFIC ADVISORY COMMITTEE

CANADA	UNITED STATES
F. E. J. Fry, Chm.	*W. M. Lawrence*
F. W. H. Beamish	A. M. Beeton
G. R. Francis	N. Kevern
M. G. Johnson	J. H. Kutkuhn
A. H. Lawrie (Convenor)	J. J. Magnuson
H. A. Regier	S. H. Smith
J. Watson	D. A. Webster

SEA LAMPREY CONTROL AND RESEARCH

CANADA	UNITED STATES
C. J. Kerswill	*W. M. Lawrence*, Chm.
K. H. Loftus	*L. P. Voigt*
J. J. Tibbles	A. L. McLain

MANAGEMENT AND RESEARCH COMMITTEE

CANADA	UNITED STATES
C. J. Kerswill, Chm.	*Claude Ver Duin*
F. E. J. Fry	*N. P. Reed*
R. M. Christie	J. T. Addis
D. E. Gage	M. Conlin
W. Hendry	D. L. Haney
A. Holder	E. Kinney
J. J. Tibbles	W. A. Pearce
	J. A. Scott

FINANCE AND ADMINISTRATION COMMITTEE

CANADA	UNITED STATES
E. W. Burridge, Chm.	*L. P. Voigt*
K. H. Loftus	*N. P. Reed*

LAKE COMMITTEES

LAKE HURON	LAKE ONTARIO
J. A. Scott, Chm.	W. A. Pearce, Chm.
R. M. Christie, V-Chm.	D. E. Gage, V-Chm.

LAKE MICHIGAN	LAKE SUPERIOR	LAKE ERIE
J. T. Addis, Chm.	W. Hendry, Chm.	D. L. Haney, Chm.
M. W. Conlin, V-Chm.	J. A. Scott, V-Chm.	A. Holder, V-Chm.
R. Hollingsworth	J. T. Addis	N. E. Fogle
H. J. Vondett	C. R. Burrows	D. R. Graff
		W. Shepherd