# ANNUAL REPORT

## GREAT LAKES FISHERY COMMISSION

1982

## GREAT LAKES FISHERY COMMISSION

### MEMBERS
### AND PERIOD OF SERVICE
### SINCE THE INCEPTION OF THE COMMISSION
### IN 1956

**CANADA**

| | |
|---|---|
| A. O. Blackhurst | 1956–1968 |
| W. J. K. Harkness | 1956–1959 |
| A. L. Pritchard | 1956–1971 |
| J. R. Dymond | 1961–1964 |
| C. H. D. Clarke | 1965–1972 |
| E. W. Burridge | 1967–1977 |
| F. E. J. Fry | 1969–1980 |
| C. J. Kerswill | 1971–1978 |
| K. H. Loftus | 1972– |
| M. G. Johnson | 1978–1982 |
| H. D. Johnston | 1979–1982 |
| H. A. Regier | 1980– |
| G. C. Vernon | 1982– |
| P. S. Chamut | 1982– |

**UNITED STATES**

| | |
|---|---|
| J. L. Farley | 1956–1956 |
| C. Ver Duin | 1956– |
| L. P. Voigt | 1956–1978 |
| D. L. McKernan | 1957–1966 |
| C. F. Pautzke | 1967–1968 |
| W. M. Lawrence | 1968– |
| C. H. Meacham | 1969–1970 |
| N. P. Reed | 1971–1977 |
| R. L. Herbst | 1978–1981 |
| F. R. Lockard | 1978–1981 |
| W. P. Horn | 1982– |

### 1982 SECRETARIAT

C. M. Fetterolf, Jr., Executive Secretary
A. K. Lamsa, Assistant Executive Secretary
R. L. Eshenroder, Senior Scientist for Fishery Resources
M. A. Ross, Fishery Biologist
B. S. Staples, Administrative Officer
R. E. Koerber, Word Processing Supervisor

# GREAT LAKES FISHERY COMMISSION

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

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## ANNUAL REPORT
for the year
**1982**

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### COMMISSIONERS

| | |
|---|---|
| P. S. Chamut | W. P. Horn |
| W. M. Lawrence | K. H. Loftus |
| H. A. Regier | C. Ver Duin |
| G. C. Vernon | Vacancy |

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1451 Green Road
Ann Arbor, Michigan
U.S.A.
1984

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 1982.

Respectfully,
K. H. Loftus, *Chairman*

## CONTENTS

# ANNUAL REPORT FOR 1982

## 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 27 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 Green Bay, Wisconsin, June 9–10, 1982 and its Interim Meeting was convened in Toronto, Ontario, December 2–3, 1982.

# ANNUAL MEETING

## PROCEEDINGS[1]

The twenty-seventh annual meeting of the Great Lakes Fishery Commission was held in Green Bay, Wisconsin, on June 9th and 10th, 1982.

Chairman Mason Lawrence convened the meeting at 0940 h, and called upon James Addis, Wisconsin Department of Natural Resources, to deliver a welcoming address on behalf of Carrol Besadny, Secretary of the Wisconsin Department of Natural Resources. Mr. Addis stated his belief that fish managers' achievements over the past 25 years are reflected in the allocation disputes currently possible. Environmental issues are encountered more frequently now by fisheries managers, and cooperative adaptive management techniques are beginning to be employed in their resolution.

### Lake Trout Rehabilitation in the Great Lakes—Perspectives and Issues After Twenty-five Years

Former Commissioner and current Executive Director of Trout Unlimited, Robert Herbst, introduced this session on lake trout rehabilitation saying that in order to continue our progress in lake trout rehabilitation, cooperation in fishery research and management activities at all levels must continue. Wisconsin Department of Natural Resources' Bruce Swanson, Peter Ihssen (Ontario Ministry of National Resources), Ross Horrall (University of Wisconsin), Dick Pycha (U.S. Fish and Wildlife Service), John Dorr (University of Michigan), and George Spangler (University of Minnesota) addressed lake trout production in hatcheries, reproductive biology, performance and protection of stocked lake trout and natives, ecological concerns, and the prognosis for lake trout rehabilitation. Their recommendations were for more research into environmental limitations on

[1]Minutes of the meeting are available from the Secretariat for readers desiring further detail.

rehabilitation of Great Lakes lake trout (e.g. chemical contamination of Lakes Michigan and Ontario), and for further investigation of factors responsible for the relative inefficiency of hatchery produced lake trout compared with natives in survival and reproduction. The existence and process of imprinting, with development of such tools as inherent (e.g. genetic) marks and attractants for spawning lake trout were deemed important topics for research emphasis. In order to encourage maximum contributions from hatchery fish, stocking strategies such as intensive stocking in appropriate areas (reefs, etc.), protection from fishing and other preventable mortality, and use of attractants if such become available, were strongly endorsed. No less important are hatchery strategies to produce lake trout best suited for survival and reproduction in the Great Lakes, including careful selection of stocks and utilization of wild proven sources, reduced reliance on success of fish under hatchery conditions in favor of feedback on in-lake survival and spawning success, modeling of hatchery conditions after those encountered by wild fish, and use of genetic markers and imprinting technology if such become available. Feedback from in-lake assessment efforts are essential to continued refining of stocking and hatchery strategies, and to the ultimate success of the lake trout rehabilitation program, and thus the coordination and opportunities for communication afforded by the Commission's committee structure was highly recommended to managers, researchers and fish culturists alike.

### Contaminants and Great Lake Fish

In giving Commissioner Murray Johnson's introductory remarks, the Executive Secretary assailed as short-sighted the regulatory mindset which deals with levels and not effects of contaminants in fishes, and which regards contaminants as primarily the responsibility of environmental agencies: "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 fishermen; 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 resources."

Peter Hodson (Fisheries and Oceans Canada), Wayne Willford (U.S. Fish and Wildlife Service), William Strachan (Environment Canada), and Clay Edwards (International Joint Commission) discussed the role of laboratory and field work in assessing the effects of contaminants of fish (complementary, with each finding its direction through the other), and the regulatory processes in Canada and the United States. Because of the large number of chemicals in the Lakes and soon to be introduced, and the interactive (even synergistic) nature of their effects on fish, regulators and researchers are in need of greater support from entities such as the Great Lakes Fishery Commission and its cooperators. Of particular interest is information on contaminants' effects on fish, habitat needs of fish, and priorities of fishery managers. It was formally recommended that the GLFC establish a standing sub-committee to evaluate the hazards which are posed to the fish and fisheries by these chemicals and to present such evaluations as appropriate to the regulatory agencies of Canada and the United States.



### Great Lakes Ecosystem Rehabilitation III: The Green Bay/Fox River System

Bud Harris (University of Wisconsin), George Francis (University of Waterloo), Jack Day (University of Wisconsin), Jim Kitchell (University of Wisconsin), Ralph Bergman (Bay-Lake Regional Planning Commission), Joe Decker (Wisconsin Natural Resourcs Board), Lee Kernen (Wisconsin Department of Natural Resources), and Bill Nelson (Green Bay Packaging Inc.) discussed their application of the GLER process in improving the water quality, and subsequently recreational and fishing opportunities in the Green Bay/Fox River system. (Detailed accounts are available in the Commission's Technical Reports No. 37, 38.) It was noted that the Green Bay/Fox River situation was particularly suitable for application of the GLER process, having local, defined problems whose solution will yield certain rewards for the community; having the support of a concerned community, including corporate members; and requiring cooperation for success, as no one element of the community acting independently could achieve rehabilitation of the Green Bay/Fox River system.

### Report of the Board of Technical Experts

George Spangler (University of Minnesota) reported the proceedings of the Board of Technical Experts' first 1982 semi-annual meeting where it was briefed by its committees on providing fish habitat advice, distributing a summary of the Fish Health Workshop (details being published by Wiley and Sons), status of socio-economic projects, outcome of adaptive management workshops on lake trout/sea lamprey interactions and those of Lake Erie percids, implementation of findings from the Stock Concept Symposium, suggested terms of reference for the Steering Committee on Integrated Management of Sea Lamprey, and report of members attending Lake Committee meetings. Assignments underway included papers on lake trout rehabilitation and allocation. Supported were indexing of 30 years of the proceedings and the Journal of the International Association for Great Lakes Research, Eric Volk's (University of Washington) research proposal to develop ammocoete aging techniques, Stephen Gloss's (Cornell University) work with Bayer 73, and development of proposals to determine research needs for lake trout rehabilitation and resolution of socio-economic issues. Scheduled for a later meeting were consideration of a proposal to examine possible "resistance" of Seneca Lake lake trout to sea lamprey induced mortality, and an evaluation of the Board's role in advising the Commission.

## Lake Committees Reports

Chairmen of each Lake Committee (Superior, Michigan, Huron, Erie, and Ontario) and the Council of Lake Committees, discussed issues of prime concern to Great Lakes fishery managers: managing stocks of common concern (including lake trout, percids, and sea lamprey), preservation of fish habitat, and allocation policies. (Highlights of the 1982 Lake Committee meetings may be found in the Management and Research section of this Annual Report.) Lake Committees reviewed and largely approved a proposed process for implementing integrated sea lamprey management, and expressed their concerns regarding cuts in the Commission's budget and sea lamprey control and assessment activities. They urged the Commission to proceed in organizing a fish habitat advisory committee. The Commission agreed to finance an adaptive management workshop devoted to fish community and fishery interactions in Lake Erie, and commended Lake Committees for the formation of technical committees charged with developing plans for achieving lake trout rehabilitation.

## Report of the Great Lakes Fish Disease Control Committee

James Warren (U.S. Fish and Wildlife Service), Chairman of the Great Lakes Fish Disease Control Committee, reported on the status of fish disease in the Great Lakes basin: disease agents denied entry (hemorrhagic septicemia virus, infectious hematopoietic necrosis virus, and the parasite *Ceratomyxa shasta*); limited numbers of cases of enteric redmouth and whirling disease; and a decline in instances of infectious pancreatic necrosis and bacterial kidney disease. Furunculosis, however, is common and may cause serious losses. Warren discussed his Committee's progress on "A Guide to Integrated Fish Health Management in the Great Lakes Basin," exploration of the causes of early mortality in salmon and steelhead trout, and a review of agency fish health protection programs and regulations. The Commission responded positively to its Fish Disease Committee's recommendation that proliferative kidney disease (PKD) be designated an emergency disease (i.e. its detection requires immediate efforts at eradication), and expressed its willingness to consider sponsoring a modest brochure on fish disease control.



## Progress Toward Integrated Sea Lamprey Management

Bob Stevens (U.S. Fish and Wildlife Service), John Davis (Fisheries and Oceans Canada), Don Hales (U.S. Fish and Wildlife Service), Jim Seelye (U.S. Fish and Wildlife Service), and Commission Chairman Mason Lawrence discussed improvements in the U.S. Agent's research capabilities; a proposed planning and implementation process for integrated pest management (IPM); developments in lampricide formulations and alternatives; the status of the barrier dam program and its importance in IPM; and other elements in the integrated sea lamprey management arsenal i.e. competitive displacement, pathogens and parasites, physical and electrical barriers, toxicants, attractants and repellents, chemosterilization, immunosterilization, and radiation sterilization. (More details are given in the Sea Lamprey Control and Research Section of this Annual Report.)

## Update From the International Joint Commission

Clay Edwards (International Joint Commission) reported on the meeting then underway of Great Lakes States Governors and Premiers of Quebec and Ontario, a possible hearing on Soo Power Company's request for increased water allocation from the St. Marys River, the IJC's Water Quality Board's request for input from the GLFC on its report "Water Intakes and Thermal Discharges," and his efforts to alert headquarter offices and the Boards of Control to the issue of winter navigation.

## National Section Meetings

Commissioner Henry Regier reported much useful discussion but no specific action at the Canadian Section meeting, and Commissioner Claude Ver Duin reported enthusiasm and progress among the newly reorganized U.S. Advisors who expressed concern, however, that one U.S. position on the Great Lakes Fishery Commission remained unfilled.

## Administrative and Executive Actions

Summaries of Commission actions since the 1981 Annual Meeting through this 1982 Annual Meeting included:

*General*

— presenting Meritorious Achievement Awards to Joe Kutkuhn (U.S. Fish and Wildlife Service) for his service to the Commission on the Board of Technical Experts, to Andy Lawrie (Ontario Ministry of

National Resources) and Bill Pearce (New York Department of Environmental Conservation) for chairing the Strategic Plan Steering Committee. Authorization of a Meritorious Achievement Award to Pat Chamut (Fisheries and Oceans Canada) for his leadership of the Sea Lamprey Audit Team.

— establishing an external committee to review the administrative/operative procedures of the Board of Technical Experts.
— revising and approving of budgets for fiscal years 1982 through 1984.
— establishing a common fiscal year for the Commission and its U.S. and Canadian Agents, i.e. the period 1 October to 30 September.
— acting to insure specified capital goods and to secure immunity from suit in Canada.
— improving a chemistry laboratory at the Hammond Bay Biological Station, and boat docking and water supply facilities at the Sault Ste. Marie Sea Lamprey Control Centre.
— agreeing to supply granular Bayluscide at cost to the Lake Champlain Fish and Wildlife Management Cooperative, and to the New York Department of Environmental Conservation for its studies in Seneca Lake.
— designating that the Memorandum of Understanding with the U.S. Fish and Wildlife Service will now be made by the full Commission and not just the U.S. Section.

*Publications*

— the proceedings of the Commission-sponsored Stock Concept Symposium in the December 1981 issue of the Canadian Journal of Fisheries and Aquatic Sciences.
— the Strategic Great Lakes Fisheries Management Plan, and a brochure on same for cooperators' distribution.
— the U.S. Fish and Wildlife brochure on sea lamprey control.
— the slide/tape shows, "The Sea Lamprey—Great Lakes Invader" and "Bringing Back the Great Lakes."
— a Special Publication, Nancy Auer et al.'s (University of Michigan) Great Lakes larval fish manual.
— revising the Commission's policy on the style of its Technical Report Series, now to follow that of the Canadian Journal of Fisheries and Aquatic Sciences.

*Fisheries and Environment*

— collection of papers related to the Stock Concept Symposium installed at the Ontario Ministry of Natural Resources' Maple Research Station library.



— distributing to cooperators pertinent recommendations of Stock Concept Symposium participants.
— holding a workshop on effects of various stresses on fish health, co-sponsored by the Commission and Fisheries and Oceans Canada, at Ontario's Geneva Park in November 1981.
— contracting with Hough, Stansbury and Michalski Ltd. for an analysis of the St. Marys Rapids dewatering problem and proposed solutions, which was useful in February 1982 discussions with the International Joint Commission. Other topics discussed were the ecosystem approach, dewatering of the St. Marys Rapids, fish contaminants, and the Niagara River situation.
— sponsoring an October 1981 adaptive management workshop on sea lamprey/salmonid community dynamics.
— providing funds for computer analysis of Lake Erie yellow perch data and the development of a model for interjurisdictional management.
— sponsorship of a summer 1982 adaptive management workshop to examine percid community interdependence in Lake Erie.
— funding of phase three of Great Lakes Ecosystem Rehabilitation, a feasibility report.
— financially supporting Lino Grima's (University of Toronto) "Allocation of Fishery Resources: Interpretive Review and Great Lakes Experience."
— funding meeting chaired by Dan Talhelm (Michigan State University) to consider how best to isolate and present Great Lakes sport fishing data collected in the 1980 National Fishing Survey of Canada and the U.S., Talhelm's development of the 1980 data, and his updating of the "1979 Current Estimates of Great Lakes Fisheries Values."
— placing proliferative kidney disease (PKD) on the list of emergency diseases.
— revising the Commission's 1976 position statement on lake trout rehabilitation, and endorsing the U.S. Fish and Wildlife Service's lake trout policy.

*Sea Lamprey*

— approving a proposed process for planning and implementation of integrated sea lamprey management.
— supporting as part of an ongoing process an October 1981 workshop to promote uniformity in classifying and reporting sea lamprey marks on fish.
— revising the Commission's "Administrative Guidelines for the Barrier Dam Program for Sea Lamprey Control" to make them more compatible with the Canada-Ontario barrier dam agreement.

- providing funds to the Michigan Department of Natural Resources for construction of barrier dams on the Au Gres River, White River, Days River, and Bear Creek.
- arranging for study of the acoustic properties of sea lamprey in varying life stages.
- providing for an update through 1983 of a computerized annotated cyclostomata bibliography by William Beamish (University of Guelph).
- establishing a committee to develop plans for conducting research on the effects of TFM on stream invertebrates.

*Election of Officers*

- election of Commissioner Doug Johnston Commission Chairman, and Commissioner Bill Horn Vice Chairman, for a two year period up to and including the 1984 Annual Meeting.

### ADJOURNMENT

After announcing the locations and dates of the 1982 interim Meeting (Toronto on December 2nd and 3rd) and the 1983 Annual Meeting (Burlington, Ontario, on May 11th and 12th), and thanking all concerned for their participation, Chairman Mason Lawrence adjourned the two day meeting.

# INTERIM MEETING

## PROCEEDINGS[1]

The Great Lakes Fishery Commission's 1982 Interim Meeting was held in Toronto, Ontario, Canada, on December 2 and 3, 1982. In his introductory remarks, Chairman K. H. Loftus welcomed the two new Canadian Commissioners, G. C. Vernon and P. S. Chamut.

The Region III Director, United States Fish and Wildlife Service, H. K. Nelson, reviewed personnel changes at the national, regional, and control units levels, and presented to retiring project supervisor Robert Braem (in charge of the U.S. sea lamprey control stations in Marquette and Ludington, Michigan), a U.S. Fish and Wildlife Service award. He discussed the federal and Commission lake trout policies, the need for continued cooperation in efforts such as the Strategic Great Lakes Fishery Management Plan and integrated management of sea lamprey, the status of national fish hatcheries, travel restrictions, and the impact on the rehabilitation programs of the illegal harvest of lake trout and other species.

John Davis (Department of Fisheries and Oceans) summarized progress made by the steering committee on developing recommendations for implementing integrated management of sea lamprey. He explained that such an approach was best on a lake-by-lake basis which should involve those agencies with fishery management responsibilities. The steering committee would provide guidelines for agency use. He reviewed the philosophy of integrated management of sea lamprey, its common goal, issue statements, and strategies for implementing it. It was thought that if the Commission endorses this process, one or two lake committees could start planning in the near future. On behalf of the chairman of the Council of Lake Committees, R. M. Christie (Ontario Ministry of Natural Resources) expressed the Council's pleasure with the process for implementing inte-

[1]Minutes of the meeting are available from the Secretariat for readers desiring further detail.

grated sea lamprey management, the concept of which had been accepted at the 1982 Lake Committee Meetings, as a logical outgrowth of the Strategic Great Lakes Fishery Management Plan. If approved by the Commission, the process will be addressed at the 1983 Lake Committee Meetings.

The Secretariat reviewed the strategy proposed by the committee to measure the long-term impact of regularly scheduled applications of lampricides on stream invertebrates and fish and to determine the short-term effect.

George Spangler (University of Minnesota) described the three completed Adaptive Management Workshops, summarized ancillary benefits, noted future directions for simulation modelling, and demonstrated the lake trout rehabilitation model. He concluded that the Adaptive Management Workshop process has proven useful in fostering communication among Great Lakes biologists and seems certain to play a role in future activities of the Commission and its constituent agencies.

The Commission also heard the following reports: the Secretariat reported on the recommendations of the committee developing standards for reporting sea lamprey marks on fish; the New York Department of Environmental Conservation reported on sea lamprey control in Seneca Lake; the U.S. Fish and Wildlife Service described the Lake Champlain Fisheries and Wildlife Management Committee's efforts to develop and maintain a diverse salmonid fishery in Lake Champlain to supplement the existing fishery, along with studies to assess sea lamprey populations in the lake for developing appropriate recommendations for the fall of 1984. The Commission also accepted, with thanks to the Department of Fisheries and Oceans Canada who have funded the study, the report on the degradation and fate of TFM in the environment.

The Commission's contract agents, the U.S. Fish and Wildlife Service and Department of Fisheries and Oceans Canada, reported on the problems of sea lamprey in the St. Marys River (which connects Lake Superior to Lake Huron), on the development of sterile male techniques for sea lamprey management, pheromone research, lampricide studies, and developments from the perspective of the contract agents. (More detailed information is available elsewhere in this annual report under Sea Lamprey Control in the Great Lakes and Sea Lamprey and Related Research at the National Fishery Research Laboratory, Hammond Bay Biological Station, and Monell Chemical Senses Center.)

The Commission also accepted reports on sea lamprey wounding rates on fish in the five Great Lakes. In most of Lake Superior, Lake Michigan, and Lake Huron, the rates showed no major increases. In Lake Erie, lamprey wounding on lake trout was considerably higher than in the upper Great Lakes and ranged from 9.6% to 55.6% depending on size of fish. Coho salmon in Lake Erie averaged 12.2% wounding. In Lake Ontario wounding rates on lake trout were considered high with evidence of significant mortality; New York Department of Environmental Conservation recommended a 5-year experimental control project in Oneida Lake to determine whether sea lamprey from that system migrate to Lake Ontario.



The Secretariat summarized programs and budgets for fiscal years 1983 and 1984. Program costs for fiscal year 1983 were expected to total $6.4 million and for fiscal year 1984 $6.5 million.

## Lake Committee Reports

Four of the five lake committees elected to report on items of interest. The Lake Ontario Committee report addressed the loss of the European market for eels due to contaminant residues, an attempt to establish a lake trout strain adapted to Lake Ontario, Ontario's first use of coded wire tags in Lake Ontario, a large decrease in sculpin and trout-perch populations, and the maintenance of Bay of Quinte walleye populations. The Lake Erie Committee reported on the development of a proposal for integrated sea lamprey management for consideration in 1983 and a proposed lake trout rehabilitation plan. Attendees also heard a presentation on the Commission-funded Lake Erie percid workshop, its objectives and findings. The Lake Huron Committee shared with the attendees the encouraging news that young splake had been taken by commercial fishermen in shallow yellow perch nets, and that more data will be sought. The Lake Superior Committee reviewed the progress of the Lake Superior Technical Committee in addressing major concerns such as establishment of a lake trout rehabilitation goal and associated strategies, identification of goals and objectives for the lake, the subject of fisheries allocation, and input into the development of a basinwide approach to sea lamprey control.

The Council of Lake Committees representative reported on participation in planning associated with integrated sea lamprey management, advised the Board of Technical Experts on some management interests, attended the 1982 U.S. Fish and Wildlife Service sea lamprey research needs meeting, provided the U.S. Core of Engineers with a statement at its public workshop and additional lock studies for the St. Lawrence Seaway, and participated in the adaptive management (modelling) workshops (sea lamprey, lake trout) as a fishery management respresentative.

## Board of Technical Experts

The Board Chairman reported on recent activities and recommendations to the Commission including the recommendation that the Commission support the proposal to investigate differential mortality of Great Lakes and Seneca Lake strains of lake trout following attacks by sea lamprey, reviewed and accepted for publication in the Technical Report Series a paper by Heimbuch and Youngs (Cornell University) titled "Application of decision analysis to sea lamprey control," reported on planning for the 1983 lake trout research needs workshop, initiated evaluation of the three adaptive management workshops sponsored by the Board, and experimented in a creative problem identification and solution exercise. The Board also supported a proposal from Commission Chairman Loftus for a Commission-sponsored symposium on prediction and assessment of available and realized fish harvests, and one from Commission Regier for an American Fisheries Society symposium on rehabilitation of the fisheries and habitat of walleye in the Great Lakes basin. The Commission also heard the Board's recommendations for developing a fish habitat advisory capability for the Commission.

### International Joint Commission (IJC)

The Commission heard the report of the first successful attempt by the IJC's Science Advisory Board to relate ongoing projects to research needs. Data from 25 institutes under 10 issues extracted from the Water Quality Agreement and an assortment of IJC Board recommendations were compared to ongoing research subjects and activities. Among the findings were that a shift has occurred in the topics being addressed (to those identified as "priority") but no shift has occurred in the disciplines of researchers; historical change in sources of pollution has been slight. It was believed that such an analysis was important in that it encourages continued support for critical areas of research and identifies areas for additional research efforts.

The Commission was also informed of recent IJC-sponsored reports such as the first biennial report under the 1978 Great Lakes Water Quality Agreement, new objectives issued by the Aquatic Ecosystem Objectives Committee of the Science Advisory Board, a detailed review by the Water Quality Board of 18 class "A" areas of concern identified in the previous report, and two reports from the Committee on the Assessment of Human Health Effects of Great Lakes Water Quality.

### Other Reports

The Executive Director of the Great Lakes Commission reviewed resolutions approved at the Great Lakes Water Resources Conference for Governors and Premiers held in June 1982. The resolutions addressed items such as water diversion and consumptive uses, navigation and shipping, and water quality. He believed that there was great significance in that the governors and premiers felt the need to meet and consider issues of concern to all.

Daniel Talhelm (Michigan State University) reported that his projects on the national fishing surveys and current annual monetary values are in process and he reviewed nonuse and unrevealed values from his extra-market values study.

The Commission also heard reports on acid precipitation and the status of negotiations from the Canadian and U.S. perspectives.



### Other Business

The Commission presented Robert Braem, retiring supervisor of the sea lamprey control stations of the U.S. Fish and Wildlife Service, and J. J. Tibbles, the director of the Canadian Sea Lamprey Control Centre, letters of appreciation and Meritorious Service Awards. Other awards included a Meritorious Service Award to Commissioner Chamut for his leadership in the program audit of sea lamprey control, and letters of appreciation and satellite photos of the Great Lakes to retired Commissioners Murray Johnson and Doug Johnston.

### Summary of Executive Action

#### *Sea Lamprey Committee*

The Commission will sponsor U.S. Fish and Wildlife Service research to identify bisazir residues (sterilant) in sea lamprey. Hopefully the radiation and bisazir will continue to be developed as agents for sterilization of male sea lamprey until such time as a decision on methods of choice can be knowledgeably made. The plan for integrated sea lamprey management was accepted. A small group will be convened to prepare a report for the Sea Lamprey Committee on the role of hormones and attractants/repellents in sea lamprey management.

#### *Fisheries and Environment Committee*

The Committee reported that a Commission brochure on lake trout rehabilitation is under active development. The Commission also adopted for use in hearings and by cooperators a "position on maintenance of fish habitat in the St. Marys Rapids."

Membership in the Board of Technical Experts was reviewed and eight individuals were appointed for 2-year terms. A report on Board functions and procedures has been received and will be reviewed. Further, the Fisheries and Environment Committee will work with Board members to develop a fish habitat advisory capability mechanism for handling broad issues and facilitating lake committee planning.

Planning is underway for Chairman Loftus's proposed symposium on prediction and assessment on available and realized fish harvest.

The Commission funded the first year of a study of causes of differential mortality of lake trout and has also partially funded the American Fisheries Society Urban Fishing Symposium.

#### *Finance and Administration Committee*

The Commission will send a letter to the IJC congratulating them on their first biennial report under the Great Lakes Water Quality

Agreement of 1978. A second letter will relay comments on the report and a third will offer to co-sponsor with the IJC a task force on indicators (e.g. lake trout) of healthy aquatic ecosystems.

ADJOURNMENT

The meeting was adjourned at 1245 h on 3 December 1982.

# BOARD OF TECHNICAL EXPERTS REPORT

F. W. H. Beamish, Chairman
Board of Technical Experts
*University of Guelph*
*Guelph, Ontario N1G 2W1*

The Board includes 15 members with voting privileges, two liaison Commissioners, Secretariat liaison and the chairman of the Council of Lake Committees as an ex-officio member. The Board is strongly committed to a proactive role in identifying and evaluating the needs of the Great Lakes Fishery Commission as well as the Great Lakes community as a whole. To this end the Board has, with the benefit of expert leadership, devoted considerable time to creative problem solving and the establishment of objectives conducive to the long term benefit of the Great Lakes. The Board has undertaken to prepare a Prospectus of Great Lakes Fishery Research not only to provide a current data base but also to delineate future research priorities.

The earlier Board initiatives in adaptive management, the Salmonid Community Workshop and the Lake Erie Fish Community Workshop have been published as Great Lakes Fishery Commission Special Reports, 82-2 and 83-1, respectively. Final reports on the Lake Trout Rehabilitation Model (from SLIS) and the Integrated Pest Management Workshop (held in August 1982) are near completion, again as special reports. A comprehensive evaluation of the adaptive management concept will be coordinated by the Board within the forthcoming year. Other Board initiatives include a Lake Trout Research Needs Workshop (scheduled for August 1983) and a Fisheries Assessment Symposium (scheduled for 1985).

BOTE reviewed a number of research proposals and supported two: causes of differential mortality of lake trout strains resulting from sea lamprey attack and development of techniques for aging sea lamprey.

Unification of the diverse discipline interests among the BOTE membership towards proactive objectives for the Great Lakes Fishery Commission will provide for stimulating and provocative recommendations in the future.

# SUMMARY OF MANAGEMENT AND RESEARCH[1]

## Reports From Lake Committees

This section examines 1982 highlights of fishery management and research activities and major changes in the status of fish stocks in the Convention Area as reported to the Commission's lake committees in the spring of 1983. Great Lakes state, provincial, and federal fishery agencies participate in lake committee meetings, which provide a forum for implementing coordinated management and research programs and scientific data exchange on fish stocks of common concern. A review of these activities by species follows.

### *LAKE TROUT*

Efforts to reestablish self-reproducing stocks of lake trout in the Great Lakes basin were intensified in 1982. The lake committees reexamined their goals relative to rehabilitating lake trout populations, and initiated a planning process to provide direction for conducting the rehabilitation program on a more coordinated basis.

The Council of Lake Committees (with Canadian members abstaining) reviewed the distribution agreement for lake trout reared in USFWS hatcheries and stocked in U.S. waters. In addition to retaining the formula used in the past for distributing lake trout produced in existing USFWS hatcheries, the Council agreed that the interim production from the new Iron River National Fish Hatchery (i.e. the fish reared during the early phase-in stage) would be stocked in Lake Michigan refuges. When the interim production exceeds one million yearlings, the accord will be renegotiated.

Progress in lake trout rehabilitation is reviewed for each lake as follows:

[1]Commercial fish landings by lake and species for 1982 are given in Tables 1–5.





*Lake Superior*—In 1982 a technical working committee that included representatives from each state, the Province of Ontario, the USFWS, and U.S. Indian tribes, was established and charged with reviewing long range goals for rehabilitation, developing recommendations on desirable strains of lake trout for stocking, determining an acceptable mortality rate, and suggesting management strategies for achieving rehabilitation. The technical committee would make recommendations on the charges and report back at the 1983 meeting of the lake committee.

In Michigan's inshore waters of Lake Superior, native lake trout comprised 37% of the 1982 assessment catch; total abundance (native plus hatchery trout) was down 35% from 1981. This decline reportedly resulted from increased fishing and reduced stocking.

Results from field studies of lake trout reproduction on two reefs in Presque Isle Harbor, Michigan were reported in 1982. An average of 6,663 fish (31% females) were estimated to have spawned on these reefs in 1977–80. Egg densities on the reefs varied from 122 to 518/m$^2$ and survival to the fry stage fluctuated between 9 and 16%.

Wisconsin biologists reported that the spawning run of lake trout on Gull Island Shoal in 1982 (13,270 fish) was slightly larger than in 1981. In Minnesota waters older lake trout are becoming more common in assessment catches; before 1972 no fish older than age 9 were observed, but during 1977–82 fish of ages 9–14 were taken in samples. Abundance of adult native lake trout remains low, (only 6% of adults in assessment samples), but increasing numbers of juvenile natives are encouraging.

Considerable progress in lake trout rehabilitation is also reported for Ontario waters of Lake Superior. The proportion of native fish in commercial lake trout catches varied widely according to locality, ranging from 9 to 100% in 1982.

Sea lamprey wounding rates on lake trout in Lake Superior have been edging upward since 1980, when rates were generally low (less than 5%). Wounding rates in one area, lower Keweenaw Bay, were reported to be as high in 1982 (near 50%) as those recorded before sea lamprey numbers were greatly reduced in 1962. The increase in wounding is thought to be related to reductions in lake trout abundance (from fishing), which leave fewer prey fish to support the residual stocks of sea lamprey.

*Lake Michigan*—The Lake Michigan Committee approved a proposal from its Lake Trout Technical Committee to develop a coordinated, interagency plan for achieving lake trout rehabilitation. The technical committee will recommend maximum allowable mortality rates, appropriate strains and strategies for stocking, and areas for designation as refuges. A report is expected for consideration at the 1983 meeting of the lake committee.

The technical committee reported that the lakewide catch of lake trout was 321,000 fish in 1981 (261,000 were caught in 1980). This amount is considered to be excessive, when combined with losses from sea lamprey predation and from natural causes, and may be the major reason that few lake trout in Lake Michigan survive past age 10—despite large stockings that commenced in 1965–66. Recruitment from natural reproduction has not been observed, and may be impeded by spawning stocks comprised of only 3 or 4 year-classes.

Sea lamprey wounding rates in northern Lake Michigan waters declined in 1982 following a sharp increase in 1981. Wounding rates remain low (less than 2%) in southern waters.

*Lake Huron*—Neither lake trout (Michigan waters) nor splake (a brook trout x lake trout hybrid stocked in Ontario waters) have been observed to reproduce successfully in Lake Huron. In Michigan, lake trout mortality was estimated at 76% for mature fish in northern waters where angler and tribal commercial fisheries operated, and at 54% in central waters where the angler fishery is very developed but commercial fishing is lacking. The treaty fishery reported a catch of 240,000 pounds of lake trout in 1982; comparable figures for the angler fishery were not available.

Sea lamprey wounding rates appeared to be down from 1981 in northern and central Lake Huron (main basin), but sample sizes may have been too small for an accurate assessment. Wounding rates in southern waters remained low (1.8–3.2%), although they increased somewhat from 1981 (0.9–1.5%).

*Lake Erie*—A Lake Trout Task Group was formed in 1980 to formulate goals and objectives for lake trout rehabilitation in Lake Erie. The task group was further directed by the Lake Erie Committee in 1981 to develop a management plan for lake trout. In 1982 the task group presented a plan for the U.S. waters of the eastern basin, but there was insufficient time for a review of the plan by the Standing Technical Committee (STC), a group of senior agency biologists who advise the lake committee and oversee the work of various task groups. Therefore, the lake committee tabled the plan pending a STC review.

Stocking of lake trout in the U.S. waters of the eastern basin began in 1969, but plantings of yearlings (an age considered to be optimum for planting) were small until 1978 and thereafter (exclude 1980), when an average of about 200,000 were planted. Therefore, significant spawning stocks resulting from the larger yearling plants have not had time to develop.

*Lake Ontario*—A progress report on the development of a plan for rehabilitating lake trout in Lake Ontario was presented to the Lake Ontario Committee by a technical subcommittee in 1982. In the preceding year a strategy for rehabilitation had been formulated by the subcommittee. The strategy outlined an objective of establishing a stock of 0.5–1.0 million adults from annual plantings of 2–3 million fish (1.5 million were stocked in 1981). Management initiatives relating to strain selection, hatchery practice, mortality regimes, and reproductive requirements are discussed in the progress report. A final plan is expected soon.



In Lake Ontario abundance of adult lake trout increased 130% from 1981 levels as a result of larger stockings begun in 1978. However, sea lamprey wounding rates on reference size classes of lake trout increased from 3–5% in 1981 to 8–13% in 1982. This increase was surprising because the acceptable level to which wounding rates declined in 1981, attributed to the treatment of the Black River in 1980, was expected to persist for several years. Sea lamprey-induced mortality on lake trout may be high; surveys conducted with bottom trawls in the fall of 1982 indicated that as many as 71,000 parasitized, dead lake trout were on the lake floor at that time. The magnitude of this loss indicates that additional sea lamprey control measures are needed for Lake Ontario.

### *LAKE WHITEFISH*

Whitefish landings which had reached a modern high from the upper Great Lakes in 1981, did so again in 1982, when a catch of 10.9 million pounds was reported. The 1982 catch exceeded that of 1981 by 10%, mainly as a result of larger catches in Lake Huron. Most of the improvement in 1981 had come from larger catches in Lake Michigan. Lake Superior catches decreased slightly in 1982, but are still above long term averages. Hence, whitefish stocks appear to be at very high levels of abundance in each of the upper lakes, and ths high abundance is in large part a result of the sea lamprey control program.

In the lower Great Lakes, whitefish stocks are reported to be improving in Lake Ontario and perhaps in Lake Erie, but numbers presently in each lake are only a small fraction of historical abundance levels.

### *LAKE HERRING*

Once considered one of the most prolific of fishes throughout the Great Lakes, the lake herring maintains a stronghold only in the Canadian waters of eastern Lake Superior. It was feared that fishing practices or the invasion of exotic species had precluded a recovery of remnant populations, but the appearance of strong year-classes each year 1978–80 in the Wisconsin and Minnesota waters of Lake Superior has considerably brightened the prospects for the recovery of this species.

### *CHUBS*

Chub stocks continue to improve in Lakes Michigan and Huron, but they are unchanged in Lake Superior. Adult chubs in Lake Michigan are reported to be 40 times as abundant in 1981 and 1982 as in 1973–77, when they were very scarce. Chub landings in Lake Michigan should soon increase as a result of larger catch quotas, and because the ban on the sale of chubs from the southeastern part of the lake will be lifted. Concentrations of dieldrin in chubs from the southeastern area formerly exceeded USFDA tolerance levels and led to the ban, but they have now dropped to acceptable levels.

Chub spawning stocks have improved in Lake Huron, largely because of a strong 1977 year class. Reproduction was also good in 1982, so chubs in the main basin appear to be recovering after almost two decades of very low abundance that followed fishery induced stock collapses in the early 1960s. A Lake Huron Chub Technical Committee was formed in 1981, and was charged with establishing areas for interagency management, assembling pertinent data, and determining key informational needs and management options.

Low market demand for Lake Superior chubs has caused catches in that lake to decline to 263,000 pounds, or only about 1/6 the average catch in the preceding decade. It appears that the recovery of chub fisheries in Lakes Michigan and Huron is responsible for the curtailed demand for Lake Superior chubs.

*PINK SALMON*

State of Michigan biologists reported that spawning runs of pink salmon occurred in 26 Lake Superior, 3 Lake Michigan and 3 Lake Huron tributaries during 1982, and that in Lake Superior 11% of the spawners were 3-year olds. Pink salmon were inadvertently released into Lake Superior streams in 1956, and because the species normally has a 2-year life cycle, major runs originally occurred only in odd-numbered years. However, slow growth rates in Lake Superior delayed maturity to 3 years in enough fish to start significant even-year runs, and even year spawning now occurs in each of the upper lakes.

Pink salmon have also spread to the lower Great Lakes, but even-year runs have not been reported in them.

*RAINBOW SMELT*

Smelt continue to decline in southwestern Lake Superior; they were so scarce in 1982 that they were not fished commercially at all in two Minnesota districts. By way of contrast, smelt remain abundant in Lakes Michigan and Huron because of good reproduction in 1980 and 1981.

The Canadian smelt fishery in Lake Erie continued to expand in 1982 with a record catch of 37.4 million pounds, a 23% increase from 1981, which was also a record year. Smelt reproduction was very successful in 1981 and in 1982, so that recruitment appears to be adequate to sustain the fishery.

Smelt remain dense in Lake Ontario, but they are not sought much by commercial fishermen.

*ALEWIFE*

Alewives are native only to Lake Ontario, and invaded the other Great Lakes following the construction of the Welland Canal, which bypasses Niagara Falls. In Lake Michigan alewives dominated the fish biomass in the 1950s and 1960s, but a recent decline has reduced them to the lowest level



since surveys began in 1973. Alewives also declined in Lake Huron, but not as severely as in Lake Michigan. Following major mortality in the winter of 1976–77, alewives in Lake Ontario increased their abundance rapidly, and reached their pre-dieoff level of density in 1981. Alewife abundance remained high in 1982.

*WHITE PERCH*

Not native to the Great Lakes, white perch are thought to have entered Lake Ontario via the Erie Barge Canal (opened to Lake Ontario in 1819) and Lake Erie via the Welland Canal (opened in 1829). In Lake Ontario the abundance of white perch has recently declined in association with an alewife population recovery.

White perch were first reported from Lake Erie in 1953, and numbers remained low until a strong year-class was produced in 1977. Each year since then, young-of-the-year white perch have been taken in assessment trawls, and concern is expressed that the species may proliferate and displace native fishes. White perch also reproduced in good numbers in Lake St. Clair in 1977. They have now entered the Lake St. Clair sport catch, 9,000 having been creeled in 1982.

White perch have not been reported from the upper lakes, but their colonization of the connecting waters between Lakes Erie and Huron suggests that an invasion of the upper lakes is imminent.

*WALLEYE*

Considerable management and research efforts are devoted to walleye in the Great Lakes, because the species is in great demand as a sport and food fish. Walleyes prefer shallower, warmer waters, and consequently are most abundant in embayments.

*Green Bay*—A total of 1.7 million walleye fingerlings and 28 million fry have been stocked in Sturgeon Bay (southeastern Green Bay) in alternate years beginning in 1973. The hatchery fish reproduced in the Bay in 1980, suggesting that the stocking program may be successful in re-establishing self-sustaining populations. In 1977 the stocking program was extended to the lower Fox River, the major tributary to Green Bay, and feral populations have been established there.

*Saginaw Bay*—Native walleye stocks collapsed in Saginaw Bay in the early 1940s, and the populations remained depresed for almost four decades. Planting of fingerlings was initiated in 1979 (0.3 million each year except none in 1980), and the 1979 and 1981 year-classes were commonly observed in sample catches in 1982. It is not known to what extent, if any, the hatchery fish are reproducing in the Bay.

*Lake St. Clair*—Abundance of adult walleyes in Lake St. Clair is high, due mainly to good reproduction in 1977, 1979, and 1980. The Thames River (a major tributary of Lake St. Clair) is used for spawning by walleyes inhabiting a wide geographical area, according to results of a study in which about 23,000 walleyes that entered the river to spawn during 1980–82 were tagged. Of over 3,000 tag returns to date, 40% came from fish caught in Lake St. Clair, 30% in the St. Clair River, 22% in southern Lake Huron, and 8% in the Detroit River and Lake Erie.

*Lake Erie*—The walleye stocks in Lake Erie's western basin are by far the largest of any in the Great Lakes, with the fishable portion estimated at 25 million fish in 1982. Based on recommendations from its Standing Technical Committee, the Lake Erie Committee approved a fishing rate of F = 0.285, which corrsponded to a catch quota of 5.7 million fish, for 1982. However, mainly because of underharvests in Ontario and Michigan, the actual catch in 1982 was 16% less than the quota, and the actual fishing rate was F = 0.238.

Recruitment of walleyes to the western basin populations continues at high levels with reports of a very strong 1982 year-class. However, stock size may be reaching a limit. Fish older than age-8 are appearing for the first time, weight at age is decreasing, and maturation is being delayed. Now only 9% of the age-2 females are spawning, whereas in the 1920s and in 1974–76 over 70% of this age group spawned.

*YELLOW PERCH*

Yellow perch are often associated with walleyes in the Great Lakes, and are considered to be equally valuable. In Green Bay commercial landings amounted to 600,000 pounds in 1982, compared with the 1972–81 average of only 463,000 pounds. However, fishing effort (mainly gill nets) jumped by 100%, and CPE's actually declined. New regulations (quotas, closed seasons, and closed areas) are being considered for 1983. Reproduction of yellow perch was good in 1982.

In Saginaw Bay the 1982 year-class of perch was reported to be the best since assessment trawling began in 1970. The commercial catch (155,000 pounds) in 1982 was 15% less than in 1981, probably as a result of a regulation put into effect in 1982 that increased the minimum size limit of commercially-caught perch from 8.0 to 8.5 inches.

With 10 million pounds landed by the commercial fishery in 1982, Lake Erie is the major producer of yellow perch in the Great Lakes. The 1982 catch was down by 1 million pounds from 1981 as a result of restrictions placed on Ohio's commercial fishery in the central basin. The new regulations are aimed at increasing numbers of spawners, in response to concerns of Ohio fishery managers with the lowered productivity since 1970 of the central basin stocks. Angler catches of perch remain high (3 million pounds in 1982) in Ohio's waters of Lake Erie.

A Yellow Perch Task Group presented management options to the Lake Erie Committee for rehabilitating central basin perch stocks. The report was taken under advisement and the task group was directed to develop a quota management scheme for the entire lake.



In Lake Ontario reproduction of perch has been poor for four consecutive years. The last good year-classes were produced in 1977 and 1978, immediately following a massive alewife mortality. It is speculated that in Lake Ontario when alewives are abundant, yellow perch (as well as white perch) reproduction is poor.

Table 1. Lake Superior commercial fish production in pounds for 1982.

| Species | Michigan | Wisconsin | Minnesota | U.S. Total | Ontario | Grand Total |
|---|---|---|---|---|---|---|
| Alewife | – | – | 2 | 2 | – | 2 |
| Burbot | 8,564 | 6,500 | 559 | 15,623 | 6,162 | 21,785 |
| Carp | 72 | – | – | 72 | – | 72 |
| Chubs | 92,021 | 114,416 | 17,140 | 223,577 | 39,509 | 263,086 |
| Lake herring | 23,352 | 96,655 | 186,038 | 306,045 | 2,002,267 | 2,308,312 |
| Lake sturgeon | – | – | – | – | 1,700 | 1,700 |
| Lake trout | 101,217 | 254,050 | 34,736 | 390,003 | 419,439 | 809,442 |
| Lake whitefish | 737,838 | 173,442 | – | 911,280 | 364,912 | 1,276,192 |
| Northern pike | – | – | – | – | 3,372 | 3,372 |
| Pacific salmon | – | – | – | – | 8,828 | 8,828 |
| Round whitefish | 1,392 | 335 | 1 | 1,728 | 46,617 | 48,345 |
| Smelt | 590 | 99,994 | 152,456 | 253,040 | 38,393 | 291,433 |
| Suckers | 27,878 | 3,605 | 4,560 | 36,043 | 274,493 | 310,536 |
| Walleye | – | – | – | – | 1,471 | 1,471 |
| Yellow perch | 254 | – | – | 254 | 134,409 | 134,663 |
| Total | 993,178 | 748,997 | 395,492 | 2,137,667 | 3,341,572 | 5,479,239 |

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| Yellow perch | 254 | – | – | 254 | 134,409 | 134,663 |
| Total | 993,178 | 748,997 | 395,492 | 2,137,667 | 3,341,572 | 5,479,239 |



Table 2. Lake Michigan commercial fish production in pounds for 1982.

| | Michigan | | | Wisconsin | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | Green Bay MM-1 | Michigan proper | Total | Green Bay WM-1,2 | Michigan proper | Total | Illinois | Indiana | Grand Total |
| Alewife | 1,694,592 | 733 | 1,695,325 | 1,728,588 | 18,734,676 | 20,463,264 | – | 1,307 | 22,159,896 |
| Bullheads | – | – | – | 27,548 | – | 27,548 | – | – | 27,548 |
| Burbot | 20,254 | 11,544 | 31,798 | 85,506 | 119 | 85,625 | – | 342 | 117,765 |
| Carp | – | 1,500 | 1,500 | 599,488 | 35,431 | 634,919 | – | – | 636,419 |
| Channel catfish | – | 2,681 | 2,681 | 286 | – | 286 | – | 76 | 3,043 |
| Chubs | 7,403 | 751,733 | 759,136 | 9,083 | 1,905,107 | 1,914,190 | 204,978 | 2,446 | 2,880,750 |
| Lake herring | – | 53 | 53 | – | – | – | – | 17 | 70 |
| Lake trout | 14,869 | 260,809 | 275,678 | – | – | – | – | 388 | 276,066 |
| Lake whitefish | 1,640,957 | 3,115,512 | 4,756,469 | 559,609 | 613,930 | 1,173,539 | – | 74 | 5,930,082 |
| Northern pike | – | – | – | 6,865 | – | 6,865 | – | – | 6,865 |
| Pacific salmon | 490 | 344 | 834 | – | – | – | – | 824 | 1,658 |
| Round whitefish | – | 168,963 | 168,963 | 3,107 | 57,525 | 60,632 | – | 111 | 229,706 |
| Smelt | 1,529,644 | 762 | 1,530,406 | 54,737 | 267,107 | 321,844 | – | 3,430 | 1,855,680 |
| Suckers | 741,317 | 68,851 | 810,168 | 230,113 | 4,629 | 234,742 | – | 6,162 | 1,051,072 |
| Walleye | 794 | 786 | 1,580 | 4 | – | 4 | – | – | 1,584 |
| White bass | – | – | – | 9,983 | – | 9,983 | – | – | 9,983 |
| Yellow perch | 36,196 | 1,850 | 38,046 | 576,338 | 46,796 | 623,134 | 84,818 | 493,143 | 1,239,141 |
| Total | 5,686,516 | 4,386,121 | 10,072,637 | 3,891,255 | 21,665,320 | 25,556,575 | 289,796 | 508,320 | 36,427,328 |

Table 3. Lake Huron commercial fish production in pounds for 1982.

| | Michigan | | | Ontario | | | | |
|---|---|---|---|---|---|---|---|---|
| Species | Huron proper | Saginaw Bay MH-4 | Total | Huron proper | Georgian Bay GB-1,2,3,4 | North Channel NC-1,2,3 | Total | Grand Total |
| Alewife | – | 1,479 | 1,479 | – | – | – | – | 1,479 |
| Bowfin | – | 504 | 504 | – | 240 | – | 240 | 744 |
| Buffalo fish | – | 1,456 | 1,456 | – | – | – | – | 1,456 |
| Bullheads | – | 7,632 | 7,632 | 21 | 647 | 19 | 687 | 8,319 |
| Burbot | 740 | 328 | 1,068 | 3,119 | 9,843 | 2,931 | 15,893 | 16,961 |
| Carp | 885 | 726,262 | 727,147 | 28,259 | 2,852 | 6,319 | 37,430 | 764,577 |
| Channel catfish | 6,244 | 669,414 | 675,658 | 39,459 | 477 | 196 | 40,132 | 715,790 |
| Chubs | – | – | – | 430,532 | 126,137 | 36 | 556,705 | 556,705 |
| Crappie | – | 11,226 | 11,226 | – | – | – | – | 11,226 |
| Garfish | – | 309 | 309 | – | – | – | – | 309 |
| Gizzard shad | – | – | – | 3,243 | – | – | 3,243 | 3,243 |
| Lake herring | 2,825 | – | 2,825 | 8,155 | 25,763 | 8,953 | 42,871 | 45,696 |
| Lake sturgeon | – | – | – | 3,542 | 514 | 4,906 | 8,962 | 8,962 |
| Lake trout | 232,743 | – | 232,743 | 39,178 | 1,221 | 2,995 | 43,394 | 276,137 |
| Lake whitefish | 1,544,876 | 77,167 | 1,622,043 | 1,559,714 | 171,657 | 379,087 | 2,110,458 | 3,732,501 |
| Northern pike | – | – | – | 921 | 4,287 | 19,106 | 24,314 | 24,314 |
| Pacific salmon | – | – | – | 10,491 | 232 | 2,302 | 13,025 | 13,025 |
| Quillback | – | 80,430 | 80,430 | – | – | – | – | 80,430 |
| Rock bass | – | 682 | 682 | 404 | 407 | 875 | 1,686 | 2,368 |
| Round whitefish | 22,608 | 15,895 | 38,503 | 9,259 | 20,177 | 1,591 | 31,027 | 69,530 |
| Sauger | – | – | – | – | 240 | 48 | 288 | 288 |
| Sheepshead | 15 | 35,137 | 35,152 | 43,433 | – | – | 43,433 | 78,585 |
| Smelt | – | 27,023 | 27,023 | 164 | 275 | – | 439 | 27,462 |
| Splake | – | – | – | 494 | 83,929 | 5,070 | 89,493 | 89,493 |
| Suckers | 9,505 | 141,609 | 151,114 | 139,419 | 43,363 | 60,787 | 243,569 | 394,683 |
| Walleye | 13,675 | – | 13,675 | 258,964 | 19,376 | 44,966 | 323,306 | 336,981 |
| White bass | – | 1,725 | 1,725 | 12,671 | – | – | 12,671 | 14,396 |
| Yellow perch | 3,147 | 155,244 | 158,391 | 300,806 | 86,215 | 87,006 | 474,027 | 632,418 |
| Total | 1,837,263 | 1,953,522 | 3,790,785 | 2,892,248 | 597,852 | 627,193 | 4,117,293 | 7,908,078 |

Table 4. Lake Erie commercial fish production in pounds for 1982.

| Species | Michigan | New York | Ohio | Pennsylvania | U.S. Total | Ontario | Grand Total |
|---|---|---|---|---|---|---|---|
| Bowfin | – | – | – | – | – | 23,200 | 23,200 |
| Buffalo | 22,474 | – | 36,054 | – | 58,528 | – | 58,528 |
| Bullheads | 58 | 1,202 | 63,025 | 314 | 64,599 | 49,300 | 113,899 |
| Burbot | – | – | – | 347 | 347 | – | 347 |
| Carp | 678,096 | 664 | 906,296 | 126 | 1,585,182 | 43,208 | 1,628,390 |
| Channel catfish | 20,354 | 179 | 217,641 | 881 | 239,055 | 70,017 | 309,072 |
| Crappie | – | – | – | – | – | 12,014 | 12,014 |
| Eel | – | – | – | – | – | 45 | 45 |
| Gizzard shad | 76,000 | 980 | 161,698 | 7,979 | 246,657 | 3,750 | 250,407 |
| Goldfish | – | – | 11,159 | – | 11,159 | – | 11,159 |
| Lake herring | – | 40 | – | – | 40 | – | 40 |
| Lake sturgeon | – | – | – | – | – | 1,049 | 1,049 |
| Lake trout | – | – | – | – | – | 3,461 | 3,461 |
| Lake whitefish | – | 7 | – | 340 | 347 | 26,733 | 27,080 |
| Northern pike | – | – | – | – | – | 53,202 | 53,202 |
| Pacific salmon | – | – | – | – | – | 36,612 | 36,612 |
| Quillback | 1,430 | – | 113,717 | – | 115,147 | – | 115,147 |
| Rock bass | – | 295 | – | – | 295 | 29,418 | 29,713 |
| Sheepshead | 608 | 41,112 | 781,660 | 241,140 | 1,064,520 | 421,223 | 1,485,743 |
| Sauger | – | – | – | – | – | 201 | 201 |
| Shiners | – | – | – | 7,947 | 7,947 | – | 7,947 |
| Smelt | – | 1,383 | – | 17,619 | 19,002 | 43,547,365 | 43,566,367 |
| Suckers | 178 | 20,396 | 42,231 | 18,638 | 81,443 | 15,043 | 96,486 |
| Sunfish | – | 61,734 | – | – | 61,734 | 58,729 | 120,463 |
| Walleye | – | 47,745 | – | 6,338 | 54,083 | 2,020,883 | 2,074,966 |
| White bass | 1,742 | 30 | 603,691 | 73,624 | 679,087 | 3,458,005 | 4,137,092 |
| White perch | – | – | 26,935 | 1,439 | 28,374 | 9,347 | 37,721 |
| Yellow perch | – | 118,392 | 244,934 | 203,988 | 567,314 | 9,186,462 | 9,753,776 |
| Total | 800,940 | 294,159 | 3,209,041 | 580,720 | 4,884,860 | 59,069,267 | 63,954,127 |

Table 5. Lake Ontario commercial fish production in pounds for 1982.

| Species | New York | Ontario | Grand Total |
|---|---|---|---|
| Bowfin | 70 | 167 | 237 |
| Bullheads | 40,125 | 241,264 | 281,389 |
| Carp | 2,368 | 29,153 | 31,521 |
| Channel catfish | 1,986 | 25,968 | 27,954 |
| Crappie | 2,777 | 17,768 | 20,545 |
| Eel | 79,401 | 64,656 | 144,057 |
| Gizzard shad | – | 242 | 242 |
| Lake herring | 14 | 4,829 | 4,843 |
| Lake sturgeon | – | 593 | 593 |
| Lake trout | – | 87 | 87 |
| Lake whitefish | 2 | 22,268 | 22,270 |
| Northern pike | 55 | 18,535 | 18,590 |
| Pacific salmon | – | 139 | 139 |
| Rock bass | 13,501 | 12,547 | 26,048 |
| Round whitefish | – | 315 | 315 |
| Sheepshead | 379 | 6,712 | 7,091 |
| Smelt | 14 | 81,660 | 81,674 |
| Suckers | 2,776 | 26,611 | 29,387 |
| Sunfish | 7,682 | 153,711 | 161,393 |
| Walleye | 54 | 3,468 | 3,522 |
| White bass | 137 | 15,795 | 15,932 |
| White perch | 53,612 | 75,250 | 128,862 |
| Yellow perch | 89,814 | 1,197,259 | 1,287,073 |
| Total | 294,767 | 1,998,997 | 2,293,764 |

# GREAT LAKES FISH DISEASE CONTROL COMMITTEE REPORT

J. W. Warren, Chairman
Great Lakes Fish Disease Control Committee
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*La Crosse, Wisconsin 54601*

The major committee accomplishment of 1982 was the completion of the edited text of "A Guide to Integrated Fish Health Management in the Great Lakes Basin." This new 262-page book will contain 27 chapters written by a total of 19 contributors. It is directed at an audience of fish culturists, fish pathologists, resource administrators, students and interested lay persons. The "Guide" will serve to flesh out the fish health protection guidelines established by the Commission in 1975.

Al Sippel, fish pathologist for the Ontario Ministry of Natural Resources prepared an excellent resume of the objectives and activities of the Great Lakes Fish Disease Control Committee for a workshop on the health of fish populations held in Geneva Park, Ontario in November 1981. The paper was distributed to all Great Lakes agencies and submitted to the American Fisheries Society for publication in the March–April 1982 issue of "Fisheries."

In response to the first known North American outbreak of proliferative kidney disease (PKD), the Committee recommended Commission action to officially list the disease as an Emergency Disease under the provisions of the Great Lakes Fish Disease Control Program. The Commission accepted this recommendation at the 1982 annual meeting, establishing a basin-wide policy to support the prompt implementation of disease eradication procedures in the event PKD is diagnosed in cultured fish in the Great Lakes basin.

Communications between members of the GLFDCC brought to light larger than usual post swim-up losses of fall chinook salmon early in the year. Data were reviewed at the April annual meeting of the committee.





Following a lengthy discussion and the layout of a proposed course of action, an "Early Mortality Sub-Committee" was named. Dr. John Schachte, fish pathologist for New York, was selected to chair the work group. The Sub-committee went right to work, gathered extensive preliminary information and met to review progress in November. A questionnaire to help sort out field data has been circulated.

In an effort to improve communications with the private sector of fish culture and with the public at large, a project was initiated to develop a colorful brochure highlighting the contribution to the advancement of fisheries resources programs made by the Great Lakes Fish Disease Control Program. In addition, committee members, Mr. Clayton Lakes of Ohio and Mr. John Daily of Minnesota, developed an updated listing of fish disease control regulations affecting interstate and international transport of fish. This material will help public and private fish haulers alike and will facilitate compliance with regulatory programs.

# 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 1982, about 36 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 wounding of survivors. In Lake Erie there is no clear evidence that the sea lamprey population causes high mortality of planted salmon and trout; the relatively low numbers of sea lamprey in Lake Erie is usually attributed to the scarcity of suitable streams for spawing, although improved water quality in some streams is increasing the reproductive potential of the sea lamprey.

Most of the rainbow, brook, and brown trout, and all of the Pacific salmon plantings are aimed at the recreational fishery. On the other hand, most lake trout and 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 panfish and bass, it was estimated that the economic impact of the Great Lakes recreational fishery is $1 billion annually. The economic impact of the non-native commercial fishing industry, which harvests relatively few of the stocked salmonids, has been estimated at $160 million (Talhelm, 1979).

Article IV(A) of the Convention on Great Lakes Fisheries charges the Great Lakes Fishery Commission to determine measures for continued productivity of desirable fish species in the Convention area. The Commission views securing fish communities based on foundations of self-sustaining stocks as the ultimate goal of this charge, and believes that stocking with hatchery-reared lake trout is an essential step towards achieving self-sustaining lake trout populations—a major Commission objective. It is an objective which is being increasingly realized in Lake Superior, and possibly, on the verge of being realized in Lakes Michigan and Huron, and even Lake Ontario.





Lake trout have been planted annually in Lake Superior since 1958, in Lake Michigan since 1965 in Lake Huron and Erie since 1969, and in Lake Ontario since 1972. These fish are provided by the U.S. Fish and Wildlife Service, the Great Lakes states of Michigan, Wisconsin, Minnesota and New York, and the Province of Ontario. Lake trout eggs are largely obtained from brood fish in hatcheries, and, to a lesser extent mature lake trout from inland lakes and Lakes Superior and Ontario. Nearly all trout are reared to yearlings (ca. 30/pound) and planted during the spring and early summer. Some, however, are planted as fingerlings in fall. Despite certain advantages (related to hatchery production) associated with stocking in the fall, the procedure has not been used extensively; studies have shown that lake trout planted in fall as fingerlings generally do not survive nearly as well as those stocked in spring as yearlings. The higher mortality of fall-stocked fish is commonly believed to be related to their smaller size at time of planting. The Ontario Ministry of Natural Resources plans to study relative survival rates of 1981–1987 year-classes fingerlings and yearlings in Lake Superior.

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 milt also was used to fertilize lake trout egs 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 to have 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 1979. The Province of Ontario continued to plant highly selected splake through 1982 but also made a small planting of lake trout. Survival of Ontario's splake has improved dramatically in recent years, following hatchery cleanup and an adjustment in genetic content in favour of lake trout.

Lake trout broodstock came to be increasingly scrutinized subsequent to the 1980 Stock Concept Symposium, and as early results became available from experimental plantings in Lake Michigan of Green Lake trout, and in Lake Ontario of three strains of lake trout (Clearwater Lake, Lake Superior, and Seneca Lake strains). Choice and handling of broodstock will doubtlessly figure large in future hatchery programming, and in management plans. (See Management and Research Section.)

Table 1 summarizes annual plantings of lake trout and hybrids in the Great Lakes, and Table 2 details the 1982 plants in each of the Great Lakes. Other small experimental plants of first generation splake and backcrosses have been made by Wisconsin, Michigan, and Minnesota in Lake Superior (Table 3) with the objective of providing a nearshore fishery; these plants are not thought to contribute to offshore populations.

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 1982 coho plantings.

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 1982 plantings in each of the Great Lakes.

In 1972, Michigan and Wisconsin inaugurated plants of Atlantic salmon in the Upper Great Lakes. Table 8 summarizes Atlantic salmon plantings in the Great Lakes 1972–1982.

Plantings of rainbow and steelhead trout, brown trout, and brook trout have been continued in the Great Lakes over the years, but were not included in these records prior to 1975 (1976 for brook trout) 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 inclusion of rainbow and steelhead trout, brown trout, and brook trout plantings in the Annual Report. Table 9 summarizes the annual plantings of rainbow and steelhead trout for 1975 through 1982, and Table 10 details the 1982 plantings. Table 11 summarizes annual plantings of brown trout for 1975 through 1982, and Table 12 details the 1982 plantings. Brook trout plantings were included for the first time in 1976 (Table 13). Table 14 details the 1982 plantings of brook trout.

The grid number system developed by Stan Smith and others in the early 1970s, is used in the Annual Report series, in order to assist readers in the location of planting sites. Copies of Great Lakes maps with superimposed numbered grids are available through the Secretariat.

The abbreviations SF, FF, F, Y, and A designate ages of planted fish. Their respective meanings are fingerlings planted in the spring, fingerlings planted in the fall, fingerlings, yearlings, and adults.

Coded wire tag numbers appear under the "Fin Clip/Mark" heading in Table 2 as "CWT (agency code) first data row/second data row."

## LITERATURE

Talhelm, D. R., R. C. Bishop, K. W. Cox, N. W. Smith, D. N. Steinnes, and A. L. W. Tuomi. 1979. Current estimates of Great Lakes fisheries values: 1979 status report. Great Lakes Fishery Commission. Ann Arbor, Michigan. Rep. 79–1: 17 pp. (Mineo.)



Table 1. Annual plantings (in thousands) of lake trout, splake[1,2] and backcrosses[3] in the Great Lakes, 1958–1982.

| | 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 |
| 1978 | 855 | 622 | 355 | 630 | 2,461 |
| 1979 | 1,055 | 508 | 314 | 526 | 2,403 |
| 1980 | 778 | 522 | 351 | 759 | 2,409 |
| 1981 | 714 | 639 | 312 | 1,014 | 2,679 |
| 1982 | 894 | 508 | 235 | 1,198 | 2,835 |
| Subtotal | 26,227 | 10,036 | 5,943 | 14,660 | 56,864 |
| | LAKE MICHIGAN | | | | |
| Year | Michigan | Wisconsin | Illinois | Indiana | Total |
| 1965 | 1,069 | 205 | – | – | 1,274 |
| 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 |
| 1978 | 1,304 | 994 | 116 | 175 | 2,589 |
| 1979 | 1,216 | 943 | 162 | 176 | 2,497 |
| 1980 | 1,375 | 1,255 | 87 | 174 | 2,891 |

Table 1. (Cont'd.)

| Year | Michigan | Wisconsin | Illinois | Indiana | Total |
|---|---|---|---|---|---|
| | LAKE MICHIGAN | | | | |
| 1981 | 1,459 | 831 | 173 | 172 | 2,635 |
| 1982 | 1,305 | 1,022 | 204 | 216 | 2,746 |
| Subtotal | 20,689 | 17,181 | 2,160 | 2,329 | 42,355 |

LAKE HURON

| Year | Michigan | | | Ontario | | | Total |
|---|---|---|---|---|---|---|---|
| | Lake trout | Splake | Backcrosses | Lake trout | Splake | Backcrosses | |
| 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 |
| 1978 | 1,217 | – | – | 15 | 175 | – | 1,407 |
| 1979 | 1,338 | – | – | 15 | 798 | – | 2,151 |
| 1980 | 1,381 | – | – | – | 561 | – | 1,941 |
| 1981 | 1,340 | – | – | 49 | 680 | – | 2,068 |
| 1982 | 1,340 | – | – | 9 | 926 | – | 2,275 |
| Subtotal | 11,148 | 332 | 736 | 103 | 6,994 | 61 | 19,372 |

LAKE ERIE

| Year | Pennsylvania | New York | Total |
|---|---|---|---|
| 1969 | 17 | – | 17 |
| 1974 | 26 | – | 26 |
| 1975 | 34 | 150 | 184 |
| 1976 | 16 | 186 | 202 |
| 1977 | – | 125 | 125 |
| 1978 | 118 | 118 | 236 |
| 1979 | 355 | 355 | 709 |
| 1980 | 168 | 339 | 507 |
| 1981 | 20 | 20 | 41 |
| 1982 | 97 | 139 | 235 |
| Subtotal | 851 | 1,432 | 2,282 |



Table 1. (Cont'd.)

LAKE ONTARIO

| Year | Ontario | | New York | Total |
|---|---|---|---|---|
| | Splake | Lake trout | Lake trout | |
| 1972 | 48 | – | – | 48 |
| 1973 | 39 | – | 66 | 105 |
| 1974 | 26 | – | 644 | 670 |
| 1975 | – | – | 514 | 514 |
| 1976 | 6 | 194 | 337 | 537 |
| 1977 | – | 288 | 298 | 586 |
| 1978 | – | 200 | 1,043 | 1,243 |
| 1979 | – | 201 | 686 | 887 |
| 1980 | – | 383 | 1,194 | 1,577 |
| 1981 | – | 387 | 1,146 | 1,533 |
| 1982 | – | 391 | 1,259 | 1,650 |
| Subtotal | 119 | 2,044 | 7,187 | 9,350 |
| Great Lakes Total, lake trout, splake and backcrosses, 1958–1982 | | | | 130,223 |

[1]Lake trout × brook trout hybrid.
[2]Excludes small experimental splake plants by Michigan and Wisconsin in Lake Superior (see Table 3).
[3]Lake trout × splake hybrid, (see text).

Table 2. Plantings of lake trout and splake[1] in the Great Lakes, 1982.

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| **LAKE SUPERIOR-LAKE TROUT** | | | | |
| Michigan waters | | | | |
| Anna River | 1633 | 25,000[2] | Y | right ventral |
| Big Bay Reef | 1328 | 25,000[2] | Y | right ventral |
| Black River | 1413 | 25,000[2] | Y | right ventral |
| Copper Harbor | 0926 | 25,000[2] | Y | right ventral |
| Grand Marais Reef | 1437 | 25,000[2] | Y | right ventral |
| Laughing Fish Point | 1531 | 75,300[3] | Y | right ventral |
| Loma Farms | 1428 | 25,000[2] | Y | right ventral |
| Manitou Island | 1028 | 59,700[3] | Y | right ventral |
| McLain State Park | 1122 | 25,000[2] | Y | right ventral |
| Ontonagon River | 1318 | 25,000[2] | Y | right ventral |
| Partridge Island Reef | 1529 | 65,100[3] | Y | right ventral |
| Pequaming | 1323 | 92,900 | FF | adipose-right pectoral |
| Point Abbaye Reef | 1325 | 75,000[2] | Y | right ventral |
| Presque Isle Harbor | 1529 | 75,000[2] | Y | right ventral |
| Shelter Bay | 1632 | 25,000[2] | Y | right ventral |
| Tahquamenon Island Reef | 1544 | 125,512[3] | FF | adipose-right pectoral |
| Traverse Island Reef | 1224 | 75,400[3] | Y | right ventral |
| Union Bay | 1316 | 25,000[2] | Y | right ventral |
| Subtotal | | 893,912 | | |
| Minnesota waters | | | | |
| Beaver Bay | 1106 | 33,155[2] | FF | adipose dorsal |
| French River | 1302 | 24,100 | Y | right ventral |
| Grand Marais | 811 | 39,000 | FF | dorsal left pectoral |
| Knife River | 1302 | 39,000 | FF | dorsal left pectoral |
| Two Harbors | 1303 | 100,000 | Y | adipose left ventral |
| Subtotal | | 235,255 | | |
| Ontario waters | | | | |
| Battle Island | 228 | 7,280[3] | Y | right ventral |
| Boone Island | 128 | 3,640[3] | Y | right ventral |
| Buck Island South | 320 | 26,600[3] | Y | right ventral |
| Caribou Island | 320 | 90,420[3] | Y | right ventral |
| Cat Island | 229 | 13,186[3] | Y | right ventral |
| Channel Island | 229 | 8,372[3] | Y | right ventral |
| Cobinosh Island | 228 | 3,458[3] | Y | right ventral |
| Coldwell | 234 | 122,829 | Y | right ventral |
| Copper Island | 229 | 7,280[3] | Y | right ventral |
| Detention Island | 234 | 3,462[3] | Y | right ventral |
| Foster Island | 234 | 3,462[3] | Y | right ventral |
| Harry Island | 228 | 4,080[3] | Y | right ventral |



Table 2. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Healey Island | 229 | 8,372[3] | Y | right ventral |
| Inner Island | 320 | 35,690[3] | Y | right ventral |
| Jackpine River | 475 | 1,770 | 6 yr | adipose |
| Lambert Island | 320 | 4,810[3] | Y | right ventral |
| Lapoints | 1447 | 40,000 | Y | right ventral |
| Mamainse Point | 1245 | 41,200 | Y | right ventral |
| Maple Island | 1446 | 43,800[3] | Y | right ventral |
| Mary Island | 320 | 67,340[3] | Y | right ventral |
| Michipicoten Harbor | 744 | 47,593 | Y | right ventral |
| Minnie Island | 228 | 9,723[3] | Y | right ventral |
| Montreal River | 1145 | 50,000 | Y | right ventral |
| Morning Harbour | 228 | 6,120[3] | Y | right ventral |
| Nicol Island | 128 | 6,121[3] | Y | right ventral |
| Nipigon River | 124 | 40 | 6 yr | adipose |
| Palette Island | 320 | 29,890[3] | Y | right ventral |
| Papoose Island | 418 | 6,190[3] | Y | right ventral |
| Papoose Island | 418 | 29,240[3] | Y | right ventral |
| Pie Island | 518 | 206,220[3] | FF | adipose-left pectoral |
| Quarry Island | 228 | 12,167[3] | Y | right ventral |
| Rossport Dock | 228 | 135,180 | Y | right ventral |
| Rossport Point | 128 | 11,305 | Y | right ventral |
| Salter Island | 228 | 25,232[3] | Y | right ventral |
| Silver Harbor | 320 | 16,000 | Y | right ventral |
| Sinclair Cove | 1045 | 27,415 | Y | right ventral |
| Tracy Shoal | 228 | 8,372 | Y | right ventral |
| Wilson Island | 228 | 13,181[3] | Y | right ventral |
| Ypres Point | 235 | 20,758 | Y | right ventral |
| Subtotal | | 1,197,798 | | |
| Wisconsin waters | | | | |
| Bayfield | 1409 | 113,700 | Y | right ventral |
| Devil's Island | 1209 | 180,000[2] | FF | dorsal right ventral |
| Saxon Harbor | 1511 | 85,800 | Y | adipose |
| Superior Entry | 1401 | 128,400 | Y | right ventral |
| Subtotal | | 507,900 | | |
| Total, Lake Superior | | 2,834,865 | | |
| **LAKE MICHIGAN-LAKE TROUT** | | | | |
| Illinois waters | | | | |
| Julian's Reef | 2403 | 52,000[3] | FF | both ventral |
| Julian's Reef | 2403 | 151,800[3] | Y | adipose left pectoral |
| Subtotal | | 203,800 | | |

Table 2. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Indiana waters | | | | |
| Burn's Harbor | 2707 | 63,000 | FF | adipose |
| Burn's Harbor | 2707 | 76,250 | Y | right ventral |
| East Chicago | 2705 | 38,100 | Y | right ventral |
| Michigan City | 2707 | 38,200 | Y | right ventral |
| Subtotal | | 215,550 | | |
| Michigan waters | | | | |
| Acme | 916 | 83,200 | FF | adipose |
| Benton Harbor | 2509 | 91,000 | Y | right ventral |
| Charlevoix | 616 | 83,500 | FF | adipose |
| Escanaba | 306 | 45,000[2] | Y | right ventral |
| Frankfort | 1011 | 74,700 | Y | right ventral |
| Good Harbor Bay Reef | 814 | 28,000[3] | FF | right ventral, left ventral |
| Grand Haven | 1911 | 85,600 | Y | right ventral |
| Greilickville | 915 | 111,000 | FF | adipose |
| Harbor Springs | 519 | 24,900 | Y | right ventral |
| Holland | 2111 | 90,900 | Y | right ventral |
| Little Bay de Noc | 306 | 45,000[2] | Y | right ventral |
| Ludington | 1410 | 68,000 | Y | right ventral |
| Manistee | 1211 | 90,300 | Y | right ventral |
| Montague | 1710 | 68,000 | Y | right ventral |
| Muskegon Reef | 1810 | 78,500[3] | Y | right ventral |
| Pentwater Lake | 1510 | 68,000 | Y | right ventral |
| Petoskey | 518 | 50,400 | Y | right ventral |
| South Fox Island | 513 | 28,000[3] | FF | right ventral, left ventral |
| South Haven | 2311 | 91,000 | Y | right ventral |
| Subtotal | | 1,305,000 | | |
| Wisconsin waters | | | | |
| Black Can Reef | 905 | 218,200[3] | Y | adipose left pectoral |
| Kewaunee | 1104 | 85,000[3] | Y | left pectoral |
| Manitowoc Reef | 1303 | 132,870[3] | FF | both ventral |
| Manitowoc | 1303 | 64,800[3] | Y | right ventral |
| Northeast Reef | 1803 | 33,077[2,3] | FF | dorsal left ventral |
| Northeast Reef | 1803 | 92,700[3] | FF | right pectoral, left ventral |
| Northeast Reef | 1803 | 180,500[3] | Y | adipose left pectoral |
| Sheboygan Reef | 1705–1706 | 100,300[3] | Y | adipose left pectoral |
| Sheboygan | 1502 | 48,000 | Y | right ventral |
| Wind Point | 2102 | 16,340[2] | FF | dorsal right ventral |
| Wind Point | 2102 | 50,000 | Y | right ventral |
| Subtotal | | 1,021,787 | | |
| Total, Lake Michigan | | 2,746,137 | | |



Table 2. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| LAKE HURON-LAKE TROUT AND SPLAKE | | | | |
| Michigan waters (lake trout) | | | | |
| Black River Island | 1010 | 89,700[3] | Y | left pectoral |
| Detour Ferry Dock | 306 | 44,830 | FF | left ventral |
| Greenbush | 1110 | 90,700 | Y | left pectoral |
| Grindstone City | 1412 | 91,450 | Y | left pectoral |
| Hammond Bay | 505 | 66,000 | Y | left pectoral |
| Harbor Beach | 1514 | 76,000 | Y | left pectoral |
| Lexington Harbor | 1915 | 23,500 | FF | right ventral, left ventral |
| Middle Entrance Reef | 303 | 93,000[3] | FF | left ventral |
| Middle Island Reef | 709 | 50,300[3] | Y | left pectoral |
| Oscoda | 1210 | 90,300 | Y | left pectoral |
| Point Lookout | 1408 | 75,550 | Y | left pectoral |
| Port Austin | 1411 | 50,000 | Y | left pectoral |
| Port Sanilac | 1814 | 48,500 | Y | left pectoral |
| Rogers City | 607 | 100,000 | Y | left pectoral |
| Round Island Shoal | 302 | 100,700[3] | FF | right ventral, left ventral |
| Scarecrow Island | 910 | 89,600[3] | Y | left pectoral |
| Sturgeon Point Reef | 1010 | 70,000[3] | Y | left pectoral |
| Tawas Point | 1309 | 90,300 | Y | left pectoral |
| Subtotal | | 1,340,430 | | |
| Ontario waters (lake trout) | | | | |
| McGregor Bay | 219 | 2,000 | Y | right pectoral |
| South Bay | 418 | 7,148 | Y | right pectoral |
| Subtotal | | 9,148 | | |
| Ontario waters (splake) | | | | |
| Boucher Point | 1126 | 34,846 | Y | left ventral |
| Cape Dundas | 925 | 38,548 | Y | left ventral |
| Fisher Harbor | 318 | 2,400 | Y | left ventral |
| Griffith Island | 1024 | 31,441 | Y | left ventral |
| Heywood Island | 319 | 131,000[3] | Y | left ventral |
| Jackson Shoal | 822 | 47,405 | Y | left ventral |
| Manitowaning Dock | 318 | 400 | Y | left ventral |
| Mary Ward Ledges | 1128 | 122,147[3] | Y | left ventral |
| Meaford Range | 1126 | 100,095 | Y | left ventral |
| Mowat Island | 628 | 43,190 | Y | left ventral |
| Parry Sound Harbor | 629 | 12,024 | Y | left ventral |
| Pyette Point | 1025 | 101,025 | Y | left ventral |
| Sheguiandah Dock | 318 | 3,880 | Y | left ventral |
| South Bay | 617 | 14,800 | Y | left ventral |
| Wall Island | 628 | 41,681 | Y | left ventral |

Table 2. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| White Cloud Island | 1024 | 78,178 | Y | left ventral |
| Vail Point | 1025 | 122,550 | Y | left ventral |
| Subtotal | | 925,610 | | |
| Total, Lake Huron | | 2,275,188 | | |
| **LAKE ERIE-LAKE TROUT** | | | | |
| New York waters | | | | |
| Barcelona | 424 | 15,650 | FF | left pectoral |
| Barcelona | 424 | 40,500[3] | Y | adipose–CWT(60)41/50 |
| Barcelona | 424 | 40,550[3] | Y | adipose–CWT(60)41/53 |
| Barcelona | 424 | 8,024 | Y | left pectoral |
| Barcelona | 424 | 33,940 | Y | left pectoral–right ventral |
| Subtotal | | 138,664 | | |
| Pennsylvania waters | | | | |
| New York border | 424 | 15,650 | FF | left pectoral |
| New York border | 522 | 40,500[3] | Y | adipose–CWT (60)41/54 |
| New York border | 522 | 40,550[3] | Y | adipose–CWT (60)41/51 |
| Subtotal | | 96,700 | | |
| Total, Lake Erie | | 235,364 | | |
| **LAKE ONTARIO-LAKE TROUT** | | | | |
| New York waters | | | | |
| Dablon Point | 322 | 37,600 | Y | adipose-CWT(60)41/52 |
| Dablon Point | 322 | 40,800 | Y | adipose-CWT(60)42/2 |
| Dablon Point | 322 | 40,550 | Y | adipose-CWT(60)41/33 |
| Dablon Point | 322 | 52,250 | Y | left ventral |
| Hamlin | 713 | 40,500 | Y | adipose-CWT(60)41/60 |
| Hamlin | 713 | 40,550 | Y | adipose-CWT(60)41/61 |
| Hamlin | 713 | 40,500 | Y | adipose-CWT(60)41/48 |
| Hamlin | 713 | 41,000 | FF | adipose-CWT(60)42/6 |
| Hamlin | 713 | 55,410 | Y | left ventral |
| Niagara | 806 | 40,550 | Y | adipose-CWT(60)41/49 |
| Niagara | 806 | 40,550 | Y | adipose-CWT(60)41/62 |
| Niagara | 806 | 40,550 | Y | adipose-CWT(60)41/63 |
| Niagara | 806 | 41,000 | FF | adipose-CWT(60)42/7 |
| Niagara | 806 | 55,410 | Y | left ventral |
| Selkirk | 623 | 40,700 | Y | adipose-CWT(60)41/57 |
| Selkirk | 623 | 40,500 | Y | adipose-CWT(60)41/56 |
| Selkirk | 623 | 40,450 | Y | adipose-CWT(60)41/46 |
| Selkirk | 623 | 41,000 | FF | adipose-CWT(60)42/4 |



Table 2. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Selkirk | 623 | 55,800 | Y | left ventral |
| Sodus | 818 | 40,600 | Y | adipose-CWT(60)41/59 |
| Sodus | 818 | 40,600 | Y | adipose-CWT(60)41/58 |
| Sodus | 818 | 40,500 | Y | adipose-CWT(60)41/47 |
| Sodus | 818 | 41,200 | FF | adipose-CWT(60)42/5 |
| Sodus | 818 | 55,800 | Y | left ventral |
| Stony Point | 422 | 41,000 | FF | adipose-CWT(60)42/3 |
| Stony Point | 422 | 40,500 | Y | adipose-CWT(60)42/1 |
| Stony Point | 422 | 40,500 | Y | adipose-CWT(60)41/55 |
| Stony Point | 422 | 40,500 | Y | adipose-CWT(60)41/45 |
| Stony Point | 422 | 52,250 | Y | left ventral |
| Subtotal | | 1,259,120 | | |
| Ontario waters | | | | |
| Grimsby Harbor | 803 | 89,830 | Y | adipose right ventral |
| Main Duck Islands | 421 | 200,043 | Y | adipose right ventral |
| Port Hope | 411 | 101,325 | Y | adipose right ventral |
| Subtotal | | 391,198 | | |
| Total, Lake Ontario | | 1,650,318 | | |
| Great Lakes Total | | 9,741,872 | | |

[1]Lake trout × brook trout hybrid.

[2]State plants—all other U.S. plants by U.S. Fish and Wildlife Service except for 16,000 fall fingerlings planted by Salmon Unlimited off Wind point, Wisconsin in Lake Michigan.

[3]Offshore plants.

Table 3. Plantings of F1 splake in Lake Superior, 1971 and 1973 to 1982
The 1977 plant was of backcrosses.

| Year | State | Location | Grid No. | Numbers | Age | Fin clip |
|---|---|---|---|---|---|---|
| 1971 | Michigan | Copper Harbor | 926 | 13,199 | Y | none |
| 1973 | Wisconsin | Bayfield Area | 1409 | 5,000 | F | dorsal-left ventral |
| 1974 | Wisconsin | Washburn | 1509 | 10,316 | Y | dorsal |
| | | Houghton Point | 1509 | 9,782 | Y | dorsal |
| 1975 | Wisconsin | Pikes Bay | 1409 | 15,000 | Y | dorsal-right ventral |
| 1976 | Wisconsin | Pikes Bay | 1409 | 18,360 | Y | dorsal-right ventral |
| 1977 | Michigan | Copper Harbor | 926 | 26,100 | F | left pectoral-right ventral |
| 1978 | Wisconsin | Chequamegon Bay | 1509 | 55,200 | F | none |
| | | Cornucopia | 1307 | 26,400 | F | none |
| 1979 | Wisconsin | Bark Point | 1306 | 12,000 | F | none |
| | | Bark Point | 1306 | 6,000 | Y | none |
| | | Bayfield | 1409 | 10,800 | Y | none |
| | | Cornucopia | 1307 | 12,000 | F | none |
| | | Houghton Point | 1509 | 12,000 | F | none |
| | | Houghton Point | 1509 | 16,200 | Y | none |
| | | Madeline Island | 1409 | 12,000 | F | none |
| | | Onion River | 1409 | 36,000 | F | none |
| | | Onion River | 1409 | 22,700 | Y | none |
| | | Port Superior | 1409 | 2,675 | Y | none |
| | | Washburn | 1509 | 16,000 | Y | none |
| | | Washburn Coal Dock | 1509 | 21,150 | Y | none |
| 1980 | Wisconsin | Ashland Coal Dock | 1509 | 21,150 | Y | none |
| | | Bark Point | 1306 | 12,700 | F | none |
| | | Bodins-Houghton Point | 1509 | 25,400 | FF | none |
| | | Cornucopia Harbor | 1307 | 10,650 | Y | none |
| | | Cornucopia Harbor | 1307 | 12,700 | F | none |
| | | Onion River Mouth | 1409 | 10,650 | Y | none |
| | | Onion River Mouth | 1409 | 25,400 | F | none |
| | | Superior Entry | 1401 | 8,400 | F | none |
| | | Washburn Entry | 1509 | 20,360 | Y | none |
| | | Washburn Coal Dock | 1509 | 25,400 | F | none |
| 1981 | Michigan | Marquette Bay | 1529 | 10,000 | Y | none |
| | Minnesota | French River | 1302 | 1,550 | FF | none |
| | Wisconsin | Bayfield | 1409 | 13,750 | F | none |
| | | Herbster | 1306 | 13,750 | F | none |
| | | Saxon Harbor | 1511 | 13,750 | F | none |
| | | Siskwit | 1307 | 13,750 | F | none |
| | | Superior | 1401 | 12,000 | F | none |
| | | Washburn | 1509 | 111,514 | F | none |
| 1982 | Michigan | Copper Harbor | 926 | 10,000 | Y | none |
| | | Marquette Bay | 1529 | 10,000 | Y | none |
| | | Munising Bay | 1634 | 10,000 | Y | none |



Table 3. (Cont'd.)

| Year | State | Location | Grid No. | Numbers | Age | Fin clip |
|---|---|---|---|---|---|---|
| | Wisconsin | Ashland | 1509 | 20,000 | F | none |
| | | Bark Point | 1307 | 12,000 | F | none |
| | | Cornucopia | 1307 | 15,750 | F | none |
| | | Houghton Point | 1409 | 25,000 | F | none |
| | | Onion Bay | 1409 | 13,000 | F | none |
| | | Superior | 1401 | 10,000 | F | none |
| | | Washburn | 1509 | 30,000 | F | none |
| Great Lakes Total, 1971 to 1982 | | | | 880,356 | | |

Table 4. Annual plantings (in thousands) of coho salmon in the Great Lakes, 1966–1982.

| Year | LAKE SUPERIOR 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 |
| 1978 | 140 | – | – | 140 |
| 1979 | 200 | – | – | 200 |
| 1980 | 350 | – | – | 350 |
| 1981 | 227 | – | – | 227 |
| 1982 | 236 | – | – | 236 |
| Subtotal | 5,638 | 663 | 78 | 6,379 |

| Year | LAKE MICHIGAN 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 |
| 1978 | 1,802 | 499 | 105 | 279 | 2,685 |
| 1979 | 3,317 | 320 | 118 | 289 | 4,044 |
| 1980 | 2,243 | 492 | 169 | 39 | 2,943 |
| 1981 | 1,707 | 2,451 | 102 | 329 | 2,451 |
| 1982 | 1,645 | 216 | 160 | 159 | 2,181 |
| Subtotal | 36,572 | 7,232 | 1,395 | 1,297 | 44,359 |



Table 4. (Cont'd.)

| Year | LAKE HURON Michigan | Total |
|---|---|---|
| 1968 | 402 | 402 |
| 1969 | 667 | 667 |
| 1970 | 571 | 571 |
| 1971 | 975 | 975 |
| 1972 | 249 | 249 |
| 1973 | 100 | 100 |
| 1974 | 500 | 500 |
| 1975 | 627 | 627 |
| 1976 | 690 | 690 |
| 1977 | 416 | 416 |
| 1978 | 84 | 84 |
| 1979 | 1,082 | 1,082 |
| 1980 | 375 | 375 |
| 1981 | 135 | 135 |
| 1982 | 453 | 453 |
| Subtotal | 7,326 | 7,326 |

| Year | LAKE ERIE 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 |
| 1978 | 296 | 240 | 961 | 134 | 1,631 |
| 1979 | 303 | 110 | 108 | 100 | 621 |
| 1980 | 498 | 500 | 543 | 81 | 1,621 |
| 1981 | 270 | 273 | 468 | – | 1,011 |
| 1982 | 300 | 282 | 1,396 | 139 | 2,116 |
| Subtotal | 2,812 | 3,295 | 6,104 | 1,588 | 13,796 |

Table 4. (Cont'd.)

| Year | Ontario | New York | Total |
|---|---|---|---|
| | LAKE ONTARIO | | |
| 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 |
| 1978 | 201 | 80 | 281 |
| 1979 | 286 | 344 | 630 |
| 1980 | 77 | 299 | 377 |
| 1981 | 363 | – | 363 |
| 1982 | 112 | 367 | 479 |
| Subtotal | 3,011 | 3,371 | 6,382 |
| Great Lakes Total, coho salmon, 1966–1982 | | | 78,242 |



Table 5. Plantings of coho salmon in the Great Lakes, 1982.

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| LAKE SUPERIOR-COHO SALMON | | | | |
| Michigan waters | | | | |
| Black River | 1413 | 49,964 | Y | none |
| Dead River | 1529 | 135,680 | Y | none |
| Sucker River | 1439 | 50,000 | Y | none |
| Subtotal | | 235,644 | | |
| Total, Lake Superior | | 235,644 | | |
| LAKE MICHIGAN-COHO SALMON | | | | |
| Illinois waters | | | | |
| Chicago, Calumet Yacht Club | 2703 | 2,750 | Y | none |
| Chicago, Diversey Harbor | 2603 | 375 | Y | none |
| Chicago, Navy Pier | 2603 | 16,450 | Y | none |
| Chicago, Ohio Street and Lake Shore Drive | 2603 | 16,450 | Y | none |
| Great Lakes Naval Training Station | 2402 | 16,200 | Y | none |
| Winnetka, Tower Road | 2502 | 16,450 | Y | none |
| Zion, Kellogg Creek | 2302 | 85,200 | SF | none |
| Zion, Kellog Creek | 2302 | 4,800 | Y | left ventral |
| Subtotal | | 158,675 | | |
| Indiana waters | | | | |
| Little Calumet River | 2705–2706 | 92,987 | FF | none |
| Trail Creek | 2707 | 67,394 | FF | none |
| Subtotal | | 160,381 | | |
| Michigan waters | | | | |
| Grand River | 1911 | 300,044 | Y | none |
| Little Manistee River | 1211 | 200,000 | Y | none |
| Platte River | 912 | 1,000,000 | Y | none |
| Portage Lake | 1111 | 45,360 | Y | none |
| Sable River | 1410 | 50,053 | Y | none |
| Thompson Creek | 211 | 49,978 | Y | none |
| Subtotal | | 1,645,435 | | |

Table 5. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Wisconsin waters | | | | |
| Kenosha | 2202 | 19,200 | Y | none |
| Milwaukee | 1901 | 44,800 | Y | none |
| Port Washington | 1701 | 50,000 | Y | none |
| Racine | 2102 | 33,640 | Y | none |
| Sheboygan | 1502 | 68,400 | Y | none |
| Subtotal | | 216,040 | | |
| Total, Lake Michigan | | 2,180,531 | | |
| LAKE HURON-COHO SALMON | | | | |
| Michigan waters | | | | |
| AuSable River | 1210 | 270,769 | FF | none |
| East Tawas | 1309 | 16,800 | Y | none |
| Flint River | 1606 | 90,020 | Y | none |
| Tawas River | 1308 | 75,000 | Y | none |
| Subtotal | | 452,589 | | |
| Total, Lake Huron | | 452,589 | | |
| LAKE ERIE-COHO SALMON | | | | |
| Michigan waters | | | | |
| Detroit River (Yacht Club) | 603 | 200,000 | Y | none |
| Huron River | 702 | 100,000 | Y | none |
| Subtotal | | 300,000 | | |
| New York waters | | | | |
| Cattaraugus Creek | 327 | 69,400 | Y | none |
| Chautauqua Creek | 424 | 34,600 | Y | none |
| Eighteenmile Creek | 228 | 34,600 | Y | none |
| Subtotal | | 138,600 | | |
| Ohio waters | | | | |
| Chagrin River | 813 | 109,706 | Y | none |
| Huron River | 1006 | 171,910 | Y | none |
| Subtotal | | 281,616 | | |
| Pennsylvania waters | | | | |
| Crooked Creek | 619 | 166,000 | Y | none |
| Elk Creek | 619 | 100,000 | Y | none |
| Elk Creek | 619 | 35,600 | Y | none |
| Godfrey Run | 619 | 41,000 | Y | none |
| Orchard Beach Run | 523 | 121,000 | Y | none |
| Raccoon Creek | 619 | 175,000 | Y | none |
| Presque Isle Bay | 521 | 188,500 | Y | none |
| Sixteen Mile Creek | 523 | 100,000 | Y | none |



Table 5. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Trout Run | 620 | 94,000 | Y | none |
| Twelvemile Creek | 522 | 75,000 | Y | none |
| Twentymile Creek | 523 | 100,000 | Y | none |
| Walnut Creek | 620 | 200,000 | Y | none |
| Subtotal | | 1,396,100 | | |
| Total, Lake Erie | | 2,116,316 | | |
| LAKE ONTARIO-COHO SALMON | | | | |
| New York waters | | | | |
| Eighteen-mile Creek | 708 | 31,200 | Y | none |
| Lake Ontario | 623 | 60,000 | F | none |
| North Sandy Creek | 523 | 10,400 | Y | none |
| Oak Orchard Creek | 711 | 31,200 | Y | none |
| Salmon River | 623 | 124,000 | Y | none |
| Salmon River | 623 | 50,000 | Y | left ventral |
| Sandy Creek | 713 | 50,200 | Y | none |
| South Sandy Creek | 523 | 10,400 | Y | none |
| Subtotal | | 367,400 | | |
| Ontario waters | | | | |
| Bronte Creek | 702 | 25,085 | Y | right pectoral |
| Lake Ontario | 603 | 12,160 | Y | adipose |
| Norval | 603 | 21,878 | Y | adipose |
| Port Credit | 603 | 14,860 | Y | adipose |
| Streetsville | 603 | 25,570 | Y | adipose |
| Twelve Mile Creek | 805 | 12,480 | Y | adipose |
| Subtotal | | 112,033 | | |
| Total, Lake Ontario | | 479,433 | | |
| Great Lakes Total | | 5,464,630 | | |

Table 6. Annual plantings (in thousands) of chinook salmon in the Great Lakes, 1967–1982.

| | 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 |
| 1978 | 150 | – | 278 | 478 |
| 1979 | 100 | 60 | 341 | 501 |
| 1980 | 276 | 60 | 393 | 729 |
| 1981 | 250 | 60 | 52 | 362 |
| 1982 | 330 | 60 | 920 | 1,313 |
| Subtotal | 3,487 | 275 | 2,606 | 6,422 |

| | | 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 |
| 1978 | 2,524 | 2,017 | 213 | 611 | 5,365 |
| 1979 | 2,307 | 1,964 | 531 | 183 | 4,984 |
| 1980 | 2,903 | 2,430 | 621 | 152 | 6,106 |
| 1981 | 2,205 | 1,848 | 263 | 431 | 4,747 |
| 1982 | 2,685 | 2,521 | 313 | 793 | 6,312 |
| Subtotal | 30,496 | 15,975 | 2,822 | 4,013 | 53,305 |



Table 6. (Cont'd.)

| | LAKE HURON | |
|---|---|---|
| Year | Michigan | Total |
| 1968 | 274 | 274 |
| 1969 | 250 | 250 |
| 1970 | 643 | 643 |
| 1971 | 894 | 894 |
| 1972 | 515 | 515 |
| 1973 | 967 | 967 |
| 1974 | 776 | 776 |
| 1975 | 655 | 655 |
| 1976 | 831 | 831 |
| 1977 | 733 | 733 |
| 1978 | 1,418 | 1,418 |
| 1979 | 1,325 | 1,325 |
| 1980 | 1,878 | 1,878 |
| 1981 | 1,523 | 1,523 |
| 1982 | 2,001 | 2,001 |
| Subtotal | 14,683 | 14,683 |

| | | | 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 |
| 1978 | – | 364 | 668 | 206 | 1,238 |
| 1979 | – | 210 | 708 | – | 917 |
| 1980 | – | 350 | 544 | – | 894 |
| 1981 | – | – | 449 | 71 | 519 |
| 1982 | – | – | 47 | 280 | 327 |
| Subtotal | 1,810 | 1,928 | 5,270 | 1,319 | 10,327 |

| | | LAKE ONTARIO | |
|---|---|---|---|
| Year | Ontario | New York | Total |
| 1969 | – | 70 | 70 |
| 1970 | – | 141 | 141 |
| 1971 | 89 | 149 | 238 |
| 1972 | 190 | 427 | 617 |
| 1973 | – | 696 | 696 |

Table 6. (Cont'd.)

| | LAKE ONTARIO | | |
|---|---|---|---|
| Year | Ontario | New York | Total |
| 1974 | 225 | 963 | 1,188 |
| 1975 | – | 920 | 920 |
| 1976 | – | 593 | 593 |
| 1977 | – | – | – |
| 1978 | 393 | – | 393 |
| 1979 | 147 | 222 | 369 |
| 1980 | 118 | 788 | 906 |
| 1981 | 12 | 1,468 | 1,480 |
| 1982 | 270 | 1,808 | 2,078 |
| Subtotal | 1,444 | 8,245 | 9,689 |
| Great Lakes Total, chinook salmon, 1967–1982 | | | 94,426 |



Table 7. Plantings of chinook salmon in the Great Lakes, 1982.

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| LAKE SUPERIOR-CHINOOK SALMON | | | | |
| Michigan waters | | | | |
| Big Iron River | 1316 | 75,000 | SF | none |
| Black River | 1413 | 75,000 | SF | none |
| Dead River | 1529 | 183,000 | SF | none |
| Subtotal | | 333,000 | | |
| Minnesota waters | | | | |
| Baptism River | 1106 | 141,782 | FF | none |
| Brule River | 813 | 218,765 | F | none |
| Cascade River | 811 | 66,555 | FF | none |
| French River | 1302 | 78,560 | FF | none |
| Lake Superior | 1303 | 2,690 | FF | none |
| Lester River | 1302 | 79,376 | FF | none |
| Temperance River | 908 | 106,218 | F | none |
| Temperance River | 908 | 58,829 | FF | none |
| Rosebush Creek | 812 | 19,890 | FF | none |
| Two Island River | 908 | 101,132 | F | none |
| Two Island River | 908 | 46,284 | FF | none |
| Subtotal | | 920,081 | | |
| Wisconsin waters | | | | |
| Black River | 1401 | 60,000 | Y | none |
| Total, Lake Superior | | 1,313,081 | | |
| LAKE MICHIGAN-CHINOOK SALMON | | | | |
| Illinois waters | | | | |
| Chicago, Diversey Harbor | 2603 | 355,544 | SF | none |
| Waukegan | 2302 | 343,065 | SF | none |
| Zion, Kellogg Creek | 2302 | 73,061 | SF | none |
| Zion, Kellogg Creek | 2302 | 21,600 | SF | right ventral |
| Subtotal | | 793,270 | | |
| Indiana waters | | | | |
| Burns Harbor | 2706 | 81,153 | SF | none |
| East Chicago | 2705 | 80,052 | SF | none |
| Michigan City | 2707 | 106,666 | SF | none |
| Whiting | 2704 | 45,200 | SF | none |
| Subtotal | | 313,071 | | |
| Michigan waters | | | | |
| Brewery Creek | 915 | 50,094 | SF | none |
| Grand River | 1911 | 700,041 | SF | none |

Table 7. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Kalamazoo River | 2211 | 122,160 | SF | none |
| Little Manistee River | 1211 | 600,294 | SF | none |
| Manistee River | 1211 | 200,227 | SF | none |
| Manistique River | 211 | 50,000 | SF | none |
| Muskegon River | 1810 | 275,064 | SF | none |
| No Name Creek | 206 | 59,479 | SF | none |
| Portage Lake | 1111 | 100,768 | SF | none |
| Sable River | 1410 | 200,284 | SF | none |
| St. Joseph River | 2509 | 251,680 | SF | none |
| South Haven | 2311 | 74,995 | SF | none |
| Subtotal | | 2,685,086 | | |
| Wisconsin waters | | | | |
| Ahnapee River | 1004 | 100,000 | F | none |
| East Twin River | 1303 | 75,000 | F | none |
| Gills Rock | 606 | 150,000 | F | none |
| Kenosha | 2202 | 175,000 | F | none |
| Kewaunee | 1104 | 273,000 | F | none |
| Little Manitowoc River | 1303 | 165,000 | F | none |
| Manitowoc River | 1303 | 98,000 | F | none |
| Menominee River | 703 | 255,000 | F | none |
| Menominee River | 703 | 20,000 | F | adipose-CWT(31)16/1 |
| Milwaukee | 1901 | 200,000 | F | none |
| Oconto Park | 802 | 100,000 | F | none |
| Port Washington | 1701 | 183,000 | F | none |
| Racine | 2102 | 225,700 | F | none |
| Racine | 2102 | 20,000 | F | adipose-CWT(31)16/4 |
| Sheboygan | 1502 | 186,000 | F | none |
| Sheboygan | 1502 | 20,000 | F | adipose-CWT(31)16/3 |
| Sturgeon Bay | 905 | 230,000 | F | none |
| Sturgeon Bay | 905 | 20,000 | F | adipose-CWT(31)16/2 |
| West Twin River | 1303 | 25,000 | F | none |
| Subtotal | | 2,520,700 | | |
| Total, Lake Michigan | | 6,312,127 | | |

LAKE HURON-CHINOOK SALMON

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Michigan waters | | | | |
| AuGres | 1408 | 75,040 | SF | none |
| AuSable River | 1210 | 625,259 | SF | none |
| Carp River | 202 | 50,000 | SF | none |
| Harbor Beach | 1514 | 275,192 | SF | none |
| Harrisville | 1110 | 300,000 | SF | none |
| Lexington | 1915 | 250,080 | SF | none |
| Nagels Creek | 606 | 50,032 | SF | none |
| Port Austin | 1411 | 100,080 | SF | none |
| Port Sanilac | 1814 | 100,064 | SF | none |



Table 7 (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| St. Marys River | 0000 | 100,000 | SF | none |
| Tawas City | 1308 | 75,040 | SF | none |
| Subtotal | | 2,000,787 | | |
| Total, Lake Huron | | 2,000,787 | | |

LAKE ERIE-CHINOOK SALMON

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| New York waters | | | | |
| Cattaraugus Creek | 327 | 280,000 | SF | none |
| Pennsylvania waters | | | | |
| Elk Creek | 619 | 17,986 | SF | none |
| Elk Creek | 619 | 4,274 | Y | none |
| Walnut Creek | 620 | 24,400 | Y | none |
| Subtotal | | 46,660 | | |
| Total, Lake Erie | | 326,660 | | |

LAKE ONTARIO-CHINOOK SALMON

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| New York waters | | | | |
| Beaverdam Brook | 623 | 300,000 | SF | none |
| Black River | 424 | 112,000 | SF | none |
| Eighteen-mile Creek | 708 | 112,000 | SF | none |
| Genesee River | 815 | 169,000 | SF | none |
| Little Sodus Bay | 720 | 118,000 | SF | none |
| Niagara River | 806 | 142,000 | SF | none |
| Oak Orchard Creek | 711 | 167,000 | SF | none |
| Oswego River | 721 | 144,000 | SF | none |
| Salmon River | 623 | 311,000 | SF | none |
| Sandy Creek | 523 | 123,000 | SF | none |
| Sodus Bay | 819 | 110,000 | SF | none |
| Subtotal | | 1,808,000 | | |
| Ontario waters | | | | |
| Bronte Creek | 602 | 165,840 | SF | none |
| Credit River | 603 | 54,046 | SF | none |
| Twelve Mile Creek | 805 | 50,000 | SF | none |
| Subtotal | | 269,886 | | |
| Total, Lake Ontario | | 2,077,886 | | |
| Great Lakes Total | | 12,030,541 | | |

Table 8. Plantings of Atlantic salmon in the Great Lakes, 1972–1982.

| Year | State | Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|---|---|
| | | LAKE SUPERIOR | | | | |
| 1972 | Wisconsin | Bayfield | 1409 | 20,000 | Y | adipose-left ventral |
| 1973 | Wisconsin | Bayfield | 1409 | 20,000 | Y | right ventral |
| 1976 | Michigan | Cherry Creek | 1529 | 9,106[4] | Y | none |
| 1978 | Wisconsin | Pikes Creek | 1409 | 36,772 | Y | none |
| 1980 | Minnesota | French River | 1302 | 7,584[1] | Y | left ventral |
| 1982 | Minnesota | French River | 1302 | 8,284 | Y | adipose |
| | Minnesota | French River | 1302 | 9,668 | Y | adipose-left ventral |
| | Minnesota | French River | 1302 | 234 | A | left pectoral |
| | Total | | | 111,648 | | |
| | | LAKE MICHIGAN | | | | |
| 1972 | Michigan | Boyne River | 616 | 10,000[4] | Y | none |
| 1973 | Michigan | Boyne River | 616 | 15,000[4] | Y | none |
| 1974 | Michigan | Platte River | 616 | 7,308[4] | Y | adipose |
| | | Boyne River | 616 | 14,555[4] | Y | none |
| 1975 | Michigan | Boyne River | 616 | 18,742[4] | Y | none |
| | | | | 3,430[3] | A | right ventral |
| 1976 | Michigan | Boyne River | 616 | 20,438[4] | Y | none |
| | | | | 162[4] | A | left ventral |
| | | South Haven | 2311 | 108[4] | A | adipose |
| 1977 | Michigan | Pere Marquette River | 1410 | 7,131[2] | Y | left ventral |
| | | Little Manistee River | 1211 | 4,500[2] | Y | left ventral |
| | | Pere Marquette River | 1410 | 3,961[4] | Y | right ventral |
| | | Little Manistee River | 1211 | 2,997[4] | Y | right ventral |
| 1978 | Michigan | Little Manistee River | 1211 | 5,000[2] | Y | left pectoral |
| | | Pere Marquette River | 1410 | 14,880[3] | Y | left pectoral |
| | | Little Manistee River | 1211 | 10,000[4] | Y | right pectoral |
| | | Pere Marquette River | 1410 | 16,322[4] | Y | right pectoral |
| 1981 | Michigan | Manistee River | 1211 | 19,529[4] | Y | left ventral |
| | | Petoskey | 519 | 29[4] | A | none |
| | | Little Manistee River | 1211 | 25,030[1] | Y | adipose |
| | | Pere Marquette River | 1410 | 20,000[1] | Y | adipose |
| | Total | | | 219,122 | | |



Table 8. (Cont'd.)

| Year | State | Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|---|---|
| | | LAKE HURON | | | | |
| 1972 | Michigan | Au Sable River | 1210 | 9,000[4] | Y | none |
| 1982 | | Thunder Bay (Part Pt.) | 809 | 29,694[4] | FF | none |
| | | Thunder Bay (Part Pt.) | 809 | 600[4] | A | none |
| | | Thunder Bay (Part Pt.) | 809 | 110[4] | FF | left ventral |
| | Total | | | 39,404 | | |
| Great Lakes Total, 1972–1982 | | | | 351,856 | | |

[1]Landlocked.
[2]Atlantic salmon cross.
[3]Swedish strain.
[4]Quebec strain.

Table 9. Annual plantings (in thousands) of rainbow, steelhead, and palomino[1] trout in the Great Lakes, 1975–1982.[2]

| Year | Michigan | Wisconsin | Minnesota | Total |
|---|---|---|---|---|
| | | LAKE SUPERIOR | | |
| 1975 | 25 | 61 | 228 | 314 |
| 1976 | 36 | 400 | 9 | 445 |
| 1977 | 31 | 73 | 211 | 315 |
| 1978 | 20 | 116 | 88 | 225 |
| 1979 | – | 156 | 228 | 384 |
| 1980 | 66 | 119 | 471 | 656 |
| 1981 | 55 | 95 | – | 150 |
| 1982 | 45 | 12 | 990 | 1,048 |
| Subtotal | 278 | 1,032 | 2,225 | 3,537 |

| Year | Michigan | Wisconsin | Indiana | Illinois | Total |
|---|---|---|---|---|---|
| | | LAKE MICHIGAN | | | |
| 1975 | 701 | 397 | 217 | 253 | 1,568 |
| 1976 | 601 | 964 | 217 | 45 | 1,827 |
| 1977 | 305 | 683 | 48 | 276 | 1,312 |
| 1978 | 1,151 | 613 | 130 | 40 | 1,933 |
| 1979 | 981 | 1,211 | 182 | 215 | 2,589 |
| 1980 | 1,311 | 1,137 | 70 | 113 | 2,630 |
| 1981 | 558 | 1,007 | 230 | 186 | 1,981 |
| 1982 | 1,066 | 1,042 | 248 | 170 | 2,525 |
| Subtotal | 6,674 | 7,054 | 1,342 | 1,298 | 16,365 |

| Year | Michigan | Ontario | Total |
|---|---|---|---|
| | LAKE HURON | | |
| 1975 | 425 | 62 | 487 |
| 1976 | 333 | 33 | 366 |
| 1977 | 168 | 119 | 287 |
| 1978 | 389 | 85 | 473 |
| 1979 | 200 | 47 | 247 |
| 1980 | 345 | 320 | 665 |
| 1981 | 211 | 82 | 293 |
| 1982 | 368 | 75 | 443 |
| Subtotal | 2,439 | 823 | 3,261 |



Table 9. (Cont'd.)

| Year | Michigan | Total |
|---|---|---|
| | LAKE ST. CLAIR | |
| 1982 | 40 | 40 |

| Year | Michigan | Ontario | New York | Ohio | Pennsylvania | Total |
|---|---|---|---|---|---|---|
| | | | LAKE ERIE | | | |
| 1975 | 10 | 223 | – | 277 | 19 | 529 |
| 1976 | 60 | 250 | 25 | 196 | 113 | 644 |
| 1977 | 10 | 287 | 13 | 247 | 181 | 737 |
| 1978 | 30 | 51 | 19 | 140 | 117 | 357 |
| 1979 | – | 366 | 29 | 290 | 249 | 933 |
| 1980 | 50 | 433 | 72 | 202 | 531 | 1,287 |
| 1981 | 50 | 12 | 86 | 131 | 456 | 734 |
| 1982 | 45 | 23 | 37 | 234 | 461 | 800 |
| Subtotal | 255 | 1,645 | 281 | 1,717 | 2,127 | 6,021 |

| Year | New York | Ontario | Total |
|---|---|---|---|
| | LAKE ONTARIO | | |
| 1975 | 252 | 29 | 282 |
| 1976 | 186 | 108 | 295 |
| 1977 | 144 | 110 | 254 |
| 1978 | 313 | 121 | 434 |
| 1979 | 325 | 111 | 436 |
| 1980 | 759 | 734 | 1,493 |
| 1981 | 483 | 81 | 564 |
| 1982 | 253 | 68 | 322 |
| Subtotal | 2,715 | 1,362 | 4,080 |

Great Lakes Total, rainbow, steelhead, and palomino trout, 1975–1982 33,304

[1]Rainbow × W. Virginia Golden hybrid (small numbers planted by Pennsylvania only).
[2]Excluding eggs and fry.

Table 10. Plantings of rainbow, steelhead, and palomino[1] trout in the Great Lakes, 1982.

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| LAKE SUPERIOR-RAINBOW AND STEELHEAD TROUT | | | | |
| Michigan waters (steelhead trout) | | | | |
| Black River | 1413 | 10,046 | Y | none |
| Chocolay River | 1530 | 10,000 | Y | none |
| Ravine River | 1424 | 10,000 | Y | none |
| Two Hearted River | 1441 | 15,015 | Y | none |
| Subtotal | | 45,061 | | |
| Minnesota waters (rainbow trout) | | | | |
| Baptism River | 1106 | 26,800 | Y | adipose-right ventral |
| Beaver River | 1106 | 9,935 | Y | adipose-right ventral |
| Brule River | 813 | 21,292 | Y | adipose-right ventral |
| Cascade River | 811 | 24,145 | Y | adipose-right ventral |
| French River | 1302 | 5,823 | Y | adipose-left ventral |
| Lake Superior | 1303 | 44,684 | Y | adipose-right ventral |
| Split Rock River | 1106 | 10,000 | Y | adipose-right ventral |
| Subtotal | | 142,679 | | |
| Minnesota waters (steelhead trout) | | | | |
| Baptism River | 1106 | 188,638 | F | none |
| Beaver River | 1106 | 75,843 | F | none |
| Brule River | 813 | 42,234 | F | none |
| Cascade River | 811 | 45,491 | F | none |
| Deer Yard Creek | 811 | 10,600 | F | none |
| Devils Track River | 812 | 35,000 | F | none |
| Flute Reed River | 814 | 29,150 | F | none |
| French River | 1302 | 108,177 | F | none |
| Jonvick Creek | 910 | 5,000 | F | none |
| Onion Creek | 909 | 15,000 | F | none |
| Splitrock River | 1106 | 75,843 | F | none |
| Stewart River | 1204 | 61,283 | F | none |
| Stone Creek | 813 | 5,300 | F | none |
| Sucker River | 1302 | 100,000 | F | none |
| Temperance River | 908 | 50,000 | F | none |
| Subtotal | | 847,559 | | |
| Wisconsin waters (rainbow trout) | | | | |
| Amnicon | 1402 | 12,300 | F | none |
| Total, Lake Superior | | 1,047,599 | | |
| LAKE MICHIGAN-RAINBOW AND STEELHEAD TROUT | | | | |
| Illinois waters (rainbow trout) | | | | |
| Chicago, Calumet Yacht Club | 2703 | 4,660 | Y | none |
| Chicago, Diversey Harbor | 2603 | 750 | Y | none |
| Chicago, Navy Pier | 2603 | 25,550 | Y | none |
| Chicago, Navy Pier | 2703 | 1,000 | F | none |



Table 10. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Chicago, Ohio Street and Lake Shore Drive | 2603 | 25,550 | Y | none |
| Great Lakes Naval Training Station | 2402 | 25,965 | F | none |
| Great Lakes Naval Training Station | 2402 | 60,925 | Y | none |
| Winnetka | 2502 | 25,550 | Y | none |
| Subtotal | | 169,950 | | |
| Indiana waters | | | | |
| Little Calumet River | 2705–2706 | 70,846 | FF | none |
| Little Calumet River | 2705–2706 | 59,132 | Y | none |
| Trail Creek | 2707 | 46,096 | FF | none |
| Trail Creek | 2707 | 71,635 | Y | none |
| Subtotal | | 247,709 | | |
| Michigan waters (steelhead trout) | | | | |
| Bear River | 519 | 10,000 | Y | none |
| Betsie River | 1011 | 15,000 | Y | none |
| Big Cedar River | 504 | 10,000 | Y | none |
| Big Rabbit River | 2211 | 10,000 | Y | none |
| Boardman River | 915 | 15,000 | Y | none |
| Crockery Creek | 1911 | 5,000 | Y | none |
| Elk River | 816 | 10,000 | Y | none |
| Fish Creek | 1911 | 50,000 | FF | none |
| Fish Creek | 1911 | 5,000 | Y | none |
| Flat River | 1911 | 5,000 | Y | none |
| Flat River | 1911 | 25,000 | FF | none |
| Galien River | 2708 | 9,000 | Y | none |
| Grand River | 1911 | 35,048 | Y | none |
| Grand River | 1911 | 110,000 | FF | none |
| Kalamazoo River | 2211 | 20,011 | Y | none |
| Little Manistee River | 1211 | 100,000 | FF | fluoroscein dye |
| Little Manistee River | 1211 | 27,000 | Y | fluoroscein dye |
| Little Manistee River | 1211 | 3,000 | Y | adipose–left ventral |
| Looking Glass River | 1911 | 100,000 | FF | none |
| Looking Glass River | 1911 | 10,000 | Y | none |
| Manistee River | 1211 | 30,000 | Y | adipose-right ventral |
| Manistique River | 211 | 10,000 | Y | none |
| Muskegon River | 1810 | 50,022 | Y | none |
| Paw Paw River | 2509 | 10,000 | Y | none |
| Pentwater River | 1510 | 5,000 | Y | none |
| Rogue River | 1911 | 15,000 | Y | none |
| Ruby Creek | 1410 | 5,000 | Y | none |
| St. Joseph River | 2509 | 300,000 | FF | none |
| St. Joseph River | 2509 | 27,000 | Y | none |
| South Haven | 2311 | 10,046 | Y | none |
| Thompson Creek | 211 | 10,000 | Y | none |
| White River | 1710 | 20,000 | Y | none |
| Subtotal | | 1,066,127 | | |

Table 10. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Wisconsin waters (rainbow trout) | | | | |
| Algoma | 1004 | 25,585 | F | none |
| Bailey's Harbor | 706 | 11,000 | Y | none |
| Braunsdorf Beach | 905 | 4,000 | F | none |
| Coast Guard Station | 905 | 30,315 | F | none |
| Coast Guard Station | 905 | 6,000 | Y | none |
| Kenosha | 2202 | 53,536 | F | none |
| Kenosha | 2202 | 49,100 | Y | none |
| Kewaunee | 1104 | 25,585 | F | none |
| Kewaunee | 1104 | 28,450 | Y | none |
| Little River | 703 | 46,424 | F | none |
| Manitowoc River | 1303 | 6,200 | F | none |
| Manitowoc River | 1303 | 12,215 | Y | none |
| Menominee River | 703 | 5,000 | Y | none |
| Milwaukee | 1901 | 35,200 | F | none |
| Milwaukee | 1901 | 67,000 | Y | none |
| Moonlight Bay | 706 | 8,400 | Y | none |
| Oconto Park | 802 | 20,907 | F | none |
| Oconto Park | 802 | 8,300 | Y | none |
| Peshtigo | 803 | 10,800 | Y | none |
| Port Washington | 1701 | 13,470 | F | none |
| Port Washington | 1701 | 67,200 | Y | none |
| Racine | 2102 | 74,784 | F | none |
| Racine | 2102 | 85,400 | Y | none |
| Sheboygan | 1502 | 216,414 | F | none |
| Sheboygan | 1502 | 69,758 | Y | none |
| Sturgeon Bay | 905 | 6,000 | Y | none |
| Two Rivers | 1303 | 29,385 | F | none |
| Two Rivers | 1303 | 11,200 | Y | none |
| Wester's | 805 | 14,000 | Y | none |
| Subtotal | | 1,041,628 | | |
| Total, Lake Michigan | | 2,525,414 | | |
| LAKE HURON-RAINBOW AND STEELHEAD TROUT | | | | |
| Michigan waters (rainbow trout) | | | | |
| East Tawas | 1309 | 33,700 | Y | none |
| Michigan waters (steelhead trout) | | | | |
| AuSable River | 1210 | 50,035 | Y | none |
| AuSable River | 1210 | 81,013 | FF | none |
| Carp River | 202 | 10,003 | Y | none |
| Cheboygan River | 403 | 10,017 | Y | none |
| Pigeon River | 1510 | 13,503 | Y | none |
| Pinnebog River | 1411 | 10,098 | Y | none |
| Rifle River | 1507 | 100,000 | FF | none |
| St. Marys River | 0000 | 10,003 | Y | none |
| Thunder Bay | 809 | 20,009 | Y | none |
| Whitney Drain | 1408 | 30,000 | FF | none |
| Subtotal | | 334,681 | | |



Table 10. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip |
|---|---|---|---|---|
| Ontario waters (rainbow trout) | | | | |
| Sarnia Harbor | 2015 | 40,000 | Y | none |
| Southampton | 1221 | 35,000 | Y | none |
| Subtotal | | 75,000 | | |
| Total, Lake Huron | | 443,381 | | |
| LAKE ST. CLAIR-STEELHEAD TROUT | | | | |
| Michigan waters | | | | |
| St. Clair River, Belle River | 0000 | 20,000 | Y | none |
| St. Clair River Mill Creek | 0000 | 20,000 | Y | none |
| Subtotal | | 40,000 | | |
| Total, Lake St. Clair | | 40,000 | | |
| LAKE ERIE-RAINBOW AND STEELHEAD, AND PALOMINO TROUT | | | | |
| Michigan waters (steelhead trout) | | | | |
| Huron River | 702 | 45,049 | Y | none |
| New York waters (steelhead trout) | | | | |
| Cattaraugus Creek, Derby Cr., Spooner Bk., Connoisarauley Cr. | 327 | 22,000 | SF | none |
| Chautauqua Creek | 424 | 15,000 | SF | adipose |
| Subtotal | | 37,000 | | |
| Ohio waters (rainbow trout) | | | | |
| Chagrin River | 813 | 70,000 | F | none |
| Conneaut Creek | 718 | 58,680 | F | none |
| Grand River | 814 | 93,200 | F | none |
| Vermilion River | 1007 | 11,700 | F | none |
| Subtotal | | 233,580 | | |
| Ontario waters (rainbow trout) | | | | |
| Big Creek | 318 | 15,000 | Y | none |
| Big Creek | 318 | 3,000 | F | none |
| Clear Creek | 318 | 3,000 | F | none |
| Hay Creek | 318 | 1,900 | F | none |
| Subtotal | | 22,900 | | |
| Pennsylvania waters (rainbow trout) | | | | |
| Conneaut Creek, Taylor Run | 718 | 480 | Y | none |
| Conneaut Creek, Temple Run | 718 | 7,310 | Y | none |
| Conneaut Creek, Temple Run | 718 | 977 | 2 yrs | none |
| Conneaut Creek, West Branch | 718 | 228 | Y | none |
| Crooked Creek | 619 | 400 | Y | none |
| Crooked Creek | 619 | 1,250 | 2 yrs | none |
| Elk Creek | 619 | 11,685 | Y | none |

Table 10. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| Elk Creek, Little Elk Creek | 619 | 410 | Y | none |
| Twenty Mile Creek | 523 | 3,980 | 2 yrs | none |
| Walnut Creek | 620 | 3,300 | F | none |
| Subtotal | | 30,020 | | |
| **Pennsylvania waters (steelhead trout)** | | | | |
| Elk Creek | 619 | 50,000 | Y | none |
| Godfrey Run | 619 | 94,000 | Y | none |
| Lake Erie | 620 | 47,000 | Y | none |
| Sixteen Mile Creek | 523 | 50,000 | Y | none |
| Trout Run | 620 | 89,700 | Y | none |
| Twelve Mile Creek | 522 | 50,000 | Y | none |
| Walnut Creek | 620 | 50,000 | Y | none |
| Subtotal | | 430,700 | | |
| **Pennsylvania waters (palomino rainbow trout)** | | | | |
| Crooked Creek | 619 | 100 | Y | none |
| Elk Creek | 619 | 615 | Y,3yrs | none |
| Subtotal | | 715 | | |
| Total, Lake Erie | | 799,964 | | |
| **LAKE ONTARIO-RAINBOW AND STEELHEAD TROUT** | | | | |
| **New York waters (rainbow trout)** | | | | |
| Fourmile Creek | 806 | 6,100 | Y | none |
| Hamlin Beach | 713 | 21,510 | FF | none |
| Hamlin Beach | 713 | 8,490 | FF | adipose-left ventral |
| Irondequoit Creek | 815 | 10,700 | Y | none |
| Keg Creek | 709 | 6,300 | Y | none |
| Olcott Harbor | 708 | 10,000 | FF | none |
| Sandy Creek | 713 | 6,800 | Y | none |
| Selkirk Shores State Park | 623 | 18,000 | FF | none |
| Sodus Point | 819 | 18,500 | FF | none |
| Sodus Point | 819 | 9,690 | FF | adipose-left ventral |
| Twelvemile Creek | 707 | 8,000 | Y | none |
| Wilson Harbor | 707 | 4,260 | FF | adipose-left ventral |
| Wilson Harbor | 707 | 5,740 | FF | none |
| Subtotal | | 134,090 | | |
| **New York waters (steelhead trout)** | | | | |
| Beaverdam Brook | 0.53-8 | 114,150 | Y | left ventral |
| Spring Brook Reservoir | P6-2-Ont 53 | 4,800 | FF | left ventral–left maxillary |
| Subtotal | | 118,950 | | |
| **Ontario waters (rainbow trout)** | | | | |
| Credit River | 603 | 68,466 | Y | none |
| Total, Lake Ontario | | 321,506 | | |
| Great Lakes Total | | 5,177,864 | | |

[1] Rainbow x W. Virginia Golden hyrid (small numbers planted by Pennsylvania only).



Table 11. Annual plantings (in thousands) of brown and tiger[1] trout in the Great Lakes, 1975–1982.

**LAKE SUPERIOR**

| Year | Michigan | Wisconsin | Minnesota | Total |
|---|---|---|---|---|
| 1975 | 35 | 103 | 108 | 246 |
| 1976 | 35 | 43 | 10 | 88 |
| 1977 | 40 | 62 | 31 | 133 |
| 1978 | – | 94 | 9 | 103 |
| 1979 | 15 | 110 | 6 | 131 |
| 1980 | – | 85 | 5 | 90 |
| 1981 | 10 | 73 | – | 83 |
| 1982 | 15 | 68 | – | 83 |
| Subtotal | 150 | 638 | 169 | 957 |

**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 |
| 1978 | 150 | 1,208 | 13 | 131 | 1,503 |
| 1979 | 199 | 960 | 1 | 69 | 1,228 |
| 1980 | 105 | 1,046 | 24 | 116 | 1,292 |
| 1981 | 32 | 1,014 | 65 | 58 | 1,169 |
| 1982 | 300 | 1,821 | 18 | – | 1,904 |
| Subtotal | 1,957 | 7,499 | 267 | 702 | 10,192 |

**LAKE HURON**

| Year | Michigan | Total |
|---|---|---|
| 1975 | 155 | 155 |
| 1976 | 447 | 447 |
| 1977 | 210 | 210 |
| 1978 | 258 | 258 |
| 1979 | 90 | 90 |
| 1980 | 90 | 90 |
| 1981 | 45 | 45 |
| 1982 | 250 | 250 |
| Subtotal | 1,545 | 1,545 |

**LAKE ST. CLAIR**

| Year | Michigan | Total |
|---|---|---|
| 1982 | 48 | 48 |

Table 11. (Cont'd.)

| Year | Ohio | Pennsylvania | New York | Total |
|---|---|---|---|---|
| | | LAKE ERIE | | |
| 1975 | – | 7 | 26 | 33 |
| 1976 | – | 11 | 67 | 78 |
| 1977 | – | 49 | 125 | 174 |
| 1978 | 28 | 34 | – | 62 |
| 1979 | – | 51 | 26 | 77 |
| 1980 | 32 | 46 | 50 | 128 |
| 1981 | 35 | 41 | 34 | 111 |
| 1982 | 39 | 41 | 138 | 217 |
| Subtotal | 134 | 280 | 466 | 880 |

| Year | New York | Ontario | Total |
|---|---|---|---|
| | LAKE ONTARIO | | |
| 1975 | 371 | – | 371 |
| 1976 | 311 | – | 311 |
| 1977 | 353 | – | 353 |
| 1978 | 94 | – | 94 |
| 1979 | 219 | – | 219 |
| 1980 | 529 | – | 529 |
| 1981 | 454 | – | 454 |
| 1982 | 754 | 57 | 811 |
| Subtotal | 3,085 | 57 | 3,142 |
| Great Lakes Total, brown and tiger trout, 1975–1982 | | | 16,385 |

[1]Brown × brook trout hybrid.



Table 12. Plantings of brown and tiger[1] trout in the Great Lakes, 1982.

| Location | Grid No. | Numbers | Age | Fin Clip |
|---|---|---|---|---|
| LAKE SUPERIOR-BROWN TROUT | | | | |
| Michigan waters | | | | |
| Marquette Bay | 1529 | 10,000 | FF | none |
| Munising Bay | 1634 | 5,000 | FF | none |
| Subtotal | | 15,000 | | |
| Wisconsin waters | | | | |
| Ashland | 1509 | 35,000 | F | none |
| Ashland | 1509 | 32,000 | Y | none |
| Saxon Harbor | 1511 | 1,120 | Y | none |
| Subtotal | | 68,120 | | |
| Total, Lake Superior | | 83,120 | | |
| LAKE MICHIGAN-BROWN TROUT | | | | |
| Illinois waters | | | | |
| Great Lakes Naval Training Station | 2402 | 18,300 | F | none |
| Michigan waters | | | | |
| Betsie River | 1011 | 20,000 | FF | none |
| East Grand Traverse Bay | 915 | 40,000 | FF | none |
| Galien River | 2708 | 10,000 | FF | none |
| Greilickville | 915 | 40,000 | FF | none |
| Harbor Springs | 519 | 25,000 | FF | none |
| Henes Park | 703 | 10,000 | FF | none |
| Kalamazoo River | 2211 | 10,000 | FF | none |
| Ludington | 1410 | 20,000 | FF | none |
| Manistee | 1211 | 20,000 | FF | none |
| Muskegon Lake Outlet | 1810 | 15,000 | FF | none |
| Pine River | 616 | 40,000 | FF | none |
| St. Joseph River | 2509 | 10,000 | FF | none |
| Saunders Point | 306 | 20,000 | FF | none |
| South Haven | 2311 | 10,000 | FF | none |
| Wells State Park | 504 | 10,000 | FF | none |
| Subtotal | | 300,000 | | |
| Wisconsin waters | | | | |
| Algoma | 1004 | 79,000 | F | none |
| Bailey's Harbor | 706 | 10,000 | F | none |
| Bailey's Harbor | 706 | 4,470 | Y | none |
| Brauns Dorf Beach | 905 | 24,200 | F | none |
| Brauns Dorf Beach | 905 | 7,700 | Y | none |
| Egg Harbor | 705 | 30,000 | F | none |
| Egg Harbor | 705 | 15,600 | Y | none |
| Ephraim | 605 | 10,000 | F | none |
| Ephraim | 605 | 9,200 | Y | none |
| Fish Creek | 705 | 30,000 | F | none |
| Fish Creek | 705 | 16,800 | Y | none |

Table 12. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip |
|---|---|---|---|---|
| Gill's Rock | 606 | 10,000 | F | none |
| Gill's Rock | 606 | 5,500 | Y | none |
| Kenosha | 2202 | 31,600 | F | none |
| Kenosha | 2202 | 30,000 | Y | none |
| Kewaunee | 1104 | 2,500 | F | none |
| Kewaunee | 1104 | 78,315 | Y | none |
| Little River | 703 | 18,000 | Y | none |
| Manitowoc | 1303 | 62,700 | F | none |
| Manitowoc | 1303 | 54,300 | Y | none |
| Marinette Surf Club | 703 | 10,000 | F | none |
| Marinette Surf Club | 703 | 12,000 | F | none |
| Menominee River | 703 | 10,000 | Y | none |
| Milwaukee | 1901 | 76,491 | F | none |
| Milwaukee | 1901 | 26,200 | Y | none |
| Moonlight Bay | 706 | 10,000 | F | none |
| Moonlight Bay | 706 | 5,500 | Y | none |
| Oconto Park | 802 | 10,000 | F | none |
| Oconto Park | 802 | 19,300 | Y | none |
| Oconto Pier | 802 | 60,000 | F | none |
| Oconto River | 802 | 122,500 | F | none |
| Peshtigo River | 803 | 122,500 | F | none |
| Port Washington | 1701 | 44,789 | F | none |
| Port Washington | 1701 | 62,496 | Y | none |
| Racine | 2102 | 31,200 | F | none |
| Racine | 2102 | 30,000 | Y | none |
| Red Arrow Park | 703 | 30,000 | Y | none |
| Red Arrow Park | 703 | 10,000 | Y | none |
| Rowleys Bay | 607 | 10,000 | F | none |
| Rowleys Bay | 607 | 5,500 | Y | none |
| Shauer Park | 805 | 25,800 | F | none |
| Shauer Park | 805 | 14,900 | Y | none |
| Sheboygan | 1502 | 115,753 | F | none |
| Sheboygan | 1502 | 76,224 | Y | none |
| Sister Bay | 606 | 6,000 | Y | none |
| Sturgeon Bay | 905 | 86,660 | F | none |
| Sturgeon Bay | 905 | 32,700 | Y | none |
| Two Rivers | 1303 | 82,000 | F | none |
| Two Rivers | 1303 | 35,795 | Y | none |
| Westers | 805 | 30,000 | F | none |
| Westers | 805 | 10,500 | Y | none |
| Whitefish Bay | 805 | 30,000 | F | none |
| Whitefish Bay | 805 | 11,000 | Y | none |
| Winnegar Pond | 803 | 10,000 | F | none |
| Winnegar Pond | 803 | 15,000 | Y | none |
| Subtotal | | 1,820,693 | | |
| Total, Lake Michigan | | 1,903,813 | | |



Table 12. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip |
|---|---|---|---|---|
| LAKE HURON-BROWN TROUT | | | | |
| Michigan waters | | | | |
| East Tawas | 1309 | 25,000 | FF | none |
| Grindstone City | 1412 | 25,000 | FF | none |
| Lakeside Road Access | 304 | 15,000 | FF | none |
| Lexington | 1915 | 25,000 | FF | none |
| Port Sanilac | 1814 | 25,000 | FF | none |
| Rogers City | 607 | 20,000 | FF | none |
| Saginaw Bay, Pt. Lookout | 1408 | 15,000 | FF | none |
| Thunder Bay, Part Pt. | 809 | 85,000 | FF | none |
| Whitney Drain | 1408 | 15,000 | FF | none |
| Subtotal | | 250,000 | | |
| Total, Lake Huron | | 250,000 | | |
| LAKE ST. CLAIR–BROWN TROUT | | | | |
| Michigan Waters | | | | |
| Black River | 0000 | 22,500 | Y | none |
| St. Clair River | 0000 | 25,000 | FF | none |
| Subtotal | | 47,500 | | |
| Total, Lake St. Clair | | 47,500 | | |
| LAKE ERIE-BROWN TROUT | | | | |
| New York waters | | | | |
| Barcelona | 424 | 21,500 | Y | none |
| Center Road and Route 5 | 326 | 50,000 | F | none |
| Dunkirk Harbor | 425 | 10,000 | Y | none |
| Silver Creek | 326 | 21,500 | Y | none |
| Sturgeon Point | 227 | 35,000 | FF | none |
| Subtotal | | 138,000 | | |
| Ohio waters | | | | |
| Grand River | 814 | 38,650 | F | none |
| Pennsylvania waters | | | | |
| Conneaut Creek, Albion Reservoir | 718 | 1,162 | Y | none |
| Conneaut Creek, Temple Creek | 718 | 125 | Y | none |
| Conneaut Creek, Temple Creek | 718 | 380 | 2 yrs | none |
| Coneaut Creek | 718 | 1,156 | Y | none |
| Crooked Creek | 619 | 1,650 | 2&4 yrs | none |
| Elk Creek | 619 | 6,200 | 2&4 yrs | none |
| Elk Creek | 619 | 400 | 2 yrs | none |
| Lake Erie | 620 | 25,000 | Y | none |

Table 12. (Cont'd.)

| Location | Grid No. | Numbers | Age | Fin Clip |
|---|---|---|---|---|
| Raccoon Creek, Baldwin Pond | 619 | 60 | 2 yrs | none |
| Raccoon Creek, Baldwin Pond | 619 | 440 | Y | none |
| Twenty Mile Creek | 523 | 3,650 | F,Y | none |
| Walnut Creek | 620 | 400 | 2 yrs | none |
| Subtotal | | 40,623 | | |
| Total, Lake Erie | | 217,273 | | |
| **LAKE ONTARIO-BROWN TROUT** | | | | |
| New York waters | | | | |
| Braddock's Bay | 815 | 23,500 | Y | none |
| Fair Haven | 720 | 32,870 | Y | none |
| Genesee | 815 | 31,110 | Y | none |
| Hamlin | 713 | 35,600 | Y | none |
| Henderson Bay | 424 | 25,000 | Y | adipose |
| Henderson Bay | 424 | 4,970 | Y | Floy tag |
| Irondequoit | 815 | 23,500 | Y | none |
| Olcott | 708 | 37,600 | Y | none |
| Olcott | 708 | 25,000 | FF | none |
| Oswego | 721 | 24,090 | Y | Floy tag |
| Oswego | 721 | 4,690 | Y | adipose–left ventral |
| Oswego | 721 | 6,900 | Y | none |
| Oswego | 721 | 50,000 | SF | none |
| Oswego | 721 | 52,800 | FF | none |
| Point Breeze | 711 | 37,710 | Y | none |
| Point Breeze | 711 | 10,000 | FF | none |
| Pultneyville | 817 | 23,610 | Y | none |
| Ray Bay | 523 | 10,680 | Y | none |
| Ray Bay | 523 | 25,000 | Y | left ventral |
| Rochester | 815 | 20,000 | FF | none |
| Selkirk | 623 | 40,870 | Y | none |
| Sodus | 819 | 36,900 | Y | none |
| Sodus | 819 | 20,000 | FF | none |
| Southwicks Beach | 523 | 15,000 | Y | none |
| Webster | 816 | 23,500 | Y | none |
| Webster | 816 | 48,000 | SF | none |
| Wilson | 707 | 40,060 | Y | none |
| Wilson | 707 | 25,000 | FF | none |
| Subtotal | | 753,960 | | |
| Ontario waters | | | | |
| Ganaraska River | 411 | 17,000 | FF | none |
| Ganaraska River | 311 | 2,000 | FF | none |
| Lake Ontario | 319 | 19,150 | FF | right ventral |
| Rouge River | 506 | 19,000 | FF | none |
| Subtotal | | 57,150 | | |
| Total, Lake Ontario | | 811,110 | | |
| Great Lakes Total | | 3,312,816 | | |

[1]Brown × brook trout hybrid.



Table 13. Annual plantings (in thousands) of brook trout in the Great Lakes, 1976–1982.

| Year | LAKE SUPERIOR | | | |
|---|---|---|---|---|
| | Wisconsin | Minnesota | Ontario | Total |
| 1976 | 25 | 7 | - | 32 |
| 1977 | 123 | 66 | - | 188 |
| 1978 | 166 | 30 | - | 196 |
| 1979 | 83 | 27 | - | 111 |
| 1980 | 124 | 15 | - | 139 |
| 1981 | 80 | - | - | 80 |
| 1982 | 43 | - | 11 | 53 |
| Subtotal | 644 | 145 | 11 | 799 |
| | **LAKE MICHIGAN** | | | |
| Year | Michigan | Wisconsin | Illinois | Total |
| 1976 | 61 | 12 | 6 | 79 |
| 1977 | - | 643 | – | 643 |
| 1978 | - | 243 | 5 | 248 |
| 1979 | - | 187 | 8 | 196 |
| 1980 | - | 185 | 20 | 204 |
| 1981 | 8 | 200 | - | 208 |
| 1982 | - | 283 | - | 283 |
| Subtotal | 69 | 1,753 | 39 | 1,861 |

| Year | LAKE ERIE Pennsylvania | Total |
|---|---|---|
| 1976 | 6 | 6 |
| 1977 | 2 | 2 |
| 1978 | 2 | 2 |
| 1979 | - | - |
| 1980 | 6 | 6 |
| 1981 | – | – |
| 1982 | 4 | 4 |
| Subtotal | 20 | 20 |

| Year | LAKE ONTARIO New York | Total |
|---|---|---|
| 1976 | - | - |
| 1977 | 8 | 8 |
| 1978 | - | - |
| 1979 | - | - |
| 1980 | 326 | 326 |
| 1981 | 106 | 106 |
| 1982 | - | - |
| Subtotal | 440 | 440 |

Great Lakes Total, brook trout, 1976–1982 3,120

Table 14. Plantings of brook trout in the Great Lakes, 1982.

| Location | Grid No. | Numbers | Age | Fin Clip/Mark |
|---|---|---|---|---|
| | | LAKE SUPERIOR-BROOK TROUT | | |
| Ontario waters | | | | |
| Dublin Creek | 126 | 262 | 5 yrs | none |
| Dublin Creek | 126 | 994 | 4 yrs | none |
| Gurney | 126 | 1,122 | 4 yrs | none |
| Quarry Island | 128 | 8,372 | Y | right ventral |
| Subtotal | | 10,750 | | |
| Wisconsin waters | | | | |
| Ashland | 1509 | 7,500 | Y | none |
| Bayfield | 1409 | 3,750 | Y | none |
| Houghton Point | 1409 | 100 | A | none |
| Houghton Point | 1409 | 2,800 | Y | adipose |
| Onion River | 1409 | 1,020 | Y | adipose |
| Onion River | 1409 | 3,750 | Y | none |
| Washburn | 1509 | 8,670 | Y | adipose |
| Washburn | 1509 | 15,000 | Y | none |
| Subtotal | | 42,590 | | |
| Total, Lake Superior | | 53,340 | | |
| | | LAKE MICHIGAN-BROOK TROUT | | |
| Wisconsin waters | | | | |
| Bailey's Harbor | 706 | 12,000 | A | none |
| Kewaunee | 1104 | 12,000 | A | none |
| Oconto River | 802 | 86,000 | F | none |
| Peshtigo River | 803 | 86,000 | F | none |
| Port Washington | 1701 | 6,664 | F | none |
| Two Rivers | 1204 | 12,000 | Y | none |
| Sheboygan | 1502 | 14,813 | F | none |
| Sheboygan | 1502 | 50,123 | Y | none |
| Whitefish Bay | 805 | 3,400 | F | none |
| Subtotal | | 283,000 | | |
| Total, Lake Michigan | | 283,000 | | |
| | | LAKE ERIE-BROOK TROUT | | |
| Pennsylvania waters | | | | |
| Elk Creek | 619 | 300 | 2 yrs | none |
| Elk Creek | 619 | 3,000 | 2,4 yrs | none |
| Walnut Creek | 620 | 500 | Y | none |
| Walnut Creek | 620 | 100 | 2 yrs | none |
| Subtotal | | 3,900 | | |
| Total, Lake Erie | | 3,900 | | |
| Great Lakes Total | | 325,240 | | |

# SEA LAMPREY CONTROL IN THE GREAT LAKES

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This report summarizes the activities in 1982 of the Canadian and United States sea lamprey management units of the Great Lakes Fishery Commission, in fulfillment of the responsibility, assigned under the Convention for Great Lakes Fisheries, "to implement a program aimed at eradicating or minimizing sea lamprey populations in the Convention Area." A program of sea lamprey management is in effect in all of the Great Lakes except Lake Erie. Although a variety of possible alternate control methods are under active investigation, the current success of sea lamprey management still relies almost exclusively on the repetitive application of selective toxicants (lampricides) to streams and other water bodies containing populations of larval sea lampreys.

The detection and evaluation of larval populations are accomplished through surveys of streams and other areas, using electroshockers or application of granular Bayer 73 (2',5-dichloro-4'-nitrosalicylanilide), a bottom formulation of one of the lampricides. Treatments of streams are performed by the regulated introductions of a liquid formulation of TFM (3-trifluoromethyl-4-nitrophenol), either with or without the addition of Bayer 73 as wettable powder, at concentrations and durations predetermined to kill sea lamprey larvae without significantly affecting fish populations. Adult sea lamprey populations are monitored in the parasitic phase by solicitation of specimens and incidental catch data from commercial fishermen, or in the spawning phase by collecting the upstream migrants in various trapping devices. Other investigations are aimed at learning more about the life history and behavior of the sea lamprey in a continuing effort to make sea lamprey control more efficient and effective.

During 1982, no new populations of sea lamprey larvae were found during stream surveys. However, extensions of known distributions were found in a large river system (three tributaries of the Saginaw River, Lake Huron). A total of 81 lampricide treatments were performed by the control units, as detailed in Table 1. Monitoring of spawning-phase sea lampreys through the operation of various types of trapping devices resulted in the capture of 39,970 specimens. Details of the biological information derived from these animals are listed in Table 2.

The sections which follow describe sea lamprey management activities and biological investigations in each lake basin for 1982.

## Lake Superior

### *SURVEYS*

Ammocete surveys were conducted on 178 streams and 26 estuaries, bays, or inland lakes during 1982. Pretreatment surveys were conducted on 35 streams during the field season and 12 of the streams were treated. The other streams are scheduled for treatment in 1983 or later. Moderate to large populations were indicated in the Two Hearted and Salmon Trout (Marquette County) rivers and Polly Creek.

Index stations on tributaries to the south shore of Lake Superior have been examined each fall since 1960 to determine presence of young-of-the-year sea lampreys. The 1982 year class of sea lampreys was in 28 of 74 streams examined. Chemical treatments later eliminated this year class from nine streams: Waiska, Betsy, Sucker, Big Garlic, Ravine, Silver, Sturgeon, and Nemadji rivers and Furnace Creek. Thirty-three streams

Table 1. Summary of chemical treatments in streams and estuarine or bay areas of the Great Lakes in 1982.

| | | | | | | Bayer 73 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Discharge at mouth | | TFM | | Powder | | Granules | |
| Lake | Number of treatments | $m^3/s$ | $f^3/s$ | Act. kg | Ingr. lbs | Act. kg | Ingr. lbs | Total used[a] kg | lbs |
| Superior | 31 | 107.4 | 3,795 | 9,752 | 21,470 | 52 | 116 | 3,906 | 8,605 |
| Michigan | 13 | 157.6 | 5,568 | 31,135 | 68,640 | 94 | 208 | – | – |
| Huron | 23 | 26.2 | 922 | 6,497 | 14,318 | 8 | 17 | 2,228 | 4,900 |
| Ontario | 14 | 11.7 | 421 | 3,400 | 7,482 | 4 | 8 | 14 | 30 |
| TOTAL | 81 | 302.9 | 10,706 | 50,784 | 111,910 | 158 | 349 | 6,148 | 13,535 |

[a] Sand granules coated with Bayer 73 at 5% by weight active ingredient.



Table 2. Number and biological characteristics of adult sea lampreys captured in assessment traps in 43 tributaries of the Great Lakes in 1982.

| | | | | | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|---|
| Lake | Number of streams | Total captured | Number sampled | Percent males | Males | Females | Males | Females |
| Superior | 9 | 1,325 | 1,276 | 33 | 422 | 410 | 169 | 160 |
| Michigan | 13 | 13,505 | 4,999 | 38 | 485 | 483 | 222 | 232 |
| Huron | 7 | 21,197 | 4,435 | 41 | 468 | 470 | 211 | 220 |
| Erie | 1 | 954 | 954 | 50 | 497 | 498 | 270 | 282 |
| Ontario | 13 | 2,989 | 2,799 | 56 | 493 | 482 | 248 | 249 |

Table 2. Number and biological characteristics of adult sea lampreys captured in assessment traps in 43 tributaries of the Great Lakes in 1982.

| Lake | Number of streams | Total captured | Number sampled | Percent males | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Males | Females | Males | Females |
| Superior | 9 | 1,325 | 1,276 | 33 | 422 | 410 | 169 | 160 |
| Michigan | 13 | 13,505 | 4,999 | 38 | 485 | 483 | 222 | 232 |
| Huron | 7 | 21,197 | 4,435 | 41 | 468 | 470 | 211 | 220 |
| Erie | 1 | 954 | 954 | 50 | 497 | 498 | 270 | 282 |
| Ontario | 13 | 2,989 | 2,799 | 56 | 493 | 482 | 248 | 249 |

contain reestablished populations; however, 4 of these have shown no evidence of recruitment for the past 4 years or more. The largest reinfestations appeared to be in the Brule, Bad, and Middle rivers and Harlow Creek.

Sea lamprey ammocetes were collected from 9 of 15 streams surveyed along the north shore of Lake Superior to determine if sea lampreys had reestablished since the last lampricide treatment. The six streams from which sea lampreys have not reestablished since their last treatment are as follows (year of last treatment in parentheses): East Davignon Creek (1972), Sawmill Creek (1968), Little Pic River (1981), Blende Creek (1964), McIntyre River (1960), and the Cloud River (1976). Seven of the other nine streams known to harbor sea lamprey larvae were last treated in 1980 or 1981, whereas the Harmony and Pays Plat rivers were treated in 1976 and 1963, respectively. Each of the two rivers were surveyed on several occasions since the last treatments, but no larvae were collected until 1982.

Residual sea lampreys were found in 16 streams along the south shore of Lake Superior. Moderate to large populations were found in the Waiska and Traverse rivers during spring surveys. These rivers were treated later in the year. Small numbers of residual lampreys were revealed in 14 other streams: Two Hearted, Sucker, Au Train (Buck Bay Creek), Little Garlic, Huron, Slate, Ontonagon, Bad, Brule, Poplar, Middle, Amnicon, and Nemadji rivers and Washington Creek. Treatments later in the year probably eliminated these animals in the Sucker, Slate, Ontonagon, and Nemadji rivers.

Treatment evaluation surveys were conducted on seven north shore tributaries treated in 1981 and Batchawana River treated in the fall of 1980. Residual sea lampreys were collected from five of the streams—the Batchawana and Jackfish rivers appear to harbor a greater number than the Pancake, Little Pic, or Nipigon rivers.

Investigations continued on the St. Louis River to determine the magnitude of the recently established (1979) population. Sampling in 1982, as in past years, indicated a low density population extending downstream from the barrier dam at Fond du Lac for about 9 km (5.6 miles) to just below the Oliver Bridge. Twelve ammocetes (43–126 mm long) were recovered in surveys with granular Bayer 73.

Surveys with Bayer 73 and backpack shockers of offshore, estuarine, and inland lake areas associated with tributaries of Lake Superior continued. Sea lamprey larvae were recovered from 10 of the 20 areas examined: Sucker, Miners, Laughing Whitefish, Ravine, Slate, Silver, and Black rivers, Galloway Creek, and Beaver and Harlow lakes.

Granular Bayer 73 surveys were conducted at six sites in Batchawana Bay to further establish sea lamprey distributional patterns and document larval densities upon which to base granular Bayer treatments.

No sea lamprey infestations were found during resurveys of historically negative streams. Included in the streams surveyed were 12 tributaries located on the Slate Islands. Only two the Slate Island tributaries are thought to contain habitat suitable for sea lamprey spawning and larval survival.



*TREATMENTS*

Chemical treatments were completed on 27 streams and 4 bay areas of Lake Superior during the field season (Table 3, Fig. 1). Most of the treatments were routine with sufficient water volume to maintain lethal chemical concentrations through the estuaries. A controlled flow of 40 $m^3/s$ (1,412 $f^3/s$) on the main Michipicoten River resulted in a highly successful treatment of this large and prolific lamprey-producing river. The Sable River treatment was complicated by low water discharge which resulted in additional time and chemical applications.

Annual treatments with TFM in the United States and granular Bayer 73 in Canada to prevent establishment of sea lampreys in lentic areas continued. Annual treatments with TFM were performed on the Sucker, Big Garlic, Silver, Slate, and Ravine rivers and Furnace and Harlow creeks. Granular Bayer 73 treatments within Mackenzie, Cypress, Mountain, and Batchawana bays produced relatively low numbers of larval sea lampreys in comparison to previous annual treatments. An exception was that area of Batchawana Bay adjacent to Chippewa River where 780 larvae, including 8 metamorphosing ammocetes, were collected. The Chippewa River will be treated annually commencing in 1983 to reduce larval recruitment to a lake population.

Sea lampreys were numerous in the Misery River and Newholm Creek, an Ontonagon River tributary. About 10% of the sea lamprey larvae collected on the Goulais River were residuals left from the 1979 treatment. Transforming lampreys were collected from the Sable River and three areas of Batchawana Bay.

Mortalities of nontarget species were limited to trout-perch in the mouth area of the Gravel and Goulais rivers and numerous minnows on a section of the Waiska River.

*SPAWNING-RUN SEA LAMPREYS*

Assessment traps were fished in nine tributaries of Lake Superior in 1982 (Table 4, Fig. 1). The catch of adult sea lampreys was 1,325, compared with 1,846 in 1981. The largest decline occurred in the Tahquamenon River where the catch decreased by 365. Although only two rivers were fished in Canada compared with six in 1981, the total catch increased from 82 to 104. The average length and weight of sea lampreys have remained fairly constant, but the percentage of males decreased from 36 in 1981 to 33 in 1982 (Table 4).

*PARASITIC SEA LAMPREYS*

A total of 247 sea lampreys (228 in U.S. and 19 in Canada) were taken by commercial and sport fishermen from Lake Superior, compared with 239 (212 in U.S. and 27 in Canada) in 1981. Included in the collection were

Table 3. Details on the application of lampricides to streams and bays of Lake Superior, 1982.
[Number in parentheses corresponds to location of stream or area in Figure 1.]

| Stream or bay | Date | Discharge at mouth | | TFM | | Bayer 73 | | | | Stream treated | | Area treated | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Powder | | Granules | | | | | |
| | | | | Act. Ingr. | | Act. Ingr. | | Total used[a] | | | | | |
| | | $m^3/s$ | $f^3/s$ | kg | lbs | kg | lbs | kg | lbs | km | miles | ha | acres |
| CANADA | | | | | | | | | | | | | |
| Goulais R. (10) | June 14 | 12.0 | 425 | 1,747 | 3,844 | – | – | 5 | 10 | 133.6 | 84 | – | – |
| Little Gravel R. (4) | July 14 | 0.4 | 14 | 37 | 82 | – | – | – | – | 6.5 | 4 | – | – |
| Pearl R. (2) | July 15 | 1.5 | 55 | 188 | 414 | – | – | – | – | 3.2 | 2 | – | – |
| Cypress R. (3) | July 17 | 2.8 | 100 | 138 | 304 | – | – | – | – | 4.8 | 3 | – | – |
| Gravel R. (5) | July 19 | 9.2 | 325 | 602 | 1,325 | 9 | 20 | – | – | 16.1 | 10 | – | – |
| Sable R. (8) | Aug. 9 | 0.5 | 17 | 70 | 154 | – | – | – | – | 11.3 | 7 | – | – |
| Michipicoten R. (7) | Aug. 21 | 51.8 | 1,830 | 2,806 | 6,173 | 43 | 96 | – | – | 18.5 | 11 | – | – |
| Mountain Bay (6) | July 17 | – | – | – | – | – | – | 363 | 800 | – | – | 1.5 | 4 |
| Cypress Bay (3) | July 18 | – | – | – | – | – | – | 454 | 1,000 | – | – | 1.9 | 5 |
| Mackenzie Bay (1) | July 20 | – | – | – | – | – | – | 907 | 1,995 | – | – | 3.7 | 9 |
| Batchawana Bay (9) | | | | | | | | | | | | | |
| Harmony R. | July 29 | – | – | – | – | – | – | 272 | 600 | – | – | 1.1 | 3 |
| Stokely Cr. | Aug. 4 | – | – | – | – | – | – | 454 | 1,000 | – | – | 1.9 | 5 |
| Chippewa R. | Aug. 5 | – | – | – | – | – | – | 544 | 1,200 | – | – | 2.3 | 6 |
| Sable R. | Aug. 17 | – | – | – | – | – | – | 363 | 800 | – | – | 1.5 | 4 |
| Batchawana R. | Aug. 30 | – | – | – | – | – | – | 363 | 800 | – | – | 1.5 | 4 |
| Sand Point | Aug. 30 | – | – | – | – | – | – | 181 | 400 | – | – | 0.7 | 2 |
| Total | | 78.2 | 2,766 | 5,588 | 12,296 | 52 | 116 | 3,906 | 8,605 | 194.0 | 121 | 16.1 | 42 |
| *UNITED STATES* | | | | | | | | | | | | | |
| Cranberry R. (28) | June 17 | 0.1 | 3 | 100 | 220 | – | – | – | – | 14.5 | 9 | – | – |
| Misery R. (25) | June 19 | 0.6 | 20 | 210 | 462 | – | – | – | – | 21.0 | 13 | – | – |
| East Sleeping R. (26) | June 22 | 0.2 | 8 | 70 | 154 | – | – | – | – | 3.2 | 2 | – | – |
| Miners R. (15) | June 29 | 0.5 | 19 | 220 | 484 | – | – | – | – | 3.2 | 2 | – | – |
| Little Garlic R. (18) | June 30 | 0.1 | 3 | 40 | 88 | – | – | – | – | 4.8 | 3 | – | – |
| Traverse R. (24) | July 23 | 0.3 | 9 | 30 | 66 | – | – | – | – | 24.2 | 15 | – | – |
| Ontonagon R. (27) | | | | | | | | | | | | | |
| Newholm Cr. | July 26 | 0.1 | 2 | 20 | 44 | – | – | – | – | 1.6 | 1 | – | – |
| Ravine R. (20) | Aug. 19 | 0.1 | 3 | 20 | 44 | – | – | – | – | 8.1 | 5 | – | – |
| Silver R. (22) | Aug. 19 | 0.7 | 23 | 90 | 198 | – | – | – | – | 4.8 | 3 | – | – |
| Slate R. (21) | Aug. 20 | 0.1 | 5 | 10 | 22 | – | – | – | – | 1.6 | 1 | – | – |
| Sturgeon R. (23) | Aug. 23 | 17.0 | 600 | 2,165 | 4,774 | – | – | – | – | 161.3 | 100 | – | – |
| Nemadji R. (30) | | | | | | | | | | | | | |
| Black R. | Sept. 2 | 0.4 | 14 | 90 | 198 | – | – | – | – | 6.5 | 4 | – | – |
| Sand R. (29) | Sept. 6 | 0.2 | 8 | 70 | 154 | – | – | – | – | 8.1 | 5 | – | – |
| Sucker R. (14) | Sept. 17 | 3.1 | 110 | 509 | 1,122 | – | – | – | – | 24.2 | 15 | – | – |
| Betsy R. (13) | Sept. 17 | 1.7 | 60 | 180 | 396 | – | – | – | – | 14.5 | 9 | – | – |
| Pendills Cr. (12) | Sept. 20 | 0.8 | 30 | 50 | 110 | – | – | – | – | 1.6 | 1 | – | – |
| Big Garlic R. (19) | Sept. 28 | 0.8 | 30 | 70 | 154 | – | – | – | – | 3.2 | 2 | – | – |
| Harlow Cr. (17) | Oct. 26 | 0.2 | 7 | 20 | 44 | – | – | – | – | 1.6 | 1 | – | – |
| Waiska R. (11) | Oct. 27 | 1.7 | 59 | 160 | 352 | – | – | – | – | 12.9 | 8 | – | – |
| Furnace Cr. (16) | Oct. 27 | 0.5 | 16 | 40 | 88 | – | – | – | – | 1.6 | 1 | – | – |
| Total | | 29.2 | 1,029 | 4,164 | 9,174 | – | – | – | – | 322.5 | 200 | – | – |
| GRAND TOTAL | | 107.4 | 3,795 | 9,752 | 21,470 | 52 | 116 | 3,906 | 8,605 | 516.5 | 321 | 16.1 | 42 |

[a] Sand granules coated with Bayer 73 at 5% by weight active ingredient.

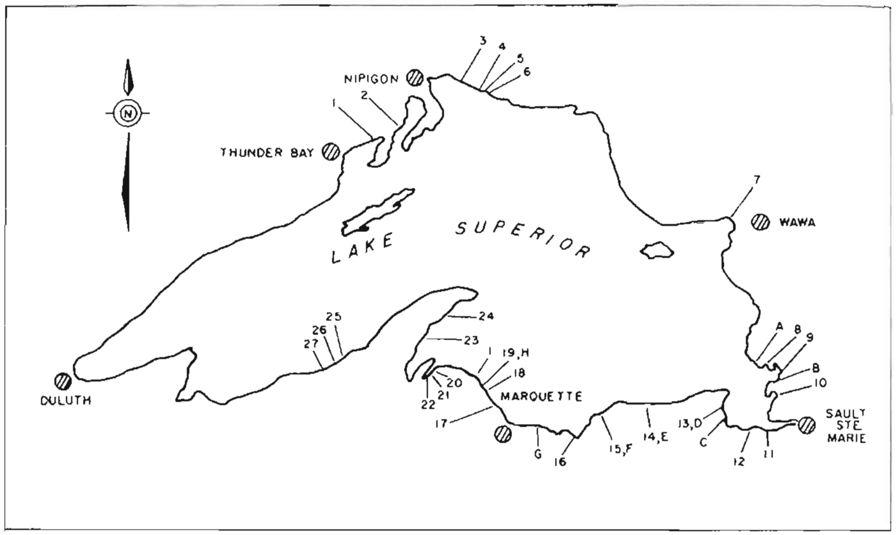


Figure 1. Location of streams and bay areas of Lake Superior treated with lampricides (numerals; see Table 3 for names of streams or areas), and of streams where assessment traps were fished (letters; see Table 4 for names of streams) in 1982.

eight recently metamorphosed sea lampreys (≤200 mm long), of which six were collected in the Grand Marais, Michigan, area (statistical district, MS-5). Fishermen from the Apostle Islands area (statistical district of Wisconsin) and the Munising, Michigan, area (MS-4) contributed 115 and 81 lampreys, respectively. Although the total catch of sea lampreys in Lake Superior was nearly the same in 1981 as in 1982, the catch from the Apostle Islands and Munising areas increased from 92 to 115 and 74 to 81, respectively. The limited number of lampreys (19) submitted from Canadian waters in eastern Lake Superior (OS-7) do not permit an estimate of trends in any biological characteristics.

*SPECIAL STUDIES*

*Big Garlic River trap*—Twenty-eight transformed sea lampreys and 3,272 ammocetes were captured at the downstream trap in the Big Garlic River in 1982, compared with 28 and 1,030, respectively, in 1981. Large larvae (>120 mm long) collected in the spring are allowed to transform in warmwater aquaria, and then transferred to the Hammond Bay Biological Station. Small larvae (<120 mm) are held in aquaria for use in bioassays conducted by personnel of the Marquette chemical control units.

*Rate of transformation*—Sea lamprey ammocetes of age IV were collected by electrofishing from three streams in May: 30 from Point Patterson Creek (Lake Michigan), 118 from the Betsy River (Lake Superior), and 50



Table 4. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Superior, 1982. [Letter in parentheses corresponds to location of stream in Figure 1.]

| Stream | Number captured | Number sampled | Percent males | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|
| | | | | Males | Females | Males | Females |
| CANADA | | | | | | | |
| Pancake R. (A) | 90 | 52 | 40 | 430 | 410 | 170 | 159 |
| Stokely Cr. (B) | 14 | 5 | 60 | 440 | 420 | 218 | 151 |
| Total or average | 104 | 57 | 42 | 430 | 410 | 176 | 158 |
| UNITED STATES | | | | | | | |
| Tahquamenon R. (C) | 229 | 227 | 54 | 430 | 428 | 184 | 185 |
| Betsy R. (D) | 232 | 232 | 40 | 422 | 410 | 176 | 163 |
| Sucker R. (E) | 58 | 58 | 21 | 404 | 420 | 140 | 159 |
| Miners R. (F) | 1 | 1 | 100 | 423 | – | 174 | – |
| Rock R. (G) | 530 | 530 | 23 | 418 | 412 | 154 | 152 |
| Big Garlic R. (H) | 170 | 170 | 27 | 413 | 414 | 160 | 164 |
| Iron R. (I) | 1 | 1 | 0 | – | 354 | – | 155 |
| Total or average | 1,221 | 1,219 | 32 | 422 | 414 | 169 | 160 |
| GRAND TOTAL OR AVERAGE | 1,325 | 1,276 | 33 | 422 | 410 | 169 | 160 |

Table 4. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Superior, 1982. [Letter in parentheses corresponds to location of stream in Figure 1.]

| Stream | Number captured | Number sampled | Percent males | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|
| | | | | Males | Females | Males | Females |
| CANADA | | | | | | | |
| Pancake R. (A) | 90 | 52 | 40 | 430 | 410 | 170 | 159 |
| Stokely Cr. (B) | 14 | 5 | 60 | 440 | 420 | 218 | 151 |
| Total or average | 104 | 57 | 42 | 430 | 410 | 176 | 158 |
| UNITED STATES | | | | | | | |
| Tahquamenon R. (C) | 229 | 227 | 54 | 430 | 428 | 184 | 185 |
| Betsy R. (D) | 232 | 232 | 40 | 422 | 410 | 176 | 163 |
| Sucker R. (E) | 58 | 58 | 21 | 404 | 420 | 140 | 159 |
| Miners R. (F) | 1 | 1 | 100 | 423 | – | 174 | – |
| Rock R. (G) | 530 | 530 | 23 | 418 | 412 | 154 | 152 |
| Big Garlic R. (H) | 170 | 170 | 27 | 413 | 414 | 160 | 164 |
| Iron R. (I) | 1 | 1 | 0 | – | 354 | – | 155 |
| Total or average | 1,221 | 1,219 | 32 | 422 | 414 | 169 | 160 |
| GRAND TOTAL OR AVERAGE | 1,325 | 1,276 | 33 | 422 | 410 | 169 | 160 |

from the Little Garlic River (Lake Superior). Another 50 (age unknown) were collected from the inclined-plane trap in the Big Garlic River (Lake Superior). Mean lengths from these streams were 123 mm (range, 116–134) for Point Patterson Creek, 131 mm (118–157) for Betsy River, 126 mm (120–145) for Little Garlic River, and 136 mm (120–157) for Big Garlic River.

The ammocetes were held under a variety of conditions to obtain transformation rates. Three groups were held in aquaria at room temperature at the Marquette Station: 15 from Point Patterson Creek, 43 from the Betsy River, and 25 from the Little Garlic River. Another group of 25 ammocetes from the Betsy River was held in a cage in that river. Six cages were placed in the St. Marys River, and ammocetes introduced as follows:

| Cage No. | Source | No. of ammocetes |
|---|---|---|
| 1 | Point Patterson Creek | 15 |
| 2 | Betsy River | 25 |
| 3 | Betsy River | 25 |
| 4 | Little Garlic River | 25 |
| 5 | Big Garlic River | 25 |
| 6 | Big Garlic River | 25 |

All sea lampreys were removed from the holding facilities in September and October. Mortality was low except for the caged ammocetes in the Betsy River where 14 of 25 were lost to unknown factors. The only transformation that occurred was 3 of 43 (7%) ammocetes in the Betsy River aquaria. A similar percentage (8%) of transformed sea lampreys were recovered also during the treatment of the Betsy River in September. A total of 8 of 105 sea lampreys greater than 120 mm collected during the treatment had transformed.

No information on natural stream transformation was available on Point Patterson Creek or the Little Garlic River. Chemical treatment was deferred on Point Patterson Creek, and the Little Garlic River was treated in June and, therefore, too early to observe transformation.

## Lake Michigan

### *SURVEYS*

Pretreatment surveys were conducted on 24 Lake Michigan tributaries during the field season. Eleven of the streams were later treated and 13 are proposed for treatment in 1983. Moderate to large populations are indicated in the Whitefish, Ford, Pere Marquette, and White rivers which will be treated in 1983.

Investigations to monitor reestablished sea lamprey populations showed that 43 streams are reinfested. No large populations of reestablished larvae were indicated in any stream except those scheduled for treatment in 1983. Sea lampreys of the 1982 year class were found in 24 streams.



Residual sea lampreys were collected from 16 streams during surveys to evaluate recent chemical treatments and monitor reestablished populations. The residual populations appeared to be small.

No sea lampreys were found in surveys of 28 negative streams or in the reexamination of one small untreated stream (Fischer Creek) where a single sea lamprey larva was taken in the past. Seiners Creek, another small untreated stream, yielded 67 sea lamprey larvae (42–114 mm long) and is recommended for treatment in 1984.

Surveys were conducted above dams on the Manistique, Grand, Betsie, and Paw Paw (St. Joseph) rivers to determine the effectiveness of barriers in these streams to block spawning-run lampreys. No sea lampreys were found. The dam on the Paw Paw River, at Watervliet, Michigan, was opened (stop boards pulled) and may have allowed sea lampreys to bypass upstream. This could open up an additional 187 km (117 miles) of stream for sea lamprey reproduction.

Lentic areas associated with 19 streams were examined for the presence of sea lampreys. Larvae were found in nine areas; the largest numbers were taken off the mouths of the Manistique (52 larvae, 52–165 mm long), Bear (30, 31–170 mm), and the Carp Lake (67, 35–154 mm) rivers. One of the larvae recovered off the Carp Lake River was 3.6 km (2.25 miles) north and east of the mouth. No lamprey larvae were found in an initial examination of the Sturgeon Bay Canal.

### *TREATMENTS*

Chemical treatments were completed on 13 Lake Michigan streams (Table 5, Fig. 2). Adequate concentrations of TFM were maintained during the treatments, except in several small tributaries of the Brevort and Sturgeon rivers where attenuation of the chemical resulted from low flows in the headwater tributaries. Sea lamprey larvae were abundant during the treatments of the Lincoln, Platte, Muskegon, and Carp Lake rivers.

A major kill of suckers, minnows, and some game fish occurred during treatment of the East Twin River. A probable cause was depressed dissolved oxygen levels and the presence of ammonia which resulted from farmland runoff.

### *SPAWNING-RUN SEA LAMPREYS*

A total of 13,505 sea lampreys were captured in assessment traps in six west shore and seven east shore tributaries of Lake Michigan (Table 6, Fig. 2). On the west shore, the catch in the Peshtigo River (475) increased from that in 1981 (294), whereas the catch in the Menominee River (62) was about the same as in 1981 (77). The combined catch in these two streams (537) remains well below the catch of 4,200 in 1978. The number of sea lampreys captured in the Manistique River (11,417) increased 39% from that in 1981 (8,226). No sea lampreys were captured for the fourth successive year in the Fox River, and only 15 were taken at the newly constructed barrier dam in the West Branch of the Whitefish River.

Table 5. Details on the application of lampricides to streams tributary to Lake Michigan, 1982.
[Number in parentheses corresponds to location of stream in Figure 2.]

| Stream | Date | Discharge at mouth | | TFM | | Bayer 73 powder | | Stream treated | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Act. Ingr. | | Act. Ingr. | | | |
| | | $m^3/s$ | $f^3/s$ | kg | lbs | kg | lbs | km | miles |
| Brevort R. (8) | May 6 | 4.5 | 160 | 848 | 1,870 | – | – | 43.5 | 27 |
| Black R. (6) | May 10 | 2.3 | 80 | 299 | 660 | – | – | 40.3 | 25 |
| Carp Lake R. (9) | May 25 | 0.7 | 26 | 150 | 330 | – | – | 14.5 | 9 |
| Sturgeon R.[a] (4) | June 4 | 2.8 | 100 | 1,138 | 2,508 | – | – | 201.6 | 125 |
| Lincoln R. (12) | June 5 | 1.7 | 60 | 469 | 1,034 | – | – | 27.4 | 17 |
| Platte R. (10) | June 18 | 11.3 | 400 | 2,106 | 4,642 | 10 | 22 | 22.6 | 14 |
| Hog Island Cr. (7) | July 8 | <0.1 | 1 | 30 | 66 | – | – | 4.8 | 3 |
| Muskegon R. (13) | July 9 | 48.3 | 1,704 | 7,484 | 16,500 | – | – | 96.8 | 60 |
| East Twin R. (1) | July 9 | 0.6 | 22 | 339 | 748 | – | – | 19.4 | 12 |
| Manistee R. (11) | Aug. 6 | 77.2 | 2,725 | 15,009 | 33,088 | 84 | 186 | 132.3 | 82 |
| Days R. (3) | Sept. 3 | 0.7 | 25 | 220 | 484 | – | – | 21.0 | 13 |
| Cedar R. (2) | Sept. 28 | 5.4 | 190 | 2,215 | 4,884 | – | – | 161.3 | 100 |
| Milakokia R. (5) | Oct. 16 | 2.1 | 75 | 828 | 1,826 | – | – | 25.8 | 16 |
| Total | | 157.6 | 5,568 | 31,135 | 68,640 | 94 | 208 | 811.3 | 503 |

[a] Two tributaries, Section 13 and Nahma creeks, were treated with solid bar formulation (24.5 bars) of TFM.

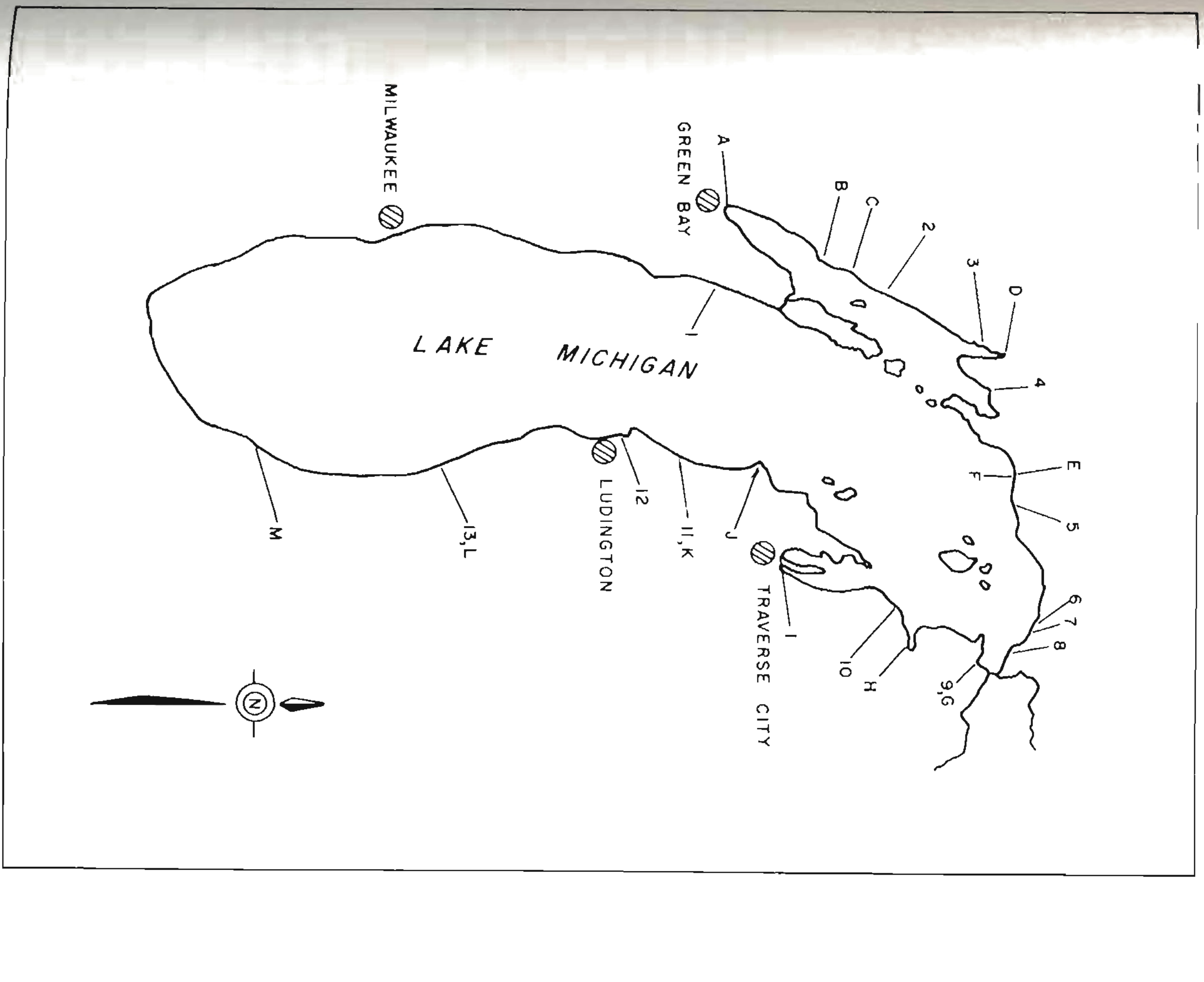


Figure 2. Location of streams tributary to Lake Michigan treated with lampricides (numerals; see Table 5 for names of streams), and of streams where assessment traps were fished (letters; see Table 6 for names of streams) in 1982.

Table 6. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Michigan, 1982. [Letter in parentheses corresponds to location of stream in Figure 2.]

| Stream | Number captured | Number sampled | Percent males | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|
| | | | | Males | Females | Males | Females |
| WEST SHORE | | | | | | | |
| Fox R. (A) | 0 | 0 | – | – | – | – | – |
| Peshtigo R. (B) | 475 | 474 | 45 | 495 | 492 | 247 | 258 |
| Menominee R. (C) | 62 | 62 | 48 | 484 | 474 | 234 | 228 |
| W. Br. Whitefish R. (D) | 15 | 15 | 47 | 503 | 481 | 266 | 245 |
| Manistique R. (E) | 11,417 | 2,968 | 39 | 487 | 488 | 215 | 229 |
| Weston Cr. (F) | 4 | 4 | 50 | 518 | 429 | 246 | 173 |
| EAST SHORE | | | | | | | |
| Carp Lake R. (G) | 575 | 524 | 27 | 452 | 455 | 191 | 197 |
| Jordan R. | | | | | | | |
| Deer Cr. (H) | 129 | 127 | 33 | 493 | 497 | 251 | 278 |
| Boardman R. (I) | 172 | 172 | 31 | 489 | 472 | 241 | 229 |
| Betsie R. (J) | 255 | 253 | 38 | 475 | 471 | 234 | 241 |
| Manistee R. (K) | 12 | 11 | 46 | 496 | 484 | 261 | 254 |
| Muskegon R. (L) | 34 | 34 | 47 | 493 | 508 | 240 | 279 |
| St. Josephs R. (M) | 355 | 355 | 35 | 488 | 490 | 246 | 256 |
| TOTAL OR AVERAGE | 13,505 | 4,999 | 38 | 485 | 483 | 222 | 232 |

Table 6. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Michigan, 1982. [Letter in parentheses corresponds to location of stream in Figure 2.]

| Stream | Number captured | Number sampled | Percent males | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|
| | | | | Males | Females | Males | Females |
| WEST SHORE | | | | | | | |
| Fox R. (A) | 0 | 0 | - | - | - | - | - |
| Peshtigo R. (B) | 475 | 474 | 45 | 495 | 492 | 247 | 258 |
| Menominee R. (C) | 62 | 62 | 48 | 484 | 474 | 234 | 228 |
| W. Br. Whitefish R. (D) | 15 | 15 | 47 | 503 | 481 | 266 | 245 |
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| EAST SHORE | | | | | | | |
| Carp Lake R. (G) | 575 | 524 | 27 | 452 | 455 | 191 | 197 |
| Jordan R. | | | | | | | |
| Deer Cr. (H) | 129 | 127 | 33 | 493 | 497 | 251 | 278 |
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| Manistee R. (K) | 12 | 11 | 46 | 496 | 484 | 261 | 254 |
| Muskegon R. (L) | 34 | 34 | 47 | 493 | 508 | 240 | 279 |
| St. Josephs R. (M) | 355 | 355 | 35 | 488 | 490 | 246 | 256 |
| TOTAL OR AVERAGE | 13,505 | 4,999 | 38 | 485 | 483 | 222 | 232 |



Catches of sea lampreys in seven streams along the east shore of Lake Michigan increased from the catches in 1981 (1,532 compared with 1,110). Most of the addition occurred in the Boardman and St. Joseph rivers, where catches increased by 110 and 218, respectively. Since the start of assessment trapping along the east shore in 1978, sea lampreys captured in the Carp Lake River have been significantly smaller than those from other sites in Lake Michigan and this trend continued in 1982. Sea lampreys from the Carp Lake River averaged 30 mm shorter and 32 g lighter than the average size of other Lake Michigan lampreys; however, their average length and weight are similar to sea lampreys captured in the Cheboygan and Ocqueoc rivers, nearby streams in Lake Huron.

*PARASITIC SEA LAMPREYS*

Lake Michigan fishermen captured 153 sea lampreys in 1982, compared with 285 in 1981. Fisheries from two Lake Michigan statistical districts, the Algoma, Wisconsin, area (WM-4) and the Naubinway-Epoufette, Michigan, area (MM-3), contributed most of the sea lampreys in 1982, 54 and 33, respectively. Sea lampreys from Algoma, Wisconsin, were predominantly spawning-phase adults collected from commercial pound nets set for rainbow smelt and alewife near the estuary of the Ahnapee River.

The number of sea lampreys collected from the fisheries of Lake Michigan indicated a decrease in the populations in northern Lake Michigan and Green Bay. Northern Lake Michigan (excluding Green Bay) produced 44 sea lampreys in 1982, compared with 80 in 1981. The number of sea lampreys taken in Green Bay shows a similar decrease from 81 in 1981 to 53 in 1982.

*SPECIAL STUDIES*

*Weston Creek barrier dam*—A low-head barrier dam was constructed on Weston Creek, a tributary of the Manistique River, in 1979. Before the installation of the barrier, sea lampreys used Weston Creek to bypass the dam on the main stream of the Manistique River.

To determine the vertical drop necessary to stop sea lampreys, observations have been made for four successive years. In 1982, the vertical drop at the Weston Creek barrier ranged from 37 to 46 cm (14 to 18 inches) and averaged 42 cm (16 inches). The water column over the dam was from 43 to 65 cm (17 to 26 inches) and averaged 54 cm (21 inches). From 1979 to 1981, the vertical drop ranged from 0 to 24 cm (9 inches) in 1980, from 6 to 23 cm (2 to 9 inches) in 1981, and 29 to 38 cm (11 to 15 inches) in 1979. The water column over the top of the dam ranged from 43 to 84 cm (17 to 33 inches) in the 3-year period.

An electrical barrier was installed upstream to evaluate the effectiveness of Weston Creek barrier dam. Larval surveys also assessed the effectiveness of the barrier. No evidence has been found to indicate lampreys surmounted the low-head barrier dam.

*Persistence of TFM in backwaters*—A study to determine the persistence of TFM in backwaters sprayed during chemical treatments was performed during treatment of the Sturgeon River, Delta County, Michigan. The backwater was sprayed with concentrations of TFM ranging from 3.5 to 13.7 mg/L on June 2. Samples were taken daily through June 10, and a final sample was taken on June 29. TFM concentrations ranged from 9% to 26% of original application levels by June 10. Trace amounts of TFM were found on June 29. Sampling was ceased after the backwater was flushed with rising water from the main Sturgeon River.

*Treatment effects upon burrowing mayflies*—Concerns of treatment effects upon burrowing mayflies prompted a study of Ephemeridae mortality during the Sturgeon River (Delta County, Michigan) treatment from June 4 to 8, 1982. Although previous field studies have evaluated treatment effects upon single species of burrowers, no study has yet compared the effects of TFM upon several species.

The Sturgeon River presents an opportunity for comparison of treatment effects upon three burrowing mayflies. Two species inhabit the upper river; *Hexagenia limbata* found in the soft silt along stream banks and *Ephemera simulans*, a common resident of sand substrates. A third species, *Litobrancha recurvata*, is present in several cold tributaries of the Sturgeon River.

Fifty large nymphs of each species were collected by electrofishing and placed in cages, 107 × 76 × 43 cm (3.5 × 2.5 × 1.5 ft.). The mayflies were allowed to burrow into 20 cm (8 inches) of substrate. Three cages were placed at sites where nymphs would be exposed to different concentrations of chemical and a fourth was put upstream of the chemical application point to serve as a control.

The timing of the study coincided with the period of emergence for *L. recurvata*. A total of 95% of the nymphs emerged as adults from the cage held in the cold tributary, the normal habitat for this species. If eggs of *L. recurvata* are as resistant to TFM as those of *Hexagenia*, then effects of treatment were probably minimal. Unseasonably cold nights with temperatures below freezing during this period probably caused some mortality of adults.

A great difference was evident in the effect of TFM upon the two other burrowers. *E. simulans* numbers were not greatly reduced by TFM concentrations used in this treatment. Concentrations and percentage mortality were: control cage, 10%; 3 ppm TFM, 26%; 4.4 ppm, 8%; and 4.9 ppm, 10%. TFM induced mortality was much higher for *H. limbata;* concentrations and percentage mortality were: control cage, 2%, 3 ppm TFM, 74%; 4.4 ppm, 92%; and 4.9 ppm, 90%.

A bioassay as described by Fremling and Mauch (1980)[1] was conducted on *E. simulans* and *H. limbata*. Glass tube substrates provided burrows to prevent mayflies from swimming throughout the bioassay. A mild shock from a 9-volt battery was used to determine the time of death. The bioassay confirmed that *E. simulans* was much more resistant to TFM than *H. limbata*. The 16-hour $LC_{50}$, corresponding to the time the chemical was metered into the stream, was 5.7 ppm TFM for *E. simulans* and 3.2 ppm TFM for *H. limbata*.

[1]Fremling, C. R., and W. L. Mauch. 1980. Methods for using nymphs of burrowing mayflies (Ephemeroptera, *Hexagenia*) as toxicity test organisms, p. 81–97. *In* A. L. Buikema, Jr., and John Cairns, Jr. (eds.) Aquatic invertebrate bioassays. American Society for Testing and Materials.



Peak emergence periods for the three species were also determined. *L. recurvata* emerged on June 5 and 6, *E. simulans* from June 24 to 30, and *H. limbata* on June 28 to 30.

We noticed during the bioassay that significant *H. limbata* mortality (> 40%) did not occur at treatment ranges of 3 to 5 ppm TFM until at least 10 hours after all larvae had died. Where practical, it would be advisable to reduce the time chemical is metered into the stream to decrease mortality of burrowing mayfly nymphs.

## Lake Huron

### *SURVEYS*

Surveys for larval sea lampreys were conducted on 48 Canadian and 69 U.S. streams tributary to Lake Huron. No new sea lamprey populations were found during surveys of 15 Canadian and 12 U.S. streams with no previous history of their occurrence; however, 3 tributaries of the Saginaw River (Michigan)—Shiawassee, Cass, and Pine rivers—were found to contain sea lampreys for the first time.

Surveys of previously treated streams showed that reestablishment of sea lampreys had occurred in 24 streams in the United States and 6 in Canada. The population density of sea lampreys in streams recently treated in southern Georgian Bay remains low. The 1982 year class of sea lampreys was absent from the Ocqueoc River (Michigan), which can be attributed to the effectiveness of the low-head barrier dam installed at the old weir site.

Posttreatment surveys revealed residual sea lamprey larvae in four U.S. and four Canadian streams. Numbers of residual sea lampreys were small except in the Garden River.

Surveys of lentic areas and one inland lake on the U.S. side of Lake Huron revealed sea lampreys in 6 of the 17 areas examined. Lampreys undergoing transformation were observed off the Carp River and Nuns and Elliot creeks. Sea lampreys reported a year ago in Mission and Ermatinger creeks, tributaries of the St. Marys River, are presumed to have originated from the main river and washed into the creeks by water level changes.

The Chippewa River (Saginaw River system) was found to contain sea lamprey larvae apparently as a result of floods or of late closure of the fish ladder at the Dow Dam on the Tittabawassee River in 1981 and 1982. The dam at Mount Pleasant, Michigan, now marks the upstream limit of sea lamprey distribution.

Surveys to establish distributional limits of larval populations were conducted on 15 Canadian tributaries. The Canadian Unit also continued surveys of the St. Marys River to provide more information on sea lamprey distribution in this system.

*TREATMENTS*

Lampricide treatments of 18 streams (10 in the United States and 8 in Canada) and granular Bayer 73 applications to five locations in Canada were conducted in 1982 (Table 7, Fig. 3). The stream treatments were judged effective. Granular Bayer 73 was applied to the estuary of Blind River, a North Channel tributary, during the TFM treatment in an effort to overcome the effects of thermal stratification which would have isolated the cold lake water from the treated river water.

Significant fish mortalities occurred in two treatments. In the Au Gres River, spawning white suckers were killed; in Black Mallard Creek, 31 spawning chinook salmon died.

Granular Bayer 73 applications to lentic areas have been effective in reducing larval populations. Treatment of Michael Bay, at the mouth of Manitou River, with granular Bayer 73 revealed a lower density of larvae than on previous occasions, indicating that repeated applications have a significant effect. Repeated applications of granular Bayer 73 have been made below Whitefish Island on the St. Marys River. A reduction in numbers of sea lampreys was noted in 1982 compared with the previous year; however, this area is subject to annual recruitment from extensive sea lamprey spawning in the St. Marys Rapids. Downstream drift of larvae from the rapids is doubtless the source of infestation of the area about 2 km (1.2 miles) downstream (Station H). Repeated granular Bayer 73 applications in this area have also been planned. The deltas of the Root and Garden rivers in St. Marys River also have been treated repeatedly with granular Bayer 73, with noticeable reductions in numbers of sea lamprey larvae obtained.

*SPAWNING-RUN SEA LAMPREYS*

During the 1982 spawning season, 20,282 sea lampreys were captured in assessment traps in U.S. tributaries of Lake Huron (Table 8, Fig. 3), nearly double that taken in 1981 (10,279). Of the total, 72% were from the Cheboygan River, but, because of an experiment conducted in the stream during the major portion of the spawning run, the catch is not comparable on a year-to-year basis. Consistent with biological data in previous years, sea lampreys captured in U.S. Lake Huron streams in 1982, except the St. Marys River, were significantly smaller than those in Lakes Michigan, Erie, and Ontario, but were larger than the lampreys in the Lake Superior population.

Portable traps were fished in two Canadian tributaries during 1982. A single trap was set below the dam on the Echo River, tributary to the St. Marys River system. High water prevented installation of this device until May 28. In a 28-night period ending June 25, 16 adults were taken by the trap. Of interest was the recovery of a sea lamprey from the Echo River which had been marked by the U.S. Fish and Wildlife Service during the previous fall in the vicinity of the Straits of Mackinac.



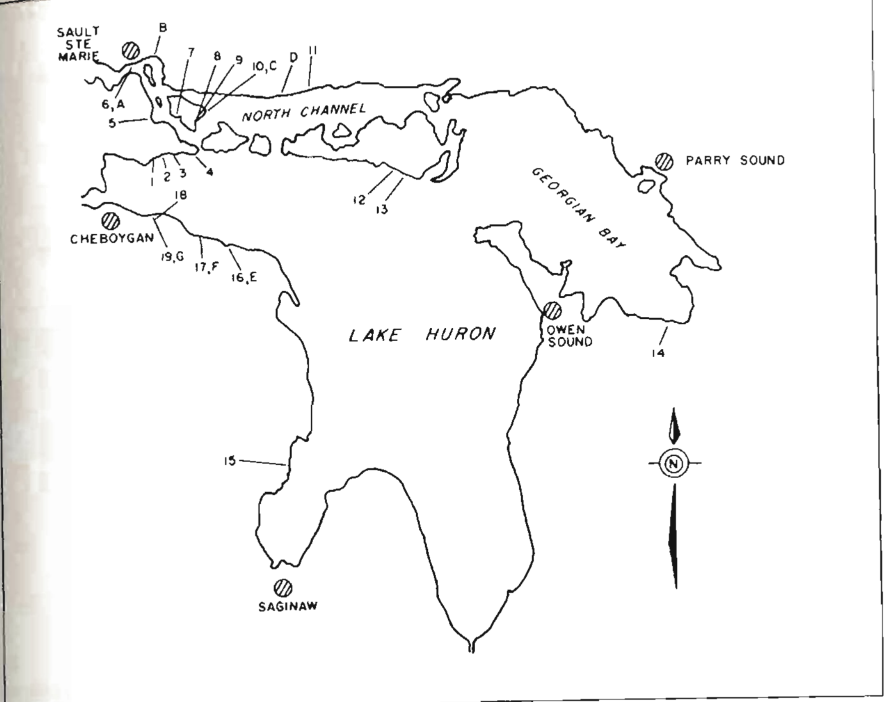


Figure 3. Location of streams and bay areas of Lake Huron treated with lampricides (numerals; see Table 7 for names of streams or areas), and of streams where adult sea lamprey collecting devices were fished (letters; see Table 8 for names of streams) in 1982.

Once again trapping was carried out on Bridgeland Creek, a major tributary of the Thessalon River. One of the two rectangular traps used was relocated downstream and provided with short leads screening part of the width of the stream. Whether or not trapping effectiveness was improved remains questionable, but servicing was aided. A total of 453 adult sea lampreys were collected in 1982, compared with previous collections of 461, 272, and 230 specimens from 1979 through 1981, respectively.

The dam on the Kaskawong River is the only tributary of Lake Huron where a permanent trap is incorporated into a sea lamprey barrier. To measure the effectiveness of this permanent trap, a mechanical weir was constructed about 1 km (0.6 mile) downstream of the dam. A total of 95 adult sea lampreys were captured in the downstream weir from May 4 to June 25, and of these, 84 were tagged and released; 19 lampreys were later recovered in this weir. The permanent trap in the barrier dam was operated for 67 nights (April 29–July 5) and captured 396 sea lampreys, of which 45 (54%) had been marked at the downstream weir. In all, 446 spawning-phase sea lampreys were captured in the Kaskawong River in 1982.

Table 7. Details on the application of lampricides to streams and bay areas of Lake Huron, 1982.
[Number in parentheses corresponds to location of stream or area in Figure 3.]

| Stream or bay area | Date | Discharge at mouth | | TFM | | Bayer 73 Powder | | Bayer 73 Granules | | Stream treated | | Area treated | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | m³/s | f³/s | Act. Ingr. kg | lbs | Act. Ingr. kg | lbs | Total used[a] kg | lbs | km | miles | ha | acres |
| CANADA | | | | | | | | | | | | | |
| Gordon Cr. (9) | May 26 | <0.1 | 2 | 7 | 15 | – | – | – | – | 1.6 | 1 | – | – |
| Two Tree Cr. (7) | May 31 | 0.1 | 3 | 33 | 73 | – | – | – | – | 4.7 | 3 | – | – |
| Watson Cr. (8) | June 2 | 0.1 | 3 | 16 | 35 | – | – | – | – | 1.6 | 1 | – | – |
| Kaskawong R. (10) | June 7 | 0.2 | 7 | 210 | 462 | – | – | – | – | 9.7 | 6 | – | – |
| Blue Jay Cr. (13) | June 9 | 0.5 | 18 | 128 | 282 | – | – | – | – | 9.7 | 6 | – | – |
| Manitou R. (12) | June 10 | 1.1 | 40 | 248 | 546 | – | – | – | – | 4.7 | 3 | – | – |
| Blind R. (11) | Aug. 12 | 5.2 | 184 | 213 | 468 | – | – | 136 | 300 | 1.6 | 1 | – | – |
| Silver Cr. (14) | Sept. 23 | 0.2 | 7 | 103 | 227 | – | – | – | – | 3.2 | 2 | – | – |
| Michael Bay | | | | | | | | | | | | | |
| Manitou R.(12) | June 11 | – | – | – | – | – | – | 136 | 300 | – | – | 0.7 | 2 |
| *St. Marys R. (6)* | | | | | | | | | | | | | |
| Station H | July 28 | – | – | – | – | – | – | 728 | 1,600 | – | – | 3.0 | 7 |
| Root R. | Aug. 4 | – | – | – | – | – | – | 136 | 300 | – | – | 0.7 | 2 |
| Whitefish Island | Aug. 5 | – | – | – | – | – | – | 728 | 1,600 | – | – | 2.2 | 5 |
| Garden R. | Aug. 6 | – | – | – | – | – | – | 364 | 800 | – | – | 1.5 | 4 |
| Total | | 7.5 | 264 | 958 | 2,108 | – | – | 2,228 | 4,900 | 36.8 | 23 | 8.1 | 20 |
| UNITED STATES | | | | | | | | | | | | | |
| West Au Gres R. (15) | May 9 | 3.1 | 111 | 848 | 1,870 | – | – | – | – | 56.5 | 35 | – | – |
| Trout R. (16) | May 21 | 0.5 | 19 | 299 | 660 | – | – | – | – | 6.5 | 4 | – | – |
| Big Munuscong R. (5) | May 22 | 2.0 | 70 | 1,118 | 2,464 | – | – | – | – | 77.4 | 48 | – | – |
| Caribou Cr. (4) | May 26 | <0.1 | 1 | 10 | 22 | – | – | – | – | 1.6 | 1 | – | – |
| Cheboygan R. | | | | | | | | | | | | | |
| Pigeon R. (19) | Sept. 6 | 4.7 | 165 | 1,517 | 3,344 | 8 | 17 | – | – | 38.7 | 24 | – | – |
| Ocqueoc R. (17) | Sept. 18 | 5.7 | 200 | 1,227 | 2,706 | – | – | – | – | 24.2 | 15 | – | – |
| Black Mallard Cr. (18) | Oct. 1 | 1.0 | 37 | 190 | 418 | – | – | – | – | 9.7 | 6 | – | – |
| Albany Cr. (3) | Oct. 15 | 0.3 | 12 | 80 | 176 | – | – | – | – | 9.7 | 6 | – | – |
| McKay Cr. (2) | Oct. 17 | 0.6 | 20 | 120 | 264 | – | – | – | – | 1.6 | 1 | – | – |
| Nuns Cr. (1) | Oct. 19 | 0.7 | 23 | 130 | 286 | – | – | – | – | 3.2 | 2 | – | – |
| Total | | 18.7 | 658 | 5,539 | 12,210 | 8 | 17 | – | – | 229.1 | 142 | – | – |
| GRAND TOTAL | | 26.2 | 922 | 6,497 | 14,318 | 8 | 17 | 2,228 | 4,900 | 265.9 | 165 | 8.1 | 20 |

[a] Sand granules coated with Bayer 73 at 5% by weight active ingredient.

Table 8. Number and biological characteristics of adult sea lampreys captured in assessment devices fished in tributaries of Lake Huron, 1982. [Letter in parentheses corresponds to location of stream in Figure 3.]

| Stream | Number captured | Number sampled | Percent males | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|
| | | | | Males | Females | Males | Females |
| CANADA | | | | | | | |
| Echo R. (B) | 16 | 16 | 69 | 480 | 460 | 239 | 225 |
| Kaskawong R. (C) | 446 | 425 | 36 | 460 | 470 | 212 | 227 |
| Thessalon R. (D) | 453 | 453 | 44 | 480 | 490 | 239 | 250 |
| Total or average | 915 | 894 | 41 | 470 | 480 | 227 | 238 |
| UNITED STATES | | | | | | | |
| St. Marys R. (A) | 3,848 | 1,253 | 49 | 485 | 484 | 232 | 237 |
| Trout R. (E) | 56 | 27 | 33 | 464 | 461 | 232 | 204 |
| Ocqueoc R. (F) | 1,794 | 452 | 36 | 445 | 456 | 177 | 204 |
| Cheboygan R. (G) | 14,584 | 1,809 | 37 | 456 | 462 | 191 | 207 |
| Total or average | 20,282 | 3,541 | 41 | 468 | 468 | 208 | 216 |
| GRAND TOTAL OR AVERAGE | 21,197 | 4,435 | 41 | 468 | 470 | 211 | 220 |

Table 8. Number and biological characteristics of adult sea lampreys captured in assessment devices fished in tributaries of Lake Huron, 1982. [Letter in parentheses corresponds to location of stream in Figure 3.]

| Stream | Number captured | Number sampled | Percent males | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|
| | | | | Males | Females | Males | Females |
| CANADA | | | | | | | |
| Echo R. (B) | 16 | 16 | 69 | 480 | 460 | 239 | 225 |
| Kaskawong R. (C) | 446 | 425 | 36 | 460 | 470 | 212 | 227 |
| Thessalon R. (D) | 453 | 453 | 44 | 480 | 490 | 239 | 250 |
| Total or average | 915 | 894 | 41 | 470 | 480 | 227 | 238 |
| UNITED STATES | | | | | | | |
| St. Marys R. (A) | 3,848 | 1,253 | 49 | 485 | 484 | 232 | 237 |
| Trout R. (E) | 56 | 27 | 33 | 464 | 461 | 232 | 204 |
| Ocqueoc R. (F) | 1,794 | 452 | 36 | 445 | 456 | 177 | 204 |
| Cheboygan R. (G) | 14,584 | 1,809 | 37 | 456 | 462 | 191 | 207 |
| Total or average | 20,282 | 3,541 | 41 | 468 | 468 | 208 | 216 |
| GRAND TOTAL OR AVERAGE | 21,197 | 4,435 | 41 | 468 | 470 | 211 | 220 |



*PARASITIC SEA LAMPREYS*

Commercial fishermen in Lake Huron submitted 960 sea lampreys in response to offers of rewards by the Control Units. A total of 787 were taken in U.S. waters (statistical districts MH-1, MH-2, and MH-4), whereas 173 were taken in Canadian waters (OH-1, NC-1, and GB-1). Most of the U.S. collection (586) came from the DeTour-Rogers City area. The increase in the number collected in U.S. waters in 1981 (1,296) may have been due to the offer of a higher reward ($5) for live specimens to use in a mark and recapture study in that year. At the time of reporting, neither the U.S. nor the Canadian collections for 1982 are complete.

*SPECIAL STUDIES*

*Radio telemetry study*—A 2-year study to determine the movement, behavior, and spawning grounds of sea lampreys in the St. Marys River was completed in 1982. Preliminary laboratory and field tests in 1981 showed that surgically implanted transmitters had little effect on lamprey behavior. In 1982, 45 sea lampreys were implanted with transmitters and released. The lampreys were tracked for 44 days using boats, shoreline searches of the St. Marys River Rapids, and two land-based continuous recording systems located about 0.8 km (0.5 mile) upstream and 2.4 km (1.5 miles) downstream of the rapids. To determine whether movement varied at a particular stage of the spawning cycle, lampreys were released on June 30 (14), July 6 (13), July 14 (12), and July 21 (6). Most lampreys (32) were released along a dike about 1.6 km (1 mile) downstream of the rapids (primary site), and 13 were released about 24 km (15 miles) downstream of the rapids at a suspected spawning area north of Neebish Island (secondary site).

All of the animals set free at the primary and secondary sites initially moved upstream. Of the 32 released at the primary site, 27 remained in the rapids/locks region of the river; 3 initially moved into the rapids, then moved downstream about 11.3 km (7 miles) to the mouth of the Garden River, but within 10 days returned to the rapids area; and 2 passed through the compensating gates at the head of the rapids into the upper St. Marys River. Of the 13 released at the secondary site, 11 returned to the rapids region and 2 apparently died about 4.8 km (3 miles) downstream of the rapids while attempting to return.

The study shows sea lamprey spawning sites in the St. Marys River are limited to a few areas in the rapids region. Scuba divers determined habitat types and lamprey activity in areas frequented by radio-tagged lampreys from July 22 to July 29. Many spawning redds and lampreys were observed in several isolated areas of the rapids, in particular, along the southwest shore of Whitefish Island and below the U.S. Army Corps of Engineers power generating stations. Other areas in the river that appeared to contain suitable spawning habitat (north of Sugar and Neebish Islands and an area in the upper river west of Point Louise) were inspected, but no nests or lampreys were observed. Based on data from radio transmitters and the observations of divers, the experimental animals frequented the following spawning sites in the St. Marys River:

- Upper rapids (10)
- Lower rapids, primarily in a shallow area southeast of Whitefish Island (7)
- Tailrace area of the U.S. Army Corps of Engineers powerhouses (10)
- High water channel along north shore of Whitefish Island (2)
- Below Soo Edison generating station (1)

In addition, 2 lampreys died before spawning and the transmitters failed in 11 before spawning occurred (sufficient data were collected on 8 of these to indicate they also probably spawned in the rapids region).

*Mark and recapture study*—A study to determine the movement of parasitic-phase sea lampreys in northern Lake Huron and the streams in which they spawn was completed in 1982. In May–October, 1981, 830 sea lampreys captured by commercial fishermen in trap nets set for lake whitefish were marked and released at Rogers City (432) and from the Straits of Mackinac to DeTour (398). The lampreys were fin-marked with fluorescent pigment dyes (coded to indicate area and time of release) and released near the point of capture. During this segment of the study, nine (1%) of the marked feeding lampreys were recovered in commercial fishery nets. Most of the recaptured animals in 1981 were taken near the point of release, but one had moved from DeTour to a point south of Epoufette in Lake Michigan (112.6 km, 70 miles) in 3 weeks.

Marked sea lampreys were recovered in assessment traps as spawning adults in 1982. Traps were fished in 13 Lake Michigan and 7 Lake Huron tributaries, and 92 (11%) marked animals were taken in 9 of these streams. Although assessment traps were fished in seven tributaries of the eastern end of Lake Superior, one tributary of Lake Erie, and five tributaries of Lake Ontario, no marked lampreys were captured outside of Lakes Michigan and Huron. In addition, sea lamprey assessment traps were fished by the Canadian Unit at two sites in eastern Lake Superior, three sites in Lake Huron, and eight sites in Lake Ontario. Personnel of both Control Units were alerted to look for marked adults; however, none were recovered.

Most of the marked lampreys were captured in four Lake Huron streams (Cheboygan River, 48; Ocqueoc River, 3; St. Marys River, 14; and in the Echo River, a Canadian tributary of the St. Marys River, 1), but 26 were taken in five tributaries of Lake Michigan (Manistique River, 14; Carp Lake River, 9; and 1 each in the Peshtigo, Boardman, and St. Joseph rivers). The greatest distance traveled by a sea lamprey was about 466.7 km (290 miles), from the Rogers City region of Lake Huron (marked between July 17 and August 1) to the Berrien Springs Dam on the St. Joseph River, Lake Michigan (recaptured on May 3).

Data were analyzed to determine if relations existed among numbers marked, release sites, time of release, numbers recaptured, and river of recapture. About half (52%) of the recaptures were collected in the Cheboygan River. Although the spawning run in the Cheboygan River is very large, when compared with the catch of marked lampreys per 1,000 unmarked, no significant differences were observed between this river (3.3/1,000) and the St. Marys River (3.9/1,000). By comparison, the ratio in the Carp Lake River (10.4/1,000) was significantly higher, whereas that in the Ocqueoc River (1.7/1,000) was much lower. The apparent low ratio from the Ocqueoc River was unexpected since this river is within 32.3 km (20 miles) of where 432 of the parasitic sea lampreys marked in the Rogers City area were released.



Sea lampreys marked in the Rogers City area predominated in the returns in the Cheboygan River (33 of 48), whereas those marked in the Straits to DeTour area were significantly more abundant in the catch in the St. Marys and Echo rivers (10 of 15). The lampreys released in the Straits to DeTour area also were slightly more abundant in the Lake Michigan streams (15 of 26). One of the three marked sea lampreys recaptured in the Ocqueoc River was released in the Rogers City area. No correlation was apparent between time of release and streams of recapture. The number of marked lampreys collected from all 2-week release periods of 1981, individually and collectively, were distributed evenly in the recovery rivers.

*Ocqueoc River barrier*—After the termination of the electrical barrier on the Ocqueoc River in 1980, the site was modified into a low-head barrier dam. In 1981, the trap was undermined and some lampreys escaped upstream. In 1982, the combination of the low-head dam with a maximum drop of 36 cm (14 inches) during low water, a 15-cm (6-inch) overhanging lip, and a trapping operation resulted in the absence of sea lampreys above the site.

During the spring breakup there was no vertical barrier to sea lamprey migration. Later when sea lampreys were captured, May 1 to July 9, the vertical drop ranged from 8 cm (3 inches) to 33 cm (13 inches).

A search for nests in a 1.6-km (1-mile) stretch of the river below Ocqueoc Falls on four occasions did not reveal any evidence of spawning sea lampreys. Pretreatment surveys with electric shockers in several areas normally infested with young-of-the-year ammocetes were negative and no young-of-the-year larvae were collected above the barrier during chemical treatment of the Ocqueoc River.

These data suggest that under certain conditions low-head barrier dams can be extremely effective in stopping upstream migration of sea lampreys.

*Use of artificial light*—In 1982, a study was completed that showed the use of an artificial light significantly increased the efficiency of assessment traps in capturing spawning-phase sea lampreys in the Cheboygan River. Routine night observations in 1981 suggested this phenomenon, and a study was developed and conducted in cooperation with the National Fishery Research Laboratory, Hammond Bay Biological Station, and Marquette Biological Station. Tests were run over 20 consecutive nights (May 18–June 6). Two side-by-side, lightproof traps, each 1.8 × 0.9 × 1.2 m (6

× 3 × 4 ft.) were equipped with a light which illuminated the funnels in the trap. Traps were designated as trap 1 and trap 2 (trap 2 was closer to shore). Randomized 45-minute trials of four lighting schemes (trap 1 lighted and trap 2 darkened, trap 1 darkened and trap 2 lighted, traps 1 and 2 lighted, and traps 1 and 2 darkened) were designed to determine whether light attracted lampreys and if one of the traps was more favorably positioned to catch lampreys than the other.

Overall, lighted traps collected about five times as many sea lampreys—5,766 of 6,983 (83%)—as did dark traps and the difference was highly significant ($P < 0.01$). Every statistical comparison between lighted and darkened traps, including even (both traps either lighted or darkened) and uneven (one trap lighted and the other darkened) lighting, for traps combined or for each trap individually, showed lighted traps caught significantly more sea lampreys than did darkened traps ($P < 0.05$).

The study also showed that the position of the trap in relation to the river bank contributed to different catch rates. A total of 5,919 of 6,983 (85%) sea lampreys were captured in trap 1. Significantly more sea lampreys were captured in trap 1 than trap 2, for periods when both traps were either lighted or darkened ($P < 0.01$) and for periods of uneven lighting ($P < 0.05$).

*Lentic population estimates*—Abundance estimates for sea lamprey ammocetes dwelling in lentic areas are essential to assess their potential contribution to adult stocks. The mark and recapture method has been used to estimate ammocete Abundance in streams. The estimates were considered reliable because they agreed with estimates of relative abundance based on pretreatment stream surveys. A study was conducted to determine whether the mark and recapture method could provide reliable estimates of larval populations in lentic areas.

A study area was selected offshore from the Carp River (Mackinac County, Michigan) a tributary of northern Lake Huron. The substrate was relatively homogenous. Scuba divers constructed a square grid of 16 plots, each plot 30.5 × 30.5 m (100 × 100 ft.). Parachute cord strung between stakes set at the corner of each plot delineated the grid on the bottom, whereas floats defined the 16 plots on the surface.

Sea lamprey ammocetes were collected from the Milakokia River (Schoolcraft County, Michigan), a tributary of northern Lake Michigan. A combination of dyes was used to mark four groups of ammocetes (180/group) subcutaneously. The ammocetes were held for 3 days, caged, taken to four central plots off the Carp River, and released on the bottom by a diver. Those that were dead or could not burrow were removed. Each plot was sprayed with Bayer granules at a rate of 112.1 kg/ha (100 lbs./acre) after a 1-week acclimation period. Ammocetes were collected on the surface from boats and on the bottom by divers.

Percent recovery of ammocetes from the four marked groups was 15, 17, 25, and 33. The average of these recovery rates (22%) was divided into the number of unmarked ammocetes captured (301) to determine the density of larvae (818/ha, 330/acre) in the area surveyed. The area infested by larvae off the Carp River is about 11.3 ha (28 acres); hence, the lentic population was estimated at 9,243. Six (2%) of the unmarked larvae were transforming, and at this rate, 185 transformed individuals would be produced from the population.



The pattern of recovery was similar for three of the four marked groups. Most larvae were taken in the release plots, whereas other recoveries decreased as distance from the release sites increased. Of the marked larvae recovered, the percent captured in the release areas was 70, 64, and 61 for the three groups.

Further study is needed to determine whether recovery rates and numbers of ammocetes can be estimated in this simple manner. In addition, the influence of water depth, substrate, release method, ammocete size, and density of larvae on recovery rates should be more thoroughly investigated.

*Efficiency of granular Bayer 73*—Field studies were conducted in eight streams and two lentic areas of the Upper Great Lakes to assess the efficiency of granular Bayer 73 as a survey tool. During each of the 20 tests, 25–28 sea lamprey ammocetes were introduced into a 1 $m^2$ (10.8 sq. ft.) circular enclosure. After an acclimation period of at least 36 hours, Bayer 73 was applied to the area and the 1 $m^2$ (10.8 sq. ft.) surrounding the cage at the rate of 112 kg/ha (100 lbs./acre).

Mean recovery rate for the 20 tests was 53% (range, 5–100%). Ammocetes that emerged and began swimming accounted for 94% of the recoveries. The rest were partially emerged or lying on the substrate when the test ended. All larvae that emerged were placed in freshwater and held for 24 hours; mortality for the tests averaged 49%.

The pattern of larval emergence was related to water temperature. In 5 of 6 tests where temperature was lower than 15°C (59°F), larvae were slow to emerge (none were recovered during the initial 40-minute period) and recovery rate was low (average, 8%) during the first 70 minutes. Also, emergence rate for larvae appeared to increase as exposure time increased. In two of the six tests, where the collecting period was 2 hours, 14% of the introduced ammocetes were captured from 40 to 70 minutes, whereas 43% were collected thereafter. In the 14 tests where water temperature was 15°C or higher, the response of larvae to Bayer 73 was more rapid (67% of the recoveries were taken in the initial 40-minute period) and recovery rates were greater (average, 57%) during the 70-minute period of collection.

Low conductivity, coupled with low temperature, may severely limit the effectiveness of Bayer 73. In the test where recovery rate was lowest (5%), conductivity and water temperature were 40 $\mu$mhos/$cm^3$ and 12°C (54°F). In the 19 tests (at all temperatures) where conductivity was 101 $\mu$mhos/$cm^3$, recovery rate was at least 16%.

Differences in recovery rate among tests could not be related to difference in pH (range, 7.2–8.6), total hardness (34–107 ppm $CaCO_3$), or substrate type (bottom composition varied from relatively pure sand to areas of heavy silt/detritus).

LAKE ERIE

No stream treatment program is in effect on Lake Erie, and no stream surveys were conducted in 1982. As a result of budgetary restrictions, the Canadian Unit suspended its adult assessment activities on Lake Erie streams in 1982. The U.S. Unit, however, continued its assessment in one stream.

*SPAWNING-RUN SEA LAMPREYS*

Assessment traps fished for the third successive year in Cattaraugus Creek captured 954 sea lampreys in 1982. The mean length and weight (497 mm and 276 g) of the spawning-run adults were about the same as those in 1981 (498 mm and 258 g), but remained slightly smaller than the sea lampreys in 1980 (512 mm and 284 g). The percentage of males decreased from 59 in 1981 to 50 in 1982.

LAKE ONTARIO

*SURVEYS*

A total of 47 tributaries to Lake Ontario (27 in Ontario and 20 in the U.S.) were surveyed for larval sea lampreys in 1982.

Reestablished sea lamprey larvae were found in six Ontario streams treated in the fall of 1980 or spring of 1981 (Duffin, Lynde, Oshawa, Farewell, Graham, and Proctor creeks) and three others (Grafton, Lakeport, and Salem creeks) treated in spring 1982. Survey of the Black River, the first there since the August 1980 treatment, discovered reinfestation both upstream and downstream of the dams in Dexter, New York. One residual larva (146 mm long) was obtained by a bait store operator in Dexter who had captured the animal while using a clam rake. Additional work on the Black River is planned for 1983 to measure relative numbers of sea lampreys, bearing in mind the difficulty in obtaining reliable survey results before the 1980 treatment. Six other New York streams (Snake, Sage, Rice, Wolcott, Third, and First creeks) showed no evidence of reestablished larvae.

Treatment evaluation surveys of streams treated in the fall of 1980 through 1982 indicated that significant escapement occurred in Orwell and Beaverdam brooks and Trout Creek, all tributaries to the Salmon River in New York. Smaller residual populations were also found in Duffin, Oshawa, Oakville, Deer, and Black creeks.

Distribution surveys were conducted on a number of streams in preparation for treatment in 1982 and 1983, whereas population surveys were conducted on other sea lamprey-producing streams to provide information supportive of future treatments.

Routine surveys on the Humber, Don, and Ganaraska rivers and Potter Creek had negative results.



*TREATMENTS*

Fourteen streams were treated with lampricides during the field season—8 in Canada and 6 in the United States (Table 9, Fig. 4). Sea lamprey larvae (many approaching transformation size) were abundant.

The spring treatments were conducted under near optimum water levels in most cases. The treatment of Oakville Creek was interrupted by heavy rains about half way through the treatment, but subsequent surveys indicated few residual larvae remained.

Treatments during September were completed under fairly low water levels and some fish mortality resulted. Moderate numbers of stonecats in Bronte Creek and white suckers, johnny darters, logperch, and yellow bullheads in Stony Creek were killed.

The treatments of Sterling and Ninemile creeks were completed by the New York State Department of Environmental Conservation under the observation and guidance of the Canadian treatment crew. This training exercise was designed to develop expertise for the Department of Environmental Conservation to conduct independent treatments on Finger Lake tributaries.

*SPAWNING-RUN SEA LAMPREYS*

A total of 1,625 spawning-phase sea lampreys were collected in trapping devices in eight north shore tributaries of Lake Ontario in 1982 (Table 10, Fig. 4). Portable traps were operated at dams on the Credit River and Oshawa, Bowmanville, and Wilmot creeks, and Shelter Valley Brook. A permanent trap built into a barrier dam was also used to collect lampreys in the Credit River and was the sole capturing device on the Humber River and Duffin Creek. A mechanical weir was used in Graham Creek.

A total of 533 spawning-phase sea lampreys were collected in portable traps from Bowmanville and Wilmot creeks and Shelter Valley Brook. Portable traps were operated in the Credit River and Oshawa Creek, but no sea lampreys were captured. Traps at all sites operated 7 nights per week, compared with 5 nights per week in past years. This improvement, in conjunction with the introduction of a second trap to Shelter Valley Brook, represents a significant increase of effort.

Traps incorporated into barrier dams were installed in the Credit and Humber rivers for the 1982 season. With the installation of the dam and trap on Duffin Creek in 1980 (first year of operation was 1981), there are now three of these structures in Lake Ontario streams. No sea lampreys were captured in the permanent trap in the Credit River (as was the result with the portable trap fished at the same site). This permanent trap was installed inside the fishway of the dam just prior to the 1982 season. Past trapping efforts in this river have always encountered difficulties. An old dam was washed out in 1980 and was replaced by a barrier dam and permanent trap in the fall of 1980, but flood water and ice damaged the barrier and destroyed the trap in 1981. High water hampered efforts in 1982.

Table 9. Details on the application of lampricides to streams of Lake Ontario, 1982.
[Number in parentheses corresponds to location of stream in Figure 4.]

| | | | | | | Bayer 73 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Discharge at mouth | | TFM | | Powder | | Granules | | Stream treated | |
| | | | | Act. Ingr. | | Act. Ingr. | | Total used[a] | | | |
| Stream | Date | $m^3/s$ | $f^3/s$ | kg | lbs | kg | lbs | kg | lbs | km | miles |
| CANADA | | | | | | | | | | | |
| Grafton Cr. (4) | May 6 | 0.3 | 12 | 106 | 233 | – | – | – | – | 6.3 | 4 |
| Lakeport Cr. (6) | May 10 | 0.4 | 16 | 415 | 913 | – | – | – | – | 14.7 | 9 |
| Smithfield Cr. (8) | May 12 | 0.2 | 7 | 138 | 304 | – | – | – | – | 5.3 | 3 |
| Port Britain Cr. (3) | May 14 | 0.2 | 7 | 163 | 360 | – | – | – | – | 9.7 | 6 |
| Salem Cr. (7) | May 17 | 0.1 | 3 | 80 | 176 | – | – | – | – | 2.1 | 1 |
| Oakville Cr. (2) | June 3 | 1.8 | 64 | 252 | 554 | – | – | – | – | 20.6 | 13 |
| Shelter Valley Cr. (5) | Sept. 16 | 0.4 | 16 | 284 | 625 | – | – | 9 | 20 | 18.7 | 12 |
| Bronte Cr. (1) | Sept. 19 | 1.4 | 50 | 509 | 1,120 | 4 | 8 | 5 | 10 | 35.6 | 22 |
| Total | | 4.8 | 175 | 1,947 | 4,285 | 4 | 8 | 14 | 30 | 113.0 | 70 |
| UNITED STATES | | | | | | | | | | | |
| Grindstone Cr. (11) | Apr. 29 | 1.0 | 35 | 178 | 392 | – | – | – | – | 39.3 | 25 |
| Ninemile Cr. (13) | May 6 | 1.3 | 46 | 249 | 548 | – | – | – | – | 24.1 | 15 |
| Sterling Cr. (14) | May 10 | 2.4 | 85 | 575 | 1,265 | – | – | – | – | 16.8 | 10 |
| Little Sandy Cr. (10) | May 11 | 1.4 | 50 | 225 | 495 | – | – | – | – | 24.0 | 15 |
| Little Salmon R. (12) | Sept. 9 | 0.6 | 23 | 147 | 323 | – | – | – | – | 12.5 | 8 |
| Stony Cr. (9) | Sept. 13 | 0.2 | 7 | 79 | 174 | – | – | – | – | 5.3 | 3 |
| Total | | 6.9 | 246 | 1,453 | 3,197 | – | – | – | – | 122.0 | 76 |
| GRAND TOTAL | | 11.7 | 421 | 3,400 | 7,482 | 4 | 8 | 14 | 30 | 235.0 | 146 |

[a] Sand granules coated with Bayer 73 at 5% by weight active ingredient.

Table 9. Details on the application of lampricides to streams of Lake Ontario, 1982. [Number in parentheses corresponds to location of stream in Figure 4.]

| Stream | Date | Discharge at mouth | | TFM | | Bayer 73 Powder | | Bayer 73 Granules | | Stream treated | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Act. Ingr. | | Act. Ingr. | | Total used[a] | | | |
| | | m³/s | f³/s | kg | lbs | kg | lbs | kg | lbs | km | miles |
| CANADA | | | | | | | | | | | |
| Grafton Cr. (4) | May 6 | 0.3 | 12 | 106 | 233 | – | – | – | – | 6.3 | 4 |
| Lakeport Cr. (6) | May 10 | 0.4 | 16 | 415 | 913 | – | – | – | – | 14.7 | 9 |
| Smithfield Cr. (8) | May 12 | 0.2 | 7 | 138 | 304 | – | – | – | – | 5.3 | 3 |
| Port Britain Cr. (3) | May 14 | 0.2 | 7 | 163 | 360 | – | – | – | – | 9.7 | 6 |
| Salem Cr. (7) | May 17 | 0.1 | 3 | 80 | 176 | – | – | – | – | 2.1 | 1 |
| Oakville Cr. (2) | June 3 | 1.8 | 64 | 252 | 554 | – | – | – | – | 20.6 | 13 |
| Shelter Valley Cr. (5) | Sept. 16 | 0.4 | 16 | 284 | 625 | – | – | 9 | 20 | 18.7 | 12 |
| Bronte Cr. (1) | Sept. 19 | 1.4 | 50 | 509 | 1,120 | 4 | 8 | 5 | 10 | 35.6 | 22 |
| Total | | 4.8 | 175 | 1,947 | 4,285 | 4 | 8 | 14 | 30 | 113.0 | 70 |
| UNITED STATES | | | | | | | | | | | |
| Grindstone Cr. (11) | Apr. 29 | 1.0 | 35 | 178 | 392 | – | – | – | – | 39.3 | 25 |
| Ninemile Cr. (13) | May 6 | 1.3 | 46 | 249 | 548 | – | – | – | – | 24.1 | 15 |
| Sterling Cr. (14) | May 10 | 2.4 | 85 | 575 | 1,265 | – | – | – | – | 16.8 | 10 |
| Little Sandy Cr. (10) | May 11 | 1.4 | 50 | 225 | 495 | – | – | – | – | 24.0 | 15 |
| Little Salmon R. (12) | Sept. 9 | 0.6 | 23 | 147 | 323 | – | – | – | – | 12.5 | 8 |
| Stony Cr. (9) | Sept. 13 | 0.2 | 7 | 79 | 174 | – | – | – | – | 5.3 | 3 |
| Total | | 6.9 | 246 | 1,453 | 3,197 | – | – | – | – | 122.0 | 76 |
| GRAND TOTAL | | 11.7 | 421 | 3,400 | 7,482 | 4 | 8 | 14 | 30 | 235.0 | 146 |

[a] Sand granules coated with Bayer 73 at 5% by weight active ingredient.



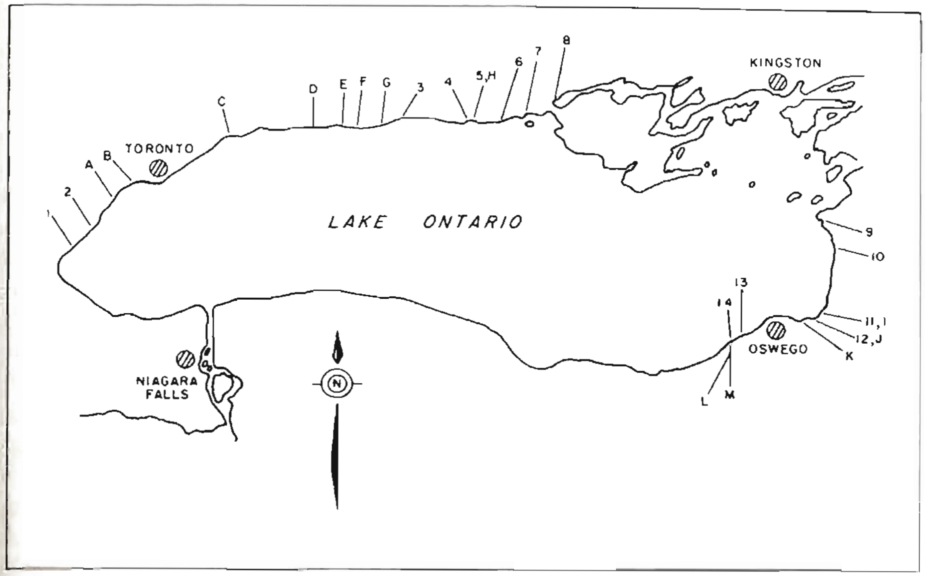


Figure 4. Location of streams tributary to Lake Ontario treated with lampricides (numerals; see Table 9 for names of streams), and of streams where sea lamprey collecting devices were fished (letters; see Table 10 for names of streams) in 1982.

Although 876 spawning-phase sea lampreys were captured in the trap in the dam on the Humber River in 1982, unanticipated problems encountered in this first year of operation probably limited the catch. Collections were made in this stream from 1968 to 1978 by dip netting, and the catch averaged about 3,300 adults annually. No collections were made in 1979, but in 1980, 104 specimens were taken in two portable traps. A limited dip net fishery in 1981 collected 609 lampreys.

The Duffin Creek barrier trap operation remained unchanged from 1981. A total of 149 sea lampreys were collected from April 30 to July 5 (66 nights), a significant reduction from the 293 adults taken in 1981.

Trapping effort at the mechanical weir on Graham Creek was reduced to 4 nights per week, compared with 5 nights in past years. Operations conducted during 32 nights from April 28 to July 5, captured 67 spawning-phase sea lampreys.

A total of 1,364 spawning-phase sea lampreys were collected in portable traps in five tributaries on the south shore of Lake Ontario in 1982 (Table 10, Fig. 4), an increase of 100% over the total captured in 1981 (677). Little change in biological characteristics was observed from those sampled in 1981. Males composed a majority (60%) of the lampreys examined, a characteristic of the population prevalent since the first year of sampling in 1978. In contrast, females outnumbered males in populations of sea lampreys in Lakes Superior, Michigan, and Huron.

Table 10. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Ontario, 1982. [Letter in parentheses corresponds to location of stream in Figure 4.]

| Stream | Number captured | Number sampled | Percent males | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|
| | | | | Males | Females | Males | Females |
| CANADA | | | | | | | |
| Credit R. (A) | 0 | – | – | – | – | – | – |
| Humber R. (B) | 876 | 698 | 52 | 480 | 470 | 227 | 230 |
| Duffin Cr. (C) | 149 | 149 | 50 | 490 | 470 | 227 | 218 |
| Oshawa Cr. (D) | 0 | – | – | – | – | – | – |
| Bowmanville Cr. (E) | 309 | 302 | 58 | 490 | 480 | 257 | 260 |
| Wilmot Cr. (F) | 80 | 80 | 53 | 500 | 500 | 277 | 291 |
| Graham Cr. (G) | 67 | 67 | 57 | 500 | 490 | 259 | 263 |
| Shelter Valley Br. (H) | 144 | 144 | 55 | 500 | 490 | 266 | 277 |
| Total or average | 1,625 | 1,440 | 53 | 490 | 480 | 242 | 244 |
| UNITED STATES | | | | | | | |
| Grindstone Cr. (I) | 255 | 255 | 62 | 502 | 489 | 253 | 256 |
| Little Salmon R. (J) | 316 | 315 | 60 | 496 | 488 | 254 | 263 |
| Catfish Cr. (K) | 10 | 9 | 33 | 459 | 476 | 164 | 251 |
| Sterling Valley Cr. (L) | 422 | 422 | 60 | 497 | 482 | 267 | 259 |
| Sterling Cr. (M) | 361 | 358 | 58 | 494 | 486 | 245 | 249 |
| Total or average | 1,364 | 1,359 | 60 | 497 | 486 | 255 | 257 |
| GRAND TOTAL OR AVERAGE | 2,989 | 2,799 | 56 | 493 | 482 | 248 | 249 |

Table 10. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Ontario, 1982. [Letter in parentheses corresponds to location of stream in Figure 4.]

| Stream | Number captured | Number sampled | Percent males | Mean length (mm) | | Mean weight (g) | |
|---|---|---|---|---|---|---|---|
| | | | | Males | Females | Males | Females |
| CANADA | | | | | | | |
| Credit R. (A) | 0 | – | – | – | – | – | – |
| Humber R. (B) | 876 | 698 | 52 | 480 | 470 | 227 | 230 |
| Duffin Cr. (C) | 149 | 149 | 50 | 490 | 470 | 227 | 218 |
| Oshawa Cr. (D) | 0 | – | – | – | – | – | – |
| Bowmanville Cr. (E) | 309 | 302 | 58 | 490 | 480 | 257 | 260 |
| Wilmot Cr. (F) | 80 | 80 | 53 | 500 | 500 | 277 | 291 |
| Graham Cr. (G) | 67 | 67 | 57 | 500 | 490 | 259 | 263 |
| Shelter Valley Br. (H) | 144 | 144 | 55 | 500 | 490 | 266 | 277 |
| Total or average | 1,625 | 1,440 | 53 | 490 | 480 | 242 | 244 |
| UNITED STATES | | | | | | | |
| Grindstone Cr. (I) | 255 | 255 | 62 | 502 | 489 | 253 | 256 |
| Little Salmon R. (J) | 316 | 315 | 60 | 496 | 488 | 254 | 263 |
| Catfish Cr. (K) | 10 | 9 | 33 | 459 | 476 | 164 | 251 |
| Sterling Valley Cr. (L) | 422 | 422 | 60 | 497 | 482 | 267 | 259 |
| Sterling Cr. (M) | 361 | 358 | 58 | 494 | 486 | 245 | 249 |
| Total or average | 1,364 | 1,359 | 60 | 497 | 486 | 255 | 257 |
| GRAND TOTAL OR AVERAGE | 2,989 | 2,799 | 56 | 493 | 482 | 248 | 249 |



*PARASITIC SEA LAMPREYS*

For the third consecutive year, no parasitic-phase sea lampreys were submitted from the commercial fisheries in response to a reward.

*SPECIAL STUDIES*

*Marking transforming sea lampreys in New York State*—The Oneida-- Oswego River system has long been suspected as a source of recruitment for parasitic-phase sea lampreys in Lake Ontario. In an effort to detect this emigation, 1,588 larvae undergoing transformation were fin-marked with fluorescent dyes and released near the point of capture in two tributaries of Oneida Lake. A total of 524 sea lampreys collected from Big Bay Creek were marked with a single fluorescent "kelly green" stripe in the posterior dorsal fin and released, and 1,064 from Fish Creek and its tributaries were marked similarly with fluorescent "rose tracer glo" and released.

Efforts have been made to coordinate the recovery of these marked sea lampreys during this parasitic phase in 1983. A notice will be issued to entrants in the Empire State Lake Ontario Fish Derby (April 1983) requesting the anglers to submit all sea lamprey specimens they collect to the New York State biologists who will monitor the catches at prearranged check points. A release has also been issued to area fishery management agencies, research institutions, and the news media advising of the release of marked sea lampreys in Oneida Lake tributaries and requesting the return of recaptured specimens to the Canadian Sea Lamprey Control Centre.

# SEA LAMPREY AND RELATED RESEARCH AT NATIONAL FISHERY RESEARCH LABORATORY, HAMMOND BAY BIOLOGICAL STATION, AND MONELL CHEMICAL SENSES CENTER, 1982

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ABSTRACT

A meeting was held at Marquette, Michigan, to prioritize the use of funds for sea lamprey control research by Fish and Wildlife Service (FWS). The research priorities identified one year earlier remained highest. These were: (1) development of nonchemical alternate control methods, (2) bottom-release formations, (3) alternate chemical lampricides, (4) determination of the basis for loss of Bayer 73 in streams, and (5) lamprey biology.

Dr. James G. Seelye was appointed Chief, Hammond Bay Biological Station (HBBS). Recruitment for a chemist at HBBS was underway.

Field tests of a TFM bar for treatment of ammocetes in small streams were successful. An application for registration of the bar formulation was submitted to Environmental Protection Agency (EPA) in December 1982.





A new lampricide label was approved by EPA. The carrier for TFM, dimethylformamide (DMF) was exempted from a requirement of tolerance.

A study to determine if TFM has teratogenic characteristics was initiated.

Data on the environmental chemistry of TFM were submitted to EPA; EPA accepted the data as part of the package required for maintenance of TFM registration.

Tributyltin fluoride (TBTF) would be extremely difficult to register as a lampricide because of its toxicity to aquatic life and humans, potential for bioaccumulation, and lack of adequate mammalian safety tests. A recommendation was made that research on the compound be discontinued.

A 2% Bayluscide formulation released about 25% more active ingredient over 1 to 2 hours than the currently used 5% formulation. Even so, only 35% of the total material on the 2% granules was released in 1 hour.

The presence of heavy metal ions does not provide a synergistic effect to TFM, but their presence does contribute to the toxic units burden to which fish are exposed.

Both TFM and Bayer 73 are more strongly absorbed by silt substrates than by sand.

A significant degree of sterility was induced in sea lampreys exposed to radiation in a Gammacell-40 irradiator with-cesium 137 radiation source. Embryo mortality of progeny from irradiated males increased as the dosage increased. Males that received high levels of radiation (2,000 and 3,000 rads) became covered with fungus and died without spawning.

Experimental techniques for immunosterilization of sea lampreys failed. Injections and water baths of methallibure, a pituitary inhibitor, failed to sterilize adult male sea lampreys and is being dropped from further study.

Clay pellets containing 10% TFM (by weight of active ingredient) and another formulation containing 98% TFM and 2% Bayer 73 (10% active ingredient by weight) killed all sea lamprey ammocetes during 6-hour exposures when administered at 112.1 kg of total formulation per hectare. Both clay formulations showed good potential as bottom-release lampricides when compared to granular Bayer 73.

A mixture with 98% TFM and 2% Salicylanidide I was more toxic to ammocetes than TFM alone, but less toxic than a mixture of 98% TFM and 2% Bayer 73.

Traps with a beam of artificial light focused on the funnel opening from the inside were five times more effective in capturing adult sea lampreys than traps with no lights.

A bioassay indicated that sand shiners exposed 2.0 mg/L of TFM in Waiska River water were more sensitive than rainbow trout.

The response of female attracting substances in male sea lamprey urine are mediated by the olfactory system.

ADMINISTRATION AND PERSONNEL

*RESEARCH PLANNING*

A meeting to discuss the research needs of the sea lamprey control units and to prioritize the use of research funds was held 13 October 1982 at the Ramada Inn, Marquette, Michigan. This meeting was a followup to one held in October 1981 in response to expressed needs for greater input and communication between researchers at the Hammond Bay Biological Station and the control agents. The Sea Lamprey Audit Team report had indicated that such a need existed. The 1981 meeting was considered to have been very successful so a second one was scheduled to assess progress made and to reassess priorities for research. Thirty-two persons representing 10 agencies attended.

The discussion addressed 31 items previously submitted by U.S. and Canadian Sea Lamprey Control Units, State agencies, Great Lakes Fishery Commission, Lake Committees, and others who have responsibilities for sea lamprey control.

Foremost, the group expressed that the needs statements developed in 1981 still represented the highest priorities for research. Those priorities are:

1. Research on nonchemical alternate* control methods—work on bisazir, attractants and repellents (including light), irradiation sterilization, and immunosterilization should continue.
2. Bottom-release formulations—ongoing work with Bayer 73, TFM, TBT, and other compounds should continue.
3. Alternate chemical lampricides—screening of candidate compounds and evaluation of TBT should continue.
4. Study of basis for loss of Bayer 73 activity in streams must be expedited.
5. **Lamprey biology—including physiology and control of transformation process, factors affecting ammocete numbers, population dynamics of transformers, population of feeding lampreys, impacts on lake trout populations.

The scope of the 31 discussion items was overly broad so the group was asked to reduce the number to the highest priority topics. Many of the listed items were interrelated so those items were grouped by the primary topics. Nonresearch items were deleted from the list. Seven major topics were developed and prioritized as the primary items to be resolved if effort is available to go beyond the 1981 listings. By priority, these items were:

*It was decided that "supplemental" methods to chemical control is a better term since it does not imply replacement of chemical control.

**Includes high priority work that exceeds the available expertise, facilities, and manpower at the HBBS and NFRL.



1. *Assessment of lamprey populations at all life stages*—This topic has many facets, including such problems of estimating numbers of ammocetes, transformers, feeding adults, and spawning adults. Estimation of numbers and population dynamics relationships between the various life stages.

   The group was urged to collect data on the above subjects but to be sure to do so by design, not according to short-term goals. It was suggested that a statistician and/or modeler could provide valuable insights as to how control crews can develop types of data that would help answer their needs and provide valuable insight to other problems. Much of the data collection could be done in conjunction with ongoing control efforts. Situations that allow before/after assessments should be exploited as they provide unique insights to untreated population structures, impacts of treatments, mark and recapture studies, etc.
2. *Bayer 73 problems*—There was considerable discussion about the role of Bayer 73 in sea lamprey control. The loss of Bayer 73 in stream treatments is attributable to adsorption on clay/silt types of sediments that are high in organic matter. The U.S. agent described a facet of the problem not previously recognized; namely, loss of Bayer 73 detectability without loss of lampricidal activity. Their concern is that they are not confident they can monitor TFM:Bayer treatments accurately. La Crosse and HBBS agreed to pursue this area of concern.

   The registration of Bayer 73 as a bona fide lampricide (not merely as a sampling tool) was also discussed. The carefully controlled Bayer applications yielded contrasting results consistent with knowledge of the effects of the bottom sediments in the two treatment areas. The Canadian agent stated that they felt 200 lbs. per acre would have yielded better control and asked that the use as a sampling tool be amended to allow that level of application. (The current label allows 100 lbs. per acre.) The question of using 2% granules at 250 lbs. per acre as opposed to 100 lbs. of 5% granules was aired. La Crosse will explore label revisions with EPA.

   Both the U.S. and Canadian agents also asked that 8- and 12-hour LC50's for native Great Lakes fish species and pink salmon be developed. La Crosse and HBBS will provide the desired data.

   A question was raised as to the possible use of Bayer 73 coated or impregnated yeast as a delivery system to take advantage of ammocete filter feeding. The question of whether or not TFM is toxic to yeast was considered. To be effective, levels of Bayer 73 would have to be sublethal to living yeast. While not urgent, HBBS will check this out when personnel and time permit.

   The use of Bayer 73 by control agents is declining—even in combination with TFM. Even though the TFM:Bayer 73 combination can provide significant cost benefit ratios, the agents are no longer using the combination. Among reasons for nonuse were the difficulties in monitoring, the need for frequent analyses, complexity of analytical procedures, and the simplicity of merely increasing TFM levels. Cost impacts of the latter course of action were explored.

3. *Fish/lamprey interactions*—This problem centers on accurate estimates of predator and prey numbers. It includes physiological impacts of attacks on lake trout. While no consensus was reached, the problem will be explored at HBBS and with the Great Lakes Fishery Laboratory.
4. *Supplemental control techniques*—It was pointed out that the use of "alternate" control techniques implies "instead of" approaches to chemical control. The situation is rather one of supplementing the lampricide program.

   The status of bisazir, methallibure, immunosterilization, radiation sterilization, and pheromone attractants were discussed. Methallibure and immunosterilization have proved ineffective and are being dropped from further consideration. Radiation sterilization has potential effectiveness, but may not prove feasible. Studies on this technique will continue. Bisazir studies at the time of the meeting, were in a holding pattern awaiting a Commission decision on funding identification of residues in treated lampreys after 24 hours of withdrawal.

   The group was informed that an isolate that has positive attractant characteristics has been identified and that individual compounds in the isolate will be identified in the near future; several compounds may be ready for testing in the 1983 spawning season. La Crosse was asked to contact EPA as to the need for Experimental Use Permits and other possible regulatory requirements for field testing pheromones.
5. *Residual ammocetes*—Concern was expressed about ammocetes that escape the treatment program. The runs of spawning sea lampreys suggest that either treatments are not completely effective or that unidentified sources are providing the transformers. This problem is related to the assessment of sea lamprey numbers (Problem No. 1) and will require work on the part of all units in the sea lamprey control effort.
6. *Miscellaneous items*—Time did not permit a full discussion of the many other interesting topics. Several, however, were very intriguing.

   An observation was described of how knocking two rocks together in a tributary to Lake Champlain caused adult sea lampreys to beach themselves, suggesting that the use of sound and vibrations may be useful for control of sea lampreys.

   The results of a 1982 study that revealed that placement of a light within a portable assessment trap increased the catch rate by 500% or more were also described. Possible use of the knowledge to help capture animals as a direct control or to obtain animals for other studies was discussed. Adult sea lampreys captured in the study were used for a number of research projects.



In summary, the group reendorsed the priorities set at the 1981 meeting and La Crosse and HBBS will continue work in these areas. HBBS and La Crosse will provide technical assistance to meet needs of the control agents in toxicity tests, improved trapping procedures, formulations work, and in designing studies that can be done by the control units to develop needed data. While not specifically stated, the feeling of the groups appeared to be that the meeting could now be effectively merged with that of the Sea Lamprey Management Committee.

*HAMMOND BAY SUPERVISION*

Dr. James G. Seelye was appointed to the position of Chief at the Hammond Bay Biological Station in May 1982.

Dr. Seelye holds Ph.D. and M.S. degrees in limnology and fishery biology from Michigan State University and a B.S. from Lake Superior State College. Previous to his being assigned at Hammond Bay, he worked for 5-½ years as a senior researcher at the Great Lakes Fishery Laboratory, Ann Arbor, Michigan. Prior to that, he was employed by the U.S. Army Corps of Engineers at the Waterways Experiment Station at Vicksburg, Mississippi.

Dr. Seelye's research interests have been related to contaminant problems and their impacts on the biological community. At the Great Lakes Fishery Laboratory, he studied the effects of PCB's and pesticides on the reproduction of lake trout in the Great Lakes. His publications include papers on contaminant effects, dredging related problems, and the effects of radiation on aquatic organisms. These research interests, coupled with his background and training, make him uniquely qualified to become an integral team member in the sea lamprey control research effort. Specifically, one of his immediate research assignments is to study why certain streams attract large numbers of spawning lampreys whereas, other apparently similar streams attract none. Hopefully, results of that work will provide valuable data that will complement ongoing studies on attractants and repellents.

Mr. Seelye's appointment increases the research staff at the Hammond Bay Biological Station to three professionals. Recruitment is under way for a fourth scientist with training in chemistry. For the past 2 years, the station has been two professionals short of the full research complement. Nine positions constitute full staffing of the facility.

## Lampricide Registration Activities

*TFM BAR REGISTRATION*

In December 1982, La Crosse National Fishery Research Laboratory (LNFRL) submitted a draft application to EPA for registration of the TFM Bar. The bar is proposed for use as an adjunct to the currently-used liquid TFM formulation in the control of sea lampreys. Use of the soluble bar will significantly reduce manpower and equipment needs for the treatment of numerous small feeder streams.

*LAMPRICIDE LABEL*

In February 1982, the FWS was requested by EPA to update the existing labels for TFM to meet current registration requirements. FWS incorporated the supplemental label that covered the combined use of Bayluscide-Lamprecid (the new registered name for TFM) into the new draft final label and submitted it to EPA on 29 May 1982. EPA approved the label in July 1982 so current uses of TFM are now properly registered with EPA. The approved label covers both TFM and its combination with Bayer 73 and will remain valid until such time as EPA calls up the label for product review. Two issues remain to be resolved with EPA before we can say that the registration effort can be considered a closed matter. These isues concern hydrolysis products and photodegradation products. A waiver is being requested from the hydrolysis requirement. Data developed by John Carey of CCIW have been submitted on photodegradation products. Action by EPA is pending but a favorable review is anticipated on both isues. If EPA accepts these items, all requirements for establishment of a tolerance will have been met.

*TERATOLOGY STUDY ON TFM*

LNFRL reviewed the report of a range-finding study that is the initial part of a study to determine if TFM has teratogenic characteristics in rats. The range-finding study provided a basis for establishing low, medium, and high dose levels to be used in the teratology study. After discussions with EPA officials, LNFRL recommended that the levels of TFM be 25 mg/kg, 125 mg/kg and 250 mg/kg. Comments and recommendations were sent to Hazleton Raltech, Inc. in October 1982. EPA requested this study as part of the reregistration rquirements for the use of TFM as a lampricide.

*ENVIRONMENTAL CHEMISTRY OF TFM*

Data submitted by the FWS for environmental chemistry requirements of TFM were accepted by EPA in September 1981. The only studies still required to complete these requirements are a hydrolysis and a photodegradation studies (with degradates identified). In June 1982, FWS submitted a copy of an article entitled "Photodegradation of the lampricide 3-trifluoromethyl-4-nitrophenol (TFM). 1. Pathway of the direct photolysis in solution" by J. H. Carey and M. E. Fox for their review. EPA requested further information on the study; FWS is currently attempting to obtain this additional material from the authors.

*TRIBUTYLTIN FLUORIDE AS A LAMPRICIDE*

The Great Lakes Fishery Commission (GLFC) requested a status statement on the registrability of tributyltin fluoride (TBTF) as a lampricide.



Upon checking with EPA, LNFRL determined that it would be extremely difficult to register TBTF because of its toxicity to aquatic organisms and humans, potential for bioaccumulation in the environment, and the lack of adequate mammalian safety tests. A status report was submitted to GLFC recommending that it no longer be considered as a candidate lampricide.

*EXEMPTION OF TFM CARRIER*

Dimethyformamide (DMF), when used in formulations of the lampricide 3-trifluoromethyl-4-nitrophenol (TFM), is now exempt from a requirement of a tolerance. This ruling, issued by EPA on 10 March 1982, removes one of the last barriers to the establishment of tolerances for TFM in potable water, fish, meat, and milk.

## Sea Lamprey Control Research—La Crosse

*TFM BAR FORMULATION*

A solid bar formulation of TFM was developed for treatment of ammocetes in small streams. The bar reduces the need for constant monitoring of TFM pumps during treatment and is more easily handled than liquid TFM for treatments of back-country streams.

The bar was used in field trials in a tributary of the Sturgeon River in the Upper Peninsula of Michigan. In the first trial, bars were placed where the stream velocity was about 0.4 ft/second. The bars dissolved in 6 hours instead of the 8 to 9 hours predicated and did not maintain a lethal concentration for the required time at the mouth of the stream. In a second trial, the bars were placed in a velocity of 0.2 ft/second. This time, the bars lasted for the predicted 9 hours and the treatment eliminated lamprey ammocetes from the stream. Treatments, thus far, have indicated that the bars must be placed where the water velocity is less than 0.25 ft/second if they are to last the 8 to 10 hours they were designed for. The bars seem effective and efficient for treating small streams. Three streams were treated with the bars and ammocetes were eliminated from all three.

An application for registration of the bar formulation was submitted to EPA in December 1982. The application included a new label, directions for use, chemistry and description of ingredients, and a summary of the existing safety and efficacy data.

*CONCENTRATED TFM FOR BAR FORMULATION*

To be acceptable, for use in the preparation of the TFM bar, formulations must contain at least 80% active ingredient. Hoechst Chemical had agreed to supply TFM for preparation of the bar, but were unable to do so in time for the LNFRL to prepare bars for the field season. Therefore, 10 L of 82% TFM were prepared by concentrating the 37% TFM lampricide formulation at the Southeastern Fish Control Laboratory; 2 L were prepared at La Crosse. Bars tested in 1982 were prepared from these batches of concentrated TFM. Additional material will be needed in the manufacture of bars for field use so a supply must be found.

*GRANULAR BAYLUSCIDE*

The 5% formulation of granular Bayluscide registered for use as a sampling tool to determine sea lamprey populations in still waters, is only partially released under most conditions of use. MOBAY, the manufacturer of Bayluscide, provided the LNFRL with five samples of modified granular formulations. Two of the samples, similar to the present formulation but with added wetting and dispersing agents, released all of the active material within the top 2 ft. of the water column.

Release of Bayluscide by two of the formulations was no better than that obtained from the currently used 5% formulation but a 2% formulation released about 25% more active ingredient over 1 and 2 hour periods. The 2% formulation appeared to be an improvement over the 5% Bayluscide but, even so, only 35% of the active ingredient was released in 1 hour.

*INFLUENCES OF CHLORINE AND METAL IONS ON THE TOXICITY OF LAMPRICIDES TFM AND BAYER 73*

Fish kills associated with stream treatments for control of larval sea lamprey with TFM and Bayer 73 have led to a study to assess the influences of certain types of contaminants on the activity of the lampricides. We evaluated the effect of joint applications of TFM and Bayer 73 with chlorine, cadmium, copper, and zinc against rainbow trout, white suckers, and fathead minnows. The data were analyzed for LC50's, 95% confidence intervals, additive indices, and their ranges.

Additive indices quantitate the combined activity of the mixture and confidence intervals define significance. Additive toxicity (index of zero) indicates that the presence of additional chemicals does not cause a greater toxic effect than that which would have been expected from the toxic contributions of the individual components. Index values that are greater than zero indicate a synergistic effect; values less than zero indicate no synergism and may even reflect antagonistic action. If the range for additive toxicity overlaps zero, the effects are considered to be simply additive. One must be aware that the addition of more chemicals will increase the total number of toxic units with which the fish must cope. If the burden of toxic units already present is high, the addition of another compound may create a lethal situation, even though its individual effect might be sublethal.

Our data for the three species showed no unexpected increase in toxic activity (Table 1). In fact, with chlorine and the lampricides the results were less than additive for rainbow trout and fathead minnows.

Also, toxicity of TFM with copper and TFM with cadmium was less than additive against fathead minnows. Therefore, we concluded that the presence of heavy metal ions does not constitute a toxicological hazard (synergistic effect), but their presence does contribute to the toxic units to



Table 1. Toxicity of lampricides TFM and Bayer 73 in combination with selected contaminants to fish in soft water at 12°C.

| Chemical combination | Additive toxicity index and range | | |
|---|---|---|---|
| | Rainbow trout | White sucker | Fathead minnow |
| TFM and Bayer 73 | (−)0.04<br>(−)0.69 to (+)0.55 | (+)0.02<br>(−)0.58 to (+)0.64 | (−)0.10<br>(−)0.71 to (+)0.42 |
| TFM and cadmium | (−)0.23<br>(−)1.19 to (+)0.46 | (+)0.07<br>(−)0.92 to (+)1.20 | (−)0.91<br>(−)1.86 to (−)0.28 |
| TFM and copper | (+)0.04<br>(−)0.66 to (+)0.77 | (−)0.01<br>(−)0.84 to (+)0.79 | (−)0.58<br>(−)1.45 to (−)0.01 |
| TFM and zinc | (−)0.06<br>(−)0.72 to (+)0.52 | (−)0.26<br>(−)1.43 to (+)0.53 | (−)0.16<br>(−)0.88 to (+)0.39 |
| TFM and chlorine | (−)1.04<br>(−)1.90 to (−)0.45 | (−)0.28<br>(−)0.95 to (+)0.18 | (−)0.63<br>(−)1.41 to (−)0.10 |
| Bayer 73 and cadmium | (−)0.73<br>(−)2.54 to (+)0.18 | (−)0.10<br>(−)0.91 to (+)0.59 | (−)0.38<br>(−)1.09 to (+)0.09 |
| Bayer 73 and copper | (−)0.22<br>(−)1.55 to (+)0.70 | (−)0.17<br>(−)0.96 to (+)0.42 | (−)0.16<br>(−)0.78 to (+)0.31 |
| Bayer 73 and zinc | (+)0.00<br>(−)0.68 to (+)0.70 | (−)0.42<br>(−)0.56 to (+)2.13 | (−)0.42<br>(−)1.04 to (+)0.01 |
| Bayer 73 and chlorine | (−)0.91<br>(−)1.96 to (−)0.24 | (+)0.39<br>(−)0.12 to (+)1.15 | (−)0.38<br>(−)1.05 to (−)0.08 |

which fish are exposed. In addition, other chemicals or contaminants may contribute toxic units during field treatments. We suspect that the combined burden of all materials (cumulative toxic units) may be responsible for some of the kills of nontarget organisms.

Briefly, the data suggested that all combinations except with chlorine, produced strictly additive effects (additive index range overlapped zero) for rainbow trout and white suckers and less than additive effects (additive index range does not overlap zero) for fathead minnows. Accordingly, fathead minnows should be affected less than rainbow trout and white suckers when exposed to these chemical mixtures.

*LAMPRICIDE SOIL BINDING*

The adsorption of $^{14}$C-TFM (3-trifluoromethyl-4-nitrophenol) and $^{14}$C-RTFM (3-trifluoromethyl-4-aminophenol) was evaluated using bottom sediments from the Cedar River (silt), Ford River (sand/silt), and Tahquamenon River (sand) in Michigan. Reduced TFM (RTFM) is the primary microbial metabolite of TFM. Solutions of TFM or of RTFM were mixed with each sediments and allowed to come to equilibrium on an orbital shaker. The solutions were then centrifuged and analyzed for residues of the chemicals in solution. Temperature (20°C) was controlled by an environmental chamber and pH's were maintained using phosphate or carbonate buffers.

The pH had little influence on the binding of RTFM to any of the three sediments. The adsorption of TFM, however, was influenced by pH, with un-ionized TFM (acidic) being more strongly absorbed by sediments than ionized TFM (basic). RTFM was more strongly adsorbed by Cedar River sediments than was TFM (Fig. 1). This trend continued with Ford River sediments (Fig. 2) and Tahquamenon River sediments (Fig. 3). More chemical was adsorbed by silt-type sediments than by sand (Fig. 4). This was especially true for TFM; the difference was about 12-fold at pH 7.0. Cedar River sediment (silt) adsorbed about 2.5 times as much RTFM as Tahquamenon River sediment (sand) at pH 7.0.

Preliminary results indicate that Bayer 73 was more strongly adsorbed to sediments from the Cedar, Ford, or the Tahquamenon rivers than TFM. Bayer 73 was also more strongly adsorbed to silt than to sand sediments.

*BISAZIR*

Bisazir is being investigated for possible use as a chemosterilant for adult sea lamprey. Samples of tissue from an adult sea lamprey treated with $^{14}$C-labeled bisazir were extracted successively with hexane, ethyl ether,

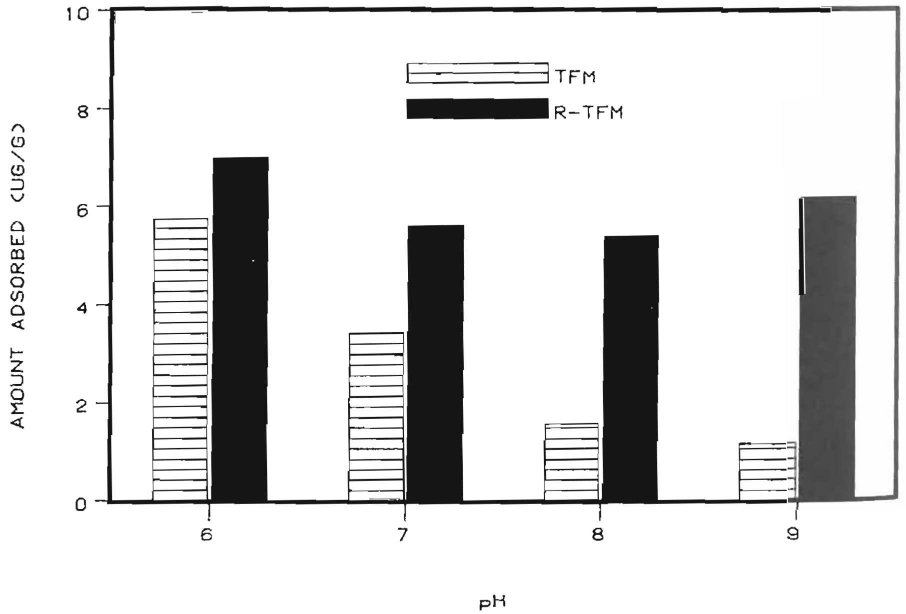


Figure 1. Adsorption of 1 mg/L solutions of $^{14}$C-TFM and $^{14}$C-R-TFM on Cedar River sediments at selected pH's.



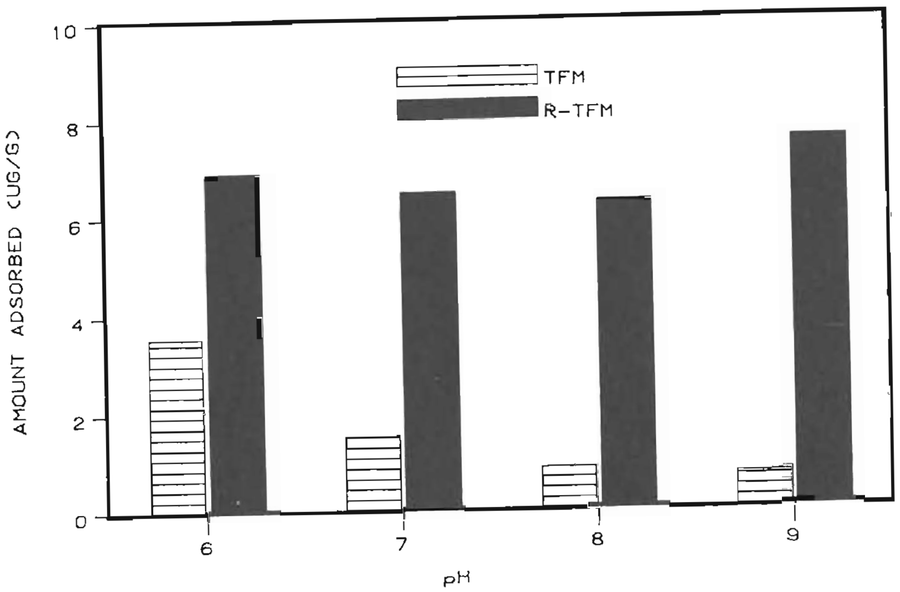


Figure 2. Adsorption of 1 mg/L solutions of $^{14}$C-TFM and $^{14}$C-R-TFM on Ford River sediments at selected pH's.

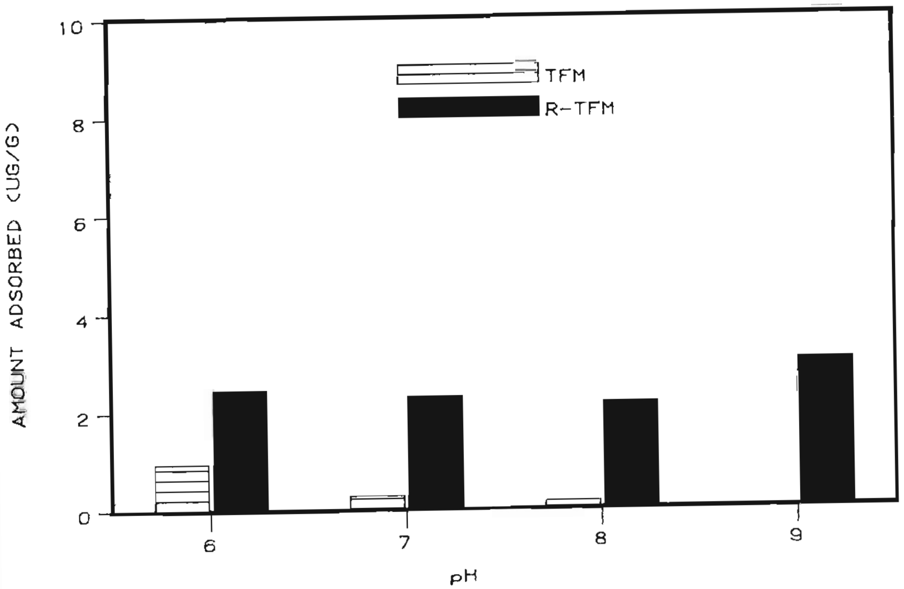


Figure 3. Adsorption of 1 mg/L solutions of $^{14}$C-TFM and $^{14}$C-R-TFM on Tahquamenon River sediments at selected pH's.

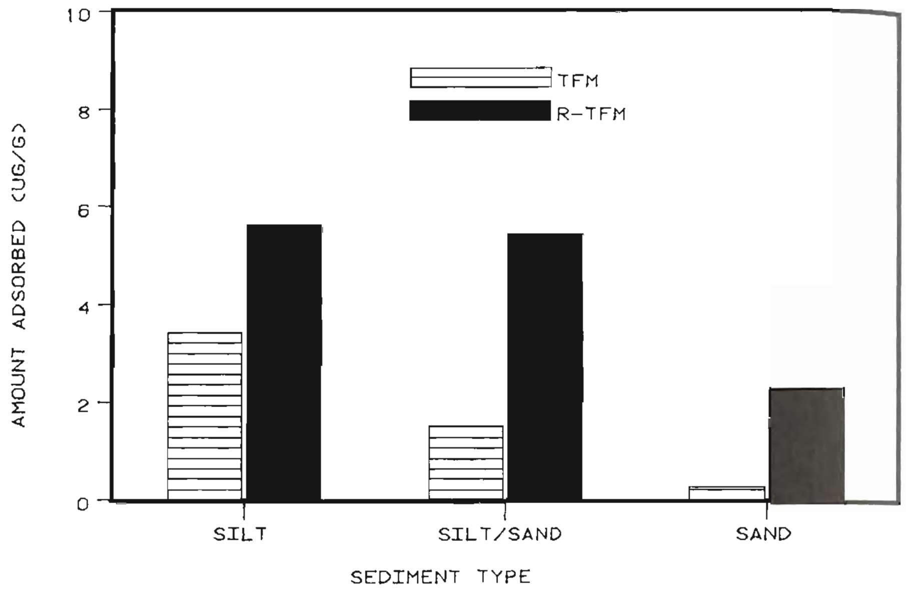


Figure 4. Comparative adsorption of 1 mg/L solutions of $^{14}$C-TFM and $^{14}$C-R-TFM on Cedar River (silt), Ford River (silt/sand), and Tahquamenon River (sand) sediments at pH 7.

and methanol. Radioactive residues were present in all three solvents. Hexane contained more than methanol which contained more than ethyl ether. These results indicate that more than one metabolite of bisazir is present in residues in lampreys and that both nonpolar and polar residues are present.

TECHNICAL ASSISTANCE—LA CROSSE

*EPA MASTER FILE ON TFM*

The Canadian Department of Fisheries and Oceans requested a list of the materials in the EPA master file on TFM, a copy of the revised label for TFM, and a list of references on TFM and Bayer 73. These documents were provided to Dr. Pat Chamut (Director General-Ontario Region, Department of Fisheries and Oceans) in October 1982, for the Department's use in the registration of lampricides in Canada.

*TFM-BAYER 73 LITERATURE LISTINGS*

The literature on TFM and Bayer 73 has been updated by computer searches. These listings have now been entered on the word processor so updates can be made quickly and easily. Listings are available to interested persons upon request to the LNFRL.



*ANALYSIS OF "SLUDGE" FROM LAMPRICIDE*

Samples of a "sludge" from TFM cans were analyzed for the Sea Lamprey Control Centre, Sault Ste Marie, Ontario. The sludge was found to be predominantly TFM (66.5% TFM sodium salt).

*TFM RESIDUES IN WATER SAMPLES FROM LUDINGTON BIOLOGICAL STATION*

Over the years, TFM leaked into concrete floors in storage areas at the Ludington Biological Station, Ludington, Michigan. Some residues of TFM have leached into the effluent discharge. The effluent at the Station is now filtered through activated charcoal and monitored weekly for TFM residues in compliance with the station's EPA discharge permit. Concentrations of TFM must be no greater than 0.10 mg/L. LNFRL analyzed effluent samples for the Ludington Station. No Bayer 73 was detected in any of the samples. TFM concentrations were as follows:

| Date sample collected | Concentration (mg/L) |
|---|---|
| 12/07/81 | <0.005 |
| 12/14/81 | <0.005 |
| 12/21/81 | 0.033 |
| 12/28/81 | 0.070 |
| 1/04/82 | 0.078 |
| 1/11/82 | 0.079 |
| 1/18/82 | 0.063 |
| 1/25/82 | 0.089 |

SEA LAMPREY CONTROL RESEARCH—HAMMOND BAY

*METHODS FOR STERILIZING ADULT SEA LAMPREYS*

The GLFC has endorsed development of an integrated sea lamprey control program that will combine continued applications of selective larvicides with other methods that may prove effective in order to achieve the desired level of control. A control method now being evaluated at the HBBS involves the release of sterilized, sexually-mature male sea lampreys into streams containing spawning populations of lampreys. In principle, sterile males will compete successfully with fertile males for mates, thereby reducing the reproductive sucess of the spawning population. A basic requirement for the successful application of the sterile-male-release technique is the development of a method of inducing sterility without causing serious adverse effects on mating behavior and competitiveness. Chemosterilants, gamma radiation, and immunological methods of sterilization have been tested in laboratory studies.

In 1982, gamma radiation, methallibure, and immunological techniques were tested as potential sterilants.

*Gamma Radiation Study*—Studies in 1981 showed that ionizing radiation had potential as a method for sterilizing male spawning-run sea lampreys. Males exposed to radiation doses of 1,000 and 2,000 rads from a cobalt-60 unit developed a high level of sterility (about 90%). Inquiries were then made regarding the specifications, cost, size, and safety requirements of different types of irradiators. One unit, the Gammacell-40 low dose rate laboratory irradiator, appeared to be suitable for laboratory use. The unit is smaller and less expensive than the cobalt-60 source. Laboratory studies to evaluate the effectiveness of this irradiator for sterilizing males were conducted in 1982.

Spawning-run lampreys were obtained from a trap on the Cheboygan River, Michigan, and transferred to HBBS. Groups of 15 male lampreys were exposed to radiation dosages of 500, 1,000, 2,000, or 3,000 rads from a Gammacell-40 irradiator (containing cesium 137 as a radiation source) at Wayne State University, Detroit, Michigan. Lampreys were exposed at a rate of 122 rads per minute. Ten lampreys from each group were weighed, fin-clipped, and placed in the artificial spawning stream at HBBS, along with normal males and females. The lampreys were observed periodically and those observed in the spawning act were removed and spawned artificially. One portion of the eggs stripped from each female was fertilized with sperm from an irradiated male; a second portion was fertilized with sperm from a normal male to provide a control.

Eggs were placed in 10 L glass jars containing 6 L of Lake Huron water. The jars were held in a constant temperature water bath at 18.3°C, the optimum temperature for development of sea lamprey embryos. Dead eggs and prolarvae were removed and counted when detected; oxygen levels were maintained near saturation with air bubblers. After 21 days of incubation, the study was terminated and live prolarvae were examined for abnormalities and counted. Prolarvae judged to be abnormal were usually so grossly deformed that survival was improbable.

Observations of the lampreys while in the artificial stream showed that males irradiated at doses of 500 and 1,000 rads exhibited no apparent adverse effects from the radiation treatment. Eight of the 10 males exposed to 500 rads, and seven of the 10 exposed to 1,000 rads were observed spawning. However, only three of the 10 males exposed to 2,000 rads, and one of 10 exposed to 3,000 rads, were observed spawning. Nearly all of the males exposed to 3,000 rads and many of those exposed to 2,000 rads became covered with fungus and died without spawning. It is probable that irradiation increased the susceptibility of the lampreys to infection. Whole-body irradiation is known to reduce natural resistance to infection and interrupt the normal immune response in other animals.

Results of the embryological portion of the study indicated that some degree of sterility was induced at all radiation dosages tested and that, generally, embryo mortality increased as the dosages increased (Tables 2–5).

*Immunosterilization study*—A cooperative study was conducted with the National Fish Health Research Laboratory (NFHRL), Leetown, West



Table 2. Effects of exposure of male spawning-run sea lampreys to a radiation dose of 500 rads from a Gammacell-40 irradiator (cesium 137) on the production of normal prolarvae after 21 days incubation when treated males were artificially spawned with untreated females. Each female spawned with a treated male was also spawned with a normal male to provide a control.

| Group | Total number eggs | Percentage dead | Percentage live, but abnormal | Percentage live and normal |
|---|---|---|---|---|
| Experimental | 355 | 53.5 | 0.0 | 46.5 |
| Control | 502 | 8.0 | 0.6 | 91.4 |
| Experimental | 363 | 45.7 | 6.3 | 47.9 |
| Control | 390 | 52.3 | 0.0 | 47.7 |
| Experimental | 485 | 28.7 | 1.6 | 69.7 |
| Control | 567 | 26.5 | 0.0 | 73.5 |
| Experimental | 452 | 27.0 | 0.0 | 73.0 |
| Control | 477 | 18.2 | 0.4 | 81.3 |
| Experimental | 464 | 15.5 | 1.1 | 83.4 |
| Control | 769 | 13.3 | 0.1 | 86.6 |
| Experimental | 771 | 69.5 | 1.3 | 29.2 |
| Control | 562 | 66.0 | 0.0 | 34.0 |
| Experimental | 354 | 93.5 | 1.4 | 5.1 |
| Control | 584 | 74.5 | 0.3 | 25.2 |
| Experimental | 508 | 32.7 | 0.8 | 66.5 |
| Control | 531 | 5.6 | 0.2 | 94.2 |

Virginia, to investigate the potential for developing an immunological method for sterilizing male spawning-run sea lampreys.

Six groups of male lampreys were weighed, fin-clipped, and injected intraperitoneally with the following materials (obtained from NFHRL) at the dose rate of 10 mL/kg. Two to four males were injected in test groups.

Group 1 Rabbit anti-lamprey sperm sera
2 Rabbit anti-lamprey sperm sera that had been absorbed with lamprey skeletal muscle
3 Rabbit anti-lamprey sperm sera that had been absorbed with lamprey skeletal muscle and mixed with Freund complete adjuvant (FCA)
4 FCA only
5 Lamprey sperm mixed with FCA
6 Saline only

Injected lampreys were placed in the artificial stream at HBBS along with normal males and females. The lampreys were observed periodically and those observed in the spawning act were removed and spawned artifi-

Table 3. Effects of exposure of male spawning-run sea lampreys to a radiation dose of 1,000 rads from a Gammacell-40 irradiator (cesium 137) on the production of normal prolarvae after 21 days incubation when treated males were artificially spawned with untreated females. Each female spawned with a treated male was also spawned with a normal male to provide a control.

| Group | Total number eggs | Percentage dead | Percentage live, but abnormal | Percentage live and normal |
|---|---|---|---|---|
| Experimental | 908 | 97.2 | 0.0 | 2.8 |
| Control | 443 | 26.0 | 0.0 | 74.0 |
| Experimental | 334 | 49.7 | 0.0 | 50.3 |
| Control | 469 | 64.2 | 0.0 | 35.8 |
| Experimental | 651 | 100.0 | 0.0 | 0.0 |
| Control | 677 | 73.7 | 0.0 | 26.3 |
| Experimental | 590 | 99.8 | 0.0 | 0.2 |
| Control | 510 | 89.2 | 0.0 | 10.8 |
| Experimental | 431 | 73.8 | 3.2 | 23.0 |
| Control | 470 | 100.0 | 0.0 | 0.0 |
| Experimental | 425 | 85.9 | 1.6 | 12.5 |
| Control | 454 | 55.5 | 2.2 | 42.3 |
| Experimental | 613 | 99.8 | 0.0 | 0.2 |
| Control | 380 | 62.1 | 0.0 | 37.9 |

Table 4. Effects of exposure of male spawning-run sea lampreys to a radiation dose of 2,000 rads from a Gammacell-40 irradiator (cesium 137) on the production of normal prolarvae after 21 days incubation when treated males were artificially spawned with untreated females. Each female spawned with a treated male was also spawned with a normal male to provide a control.

| Group | Total number eggs | Percentage dead | Percentage live, but abnormal | Percentage live and normal |
|---|---|---|---|---|
| Experimental | 737 | 96.2 | 0.0 | 3.8 |
| Control | 517 | 6.0 | 2.5 | 91.5 |
| Experimental | 750 | 68.8 | 16.3 | 14.9 |
| Control | 419 | 5.3 | 7.2 | 87.6 |
| Experimental | 399 | 98.7 | 0.0 | 1.3 |
| Control | 452 | 72.6 | 0.0 | 27.4 |

cally. The eggs were fertilized and handled according to some procedures described under "Gamma Radiation Study" above.

Serum was collected from each injected male after it was artificially spawned and sent to the NFHRL where they performed the following im-



Table 5. Effects of exposure of male spawning-run sea lampreys to a radiation dose of 3,000 rads from a Gammacell-40 irradiator (cesium 137) on the production of normal prolarvae after 21 days incubation when treated males were artificially spawned with untreated females. Each female spawned with a treated male was also spawned with a normal male to provide a control.

| Group | Total number eggs | Percentage dead | Percentage live, but abnormal | Percentage live and normal |
|---|---|---|---|---|
| Experimental | 397 | 99.7 | 0.3 | 0.0 |
| Control | 491 | 99.4 | 0.0 | 0.6 |

munological tests: macroscopic agglutination with whole, washed sperm antigens; microtiter agglutination with washed sperm antigens; and gel precipitin tests with soluble antigens.

The results of this study indicate that the injections had no sterilizing effects on the lampreys. Low antibody titers were found in only one lamprey that had been injected with lamprey sperm mixed with FCA. All other test results were negative. The production of live, normal prolarvae in batches of eggs fertilized by semen from the injected males was generally good and no evidence of a reduced survival rate was observed.

Considering the negative results of this year's study, and with the concurrence of researchers at the NFHRL, we recommend that no further research be conducted on the possible use of immunosterilization techniques for sea lamprey control.

*Methallibure Study*—A study was conducted to determine the potential of methallibure, a nonsteroid, nonhormonal chemical inhibitor of pituitary activity, for use as a sterilant of male spawning-run sea lampreys.

Sixty males were immersed in a 1,000 mg/L suspension of methallibure for 24 hours. The lampreys were placed in a fiberglass tank containing 300 L of aerated Lake Huron water and maintained at temperature of 10° to 13°C. A stock suspension consisting of 300 g of methallibure, 600 drops of Tween 80, and 3,000 mL of Lake Huron water was stirred thoroughly and added to the tank. After 24 hours, the lampreys were removed, tempered to the incoming water temperature, and placed in a fiberglass tank receiving aerated Lake Huron water. Ten lampreys were placed in an artificial spawning stream at the laboratory. Of the remainder, five were sacrificed each week for gonadosomatic index (GSI) evaluations by the Alabama Cooperative Fishery Research Unit (ACFRU) at Auburn University. All lampreys were measured, weighed, and dissected to remove their gonads. The gonads were weighed, fixed in Bouin's solution for 7 days, and then transferred to 70% alcohol.

Sixty other males were injected intraperitoneally with 1,000 mg/kg of methallibure. A stock suspension consisting of 20 g of methallibure, 40 drops of Tween 80, and 200 mL dionized water was prepared. This suspension was injected at a rate of 10 mL/kg. Fifty lampreys were held and sacrificed at intervals for GSI evaluations and histological examinations of the gonads by the ACFRU. Ten were placed in the artificial spawning stream with normal male and female lampreys.

Lampreys in the artificial spawning stream were observed periodically; those observed in the spawning act were removed and spawned artificially. The eggs were fertilized and handled in the same way as described under "Gamma Radiation Study" above.

No changes in nest building or spawning behavior were noted in males that had been immersed or injected with methallibure. Eight of 10 males immersed in a 1,000 mg/L suspension were observed spawning, while only four of 10 injected males were observed spawning. It is not known if this is significant. Results of the embryological portion of this study showed that neither the immersion of male sea lampreys in a 1,000 mg/L suspension of methallibure for 24 hours (Table 6) or the injection of methallibure at 1,000 mg)kg (Table 7) had an adverse effect on the production of normal prolarvae when semen from treated males was used to fertilize eggs from normal females. No reduction in the survival rate of prolarvae was observed

Table 6. Effects of immersion of male sea lampreys in a 1,000 mg/l aqueous suspension of methallibure for 24 hours on the production of normal prolarvae after 21 days incubation when treated males were artificially spawned with normal females. Each female spawned with a treated male was also spawned with a normal male to provide a control.

| Group | Total number eggs | Percentage dead | Percentage live, but abnormal | Percentage live and normal |
|---|---|---|---|---|
| Experimental | 501 | 98.2 | 0.0 | 1.8 |
| Control | 556 | 100.0 | 0.0 | 0.0 |
| Experimental | 509 | 98.0 | 0.0 | 2.0 |
| Control | 572 | 98.8 | 0.2 | 1.0 |
| Experimental | 474 | 25.3 | 0.2 | 74.5 |
| Control | 579 | 62.9 | 0.7 | 36.4 |
| Experimental | 553 | 57.3 | 0.0 | 42.7 |
| Control | 472 | 19.3 | 0.0 | 80.7 |
| Experimental | 710 | 31.5 | 0.0 | 68.5 |
| Control | 556 | 29.7 | 0.0 | 70.3 |
| Experimental | 786 | 17.0 | 0.0 | 83.0 |
| Control | 455 | 6.6 | 0.9 | 92.5 |
| Experimental | 431 | 31.1 | 2.3 | 66.6 |
| Control | 537 | 35.2 | 1.3 | 63.5 |
| Experimental | 354 | 97.7 | 0.6 | 1.7 |
| Control | 318 | 99.7 | 0.0 | 0.3 |



Table 7. Effects of intraperitoneal injection of male sea lampreys with methallibure (1,000 mg/kg) on the production of normal prolarvae after 21 days of incubation when injected males were artificially spawned with normal females. Each female spawned with an injected male was also spawned with a normal male to provide a control.

| Group | Total number eggs | Percentage dead | Percentage live, but abnormal | Percentage live and normal |
|---|---|---|---|---|
| Experimental | 1,153 | 12.7 | 7.4 | 80.0 |
| Control | 419 | 13.4 | 0.0 | 86.6 |
| Experimental | 634 | 56.6 | 0.2 | 43.2 |
| Control | 647 | 34.9 | 0.3 | 64.8 |
| Experimental | 429 | 35.7 | 0.0 | 64.3 |
| Control | 568 | 5.3 | 0.0 | 94.7 |
| Experimental | 477 | 14.0 | 0.6 | 85.3 |
| Control | 481 | 13.5 | 0.8 | 85.7 |

and it was concluded that the treatments had no sterilizing effects on male spawning-run sea lampreys.

## *EFFICACY OF NEW FORMULATIONS OF REGISTERED TOXICANTS*

Clay-pelleted formulations containing mixtures of TFM and Bayer 73 were tested to compare their toxicities with each other and with commercially available granular Bayer 73. Clay pellets containing 10% TFM by weight of active ingredient and other pelleted formulation containing a mixture of 98% TFM and 2% Bayer 73 (total active ingredient 10% by weight) killed all sea lamprey ammocetes during 6-hour exposures when administered at 112.1 kg of total formulation per hectare. Both clay formulations showed good potential as bottom-release lampricides when compared to granular Bayer 73. Additional bioassays were conducted to determine if the addition of Bayer 73 in the clay formulations was needed to potentiate activity of the clay mixtures. Data from these tests indicated that the TFM:Bayer 73 mixture was more toxic to larval sea lampreys than the formulation containing only TFM. Both formulations were selected for field evaluations and 90.8 kg of each have been ordered from a commercial formulator. The formulations will be tested against granular Bayer 73 under field conditions.

In anticipation of future field studies with these formulations, laboratory studies were conducted to measure the mortality of clayed and free ammocetes when dosed with two clay-pelleted formulations of TFM and Bayer 73. These studies indicated that the clay-pelleted lampricide was faster-acting on uncaged ammocetes than on caged ammocetes. Clay pellets suspended on top of the cages released the toxicant above the sediment surface and were not as effective in killing lampreys as were pellets that dropped directly to the bottom sediment.

*ALTERNATIVE SEA LAMPREY LARVICIDES*

Bioassay tests were conducted with a mixture of 98% TFM and 2% Salicylanilide 1 (Sal 1), TFM alone, and a mixture containing 98% TFM and 2% Bayer 73 to compare toxicity and selectivity. Bioassays were conducted using standard reconstituted water with a total alkalinity of 227 mg/L, total hardness of 46 mg/L, and pH 8.2. All test vessels were aerated for the 24'hour test period. Minimum lethal concentrations (concentrations producing 100% kill of sea lamprey) were determined at 9 hours of exposure.

Results indicated that the TFM-Sal 1 mixture was more toxic to lampreys than TFM alone, but not as toxic as the TFM:Bayer 73 mixture (Table 8). Data obtained on rainbow trout in the same tests demonstrated that the TFM-Sal 1 mixture was less selective to sea lampreys than the other test materials. Since no advantage was indicated in using Sal 1 over Bayer 73 as an additive for TFM, no further tests are scheduled for Sal 1 at this time.

*FIELD TESTS OF ATTRACTANTS AND REPELLENTS FOR POTENCY*

*Light Study*—Traps have been used for many years to assess populations of spawning sea lampreys in rivers that are tributaries to the Great

Table 8. Comparative toxicity, expressed as percent motality, of TFM and TFM/Sal 1 and TFM/Bayer 73. Fish exposed for 24 hours at 12°C.

| Concentrations mg/L | 100% TFM | | 98% TFM/2% Sal 1 | | 98% TFM/2% Bayer 73 | |
|---|---|---|---|---|---|---|
| | Lamprey | Trout | Lamprey | Trout | Lamprey | Trout |
| 2.0 | – | – | 10.0 | – | 60.0 | – |
| 3.0 | – | – | 20.0 | – | 100.0* | – |
| 4.0 | 70.0 | – | 100.0 | – | 100.0 | – |
| 5.0 | 100.0 | – | 100.0 | – | 100.0 | – |
| 6.0 | 100.0 | – | 100.0* | 10.0 | 100.0 | 20.0 |
| 8.0 | 100.0* | – | – | 90.0 | – | 80.0 |
| 10.0 | – | – | – | 100.0 | – | 100.0 |
| 12.0 | – | – | – | 100.0 | – | 100.0 |
| 14.0 | – | – | – | 100.0 | – | 100.0 |
| 16.0 | – | 0.0 | – | – | – | – |
| 18.0 | – | 0.0 | – | – | – | – |
| 20.0 | – | 0.0 | – | – | – | – |
| 22.0 | – | 30.0 | – | – | – | – |
| 24.0 | – | 50.0 | – | – | – | – |
| Control | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

*Denotes minimum lethal concentration at 9 hours exposure.



Lakes. These traps have funnel-shaped throats that allow migrating sea lampreys to enter a cage compartment. Spawning populations are sampled by placing these cages in streams where lampreys are expected to pass during their spawning runs. Thousands of adult lampreys have been taken in such traps from the Cheboygan River in Michigan since 1977. Although the traps capture many animals, we suspected that significant numbers managed to escape by exiting through the entry opening. In 1981, a flashlight was used to check whether lampreys were escaping. When a beam of light was focused on the funnel opening from inside the trap, it was noted that the number of lampreys entering the trap appeared to increase. These observations, along with results of preliminary tests, sugested a positive correlation between the incidence of artificial light and capture efficiency.

A cooperative field study was conducted in 1982 by the Hammond Bay Biological Station, Millersburg, Michigan, the Marquette Biological Station, Marquette, Michigan, and the National Fishery Research Laboratory, La Crosse, Wisconsin, to determine if artificial light could be used to enhance capture rates in the assessment traps. A double-compartmented trap was constructed and fished for 20 days during the peak of the lamprey spawning run in the Cheboygan River. An experimental design was developed with selected hours of fishing so that lighting of compartments could be alternated during specified trapping periods. A schedule was arranged that would minimize possible biases due to time of night, irregularity of migrant numbers, river stage, flow rates, temperature, or other possible factors.

During the course of the study, 6,983 adult sea lampreys were captured; 5,766 lampreys or 83% of the total were captured in the lighted compartments. The lighted compartments were approximately five times more efficient than the unlighted ones. The difference in catches was highly significant and demonstrated that the addition of an artificial light inside the trap was indeed effective for increasing the catch of spawning adult sea lampreys.

Sea lamprey control has been a continuing effort for United States and Canadian agents for nearly three decades. Although the use of lampricides has been the major thrust, innovations are needed for more efficient means to control this dreaded predator of Great Lakes fishes. The discovery of using artificial light to enhance the capture of spawning sea lamprey offers new insight into single as well as integrated management procedures. This technique will benefit sea lamprey control by augmenting trapping at barriers to provide better integrated sea lamprey management.

TECHNICAL ASSISTANCE—HAMMOND BAY

*COMPARATIVE TOLERANCE OF THREE LAMPREY SPECIES TO TFM*

*Lampetra*, *Petromyzon*, and *Ichthyomyzon* spp. ammocetes have been used, singly or in combination, in pretreatment bioassays for more than 20 years. The use of mixed genera of ammocetes may not have accurately defined minimum lethal concentrations for the target genus, *Petromyzon*.

Preliminary bioassays conducted in Lake Huron water at HBBS indicated that the native lampreys (*Lampetra* and *Ichthyomyzon*) are more tolerant to TFM than *Petromyzon*. The LC50 and LC99.9 for *Petromyzon* were 1.9 and 3.1 mg/L TFM, respectively; for *Lampetra*, 2.6 and 4.0 mg/L TFM respectively; and for *Ichthyomyzon*, 2.6 and 4.2 mg/L TFM, respectively. Additional bioassays are scheduled to be conducted under various test conditions to obtain more definitive results.

*WAISKA RIVER BIOASSAY*

The Waiska River, a soft-water stream tributary to Lake Superior, was chemically treated with TFM during the fall. Fyke nets fished during the treatment collected an unexpected number of dead cyprinids. The treatment concentration applied was selected on the basis of water chemistry measurements performed prior to the treatment. No pretreatment bioassay was conducted. At the request of the Marquette Biological Station staff, a bioassay was conducted with Waiska River water a few days after the TFM treatment to determine toxic concentrations of TFM in this soft water (total hardness, 24 mg/L; total alkalinity, 30 mg/L; and pH, 7.0). Sea lamprey larvae, fingerling rainbow trout, and sand shiners were exposed to a series of TFM concentrations for 16 hours at 5°C. The results (Fig. 5) indicated that if the TFM concentration remained near 2.0 mg/L for a length of time, significant numbers of cyprinids would be killed. No rainbow trout were killed at 2.0 mg/L of TFM after 24 hours of exposure.

While the fish kill in the Waiska River treatment was not serious, the use of cyprinids as an indicator nontarget species in a pretreatment bioassay might have provided predictive data whereby those nontarget fish might have been better protected. The sea lamprey control program is perhaps the only pest control operation where pretreatment bioassays are conducted routinely in efforts to protect nontarget organisms and to minimize the use of chemicals. This tradition should be maintained; pretreatment bioassays should be a high priority consideration in the design of chemical treatments.

*LOSS OF TOXICITY IN BAYER 73-TFM MIXTURES*

Laboratory bioassay tests were conducted in support of the Ludington Biological Station field bioassay unit and with the help of the chemist from the Marquette Biological Station in an attempt to determine causes for the unexpected loss of toxicity from a mixture containing 99.5% TFM and 0.5% Bayer 73 (TFM/0.5B) compared to TFM alone. Bioassays were conducted with sea lampreys and rainbow trout in water from rivers scheduled for treatment. Packets of preweighed Bayer 73 and TFM were reweighed on the HBBS analytical balance and shown to be accurate. Gas chromatographic analysis was performed to determine if Bayer 73 was lost to the test containers (polyethylene bags) used in the field bioassays. No loss was



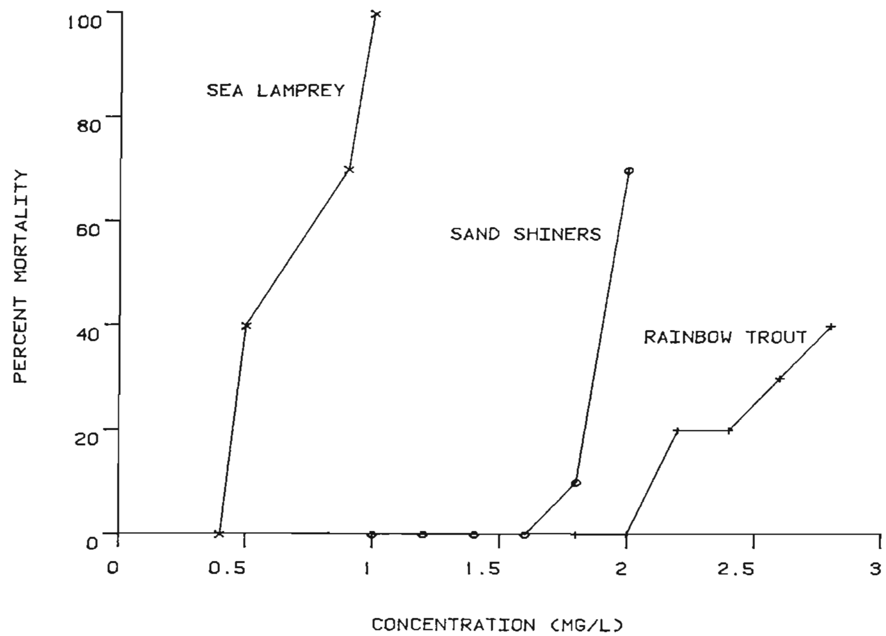


Figure 5. Toxicity of TFM in Waiska River water to sea lampreys, sand shiners, and rainbow trout (16-hour exposure at 5°C).

detected when no animals were in the test vessels. However, when the bioassays were conducted with Ocqueoc River water (alkalinity, 150 ppm) with lamprey and trout, the gas chromatographic analysis for Bayer 73 in the water showed a loss of up to 20% in the first 6 hours of the test. This loss of Bayer 73 to the fish in the tanks probably resulted in a decreased availability of the mixture of TFM and Bayer 73 to the test animals. We tentatively concluded that, under the conditions encountered on the Ocqueoc River (temperature, 12°C; alkalinity, 150 ppm), 99.0% TFM/1.0% Bayer 73 should have been the mixture of choice to maximize effectiveness. In consultation with the field bioassay crew, other possible causes (such as reduced temperature) for the loss of toxicity of TFM and Bayer mixtures are being considered.

*OCQUEOC RIVER FYKE NETS AND TRAPS*

Lamprey trapping was conducted in the Ocqueoc River in support of the Marquette Biological Station. Fyke nets fished in the fall of 1981 and spring of 1982 (1981–1982 migrational year) captured 16 recently metamorphosed sea lampreys. Spawning-run sea lamprey were captured in traps below the low-head barrier dam on the Ocqueoc River in the spring of 1982;

the large, permanent trap captured 998 lampreys and a portable trap captured 880.

*LIVE LAMPREYS*

Live lampreys were provided to the following investigators: Dr. Jon Mallatt (Washington State University, Pullman, Washington); Dr. Stacia Sower (University of Washington, Seattle, Washington); Mr. Steve Walker (Tulsa Zoological Park, Tulsa, Oklahoma); Dr. Gerardo Vasta (Medical University of South Carolina, Charleston, South Carolina); Dr. Susan Moench (Colorado State University, Fort Collins, Colorado); Dr. John Teeter (Monell Chemical Senses Center, Philadelphia, Pennsylvania); Mr. Philip Cochran (University of Wisconsin, Madison, Wisconsin); and Dr. Douglas Anderson (National Fish Health Research Laboratory-Leetown, Kearneysville, West Virginia).

*ASSISTANCE TO VISITING SCIENTIST*

Dr. Stacia Sower, from the University of Washington, Seattle, Washington, spent the summer at the HBBS conducting experiment on the effects of various anti-estrogens, androgen antagonists, and LH-RH antagonists on spawning-run sea lampreys. Technical assistance, laboratory space, and experimental animals were provided to Dr. Sower.

ATTRACTANT AND REPELLENT RESEARCH—
MONELL CHEMICAL SENSES CENTER

*IDENTIFICATION AND CHARACTERIZATION OF SEA LAMPREY PHEROMONES*

This report summarizes the results of experiments conducted during 1982 at the Monell Chemical Senses Center and at the HBBS to identify and characterize intraspecific chemical signals (pheromones) involved in sea lamprey migration and reproductive behavior. Such substances may prove useful in an integrated program of sea lamprey population management, either as highly selective lures to aid in capturing adults during spawning migration, or as agents to disrupt normal pheromone communication so that successful spawning is prevented or reduced.

The results of two-choice preference tests with over 5,000 adult sea lampreys during the 1977–1981 spawning seasons indicate that at least three different chemical signals may be involved in sea lamprey migration and spawning behavior. Two of these presumed pheromones, one released by sexually-mature males and the other by sexually-mature females, have tentatively been classified as sex attractants. The male pheromone is present in the urine of sexually mature, but not immature, males and elicits a preference response in spawning-run females. The female pheromone is present in ovarian fluid (and perhaps urine) of sexually mature, but not necessarily ovulated, females and elicits a preference response in spawning-run males. These signals are probably used primarily for short-range communication; perhaps during pair-formation or for release of spawning behavior. The possibility that they can function as long-range signals; however, has not been eliminated. Spawning-run females, which are not sexually mature, show preferences for the urine of sexually-mature males. Consequently, the presence of a relatively small number of sexually mature males, either near the mouth of a stream prior to migration or on the spawning grounds, could result in an aggregation of maturing females. The third chemical signal is released by sea lamprey larvae and appears to attract sexually immature, spawning-run adults. When sexually mature, the adults no longer respond to rinses of sea lamprey larvae. This means the response is very short-lived (a few weeks) and, consequently, it has not been as well characterized as the response to the sex attractants. This phenomenon suggests; however, the posibility that sea lamprey larvae are providing a chemical cue used by migrating adults to aid in selection of suitable streams in which to spawn. Such a substance might be useful as a long-range lure.

During the 1982 spawning season, efforts were directed at further purifying the behaviorally active compounds present in male urine so that they can be synthesized or bought in sufficient quantities for preliminary field tests. In addition, an experiment designed to determine which sensory system mediates the preference response of females to male urine was conducted.



*MALE PHEROMONE*

The results of a large number of two-choice preference tests conducted during the 1979–1981 spawning seasons have shown that: (1) the male pheromone is present in, and presumably released with, urine; (2) the behaviorally active compounds are released in quantities sufficient to elicit preference responses in females only after the males display secondary sex characteristics; (3) release of the male pheromone does not require that the males be spermiated (milt elicits no observable response in females); (4) females do not have to be ovulated to respond to the urine (females captured at the beginning of the migration are responsive to male urine); (5) concentrations of active urine as low as 6 μl/L of water in the test compartment can elicit a response in females; (6) the active compounds are relatively heat stable and can be concentrated by a variety of techniques including lyophilization and stored for up to 12 months with no appreciable loss of behavioral activity; and (7) the major active compounds have molecular weights of less than 1,000.

During 1982, preference tests were run with over 3,000 sea lampreys captured during upstream migration in the Cheboygan and St. Mary rivers. Urine was collected from males in pools of 100 to 400 ml and samples from each (12.8 μl/L) were tested for behavioral activity with a minimum of 22 females. Samples of behaviorally active urine were then separated into three initial fractions by HPLC: a water fraction, a methanol:water fraction (60:30), and a methanol fraction. Samples of each of these fractions were tested for activity and all three elicited preference responses in females (Table 9). Although this could be interpreted as evidence that the male pheromone consists of more than one active component, we believe that it is probably the result of incomplete separation of the active compound by this solvent system, with some of it getting into all three fractions. Alternative separation techniques are being examined.

The HPLC water fraction tended to be the most active and it was further fractionated by HPLC into six subfractions. Each of these fractions was tested for activity in the preference tanks and the results were presented in Table 9. Fractions #1–3 were all behaviorally active while fractions #4–6 elicited no preference responses in females.

Fraction #3 was examined using GC/MS. The reconstructed ion chromatogram of this fraction, generated using desorption-chemical ionization (DCI), is shown in Figure 6 and the mass spectrum of the major component of the ion chromatograph (peak 29) is shown in Figure 7. Methane gas was used to form the reagent gas plasma, the pressure was 0.17 torr., and the DCI probe current increased from 0 to 1,000 ma at a rate of 50 ma/sec. It is probable that m/z 236 of the mass spectrum (Fig. 7) is the parent ion, that m/z 251 is the [parent$^+$ + $CH_3^+$] adduct and that m/z 265 is the [parent$^+$ + $CH_3CH_2^+$] adduct. These results are tentative and await confirmation by comparison with a DCI mass spectrum using ammonia as the reagent gas. Although these data indicate that the major component of fraction #3 (peak 29) is probably a single compound, we do not know if it is the pheromone. It is possible that one of the smaller or unresolved components actually represents the pheromone. This can only be clarified

Table 9. Preference responses of female sea lampreys given a choice between lake water (control) and lake water plus fractions of male sea lamprey urine (experimental).

| Test substance[1] | Mean % time (± SE) in experimental side | n | p[2] |
|---|---|---|---|
| Male urine | 64.7 ± 7.9 | 24 | < 0.05 |
| HPLC (methanol) | 75.4 ± 8.1 | 23 | < 0.01 |
| HPLC (methanol:water) | 70.5 ± 6.6 | 23 | < 0.01 |
| HPLC (water) | 79.4 ± 7.5 | 24 | < 0.01 |
| Water fractions | | | |
| #1 | 63.0 ± 6.4 | 23 | < 0.05 |
| #2 | 58.8 ± 4.2 | 24 | < 0.05 |
| #3 | 67.6 ± 6.3 | 23 | < 0.05 |
| #4 | 54.9 ± 4.4 | 24 | NS |
| #5 | 59.3 ± 6.4 | 24 | NS |
| #6 | 44.0 ± 5.8 | 23 | NS |

[1] Fractions were reconstituted in water and all fractions and urine were tested at 12.8 μl/L.
[2] Wilcoxon matched-pairs signed-ranks test.



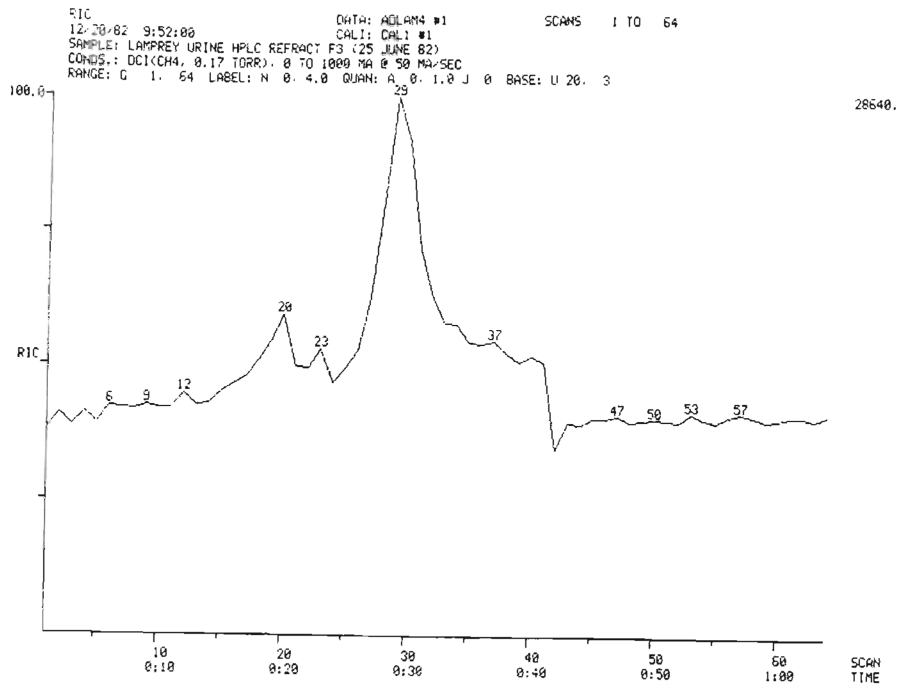

Figure 6. Ion chromatogram of HPLC water fraction #3 of bioactive male urine.

by attempting to further purify each active fraction and testing each component or purified compound in the preference tanks.

In excess of 2.3 L of urine was collected from sexually-mature male sea lampreys during the 1982 season. Although only about 600 ml of this urine elicited preference responses in females, this probably resulted from the test animals being unresponsive, rather than the pheromone not being present. An uncontrolled decrease of several degrees in the temperature of the water supply to the tanks in which the test animals were being held occurred on two occasions. A sudden decrease in water temperature has previously been observed to result in a loss of responsiveness to pheromones by both sexes. These samples were frozen and will be retested during the 1983 spawning-run.

### *OLFACTORY BASIS OF PREFERENCE RESPONSES*

The tacit assumption has been that the observed preferences of spawning stage sea lampreys for conspecifics of the opposite sex are mediated by the olfactory system. Although the chemosensory basis of these responses is apparent, the possibility that gustatory or other unidentified chemorecep-

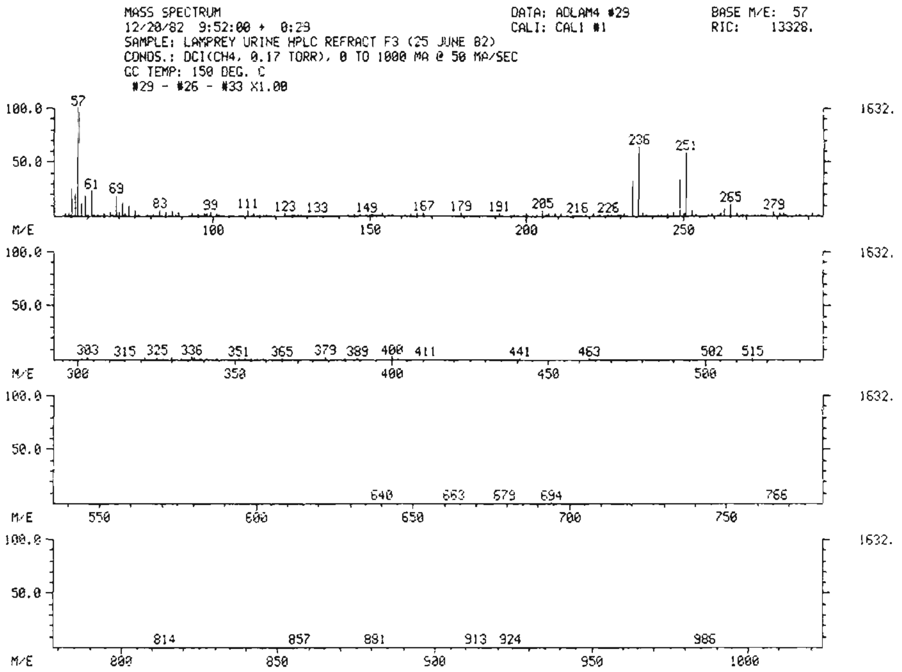


Figure 7. Mass spectrum of peak 29 (Fig. 6) of ion chromatogram of bioactive male urine.

tors (e.g., free nerve endings) are involved has not been eliminated. Consequently, an experiment was conducted in which the responses of sexually-mature females to behaviorally active male urine were observed in the preference tanks before and after they were made anosmic by plugging the olfactory capsule. The results are summarized in Table 10. Control and sham-operated animals showed a significant preference for male urine, while the anosmic females showed no preference. Responses of the anosmic group were significantly different from those of both control and sham-operated groups ($p < 0.05$; U-test). Control and sham groups were not significantly different from each other. These results clearly show that the response of female sea lampreys to attractant substances in male urine are mediated by the olfactory stystem.

Currently, an effort is being made to purify and identify the compounds represented by the major chromatographic peaks of behaviorally active fractions of male urine. These substances will be tested for behavioral activity as soon as responsive females are available this spring. In addition, preliminary field tests using either highly refined fractions of male urine or pure compounds have been designed and will be attempted when conditions are suitable.



Table 10. Preference responses of intact and anosmic female sea lampreys for urine (25.6 $\mu$l/L) from sexually-mature males.

| Test group | Mean % time (± SE) in experimental side | n | p[2] |
|---|---|---|---|
| Control | 71.9 ± 6.5 | 34 | < 0.05 |
| Sham[1] | 68.2 ± 8.2 | 17 | < 0.05 |
| Anosmic[2] | 51.0 ± 8.1 | 16 | NS |

[1] Sham-operated lampreys were randomly selected from the control group. Approximately 3 ml of lake water was injected from syringe into the olfactory capsule and a single stitch was made through the flap of skin surrounding the naris. Rather than tying a knot in the suture, it was pulled through the skin and the naris left patent.

[2] The remainder of the control animals were made anosmic by filling the olfactory capsule with a paste of Cebapol, an inert latex, which formed a solid plug blocking movement of water into and out of the olfactory capsule. A single stitch through the flap of skin around the naris prevented the plug from being dislodged.

## Publications, Special Reports, and Proposals

### *PUBLICATIONS ON LAMPREY CONTROL AND RELATED AREAS*

Abidi, S. L. 1982. Detection of diethylnitrosamine in nitrite-rich water following treatment with rhodamine flow tracers. Water Research 16(2):199–204.

Dawson, V. K. 1982. A rapid high-performance liquid-chromatographic method for simultaneously determining concentrations of TFM and Bayer 73 in water during lampricide treatments. Canadian Journal of Fisheries and Aquatic Sciences 39(5):778–782.

Dawson, V. K., J. B. Sills, and C. W. Luhning. 1982. Accumulation and loss of 2′,5-dichloloro-4′-nitrosalicylanilide (Bayer 73) by fish: Laboratory studies. Investigations in Fish Control 90. 5 pp.

Hanson, L. H. 198?. Twinning in the sea lamprey (*Petromyzon marinus*). (In review).

Hanson, L. H., and E. L. King, Jr. 198?. The recapture of spawning-run sea lampreys (*Petromyzon marinus*) marked and released as recently metamorphosed individuals in a Lake Huron tributary. (In review).

Lisowski, J. J., P. G. Bushnell, and J. H. Teeter. 198?. A re-circulating 2-choice preference tank for identifying potential chemical attractants and repellents for sea lampreys. The Progressive Fish-Culturist. (In review)

Teeter, J. H., J. J. Lisowski, and P. G. Bushnell. 198?. Evidence for pheromone communication in landlocked sea lampreys (*Petromyzon marinus*). Canadian Journal of Fisheries and Aquatic Sciences. (In review).

Teeter, J. H., J. J. Lisowski, and P. B. Johnsen. 198?. A possible role for pheromones in the spawning migration of the landlock sea lamprey (*Petromyzon marinus*). Canadian Journal of Fisheries and Aquatic Sciences. (In review)

### *SPECIAL REPORTS AND PROPOSALS ON LAMPREY CONTROL AND RELATED AREAS*

Allen, J. L., and V. K. Dawson. 1981. Factors affecting loss of Bayer 73 activity in streams. Proposal presented to the Great Lakes Fishery Commission, December 1981.

Allen, J. L., and V. K. Dawson. 1981. Identification of bisazir residues in sea lamprey following treatment with the chemosterilant. A proposal presented to the Great Lakes Fishery Commission, December 1982.

Gilderhus, P. A. 1982. Field trials of a solid bar formulation of the lampricide TFM. Special report. October 1982. 12 pp.
Gilderhus, P. A. and R. A. Schnick. 1982. TFM bar application for new pesticide product registration. Submitted to FER, 17 December 1982. 62 pp.
Hanson, L. H. 1981. Proposal for the evaluation of methallibure as a sea lamprey (*Petromyzon marinus*) chemosterilant. Hammond Bay Biological Station, RFD, Millersburg, Michigan.
King, E. L., R. A. Schnick, and J. G. Seelye. 1982. The potential of organotin formulations as lampricides: A special report prepared for the Great Lakes Fishery Commission, October 1982. 9 pp.
Marking, L. L. 1982. Factors affecting the loss of Bayer 73 activity in laboratory tests. Proposal to the Great Lakes Fishery Commission, February 1982.
Marking, L. L. 1982. Selection and screening of candidate lampricides. Proposal to the Great Lakes Fishery Commission, January 1982.
Meyer, F. P., and staff. 1982. Alternate methods of sea lamprey control. Submitted to Division of Fishery Ecology Research, May 1982. 16 pp.
Meyer, F. P., and staff. 1982. Annual report to Great Lakes Fishery Commission: Registration activities and sea lamprey control research on lampricides in 1980. Submitted to Great Lakes Fishery Commission, June 1982.
Meyer, F. P., and staff. 1982. Progress report to Great Lakes Fishery Commission: Registration activities and sea lamprey control research, January–June 1982. Submitted to Great Lakes Fishery Commission, June 1982.
Meyer, F. P., and staff. 1982. FWS Compliance to 1982 MOA with the Great Lakes Fishery Commission. Submitted to Regional Office, Twin Cities, Minnesota, 24 September 1982. 3 pp.
Meyer, F. P., and staff. 1982. FWS Compliance to 1981 MOA with the Great lakes Fishery Commission. Submitted to Regional Officer, Twin Cities, Minnesota, 27 October 1982.
Meyer, F. P. 1982. Briefing materials for the Laboratory Program Review Team related to the NFRL, La Crosse, WI. Sent to FER, 22 November 1982. Parts I–VIII.
Schnick, R. A. 1981. Letter to EPA regarding exemption from tolerance for DMF. Submitted to Division of Fishery Ecology Research 21 December 1981 and forwarded to EPA, 7 January 1982. 2 pp. and appendices.
Schnick, R. A. 1982. Revision of TFM label. Submitted to Division of Fishery Ecology Research, 18 May 1982 and forwarded to EPA, 20 May 1982. 3 pp.

# ADMINISTRATIVE REPORT FOR 1982

## Meetings

The Commission held its 1982 Annual Meeting in Green Bay, Wisconsin on 9–10 June and its Interim Meeting in Toronto, Ontario on 2–3 December. In addition, both Canadian and U.S. Sections met in plenary session on 10 June in conjunction with the Annual Meeting in Green Bay. The Commission held executive meetings of commissioners and staff as follows:

| | |
|---|---|
| 16 February | Ann Arbor, Michigan |
| 21 April | Detroit, Michigan |
| 8 June | Green Bay, Wisconsin |
| 14 September | conference call |
| 1 December | Toronto, Ontario |

The Great Lakes Fishery Commission also met with the International Joint Commission in Ann Arbor, Michigan on 17 February 1982 to discuss items of mutual interest.

Meetings of standing committees during 1982 were:

Lake Ontario Committee, Gananoque, Ontario, 2–3 March
Lake Huron Committee, St. Clair, Michigan, 9–10 March
Lake Erie Committee, Columbus, Ohio, 16–17 March
Lake Michigan Committee, Michigan City, Indiana, 23–24 March
Lake Superior Committee, Sault Ste. Marie, Ontario, 30–31 March
Great Lakes Fish Disease Control Committee, Ann Arbor, Michigan, 14–15 April
Sea Lamprey Committee, Detroit, Michigan, 20 April
Council of Lake Committees, Detroit, Michigan, 11 May
Board of Technical Experts, Green Bay, Wisconsin, 7–8 June and Detroit, Michigan, 1–2 November

Attendance at other Commission-related meetings included the sea lamprey control agents' annual sea lamprey conference, Integrated Pest Management Workshop, TFM Effects Committee, Integrated Management of Sea Lamprey Steering Committee, Lake Trout Technical Committee, Board of Technical Experts (BOTE) Review Committee, BOTE/Fish Habitat Advisory Development meeting, Sea Lamprey Research meeting, and the Lake Trout Needs Workshop.

## Officers and Staff

Several changes in Commission membership occurred during 1982. W. P. Horn, Deputy Under Secretary, Department of the Interior, was appointed commissioner on 25 February. Commissioner Horn replaced G. R. Arnett who had served as Alternate U.S. Commissioner since June 1981. Chairman H. D. Johnston resigned 16 August to accept a new position as Federal Economic Development Coordinator, Prince Edward Island, Ministry of State for Economic and Regional Development. G. C. Vernon, Assistant Deputy Minister, Pacific and Freshwater Fisheries was appointed commissioner 25 November to replace Mr. Johnston. Commissioner and Canadian Section Chairman M. G. Johnson tendered his resignation and was succeeded by P. S. Chamut, Director General Ontario Region effective 25 November.

No changes in staff membership occurred during 1982, however, B. S. Biedenbender, Administrative Officer, was married 26 June and changed her name to B. S. Staples.

Committee assignments established in 1981 remained unchanged until June 1982. Elections were held and Commissioner H. D. Johnston was named GLFC Chairman for a two year period beginning June 1982. Voted into the position of Vice chairman was U.S. Commissioner W. P. Horn. Chairman Johnston assigned responsibilities among Commissioners, effective after the 1982 Annual Meeting as follows:

*Finance and Administration Committee*

| *Commissioners* | *Staff Members* |
|---|---|
| W. P. Horn, Chairman | B. S. Staples |
| H. D. Johnston | C. M. Fetterolf |

*Fisheries and Environment Committee*

| *Commissioners* | *Staff Members* |
|---|---|
| K. H. Loftus | R. L. Eshenroder |
| C. Ver Duin | M. A. Ross |
| | C. M. Fetterolf |

*Sea Lamprey Committee*

| *Commissioners* | *Staff Member* |
|---|---|
| H. A. Regier, Chairman | A. K. Lamsa |
| M. G. Johnson | C. M. Fetterolf |
| W. M. Lawrence | |



*BOTE Liaison*

| *Commissioner* | *Staff Member* |
|---|---|
| H. A. Regier | R. L. Eshenroder |

National Sections—Commissioners elected chairmen for their respective national sections.

M. G. Johnson, Canadian Section Chairman
C. Ver Duin, U.S. Section Chairman

When GLFC Chairman H. D. Johnston resigned from the Commission 16 Auust 1982, the Commission elected Commissioner K. H. Loftus as the new chairman. At the December executive meeting, Chairman Loftus made the following assignments to the Commission's committees, and the position of BOTE liaison:

*Finance and Administration Committee*

| *Commissioners* | *Staff Members* |
|---|---|
| W. P. Horn, Chairman | B. S. Staples |
| G. C. Vernon | C. M. Fetterolf |

*Fisheries and Environment Committee*

| *Commissioners* | *Staff Members* |
|---|---|
| C. Ver Duin | R. L. Eshenroder |
| P. S. Chamut | M. A. Ross |
| | C. M. Fetterolf |

*Sea Lamprey Committee*

| *Commissioners* | *Staff Member* |
|---|---|
| H. A. Regier, Chairman | A. K. Lamsa |
| W. M. Lawrence | C. M. Fetterolf |

*BOTE Liaisons*

| *Commissioners* | *Staff Member* |
|---|---|
| W. M. Lawrence | R. L. Eshenroder |
| K. H. Loftus | |

Chairman Loftus did not at this time attach himself to a committee. Commissioner Chamut was named Canadian Section chairman.

## 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.

During 1982 the staff participated in the following conferences, meetings, and activities:

American Fisheries Society
Canadian Committee for Fisheries Research
Fish Habitat Advisory Development
Great Lakes Outdoor Writers Association
International Association for Great Lakes Research
International Joint Commission (IJC)
IJC Science Advisory Board
Lake Erie Workshop
Lake Trout Rehabilitation Program Annual Meeting
Lake Trout Technical Committee
Michigan Sea Grant
National Marine Fisheries Service
North American Benthological Society
Ontario Council of Commercial Fisheries
Percid Community Workshop Wrap Up

## Reports and Publications

In 1982, the Commission published Annual Reports for 1978 and 1979, one paper in the Technical Report Series, three Special Publications, and one brochure.

Green Bay in the future—a rehabilitative prospectus, by H. J. Harris, D. R. Talhelm, J. J. Magnuson, and A. M. Forbes. 1982. Great Lakes Fish. Comm. Tech. Rep. 38. 59 p.

Recommendations for freshwater fisheries research and management from the Stock Concept Symposium (STOCS), by A. H. Berst and G. Spangler. 1982. Great Lakes Fish. Comm. Spec. Pub. 82–1. 24 p.

A review of the adaptive management workshop addressing salmonid/lamprey management in the Great Lakes, by J. F. Koonce (ed.), L. Grieg, B. Henderson, D. Tester, K. Minns, and G. Spangler. 1982. Great Lakes Fish. Comm. Spec. Pub. 82–2. 40 p.

Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage, by N. A. Auer (ed.). 1982. Great Lakes Fish. Comm. Spec. Pub. 82–3. 744 p.

Sea Lamprey Management Program. 1982. Great Lakes Fish. Comm. Brochure.



## Accounts and Audits

The Commission's accounts for the fiscal year ending 30 September 1982 were audited by Icerman, Johnson, and Hoffman of Ann Arbor. The firm's reports are appended.

## Program and Budget for Fiscal Year 1982

At the 1980 annual meeting, the Commission adopted a program and budget for sea lamprey control and research in fiscal year 1982 estimated to cost $6,359,000. The program called 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 all the Great Lakes required to assess immediate and long-term effects of lampricides in the environment, research to improve present control techniques, including biological control, 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 $448,400 was adopted for administration and general research for a total program cost of $6,807,400. A portion of the increase in program costs over fiscal year 1981—$200,000 was absorbed by the Commission using unobligated funds derived from bank interest and unexpended monies returned by the contract agents. The funding by governments for fiscal year 1982 was scheduled as follows:

| | *U.S.* | *Canada* | *Total* |
|---|---|---|---|
| Sea Lamprey Control and Research | $4,387,700 | $1,971,300 | $6,359,000 |
| Administration and General Research | 224,200 | 224,200 | 448,400 |
| TOTAL | $4,611,900 | $2,195,500 | $6,807,400 |

Early in the fiscal year, both governments announced funding reductions which included the Great Lakes Fishery Commission's appropriations. The fiscal year 1982 budget was cut by $468,100. Consequently, the funding by governments for fiscal year 1982 was rescheduled as follows:

| | *U.S.* | *Canada* | *Total* |
|---|---|---|---|
| Sea Lamprey Control and Research | $4,064,700 | $1,826,200 | $5,890,900 |
| Administration and General Research | 224,200 | 224,200 | 448,400 |
| TOTAL | $4,288,900 | $2,050,400 | $6,339,300 |

The Commission negotiated a Memorandum of Agreement with its U.S. agent, the U.S. Fish and Wildlife Service, for work costing $3,255,100 which included contingency funding for registration-oriented research on lampricides. A Memorandum of Agreement was also executed with its Canadian agent, the Department of Fisheries and Oceans, for service costing $2,058,900, including funding of barrier dams projects.

At the end of the fiscal year, the U.S. agent refunded $27,376. The Canadian agent reported an overexpenditure of $1,076. In addition the Commission earned $382,900 in bank interest during fiscal year 1982. These monies were used to further the Commission's mandate in the Great Lakes such as the Great Lakes Ecosystem Rehabilitation Project, Adaptive Management Modelling, and several other research projects, as well as reducing future requests for funding.

A significant change in budgeting took effect in October 1982 when the Canadian Sea Lamprey Control Centre changed from the Canadian fiscal year of 1 April–31 March to the fiscal year used by the Commission (and U.S. government), namely 1 October–30 September. This, along with rendering the Canadian operations and budgets in U.S. dollars, will simplify future planning, budget preparation, and reporting.

## Program and Budget for Fiscal Year 1983

At the 1981 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research in fiscal year 1983 estimated to cost $6,858,000. 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 all the Great Lakes, required research to assess immediate and long-term effects of lampricides in the environment, research to improve present control techniques, including biological control, 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 $590,600 was adopted for administration and general research for a total program cost of $7,448,600. The Commission approved the use of $310,000 from fiscal year 1981 unobligated funds to reduce funding requests to governments. Thus, the total request was to be $7,138,600 shared by the Canadian and U.S. Governments according to contribution formulas.

Following requests by both governments, total costs were reduced by $731,600. The revised program for sea lamprey management maintains operations considered essential such as pre-treatment surveys and lampricide treatments, the use of portable assessment traps (some reductions), research at Hammond Bay and La Crosse Labs, and the barrier dam program. Cutbacks included substantial reductions in sea lamprey survey work aimed at monitoring previously unused streams tributary to Lakes Ontario and Erie, some minor reductions in surveys in the Upper Great Lakes, and reductions in lampricide purchases and U.S. supervisory and administrative costs. In addition, the budget for administrative and general research was reduced by about $19,000.



The major effect of the program reductions will be a long term threat because of lessened surveillance of potential lamprey spawning streams. No immediate damage to the program is expected. However, if the program reductions have to be maintained for several years, the threat will increase and undetected sea lamprey populations could develop.

The funding by governments for fiscal year 1983 is scheduled as follows:

| | *U.S.* | *Canada* | *Total* |
|---|---|---|---|
| Sea Lamprey Control and Research | $4,026,600 | $1,809,000 | $5,835,600 |
| Administration and General Research | 285,700 | 285,700 | 571,400 |
| TOTAL | $4,312,300 | $2,094,700 | $6,407,000 |

## Program and Budget for Fiscal Year 1984

At the 1982 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research in fiscal year 1984 estimated to cost $6,366,500. 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 all the Great Lakes, 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 $619,000 was adopted for administration and general research for a total program cost of $6,985,500. The Commission approved the use of $509,800 from fiscal year 1982 unobligated funds to reduce funding requests to governments. Thus, the total request will be $6,475,700 shared by the Canadian and U.S. Governments according to the contribution formulas.

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R. D. HENDRICKS, C.P.A.

OFFICES
ANN ARBOR, MICHIGAN
HOWELL, MICHIGAN

To the Great Lakes Fishery Commission
Ann Arbor, Michigan

We have examined the statements of certain assets, liabilities and fund balances resulting from cash transactions of the Great Lakes Fishery Commission as of September 30, 1982, and the related statements of cash receipts and disbursements and changes in fund balances 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.

As described in Note 1 to the financial statements, the accompanying statements are prepared on the cash basis of accounting, and accordingly, they are not intended to be presented in conformity with generally accepted accounting principles.

In our opinion the financial statements referred to above present fairly certain assets, liabilities and fund balances arising from cash transactions of the Great Lakes Fishery Commission as of September 30, 1982, and the cash transactions for the year then ended, in conformity with the Commission's cash basis of accounting, as described in Note 1 to the financial statements, applied on a basis consistent with the preceding year.

Iceman Johnson & Hoffman

Ann Arbor, Michigan
December 21, 1982



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GREAT LAKES FISHERY COMMISSION

STATEMENTS OF CERTAIN ASSETS, LIABILITIES AND FUND BALANCES
RESULTING FROM CASH TRANSACTIONS
September 30, 1982

| ASSETS | Administration and General Research Fund | Sea Lamprey Management and Research Fund | Totals (Memorandum Only) |
|---|---|---|---|
| Cash, including certificates of deposit of $2,705,029 | $1,134,485 | 1,684,621 | 2,819,106 |
| Due from United States Fish and Wildlife Service (Note 2) | | 26,847 | 26,847 |
| Due from Canadian Department of Fisheries and Oceans (Note 2) | | 18,660 | 18,660 |
| Due from Sea Lamprey Management and Research Fund (Note 2) | 45,507 | | 45,507 |
| Total Assets | $1,179,992 | 1,730,128 | 2,910,120 |
| **LIABILITIES AND FUND BALANCES** | | | |
| Liabilities: | | | |
| Due to Administration and General Research Fund (Note 2) | $ -0- | 45,507 | 45,507 |
| Fund Balances: | | | |
| Reserved for specific projects (Note 3) | 243,108 | | 243,108 |
| Reserved for barrier dam projects | | 1,365,200 | 1,365,200 |
| Reserved for lampricide purchases | | 219,893 | 219,893 |
| Designated for subsequent years' expenditures (Note 5) | | 310,000 | 310,000 |
| Undesignated | 936,884 | (210,472) | 726,412 |
| Total Fund Balances | 1,179,992 | 1,684,621 | 2,864,613 |
| Total Liabilities and Fund Balances | $1,179,992 | 1,730,128 | 2,910,120 |

See Notes to Financial Statements.

GREAT LAKES FISHERY COMMISSION

STATEMENTS OF CASH RECEIPTS AND DISBURSEMENTS AND CHANGES IN FUND BALANCES
Year Ended September 30, 1982

| | Administration and General Research Fund | | | Sea Lamprey Management And Research Fund | | | Totals (Memorandum Only) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Budget | Actual | Variance - Favorable (Unfavorable) | Budget | Actual | Variance - Favorable (Unfavorable) | Budget | Actual | Variance - Favorable (Unfavorable) |
| Receipts: | | | | | | | | | |
| Canadian government | $ 224,200 | 112,100 | (112,100) | 1,747,406 | 1,597,937 | (149,469) | 1,971,606 | 1,710,037 | (261,569) |
| United States government | 224,200 | 224,200 | | 4,064,700 | 4,064,700 | | 4,288,900 | 4,288,900 | |
| Interest earned | | 382,838 | 382,838 | | | | | 382,838 | 382,838 |
| Miscellaneous | | 668 | 668 | | 44,909 | 44,909 | | 45,577 | 45,577 |
| | 448,400 | 719,806 | 271,406 | 5,812,106 | 5,707,546 | (104,560) | 6,260,506 | 6,427,352 | 166,846 |
| Disbursements: | | | | | | | | | |
| Canadian Department of the Fisheries and Oceans | | | | 1,462,796 | 1,367,005 | 95,791 | 1,462,796 | 1,367,005 | 95,791 |
| United States Fish and Wildlife Service | | | | 3,255,100 | 3,031,338 | 223,762 | 3,255,100 | 3,031,338 | 223,762 |
| Lampricide purchases | | | | 1,056,000 | 772,120 | 283,880 | 1,056,000 | 772,120 | 283,880 |
| Special studies | | | | 50,000 | 35,700 | 14,300 | 50,000 | 35,700 | 14,300 |
| Barrier Dams | | | | 444,417 | 99,832 | 344,585 | 444,417 | 99,832 | 344,585 |
| Administration | 331,000 | 344,762 | (13,762) | | | | 331,000 | 344,762 | (13,762) |
| General research | 158,571 | 248,077 | (89,506) | | | | 158,571 | 248,077 | (89,506) |
| | 489,571 | 592,839 | (103,268) | 6,268,313 | 5,305,995 | 962,318 | 6,757,884 | 5,898,834 | 859,050 |
| Excess of Receipts Over (Under) Disbursements | (41,171) | 126,967 | 168,138 | (456,207) | 401,551 | 857,758 | (497,378) | 528,518 | 1,025,896 |
| Other Sources (Uses): | | | | | | | | | |
| Foreign exchange gains (losses) | | (1,410) | (1,410) | | (2,000) | (2,000) | | (3,410) | (3,410) |
| Interfund transfers (Note 2) | | 26,847 | 26,847 | | (26,847) | (26,847) | | | |
| | -0- | 25,437 | 25,437 | -0- | (28,847) | (28,847) | -0- | (3,410) | (3,410) |
| Excess of Receipts and Other Sources Over (Under) Disbursements and Other Uses | (41,171) | 152,404 | 193,575 | (456,207) | 372,704 | 828,911 | (497,378) | 525,108 | 1,022,486 |
| FUND BALANCE - October 1, 1981 | 1,027,588 | 1,027,588 | -0- | 1,311,917 | 1,311,917 | -0- | 2,339,505 | 2,339,505 | -0- |
| FUND BALANCE - September 30, 1982 | $ 986,417 | 1,179,992 | 193,575 | 855,710 | 1,684,621 | 828,911 | 1,842,127 | 2,864,613 | 1,022,486 |

See Notes to Financial Statements.

GREAT LAKES FISHERY COMMISSION

STATEMENTS OF CASH RECEIPTS AND DISBURSEMENTS AND CHANGES IN FUND BALANCES
Year Ended September 30, 1982

| | Administration and General Research Fund | | | Sea Lamprey Management And Research Fund | | | Totals (Memorandum Only) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Budget | Actual | Variance - Favorable (Unfavorable) | Budget | Actual | Variance - Favorable (Unfavorable) | Budget | Actual | Variance - Favorable (Unfavorable) |
| Receipts: | | | | | | | | | |
| Canadian government | $ 224,200 | 112,100 | (112,100) | 1,747,406 | 1,597,937 | (149,469) | 1,971,606 | 1,710,037 | (261,569) |
| United States government | 224,200 | 224,200 | | 4,064,700 | 4,064,700 | | 4,288,900 | 4,288,900 | |
| Interest earned | | 382,838 | 382,838 | | | | | 382,838 | 382,838 |
| Miscellaneous | | 668 | 668 | | 44,909 | 44,909 | | 45,577 | 45,577 |
| | 448,400 | 719,806 | 271,406 | 5,812,106 | 5,707,546 | (104,560) | 6,260,506 | 6,427,352 | 166,846 |
| Disbursements: | | | | | | | | | |
| Canadian Department of the Fisheries and Oceans | | | | 1,462,796 | 1,367,005 | 95,791 | 1,462,796 | 1,367,005 | 95,791 |
| United States Fish and Wildlife Service | | | | 3,255,100 | 3,031,338 | 223,762 | 3,255,100 | 3,031,338 | 223,762 |
| Lampricide purchases | | | | 1,056,000 | 772,120 | 283,880 | 1,056,000 | 772,120 | 283,880 |
| Special studies | | | | 50,000 | 35,700 | 14,300 | 50,000 | 35,700 | 14,300 |
| Barrier Dams | | | | 444,417 | 99,832 | 344,585 | 444,417 | 99,832 | 344,585 |
| Administration | 331,000 | 344,762 | (13,762) | | | | 331,000 | 344,762 | (13,762) |
| General research | 158,571 | 248,077 | (89,506) | | | | 158,571 | 248,077 | (89,506) |
| | 489,571 | 592,839 | (103,268) | 6,268,313 | 5,305,995 | 962,318 | 6,757,884 | 5,898,834 | 859,050 |
| Excess of Receipts Over (Under) Disbursements | (41,171) | 126,967 | 168,138 | (456,207) | 401,551 | 857,758 | (497,378) | 528,518 | 1,025,896 |
| Other Sources (Uses): | | | | | | | | | |
| Foreign exchange gains (losses) | | (1,410) | (1,410) | | (2,000) | (2,000) | | (3,410) | (3,410) |
| Interfund transfers (Note 2) | | 26,847 | 26,847 | | (26,847) | (26,847) | | | |
| | -0- | 25,437 | 25,437 | -0- | (28,847) | (28,847) | -0- | (3,410) | (3,410) |
| Excess of Receipts and Other Sources Over (Under) Disbursements and Other Uses | (41,171) | 152,404 | 193,575 | (456,207) | 372,704 | 828,911 | (497,378) | 525,108 | 1,022,486 |
| FUND BALANCE - October 1, 1981 | 1,027,588 | 1,027,588 | -0- | 1,311,917 | 1,311,917 | -0- | 2,339,505 | 2,339,505 | -0- |
| FUND BALANCE - September 30, 1982 | $ 986,417 | 1,179,992 | 193,575 | 855,710 | 1,684,621 | 828,911 | 1,842,127 | 2,864,613 | 1,022,486 |

See Notes to Financial Statements.







GREAT LAKES FISHERY COMMISSION

NOTES TO FINANCIAL STATEMENTS

Note 1. NATURE OF ORGANIZATION AND SIGNIFICANT ACCOUNTING POLICIES

Nature of the organization:

The Commission is an international organization created by convention between the United States and Canada, established to manage sea lamprey and improve fish stocks. The Commission operations are controlled by two funds:

1. Administration and General Research Fund which covers administrative expenses of the Commission and expenses of programs of general research contracted by the Commission or performed by the Commission's staff. The United States and Canada provide equal shares for its support.

2. Sea Lamprey Management and Research Fund which covers expenditures for the Lamprey Management Program including research on the sea lamprey. The Commission presently contracts the Lamprey Management Program to the United States Fish and Wildlife Service and the Canadian Department of Fisheries and Oceans. Funds for its operations are provided by the United States and Canada on a 69:31 basis.

No transfers of appropriations may be made between funds unless authorized by the Commission except as referred to in Notes 1 and 3.

Significant accounting policies:

Basis of accounting:

The Commission's accounts are maintained on a cash basis, and the statements of certain assets, liabilities, and fund balances resulting from cash transactions and the statements of cash receipts and disbursements reflect only cash received and disbursed. Therefore, receivables, inventories, fixed assets, payables, accrued income and expenses, and depreciation, which are material in amount, are not reflected and these statements are not intended to present the financial position or results of operations or changes in financial position in conformity with generally accepted accounting principles.

Fiscal year:

The Commission's September 30 fiscal year end corresponds with the United States government's fiscal year. The Canadian government has amended their budgeting process to coincide with the Commission's fiscal year for years beginning October 1, 1982. Consequently, amounts budgeted for Canadian revenue and expense represent 50% of the March 31, 1982 Canadian fiscal year and the six-month interim period from April 1 to September 30, 1982.

Income taxes:

The Great Lakes Fishery Commission is exempt from U.S. income taxes under Sec. 501(c)(1) of the Internal Revenue Code, and from Canadian income taxes under Privy Council Order-in-Council #PC-1981-2359.

Interest and miscellaneous income:

The Commission has credited all interest and miscellaneous income to the Administration and General Research Fund in accordance with established financial regulations.

NOTES TO FINANCIAL STATEMENTS (Continued)

Note 2. INTERFUND TRANSFERS AND LIABILITIES

Unused funds from United States Fish and Wildlife Service and Canadian Department of Fisheries and Oceans are refunded to the Sea Lamprey Management and Research Fund and subsequently transferred to the Administration and General Research Fund. The total transfer to the Administration and General Research Fund for fiscal year ending September 30, 1982 consists of $26,847 in United States refunds. Approximately $55,000 in additional funds have been retained by the Canadian Department of Fisheries and Oceans for future barrier dam expenditures and is not included in the refund receivable as of September 30, 1982. A refund of $18,660 is still receivable from the Canadian Department of Fisheries and Oceans for the year ended September 30, 1981.

Note 3. FUND BALANCE RESERVES

Commitments related to incomplete projects are recorded as reservations of fund balance. As of September 30, 1982, the Commission had the following commitments relating to specific projects which are to be funded by the Administration and General Research Fund.

| Project Name | Total Budgeted | Expenditures Through 9-30-81 | Expenditures During Year Ended 9-30-82 | Reserved @ 9-30-82 |
|---|---|---|---|---|
| SGLFMP | $100,000 | 42,597 | 1,638 | 55,765 |
| Brussard - 1979 project | 13,937 | 10,453 | | 3,484 |
| Brussard - 1980 project | 15,601 | 10,637 | | 4,964 |
| Monroe | 10,550 | 2,540 | 500 | 7,510 |
| Gorbman | 53,250 | 17,750 | 17,750 | 17,750 |
| Koonce - Lake Erie Perch Modeling | 22,842 | 17,132 | | 5,710 |
| Allendorf - Allelic Frequency Divergence | 5,305 | 3,979 | | 1,326 |
| Brussard - Overrun | 7,590 | 5,693 | | 1,897 |
| Lampricide Impact Review | 10,000 | | | 10,000 |
| Spitz Review | 5,000 | 812 | 521 | 3,667 |
| Talhelm's Extra Market Values | 7,200 | | 3,963 | 3,237 |
| Regier and Talhelm Ecosystem Workshop | 6,000 | | | 6,000 |
| Christie's Fish Archiving | 4,125 | | | 4,125 |
| Mathison's Acoustic Study on Sea Lamprey | 2,500 | | | 2,500 |
| Grima | 8,064 | | 5,830 | 2,234 |
| Mallatt | 2,340 | | 1,755 | 585 |
| Planning Process for Integrated Management of Sea Lamprey | 5,000 | | 682 | 4,318 |
| Smith-Lamprey History and Typing | 4,200 | | | 4,200 |
| Smith Project Canadian Addendum | 1,645 | | | 1,645 |
| Spangler/Krueger - Genetic Analysis | 20,293 | | 15,220 | 5,073 |
| Talhelm Study (Part of GLERR II) | 15,000 | 5,588 | 1,566 | 7,846 |





NOTES TO FINANCIAL STATEMENTS (Concluded)

Note 3. FUND BALANCE RESERVES (Concluded)

| Project Name | Total Budgeted | Expenditures Through 9-30-81 | Expenditures During Year Ended 9-30-82 | Reserved @ 9-30-82 |
|---|---|---|---|---|
| GLERR III Study | $ 50,000 | 3,664 | 21,300 | 25,036 |
| Talhelm's National Fishing Surveys | 3,300 | | | 3,300 |
| Volk's Aging Method | 9,636 | | | 9,636 |
| Auer's Larval Fish Manual | 11,000 | | | 11,000 |
| Talhelm's Phase II Angling Report | 2,550 | | 765 | 1,785 |
| Sower - Gorbman | 5,106 | | | 5,106 |
| IAGLR Bibliography | 3,000 | | | 3,000 |
| Socio-economic Workshop Planning | 3,000 | | | 3,000 |
| IPM Workshop | 17,000 | | 10,688 | 6,312 |
| Lake Erie Workshop | 17,500 | | 10,754 | 6,746 |
| CLAR Workshop | 14,626 | | 275 | 14,351 |
| | $457,160 | 120,845 | 93,207 | 243,108 |

Note 4. PENSION PLAN

The Commission contributes to the International Fishery Commissions' Pension Society, established in 1957, for all full-time employees/annuitants. The Commission's contribution was $9,542 for the year ended September 30, 1982. There is no unfunded liability as of September 30, 1982.

Note 5. UNRESERVED FUND BALANCE DESIGNATIONS

The excess of expenditures over revenues budgeted for the fiscal year ending September 30, 1983 is to be funded by the fund balance in the Sea Lamprey Management and Research Fund. The budgeted excess of expenditures over revenues is approximately $310,000 for the year ending September 30, 1983.

## COMMITTEE MEMBERS—1982

Commissioners in Italics

### BOARD OF TECHNICAL EXPERTS

**CANADA**

F. W. H. Beamish, Chm.
W. J. Christie
J. Cooley
J. Donnan
G. R. Francis
A. P. Grima
P. Ihssen
*H. A. Regier*
C. J. Walters

**UNITED STATES**

N. Kevern
J. L. Forney
J. J. Magnuson
P. J. Manion
H. A. Purvis
G. Spangler
D. Talhelm

### COUNCIL OF LAKE COMMITTEES

**CANADA**

L. Affleck, V. Chm.

**UNITED STATES**

W. A. Pearce, Chm.

Members are listed below under Lake Committees

### LAKE COMMITTEES

**LAKE HURON**

R. M. Christie, Chm.
D. Borgeson, V. Chm.

**LAKE ONTARIO**

D. E. Gage, Chm.
W. A. Pearce, V. Chm.

**LAKE MICHIGAN**

B. Muench, Chm.
W. James, V. Chm.
J. T. Addis
D. Borgeson

**LAKE SUPERIOR**

L. Affleck, Chm.
J. T. Addis, V. Chm.
D. Borgeson
J. H. Kuehn

**LAKE ERIE**

D. Graff, Chm.
V. Milne, V. Chm.
D. Borgeson
R. Lange
R. L. Scholl

### GREAT LAKES FISH DISEASE CONTROL COMMITTEE

J. W. Warren, Chm.
T. G. Carey, Secy.
T. Amundson
G. Armstrong
D. Bumgarner
J. M. Byrne
J. B. Daily
P. P. Economen
D. B. Goldthwaite
R. L. Gress
R. H. Griffiths
J. R. Hammond
J. G. Hnath
R. W. Horner
S. Huffaker
C. Lakes
V. A. Mudrak
J. J. O'Grodnick
L. Pettijohn
P. J. Pfister
R. Poff
R. W. Ritzert
N. J. Robbins
J. H. Schachte, Jr.
H. J. Sippel
S. F. Snieszko
B. W. Souter
W. Thompson
R. A. Williamson