ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1983

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–
J. M. Ridenour	1983–

1983 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
K. S. Shomin, Secretary

GREAT LAKES FISHERY COMMISSION

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

ANNUAL REPORT
for the year
1983

COMMISSIONERS

P. S. Chamut	W. P. Horn
W. M. Lawrence	K. H. Loftus
H. A. Regier	J. M. Ridenour
C. Ver Duin	G. C. Vernon

1451 Green Road
Ann Arbor, Michigan
U.S.A.
1985

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 1983.

Respectfully,
K. H. Loftus, *Chairman*

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ANNUAL REPORT FOR 1983

INTRODUCTION

International concern for Great Lakes fisheries began as early as 1830 for the Atlantic salmon of Lake Ontario, and by the 1870s there were recommendations for common action in regulating the fisheries. However, efforts to establish international fishery commissions and/or effective, complementary regulations and management programs for Great Lakes fisheries failed repeatedly from 1893 to 1952. By 1946 the sea lamprey (*Petromyzon marinus*), a parasitic predator native to the Atlantic Ocean, was established in the upper Great Lakes and recognized as an impending international catastrophe for the fisheries, especially lake trout and whitefish. This threat provided an added incentive to recast and complete earlier negotiations, and the Convention on Great Lakes Fisheries was entered into force in 1955. By that time, unfortunately, the lake trout commercial catch from Lakes Huron and Michigan was 99% lower than the average annual catch during the 1930s.

Recognizing that joint and coordinated efforts by the United States of America and Canada were essential to determine "the need for and the type of measures which will make possible the maximum sustained productivity in Great Lakes fisheries of common concern," the Convention charged the Commission:

a) to formulate a research program or programs designed to determine the need for measures to make possible the maximum sustained productivity of any stock of fish in the Convention Area which, in the opinion of the Commission, is of common concern to the fisheries of the United States of America and Canada and to determine what measures are best adapted for such purpose;
b) to coordinate research made pursuant to such programs and, if necessary, to undertake such research itself;
c) to recommend appropriate measures to the Contracting Parties on the basis of the findings of such research programs;
d) to formulate and implement a comprehensive program for the purpose of eradicating or minimizing the sea lamprey populations in the Convention Area; and

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

The Commission has two national sections, each composed of four Commissioners appointed respectively by the President of the United States and the Governor General of Canada. Each Section has one vote, and there is no provision for breaking tie votes.

Funding for sea lamprey control and research is provided 69% from the United States and 31% from Canada. The 69:31 ratio was established on the basis of average annual Great Lakes commercial catches of lake trout and whitefish before the impact of the sea lamprey. Funding for administration and general research is split 50:50 between the countries.

The Commission contracts with the U.S. Fish and Wildlife Service for sea lamprey research and control in the U.S., and with Fisheries and Oceans Canada for sea lamprey control in Canada. The remainder of the Commission's program is pursued through a committee structure involving representatives of the agencies with fishery and other natural resource mandates and the academic community. Central committees, whose members are appointed by the Commission and include Commissioners in their structure, are Sea Lamprey, the Board of Technical Experts (BOTE), and the Habitat Advisory Board (HAB).

The Sea Lamprey Committee reviews past programs of sea lamprey control, management, and research; current problems and opportunities; and advises the Commission on program priorities and direction. Recent emphasis has been on developing and implementing programs of integrated management of sea lamprey, improving methods to measure the efficiency and effectiveness of the control program, and matching the needs of the fishery with the level of lamprey control.

The Commission depends in part on its Board of Technical Experts for advice; synthesis of scientific, social, and economic opinion; establishment of research priorities; the vetting of research proposals; and recommendations on publication.

The Habitat Advisory Board, currently in its developmental stage, will help the GLFC determine policy direction on habitat matters, will increase interaction among fishery agencies and those agencies whose actions influence habitat quality, and provide leverage to influence decisions on management of habitat for the benefit of fish.

The Commission's technical committees are appointed by the fishery agencies. The Fish Disease Control Committee deals in part with the major interstate/international problem of protection of fish health by working with its Model Fish Disease Control Program and Policy. The program is always open for revision by teams of fish pathologists, hatchery specialists and administrators applying new science and management strategies to the existing knowledge and program base.

The five lake committees and the Council of Lake Committees have major roles in transboundary issues. A lake committee is made up of a senior staff member from each agency administering the fishery, assisted by experts and advisors from all agencies concerned. Lake committees are on the management/research firing line. They develop and coordinate studies and encourage implementation of their findings. The members appoint internal technical committees to advise on issues such as coordination of forage base assessment and stocking programs, calculation of total allowable catch for critical species, determining minimum size restrictions, allocating harvest among jurisdictions, choosing genetic strains for stocking purposes, and developing tactical management plans for various species. The Council addresses issues which affect more than one lake.

The Commission's initiatives, undertaken with its principal cooperators, the states, the Province of Ontario, and the U.S. and Canadian Federal governments, have evolved consecutively into several related areas of activities, each of which is still ongoing: 1) sea lamprey control and research; 2) coordination of lake trout and other fish stocking; 3) coordination of fish population assessment; 4) development of strategies to control exploitation; 5) registration of lampricides; 6) investigation of the feasibility of further rehabilitation of the Great Lakes ecosystem to reattain lost values; 7) development of an international Strategic Great Lakes Fishery Management Plan, an umbrella under which operational fishery management plans for each lake can be initiated; 7) development of an integrated management approach to sea lamprey control; 8) support for increased fishery-related input into environmental quality decisions; and 9) development through the lake committees of tactical management plans for lake trout. A major thrust of the Commission remains the establishment of self-sustaining stocks of lake trout.

Through the 28 years of its existence, the Commission has encouraged close cooperation among state, provincial, and federal fishery, water quality, and land use agencies on the Great Lakes. 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.

During 1983 the Commission's Annual Meeting was held at the Canada Centre for Inland Waters, Burlington, Ontario, May 11–12, and its Interim Meeting was convened in Ann Arbor, Michigan, November 29–30.

ANNUAL MEETING

PROCEEDINGS[1]

The twenty-eighth annual meeting of the Great Lakes Fishery Commission was held at the Canada Centre for Inland Waters in Burlington, Ontario, on May 11 and 12, 1983.

Chairman Ken Loftus convened the meeting at 0915 h, and welcomed newly appointed U.S. Commissioner James M. Ridenour (Indiana DNR), newly appointed Director of the USFWS Great Lakes Fishery Laboratory, Bernard Griswold, and Peter Maitland (Institute of Terrestrial Ecology), visiting from Scotland.

On behalf of Director Keith Rogers, Jim Smith welcomed attendees to the Canada Centre for Inland Waters, and explained that CCIW houses members of two Canadian departments (Environment, Fisheries and Oceans), and eight entities, the largest being the National Water Research Institute.

SEA LAMPREY MANAGEMENT

PROGRESS TOWARD INTEGRATED SEA LAMPREY MANAGEMENT

Fred Meyer (USFWS, La Crosse NFRL) presented updates from both the Hammond Bay Biological Station and the National Fisheries Research Laboratory at La Crosse, Wisconsin.

On behalf of Jim Seelye (USFWS, Hammond Bay Biological Station), he discussed the feasibility of various supplemental or alternative control measures under study. These included clay pellets designed for bottom release of TFM, and male sterilization techniques (gamma radiation, immunosterilization, methallibure, and bisazir). Other activities included investigation of the interaction and toxicity of TFM and Bayer 73 in waters of varying alkalinities. These studies found sea lamprey to be more susceptible

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

to TFM than are native lamprey. Sea lamprey were recommended for use in bioassays to determine realistic concentrations needed for stream treatment. Walleye eggs have been found to be relatively tolerant to TFM.

In an update from the National Fishery Research Laboratory, Meyer recommended that tributyltin fluoride not be developed as a lampricide. He reviewed registration activities, which included application to the EPA for registration of a TFM bar formulation, and securing an exemption from a requirement to develop a tolerance to the TFM carrier dimethylformamide. Lamprey control research included studies of synergism and lampricide toxicity, extraction of bisazir residues from bisazir-sterilized lamprey, and binding of lampricides with various kinds of soil and sediment. Meyer also reported on technical assistance afforded sea lamprey control units by La Crosse, and on Teeter's (Monell Chemical Senses Center) continuing research on pheromones.

In general discussion, he explained that the cost of radiation units for sterilizing male sea lamprey, which once cost $250,000 each, could now be installed in trailers for as little as $60,000 each. In response to a query about the completion of TFM registration, it was stated that the research was finished and awaiting review. A representative from American Hoechst (the manufacturer of TFM) stated that their reluctance to manufacture the TFM bars was based on unsatisfactory results from wrapping the bars by machine, and the danger to employees of handwrapping. Hoechst, however, may be able to develop an alternative delivery system (propellant), and welcomes dialogue with agents on this matter.

RATIONALE FOR SEA LAMPREY MANAGEMENT IN ONEIDA LAKE

In a slide presentation, Bill Pearce (NYDEC) showed the area of Oneida Lake and tributaries proposed for treatment by the Lake Ontario Committee. A critical evaluation of results following treatment must demonstrate beneficial effect on Lake Ontario fish stocks in order for further treatments of the Oneida Lake system to be carried out. He contended that treatment of the Oneida Lake system was covered by the GLFC mandate, citing the Convention statement that the Commission's jurisdiction applies ". . . to the tributaries of each of the above waters . . ." (i.e., the Great Lakes) ". . . to the extent necessary to investigate any stock of fish of common concern, the taking or habitat of which is confined predominantly to the Convention Area, and to eradicate or minimize populations of the sea lamprey in the Convention Area." Since the late 1970s, controversy has abated over New York's proposed treatment of the Finger Lakes (with which the GLFC did not wish to involve its Great Lakes program). The Black River has been discounted as a major source of wounding by lamprey in eastern Lake Ontario, and the impact of sea lamprey on Oneida Lake fish populations suggests a mass movement of sea lamprey in the summer from Oneida Lake into Lake Ontario. (See Administrative and Executive Actions.)

REPORTS FROM SEA LAMPREY CONTROL AGENT FIELD SUPERVISORS

Reporting for the U.S., Bill Daugherty (USFWS) discussed the pressures being exerted on the sea lamprey control program by U.S. funding and travel restrictions, and recommendations and initiatives emanating from the Sea Lamprey Audit Team report and development of integrated sea lamprey management. Future requests (e.g., rescheduling stream treatments) will not be easily met, nor will control units be able to participate in special studies without sacrifice in other parts of the program. Any further tightening of the budget or demands made of the control unit will cause serious reordering of priorities within the program.

Referring to Heimbuch's (formerly of Cornell University) analysis of sea lamprey control decision rules, which recommended use of less lampricide per stream and a more selective approach in choosing streams for treatment, Daugherty responded that detailed analysis showed that reduced use of lampricide posed an unacceptable risk of escapement, and that much more information on sea lamprey than that presently available would be needed to utilize Heimbuch's approach to stream selection. However, unit staff were reviewing their stream evaluation process, benefiting in this endeavor from Dr. Peter Maitland's visit.

Reporting for Canada, Jim Tibbles (DFO) outlined the Sault Ste. Marie Sea Lamprey Control Centre's public relations program: inhouse (aquaria) and traveling displays; fish boils for angling and other groups; and control unit employees wearing identifying badges. He was congratulated on the display at the recent Sportsmen's Show in Toronto. It was recognized that interaction with anglers should be encouraged, as it could engender support and information on lamprey activity.

FISHERIES AND ENVIRONMENT

GREAT LAKES FISH DISEASE CONTROL COMMITTEE

Chairman Jim Warren (USFWS) reported on the completion of "A Guide to Integrated Fish Health Management in the Great Lakes Basin," the development of a brochure on fish disease control, problems with use of West Coast and wild fish and eggs in hatcheries, and the ongoing evolution in approach from fish disease control to fish health protection.

With regard to the concern he expressed over Michigan's introduction of West Coast salmon, he explained that no new diseases had been introduced, just "more of the same." It was noted, however, that disease was such a problem on the west coast that legal suits, demanding an environmental impact statement for each introduction, were being threatened. Borgeson (MDNR) suggested a need for better communication, and stated that Michigan's introduction of summer steelhead trout was an unintentional violation of an agreement not to import from the West Coast.

Fred Meyer (USFWS) was honored with a plaque presented by Jim Warren, expressing the Committee's gratitude for his editing and support of their "Guide to Integrated Fish Health Management in the Great Lakes." The Commission honored Jim Warren with a Meritorious Service Award and letter of thanks for his leadership of the Committee.

BOARD OF TECHNICAL EXPERTS

Chairman Bill Beamish (University of Guelph) reviewed the Board's activities over the previous two days, which included involvement in a creative problem-solving process to identify areas of concern to researchers and managers. A summary of their actions and recommendations is as follows:

- — accepted Crossman's (University of Toronto) report on specimen archiving, and forwarded it to the GLFC for implementation;
- — approved the reports from the integrated pest management and lake trout rehabilitation workshops for appearance in the GLFC's Special Publication Series;
- — supported the Lake Ontario adaptive management workshop, development of second generation simulation models, and evaluation of the adaptive management approach;
- — supported the thrust of the proposed GLFC policy on use of lampricides;
- — agreed to provide two representatives to assist in development of a control unit workshop for the quantitative assessment of ammocoete and sea lamprey populations;
- — agreed to update the 1964 "Prospectus for Great Lakes Research";
- — provided one-half the required funding for the Commission's fisheries assessment symposium (Assessment of Stocks-Prediction of Yield (ASPY)).

CONFERENCE ON LAKE TROUT RESEARCH

Randy Eshenroder (GLFC) reported that the conference, by invitation only, is scheduled to be held in August 1983 in Goderich, Ontario. The purpose of the conference is to provide direction on the research needs of the Great Lakes lake trout rehabilitation program.

LAKE COMMITTEE REPORTS

Lake Ontario—Past Chairman Eric Gage (OMNR) reported that environmental degradation is a problem and future threat affecting Lake Ontario fisheries managers. Specifically, this includes: presence of contaminants; habitat loss and degradation; stream alterations; land fill and dredging; thermal discharges, entrainment and impingement; and navigation season extension. It was recommended that the GLFC could help by strengthening its Fisheries and Environment Committee, and intensifying its liaison and cooperation with the IJC.

"A Joint Plan for the Rehabilitation of Lake Trout in Lake Ontario" has been a major accomplishment of the LOC. The plan's interim objective is: "By the year 2000, develop a Lake Ontario lake trout stock consisting of 0.5 to 1.0 million adult fish with females that average 7.5 years of age and produce 100,000 yearlings annually." It was announced that the first capture in recent years of a naturally produced lake trout fry was made on May 6, 1983, at Stoney Island.

Concern was expressed over the plan's apparent neglect of fish health implications. It was explained that precautions were understood to be implicit in hatchery operation procedures, but perhaps should have been made explicit in the plan. Other Committee concerns reported were treatment of lamprey producing areas of the Oneida Lake system, fish stocking, coordination of enforcement activities, and the sport and commercial fisheries.

Lake Erie—New LEC Chairman Lange (NYDEC) reported on the past year's adaptive management workshop on percid community interactions, the apparent attainment of walleye rehabilitation goals in the Western Basin, concern for yellow perch populations of the Central and Western Basins, and sea lamprey control implications of LEC lake trout rehabilitation plans.

In discussion as to the extent of Western Basin walleye penetration eastward, it was reported that a few had been seen as far east as Port Stanley. Total allowable catch (6.5 million in 1983) was based on full recruitment at age 2, and many fish in the catch were larger than the commercial fishery desired.

The question of whether eastern Lake Erie shoals are in sufficiently good condition to support spawning lake trout will be addressed in Lake Erie's lake trout management plan. Whitefish have been found in increasing numbers in Ontario and Pennsylvania waters, but none have yet been sighted in New York. Response of the fish community to improving water quality was suggested as a possible agenda item for next year's meeting.

Lake Huron—Past Chairman Ron Christie reported on the status of forage species (indications of recovery by emerald shiners) and their limitations as a forage base, and the formation of the Lake Trout Technical Committee. His report also included the status of fish stocks, modernization of Ontario's commercial fishery, and the participation of the Chippewa/Ottawa Treaty Fishery Management Authority on technical subcommittees. He thanked the GLFC for producing a position paper on the dewatering of the St. Marys Rapids.

In general discussion, it was stated that the splake is considered a lake trout for purposes of LHC's Lake Trout Technical Committee. The LHC still expects to proceed on integrated sea lamprey and fisheries management planning, but the following and other questions must be answered before any of the Lake Committees can truly participate: What level of sea

lamprey-induced mortality can the fisheries management agencies accept? What is the current level of sea lamprey-induced mortality? What is the current sea lamprey population?

Lake Michigan—New Chairman Dave Borgeson (MDNR) reported on the highlight of the 1983 Lake Michigan Committee meeting, the unveiling and adoption of the Lake Trout Technical Committee's plan for rehabilitation, which recommended strategies in broodstock selection, mortality minimization, assessment, etc. With regard to the effects of contaminants on lake trout reproduction, it was stated that, although USFWS studies suggest that PCBs and DDT in Lake Michigan have deleterious effects on hatchability and development of lake trout, no further work has been done on this question. It was also reported that PCBs once inhibited reproduction in inland lakes, and that offspring of lake trout from Lake Ontario exhibited hatchery survival rates equal to offspring of hatchery held broodstock. Commissioner Ridenour stated that our first objective should be to rid the lakes of contaminants, and our second, to be able to inform the public about possible health threats posed by current levels. He requested information on how this is handled by various agencies.

Lake Superior—Past Chairman Affleck (OMNR) reviewed the activities of the Lake Superior Technical Committee, which identified high mortality rates and underutilization of traditional spawning areas by stocked trout as being the two main barriers to lake trout rehabilitation in Lake Superior. In general discussion, it was stated that mortality attributable to sea lamprey was a problem compounded by high fishing mortality in some areas. It was reported that the lower Nipigon River will be treated this summer, but it is not known what relief this will afford lake trout stocks. Stating that 100 to 130 lake trout stocks were once thought to exist in Lake Superior, it was asked if the LSC intended to recreate such a complex in Lake Superior. The question was recommended as a future topic for the Lake Superior Technical Committee to consider.

COUNCIL OF LAKE COMMITTEES

Past Chairman Pearce (NYDEC) reviewed the Council's recommendations to Lake Committees and the Commission on:

- integrating management techniques for sea lamprey;
- computerizing Great Lakes fish marking and stocking records;
- resolution of Indian fisheries issues;
- confronting fish habitat (environmental) management issues;
- highlighting law enforcement's role in Great Lakes fisheries management;
- commending the Secretariat's presentation at the AFS Urban Fishing Symposium;
- encouraging use of Lake Committee report data; and
- standardizing reporting format.

FEASIBILITY REPORT—WORKSHOP TO IMPROVE EFFECTIVENESS OF LAW ENFORCEMENT IN FISHERIES MANAGEMENT

Kernen (WDNR) reported on a 1983 Council of Lake Committee recommendation that a cohesive plan of action be developed to reduce the illegal catching and marketing of fish throughout the Great Lakes. The support of the Commission was requested for two meetings (September 1983 and January 1984), involving approximately 30 delegates, to develop a program and to report to the CLC at its 1984 meeting.

Commissioners and delegates discussed their concerns for law enforcement problems in the basin, the estimated magnitude of the problem, appropriate mechanisms for addressing the problem, and the severity of penalties in the U.S. Both the law and its exercise were found lacking. Commissioners Loftus and Regier, while commenting on whether sponsorship of such a workshop was within the Commission's mandate, cited several activities related to law enforcement which seem to come under the Commission's umbrella. The discussion suggested that Lake Committees may be able to pursue the issue, but the GLFC may find itself unable to assist. Commissioner Ridenour summarized by stating the GLFC's recognition of the growing problem, and the importance of finding an appropriate forum for its resolution. (See Administrative and Executive Actions.)

THE HAMILTON HARBOUR STORY

Vic Cairns (DFO) described the outer harbor of Hamilton as being relatively underdeveloped, whereas the south shore is highly industrialized. Marshlands have been reduced in area from 1,100 to 228 acres. The outer harbor once sustained commercial fisheries for lake trout, whitefish, and sturgeon; the inner harbor, or Dundas Marsh, had a thriving warmwater fishery. Where once there was recreational fishing, boating, and cottages, there is now primarily industrial boat traffic, and a settling basin. He noted that species changes were based on migration out of the bay rather than fish kills. Species currently in the harbor include carp, goldfish, brown bullhead, and white suckers. In the marsh are pike, channel catfish, carp, and brown bullhead. Salmonids cannot survive, the central basin is nearly anoxic, spawning shoals have disappeared, and water quality has deteriorated. Hamilton Harbour is designated by the IJC as a "Class A" site of concern. Sediments contain levels 4 to 200 times greater than Ontario Ministry of Environment Guidelines for lead, zinc, mercury, iron, cadmium, chromium, copper, and PCBs.

He discussed the possibilities for rehabilitating Hamilton Harbour. Since 1976, two sewage plants have almost doubled their capacity—an important development because their combined annual outflow replaces the bay water 1.6 times. The turnover rate of water in the bay is three months, and the steel companies presently use the volume of Hamilton Harbour every four months. Thus, although Hamilton Harbour is cleaner, it remains a source of pollution to western Lake Ontario. It is hoped that improved water quality will enable the fishery to be rehabilitated and to restore its productivity. Toward this end, DFO is developing strategies, reviewing data and conclusions in Tom Whillan's (University of Toronto) IAGLR paper on inshore areas, and taking inventory of the current resource.

INTERNATIONAL SYMPOSIUM ON ASSESSMENT OF STOCKS AND PREDICTION OF YIELD (ASPY)

Steering Committee Co-Chairman Jack Christie (OMNR) presented a progress report, explaining that the purpose of the symposium is to examine the problem of predicting the availability of Great Lakes fish for harvest—to further refine stock assessment methodologies and harvest measurement techniques, to assess the qualitative impacts associated with a variety of fishing activities, and to predict the short, medium, and long-term availability of Great Lakes fish for human use.

Christie identified two significant opportunities for the GLFC which have arisen from such recent developments as integrated sea lamprey management, STOCS, increased reliance on the ecosystem approach and socio-economics, renewed promise in rehabilitation of salmonid and percid communities, and SGLFMP. These opportunities are to provide leadership in formulating lake management strategies, and to relate the "ecosystem approach" to successful fishery management.

The GLFC accepted the recommendation that it convene an international symposium on the problem of prediction and assessment of fish community production and its allocation for community maintenance, rehabilitation, and harvest. It was suggested that the symposium be scheduled for June 1985, in Ontario, and that perhaps it should precede an international large river ecology conference which is in the early planning stage. (See "Administrative and Executive Actions.")

SCIENCE IN MANAGEMENT OF TREATY INDIAN FISHERIES AND RELATIONSHIPS WITH STATE AND COMMISSION PROGRAMS

Henry Buffalo, Jr., Executive Administrator of the Great Lakes Indian Fisheries Commission, presented a review of the history of management and events which resulted in responsibility for management. Of the eight tribes with such responsibility in the Great Lakes, six are members of the Great Lakes Indian Fisheries Commission—Grand Portage, Fond du Lac, Red Cliff, Bad River, Keweenaw Bay, and Grand Traverse Bay. Of these six members, two have technical capacity, and the three-person staff of the BIA-supported GLIFC will be expanded to provide more technical support. Some preliminary surveys have been scheduled, and members of the GLIFC hope to cooperate in a technical manner with other fish managers.

Joseph K. Lumsden, Chairman of the Chippewa/Ottawa Treaty Fishery Management Authority, reviewed the common approach and regulations of the Authority's three member tribes—the Sault Ste. Marie tribe of Chippewa Indians, the Bay Mills Indian Community, and the Grand Traverse Band of Ottawa-Chippewa Indians. The Authority stated its support for sanctuaries, as well as its desire to participate in the formulation of stocking recommendations. It was suggested that representation, perhaps on Lake Committees, would be helpful in the future.

REHABILITATION OF GREAT LAKES WALLEYE POPULATIONS: AN INTRODUCTION TO COMPARABILITY OF THEIR RECOVERIES

Representatives of the Lake Committees reported the following:

The decline of walleye recruitment in Michigan and Wisconsin's Green Bay from 1955 to 1969 (commercial harvest down from 53,000 lbs. to 14,000 lbs.) was attributed to overexploitation, pollution, and interaction with other species. With improvement in water quality, closure of commercial fisheries, and stocking programs, walleye populations are recovering and evidence of natural reproduction is being found.

An improvement in the water quality, including reduction in flavor tainting substances, of Minnesota and Wisconsin's St. Louis River estuary since 1978 has resulted in increased sport fishing pressure since 1979 on the already abundant Lake Superior walleye population which spawns in limited habitat below the Fond du Lac power dam. The mean age of 11, and now declining numbers suggest that this stock was "protected by pollution." Further studies are planned to monitor the response of the stock to the sudden and continuing exploitation.

In response to the 1967 collapse of the walleye population in Lake Huron, Michigan has instituted a stocking program in the hope that natural reproduction will occur. Lake Michigan's Bay de Noc sport fishery development indicates good survival of stocked fingerlings.

Walleye formed a small proportion of the commercial catch from 1910 to 1950 in southern Lake Huron, Lake St. Clair, and Lake Erie. They became an increasingly important component throughout the 60's, until the fishery was closed in the spring of 1970 due to mercury contamination. At that time, eastern Lake St. Clair supported a good population, as did southern Lake Huron, although some river spawning stocks had been lost. Catches in western Lake Erie increased steadily through 1956, and declined thereafter until closure of the fishery in 1970. International management approaches to control sport and commercial harvests were instituted under the guidance of the GLFC's Walleye Scientific Protocol Committee established in 1973, which evolved to the Lake Erie Committee's Standing Technical Committee in 1977, and to the STC's Walleye Task Group in 1980. The total allowable catch by number and other control measures appear to be successful, as indicated by the currently high levels of abundance and the apparently large brood stock. Managers must continue to be sensitive to changes in user group activities, and should charge their Walleye Task Group with monitoring and predicting implications of walleye population changes to other fish community members such as white bass, white perch, and yellow perch.

The successful rehabilitation of walleye in western Lake Erie was attributed to the availability of data and science, good interpretation and administrative action, and possibly environmental change beyond the presence of mercury which caused the initial closure of the commercial fishery. It was suggested that successful management is often knowing how to take advantage of opportunities, and that although desirable, it is not always necessary to understand in detail the mechanisms through which an objective is achieved.

LAKE ONTARIO/ST. LAWRENCE RIVER WETLAND INVENTORIES: IMPACTS OF WATER LEVEL REGULATIONS

Dieter Busch (USFWS) discussed the need for more information on the impact of various water level regimes on the nearshore zone, including wetlands. Such information would be useful in countering demands by special interest groups for actions which would impose artificially regulated water levels. Evidence to date indicates that Lake Ontario wetlands are used by at least 27 species of fish for spawning or nursery grounds, and that in western Lake Erie, different fish species produce stronger year classes during high or low water years, and some species seem not to be affected by water levels. He outlined the cost, personnel, and time required to survey two Lake Ontario marshes, and suggested 15 wetland sites which should be surveyed on the U.S. Lake Ontario–St. Lawrence River shoreline, as well as two shoal areas and two beach areas along Lake Ontario, and two shoal areas in the St. Lawrence. Computerized data management was strongly recommended.

UPDATE FROM THE INTERNATIONAL JOINT COMMISSION

Bill Nye reported on the following areas of IJC concern:

- increased development of international information through coordinated research and improved monitoring of water quality in the Great Lakes;
- issues such as health concerns with toxic substances and ecosystem health;
- rehabilitation of areas of concern.

Areas of shared interest or cooperation between the IJC and GLFC include:

- the recently held workshop on the ecosystem approach to managing the Great Lakes;

— cosponsorship of the ecosystem health indicator task force;
— the IJC's establishment of seven task forces complementary to the GLFC's Lake Committees;
— consideration of flow allocation applications from St. Marys River hydropower facilities.

PUBLIC ATTITUDES AND INVOLVEMENT IN FISHERIES ISSUES

Ben Peyton (Michigan State University) introduced the concept of a "decision-making pentagon" in which decisions must take into account legal structure, fiscal structure, resource capability, public attitudes, and technology. He suggested that poor decisions result when one constraint is allowed to dominate, when all constraints are not considered, or when constraints are unrealistically defined. He then explained how issues such as snagging, etc., may be typed by determining which of the following components are in play: the science/technology or bounds of the problem, the public beliefs system, and/or the public value system. The effectiveness of public involvement programs should be increased if they are designed to cope with each of these three components of a natural resource issue. It was noted that the three components build upon each other, the base being science and technology.

THE ECOSYSTEM APPROACH TO MANAGING THE GREAT LAKES BASIN

Jack Vallentyne (DFO) reviewed the history of the concept with the IJC, and discussed the ecosystem way and approach (personal as opposed to management) to planning and problem-solving. The concept was visualized as regarding oneself as living in an ecosystem (home) rather than an environment (house). A strategy document will be one of the products of the March 22–24, 1983, workshop to implement an ecosystem approach, cosponsored by GLFC, IJC, the International Association for Great Lakes Research, and Great Lakes Tomorrow, will be a strategy document designed to counteract past piecemeal approaches to solving man-made problems. The workshop report will be available for presentation in the fall.

NATIONAL SECTION MEETINGS

The following discussions were reported by the Canadian Section:
— the status of the nearly complete federal-provincial barrier dam agreement;
— the need for habitat protection in the St. Marys Rapids;
— the question of broader publicity of the GLFC.

Addressing the concern raised with regard to the planting of exotic species such as Atlantic salmon, the GLFC was reminded of the protocol for prior consultation and assessment. It was suggested that this be brought to the attention of Lake Committees and discussed by the GLFC in December.

The following discussions were reported by the U.S. Section:
— the U.S. Advisors' reports;
— allowing proxy attendance at meetings;
— the New York Assembly passage of a request for sea lamprey control in Lake Erie;
— a suggestion that Ray Full convene a meeting of U.S. Advisors prior to the next GLFC meeting;
— cooperative management in Lake Erie;
— activities of the merchant marine.

The U.S. Section recommended to the GLFC that better public relations be sought for sea lamprey control, and that the role of U.S. advisors be considered if the GLFC decides to proceed with a review of its mandate and objectives. Abele (PFC) extended an invitation to hold the proposed law enforcement workshop in Pennsylvania.

ADMINISTRATIVE AND EXECUTIVE ACTIONS

A summary of Commission executive action and responses to committee recommendations is as follows:

GENERAL

— revised and approved budgets for fiscal years 1983 through 1985.

FINANCE AND ADMINISTRATION

— will prepare a working paper for an informal review of GLFC mandate and objectives by four Commissioners and the Secretariat for consideration at a July 28–29 meeting. (Article 12 requires a formal review of the Convention for its eighth year only, but the GLFC is considering the utility of a second review.)
— provide 75 copies of the book, "Contaminant Effects on Fisheries" (a product of the GLFC's Fish Health Workshop), to cooperators.

SEA LAMPREY

— authorize, within existing budgets, a survey of the Oneida Lake system in 1983, and its treatment in 1984;
— review attractants research and its feasibility;
— fund a history of sea lamprey control;
— fund a workshop on quantitative assessment of ammocoetes and sea lamprey, as suggested by the control units' commonality committee.

FISHERIES AND ENVIRONMENT

— provide a revised GLFC lake trout rehabilitation policy to cooperators;
— address fish habitat concerns of the Lake Committees at a July meeting of the Fisheries and Environment Committee;
— fund an "International Symposium on Assessment of Stocks and Prediction of Yields";
— fund the Law Enforcement Workshop proposed by the Council of Lake Committees.

ADJOURNMENT

Following Commissioner Ridenour's expression of thanks to the host, CCIW, and to the Ontario Council of Commercial Fisheries for the smoked fish enjoyed by all, and after the announcement of locations and dates of future meetings, Chairman Loftus adjourned the meeting at 1610 h on May 12, 1983.

INTERIM MEETING

PROCEEDINGS[1]

The Great Lakes Fishery Commission's 1983 Interim Meeting was convened in Ann Arbor, Michigan, on November 29 and 30.

The chairman, K. H. Loftus, reported on the Commission's activities during the previous six months, including the establishment of a fish habitat advisory board, the sponsorship of the Board of Technical Experts Conference on Lake Trout Research, and the Lake Committees' Law Enforcement Workshop. He also reported on Commission meetings to review the Convention and consider the Commission's mandate and role in coordinating Great Lakes fishery activities, on communications with other groups on matters of mutual interest, and on publications published and in progress, and on research contracts let.

Mr. Bernard E. Skud, president of the American Institute of Fishery Research Biologists, presented the AIFRB's 1983 Special Group Award of Merit to the Commission and cooperating agencies in recognition of the successful, cooperative sea lamprey control program. Chairman Loftus accepted the award on behalf of the current and previous Commissioners, staff and agency people, and conveyed appreciation for recognition from colleagues beyond the Great Lakes basin.

Chairman Loftus presented Commissioner Ver Duin with a satellite photograph of the Great Lakes and a letter of appreciation to commemorate his 27 years of service with the Commission.

The Commission also heard reports on artificial reefs in the Great Lakes, progress following the Great Lakes fisheries/law enforcement workshop (conclusions and recommendations being developed for presentation to the Council of Lake Committees in April 1984, an update on the International Symposium on Yield Prediction and Harvest Assessment, opinions on the adaptive management workshops (where a diverse array of managers, policy makers and scientists are brought together to develop simulation models that are sensitive to policy choices), and implementing a

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

program to control bacterial kidney disease (from Great Lakes Fish Disease Control Committee).

The chairman of the Board of Technical Experts reported on revisions to their meeting structure, on projects underway and new initiatives, and identification of merging issues.

James T. Addis, chairman of the Fish Habitat Advisory Board (FHAB), announced that with his co-chairman he would begin developing a list of nominees and terms of reference for the new board. One of FHAB's first tasks is to draft a statement which will: 1. identify the critical importance of protecting habitat to maintain fish populations, and for providing security for the public and private sector investments in the fishery; 2. define current and emerging issues constraining achievement of fishery goals; 3. propose objectives for habitat protection and rehabilitation; 4. describe strategies to achieve habitat conservation in the Great Lakes; and 5. serve as a basis for encouraging public support for habitat management initiatives and to foster a commitment of agencies to improve habitat management.

PANEL ON CONTAMINANTS AND GREAT LAKES FISHERIES: WHERE TO FROM HERE?

In his introduction of the panel, Commissioner Chamut noted that contaminants in fish cast a pall over the social and economic aspects of Great Lakes fisheries and deny their full use.

Commissioner Claude Ver Duin, on behalf of the Great Lakes Fisheries Foundation, remarked on the impact of contaminants on the Great Lakes commercial fishery—closure of fisheries, loss of markets, repercussions in market for adjacent fisheries, and possible effects on fish themselves.

John Waugh (Ontario Council of Commercial Fisheries) added that pollution is the root of many commercial fishery problems. He raised questions of compensation to fishermen, prevention of contamination, some questions on assumptions behind criteria for contaminants in food, rationale of risk estimates, and the need for accurate reporting because baseless rumors have closed fish markets.

Douglas Hallett (Environment Canada) discussed the problem of contaminants for self-sustaining fisheries, saleable/edible products in human health. Of the more than 1,000 recognized contaminants in the Great Lakes, he cited a "dirty dozen." He also addressed three sources of contaminants—groundwater, atmospheric pollution, and sediments.

Grace Patterson (Canadian Environmental Law Association) discussed the effectiveness of Canada's law and regulations with respect to toxic contamination of the Great Lakes. She also addressed various problems involving governmental control.

Vacys J. Saulys (EPA) reviewed seven principle U.S. pollution federal control laws and highlighted several approaches which would improve interactions among various institutions concerned with contaminants.

Kenneth S. Kamlet (National Wildlife Federation) discussed problems of toxic contamination and Great Lakes fisheries and urged upon the Commission and other appropriate agencies several steps. These included setting tolerance levels for contaminants, establishing monitoring programs, setting up a registration of fish tumors, directing a formal reference to the IJC on airborne pollutants and the Great Lakes, identification of populations at risk, reassessment of "Special objectives" under the 1978 Great Lakes Water Quality Agreement, consideration of food chain contamination potential in the U.S. "Superfund" Hazard Ranking System, requirement of biomonitoring and waste water discharge permits, and attention to sampling and analysis of bottom sediments in relation to health hazards.

Al Johnson (Ontario Ministry of Environment) referred attendees to Ontario's "Guide to Eating Ontario's Sports Fish" saying that medical background materials and guidelines for various contaminants are available. Although there remain areas of concern, progress is being made with mercury, PCBs, Mirex, and dioxin.

REPORT ON THE INTERNATIONAL JOINT COMMISSION

The Director of the International Joint Commission, Great Lakes Regional Office, William Nye, highlighted the 1983 reports of the Water Quality Board and Science Advisory Board, and discussed institutional trends of the IJC: 1. increased role as data center; 2. the implementation of Great Lakes International Surveillance Program with surveillance plans and task forces for lakes and channels, increased reliance on biological indicators, and broadening of data quality control; 3. movement toward the ecosystem approach, e.g. in increased attention by a science advisory board to health of aquatic communities as well as human; and 4. more attention being paid to inplace pollutants (sediments) as sources come under control. He noted that the proposed dewatering of the St. Marys Rapids was being resolved in a manner favorable to the fishery.

FISHERY REPORTS

The Secretariat reported on the status of the August 1983 Conference on Lake Trout Research, its organizers, structure, hypotheses, and subsequent wrap-up activities. Preliminary findings distinguished between first order research necessary for detectable recruitment, and second order research leading to enhanced recruitment.

James T. Addis (Wisconsin DNR) citing recent activities such as the Law Enforcement Workshop and Conference on Lake Trout Research, and congratulating the Commission and cooperators, past and present, remarked on how well the Commission structure incorporates the eight behaviors associated with excellence (as outlined in the book, "In Search of Excellence"): 1. bias for action; 2. close to customer needs; 3. economy and entrepreneurship encouraged; 4. effectiveness depended upon coopera-

BOARD OF TECHNICAL EXPERTS REPORT

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

The Board met as a full committee twice in 1983, May 9–10 (Burlington, Ontario) and October 27–28 (Ann Arbor, Michigan). One new member, Dr. W. Hartman, was welcomed to the ranks of the Board.

The need for two symposia was identified. Concern for predicting the availability of Great Lakes fish for harvest will be the subject of a fisheries assessment symposium. A companion symposium (socio-economic assessment) to focus on the values of fishery resources to society and the impacts of society on fishery resources was endorsed by the Board and will follow the fisheries assessment symposium.

The Board undertook to identify and advise the Commission of important emerging issues within the Great Lakes. An evaluation of previously held adaptive management workshops indicated overwhelming endorsement to continue the process. The results of the evaluation will be prepared as a special report. The results of two adaptive management workshops, Salmonid Community Workshop and the Lake Erie Fish Community Workshop have been published as special reports. The Board supported the initiation of an adaptive management workshop to provide an assessment of realistic trade-offs between sea lamprey control and lake trout management in the rehabilitation program for lake trout in Lake Superior.

The Board established a Policy and Priorities Committee with the mandate (i) to identify, review and recommend evaluation techniques relevant to decision making and to provide assistance in applying these techniques, (ii) to identify, promote and propose mission-oriented research activities designed to generate information relevant to decision making, (iii) to review and comment on procedures for evaluating internal research proposals.

The Board supported strongly a draft GLFC policy statement relating to sponsored research on the long term environmental effects of TFM on stream biota.

The Board recommended financial support for the following research proposals: chub stock identification, application of chromosome banding techniques to lake trout stock identification, identification of native lake trout, and response of fish in Oneida Lake to sea lamprey control.

SUMMARY OF MANAGEMENT AND RESEARCH[1]

REPORTS FROM LAKE COMMITTEES

This section examines 1983 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 1984. 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

Rehabilitation of lake trout populations in the Great Lakes continues to be a major goal of the Commission. Greatest progress has been made in Lake Superior, where sea lamprey control began soon enough (1958) to save a small portion of the wild stocks. In the other lakes reproduction is entirely dependent upon fish of hatchery origin. Lakewide stocking of lake trout began in Lakes Superior in 1958, Michigan in 1965, Huron and Ontario in 1973, and Erie in 1978. Progress in lake trout rehabilitation is reviewed for each lake as follows:

Lake Superior—In 1983 a technical working committee (formed in 1982) reported its progress in developing a plan for rehabilitating lake trout populations in the lake. In its report the technical committee evaluated, and found biologically feasible, the Lake Superior Committee's long range rehabilitation goal of a sustained annual harvest of four million pounds of naturally reproduced lake trout. Other sections of the technical committee report identified appropriate sources for hatchery brood stocks and recommended that mortality should not be allowed to exceed 50% in any part of the lake. The recommended mortality rate has generally been exceeded

[1]Commercial fish landings by lake and species for 1983 are given in Tables 1–5.

recently. For example, mortality rates in 1983 were 42–66% in Michigan waters (depending on location), 60% in Minnesota, 43–77% in Ontario, and 53–65% in Wisconsin. The technical committee recommended that fishery regulatory agencies take measures to reduce fishing in those areas where mortality exceeded 50%.

For the second straight year the combined abundance of native and hatchery lake trout declined in inshore Michigan waters between the Keewenaw Peninsula and Marquette. The decline was 26% in 1983 and 37% in 1982. Identification of the exact causes of the decline in this area, which had previously achieved the highest degree of rehabilitation in U.S. waters of the lake, has not yet been established. However, slower growth, which would delay recruitment, and lower stocking rates after 1970 are suspected as having contributed to the reduced abundance. On the brighter side, the proportion of native fish in the catch increased from 37% in 1982 to 42% in 1983. In Michigan waters west of the Keewenaw Peninsula and east of Marquette changes in abundance were much less severe than in central waters; also, west of the Keewenaw, the proportion of native lake trout in the assessment catch increased from 15% in 1982 to 24% in 1983.

Spawning-run surveys on six reefs in central Michigan waters showed that only three had significant runs, and that spawner abundance on all three was slightly lower in 1983 than in 1982. Lake trout from specially marked plantings stocked directly on several of the spawning reefs were less abundant in the survey catches than were trout stocked inshore in the normal manner. Remarkably, the proportion of wild to hatchery origin lake trout in spawning-run samples from Marquette Harbor increased from nil in 1975 to 25% in 1980 to 78% in 1983. It therefore appears that the Marquette spawning populations may be self-sustaining.

In Wisconsin waters the number of spawning lake trout on Gull Island Shoal increased to 17,000 in 1983, from 13,000 in 1982. This spawning population has recovered on its own after sea lamprey populations were suppressed in the lake beginning in the late 1950s.

Although the numbers of adult lake trout in Minnesota waters are not increasing, the CPUE of wild juvenile trout has increased steadily from 1.0 fish/1,000 m of net in 1976 to 23.0 in 1983. Angling catches of lake trout from Minnesota waters are increasing sharply with 36,000 landed in 1983. An additional 6,000 lake trout were removed in the assessment fishery, and 2,000 in the commercial fishery bycatch.

Commercial fishermen caught 450,000 lbs. of lake trout in Ontario waters in 1983. Most of the catch was from rehabilitated, offshore populations. Anglers accounted for a catch of 215,000 lbs.

Sea lamprey wounding rates on lake trout were generally lower than in 1982. The rates declined to particularly low levels in Michigan (except Whitefish Bay) and Wisconsin.

Lake Michigan—The Lake Michigan Committee accepted and endorsed a draft lake trout rehabilitation plan from its technical commmittee. Major features of the plan are a genetic evaluation of deep water and shallow water spawning strains of lake trout in two offshore refuges, establishment of a maximum allowable mortality rate of 40%, and a definition of priority zones for stocking. Other components of the plan deal with environmental surveillance, hatchery brood stocks, research on reproductive biology, the forage base, and information needs. Additional subject areas requiring further work by the technical committee are the development of a lakewide assessment plan, the establishment of stocking rates and boundaries for high priority stocking zones, and target dates for completion of the different stages of rehabilitation.

For the first time biologists reported the recovery of wild lake trout in Lake Michigan at life stages beyond that of eggs or fry. Wild trout were taken at Grand Traverse and Good Harbor Bays in Michigan waters in 1983. The proportion of wild lake trout in the assessment catch was 8% and 4% respectively for the two bays. Less encouraging, standing stocks of lake trout in all but one statistical district in Michigan waters (MM-8) were reported to be smaller (reductions varied from 31% to 79%) in 1983 than in 1976–81. In addition, depending on location, mortality was estimated at 53–65%, rates that substantially exceed the 40% maximum recommended by the technical committee. Fishing is believed to be the primary cause of the high mortality and consequent reductions in stocks. This factor has resulted in the near extinction of the 1964–71 year classes and made reproduction dependent on only three cohorts of spawners.

Sea lamprey wounding rates were higher in northern Wisconsin and northern Michigan waters (0.0–5.8% in 1982 and 0.5–9.6% in 1983) and in southern Wisconsin and Illinois (0.0–1.5% in 1982 and 0.6–5.3% in 1983). Higher rates in northern areas of the lake were associated in part with reductions in the density of lake trout caused by reduced stocking and expanded fishing. However, lamprey numbers may also have increased in 1983, especially in southwestern Lake Michigan.

Lake Huron—A lake trout technical committee was formed in 1983 and charged with developing a rehabilitation plan for the lake. The technical committee was instructed to provide annual reports for the lake committee. The first year class of wild lake trout produced from hatchery spawners was recovered off Rockport in northern Michigan waters. The ratio of wild to hatchery fish in the samples was 1:7.

Surveys of spawning runs in Michigan waters showed that numbers were low (CPUE = 1) in offshore northern waters despite 6 years of stocking, somewhat higher in inshore northern waters (CPUE = 23), and much higher in central areas (CPUE = 105). However, mean age of spawners is only 5.9 years, and the sex ratio is likely unbalanced in favor of males (4.7:1), most of them early maturing and spawning for the first time. The lower CPUEs in offshore northern waters are thought to be caused by a failure of lake trout stocked as yearlings to home and spawn on offshore stocking sites; and in inshore northern waters the lower CPUEs have been attributed to heavy fishing mortality.

In Georgian Bay, abundance of backcross lake trout (lake trout × brook trout hybrids) was unchanged from 1982, when significant stock sizes were first observed. Unfortunately, as a consequence of high mortality (92%) between ages 2 and 3, the very successful 1981 planting has not improved the spawning potential of the population. Excessive bycatch in the whitefish fishery is thought to be responsible for the poor carryover of adult fish.

Sea lamprey wounding rates in Lake Huron were higher in southern Michigan waters in 1983 (2.2–7.8%) than in 1982 (1.8–6.1%); data from central and northern waters were too scanty for meaningful analysis. Wounding rates in Georgian Bay remained low in 1983.

Lake Erie—In 1983 the Standing Technical Committee, a group of senior biologists who advise the lake committee and oversee the work of various task groups, reviewed the lake trout rehabilitation plan developed by a task group, and directed the group to address the following key points in a revised draft: is natural reproduction of lake trout in Lake Erie a realistic goal; what degree of interagency cooperation is required to achieve high survival rates; what are possible strategies for controlling harvest; and what are the primary problems concerning reproduction.

Because significant stocking began in Lake Erie (eastern basin) only in 1978 and sampling programs are not firmly established, most of the information on stock biology is preliminary. Survival rates for adult lake trout appear to be low (less than 32%). Maturation of females is accelerated in comparison to the other lakes with full maturity reached at age 6. Sea lamprey wounding rates are high on lake trout in Lake Erie; it is thought that lampreys are a significant factor in the low survival of adult trout.

Lake Ontario—The lake committee adopted a plan that outlines goals and procedures for rehabilitating lake trout in Lake Ontario. The Lake Ontario document is the first lake trout rehabilitation plan to be adopted by a lake committee. Studies of juvenile lake trout in Lake Ontario indicated that 14 months after stocking mean dispersal distance from the release site was 50 km. After 14 months in the lake, spring-stocked yearlings survived about 3 times as well as fall-stocked fingerlings. Abundance of adult lake trout in U.S. waters increased 47% over 1982 levels due to recruitment into adult stocks of year classes represented by large plantings. CPUE of female spawners increased 24% over that of 1982, but mean age was only 5.8 years, considerably less than the target mean age of 7.5 years established in the rehabilitation plan. Survival of adult lake trout was estimated at 45%, well below the goal of 60–65%. Survival must improve if the mean age of spawners is to increase. More encouraging, the first naturally reproduced lake trout was taken in a fry trap in the eastern basin.

Sea lamprey wounding rates declined 53% in 1983 and now are low (0–2.9%). However, abundance of lake trout increased almost as much as marking declined so that lamprey numbers may be unchanged from 1982.

LAKE WHITEFISH

For the third consecutive year, whitefish landings in the upper Great Lakes reached a new modern high. The catch of 14.2 milion pounds in 1983 exceeded that of 1982 by 30%. The increases in catch occurred in each of the upper lakes, but was greatest in the main basin of Lake Huron and in northern Lake Michigan. Total mortality was an estimated 77–90% in northern Lake Michigan, 51–63% in northern Lake Huron, and only 38% in an unfished population in lower Grand Traverse Bay (Lake Michigan). Pre-recruit year classes in central Lake Huron appear strong, so record catches should continue in those waters for several years.

Whitefish populations remain severely depressed in the lower lakes, but reproduction has been edging upward in Lake Ontario since 1977.

LAKE HERRING

Prospects for the recovery of this once very abundant and valuable species continue to improve in Lake Superior, where a resurgence that began in Wisconsin waters has now spread into Michigan waters (Keweenaw Bay). Herring populations in Canadian waters of Lake Superior never declined to the extent that they did elsewhere in Lake Superior, but low market prices have inhibited the Canadian fishery. Although the recovery of lake herring may not greatly benefit the commercial fishery directly because of marketing problems, the species is valuable as food for lake trout.

CHUBS

Large improvements in the chub populations of Lakes Michigan and Huron, which began in the late 1970s, continued in 1983. CPUEs of adult chubs, as compared with 1982, were up three-fold in Lake Michigan and two-fold in Lake Huron. The recruiting year classes in both lakes are estimated to be strong so population increases are expected to continue. Chub landings from Lake Superior remain low because of the increasing availability of Lakes Michigan and Huron chubs, which are favored in the market. Commercial landings in 1983 amounted to 3.5 million pounds in Lake Michigan and one million pounds in Lake Huron. A comprehensive report from the Lake Huron Chub Technical Committee (formed in 1981) is expected in 1985.

PINK SALMON

Pink salmon in Lake Superior, where they were inadvertently released in 1956, do not show signs of recovery to the record levels of 1979. For instance, the spawning run in the French River (Minnesota) was estimated at only 22 fish in 1983, compared with 3,191 in 1979. Pink salmon are widely distributed in northern Lakes Michigan and Huron, but they are rare in the lower Great Lakes.

FORAGE SPECIES

Lake Superior—Smelt have been the principal prey fish of lake trout, Pacific salmon, and anadromous trout (brown and rainbow trout) in Lake Superior, but they are now much less abundant than in the 1970s, when populations peaked following invasion. For example, commercial landings of smelt were down to only 0.4 million pounds in 1983 from a high of 4 million pounds in 1976. Reductions in smelt abundance are thought to be caused by predation by trout and salmon. It is expected that lake trout, the major predator in the lake, will begin to utilize juvenile lake herring (the primary prey fish before the 1960s) and the abundant chubs.

Lake Michigan—In recent years smelt, alewife, and slimy sculpin have been the major forage species in Lake Michigan; however, of the three species only smelt remain at high levels of abundance. Sculpins were only 1/6 as abundant in 1983 as they were in 1975, when estimates of relative stock size first became available. Adult alewives declined for the second straight year, the CPUE in 1983 amounting to only 12% that of 1981. Adult alewives in Lake Michigan are now at their lowest level since sampling began in 1973. Alewife reproduction was good in 1983, but the eventual contribution of the 1983 year class to the adult stock is uncertain, because overwinter survival of the young-of-the-year alewives is variable.

Declines in alewife and sculpin abundance in Lake Michigan are thought to be related to predation from trout and salmon. Increases in chubs may provide alternative food sources for predator fish.

Lake Huron—The status of forage fish in the main basin of Lake Huron is somewhat similar to that of Lake Michigan, with abundance of adult smelt high (about 40% above the 1976–83 average) and abundance of adult alewives low (approximately 7% of the 1973–83 average). Alewife reproduction was good during 1980–82 (and in 1983), but survival from the young-of-the-year stage has apparently been low. Low survival undoubtedly has been due partly to predation by trout and salmon, but poor overwinter survival is also thought to have influenced the decline.

Lake Erie—Smelt are the primary forage fish for trout and salmon in Lake Erie and the principal commercial species in the central and eastern basins. Landings of smelt rose steadily from 1977 to 1982, when a peak catch of 37.4 million pounds was recorded. The 1983 catch, though still high, dropped to 29.5 million pounds. Causes for the lowered catches were reduced availability, especially in the central basin, and disruptions in the export market.

In the western basin of Lake Erie, where salmonids are scarce, young-of-the-year gizzard shad are the primary prey fish; the walleye is the main predator. Shad reproduction was good in 1981–82, years of exceptionally high walleye abundance. Before gizzard shad became abundant in Lake Erie (i.e. before the 1960s), emerald and spottail shiners were preferred food of walleyes, but the great abundance of walleyes since the late 1970s has reduced the shiners to a minor role as a forage species.

Lake Ontario—Smelt and alewives, which together with shiny sculpins are the primary prey species in Lake Ontario, have reached extreme abundance. CPUE of adult smelt in 1983 increased 2.7 times over 1982, and steadily increasing numbers in recent years are believed to be responsible for declines in growth. For instance, between 1978 (when sampling began) and 1983 age 2 smelt declined in mean length from 141 mm to

115 mm, and their mean weight decreased nearly 50%. During the same period, adult alewives also increased greatly in abundance (about sevenfold) and declined in condition. The resurgence of alewives following the major dieoff in the winter of 1977–78 was greater than had been anticipated. Greater predation, resulting from increased plantings of trout and salmon in Lake Ontario from 2.1 million in 1978 to 5.3 million in 1982, apparently has not been very effective in holding down the abundance of alewives and smelt. The only discernable change in forage abundance associated with predation appears to be a modest decline in numbers of slimy sculpin, which are common in the diet of lake trout.

WHITE PERCH

The white perch, non-native to the Great Lakes, continues to decline in Lake Ontario in association with the recovery of alewives. For example, CPUE of young-of-the-year white perch dropped from 247 in 1978 to 3 in 1983. In contrast, white perch populations in Lake Erie (where the species was first observed in 1947) are increasing; young-of-the-year have been captured each year since 1979 in assessment trawls fished in the eastern basin. In the western basin good reproduction has been evident since 1977. White perch are expanding their range northward from Lake Erie, having been reported to be in southern Lake Huron and Saginaw Bay in 1983. Impacts of white perch on native species in the Great Lakes are unknown.

YELLOW PERCH

Yellow perch support important fisheries in all the Great Lakes except Superior, where they are relatively scarce. In Lake Michigan the two most important populations are in a recovery phase. A strong 1982 year class keeps adult abundance high in Green Bay. The perch fishery, which was thought to be overharvesting in the recent past, is regulated by a quota (200,000 pounds from July 1983 to June 1984). In southern and central Lake Michigan perch stocks continue to expand. Reproduction in 1983 was 50 times greater than in any year since sampling began in 1973. This expansion is thought to be related to the decline of alewives in the lake.

Perch populations are also increasing in the southern half of Lake Huron and in Saginaw Bay. The 1980–83 year classes are all reported to be good. Age composition and growth of perch in Saginaw Bay are now similar to those of the 1950s, when stocks were very abundant.

It is anticipated that in Lake Erie a common management protocol for perch will be adopted by all management agencies. In preparation for adoption the Yellow Perch Task Group was charged in 1983 with developing quota options for four divisions of the lake as follows: western basin, west half of the central basin, east half of the central basin, and the eastern basin. Additionally, the task group is to investigate north-south differences in productivity of the stocks. Landing of perch from Lake Erie amounted to 6 million pounds in 1983, a decline of 4 million from the preceding year. Weaker year classes and unusually large stocks of adult gizzard shad that interfered with netting operations were reasons for the drop in landings.

Adult stocks of perch in Lake Ontario consist mainly of the strong 1978 year class, which is approaching senescence. Nevertheless, commercial landings increased 10% in 1983 over the previous year, apparently because of increased effort. Research underway is aimed at evaluating whether the very abundant alewives are inhibiting perch reproduction in Lake Ontario.

WALLEYES

Stocking programs were recently begun in Green Bay and Saginaw Bay to repopulate these former centers of walleye fishing in the Great Lakes. Fish of hatchery origin spawned successfully in Sturgeon Bay (a bay within Green Bay) in 1980 and 1982, and there is optimism that this population will become self-sustaining. An estimated 13,000 spawners in Sturgeon Bay were the product of plantings that began in 1973 and have totaled 1.7 million fingerlings and 28 million fry. An additional spawning stock of 12–18,000 walleyes has been established by plantings in the extreme south end of Green Bay off the Fox River, but natural reproduction has not been documented there. Plantings in Saginaw Bay in 1983 reached a record level of 0.8 million fingerlings. Stocking began in Saginaw Bay in 1979.

Walleye tagging studies in the connecting waters between Lakes Huron and Erie (the St. Clair River, Lake St. Clair, and the Detroit River) indicate that survival is good (51%) and rate of exploitation is low (8%). Walleye numbers in the connecting waters are high, as demonstrated by Canadian creel surveys, which show that 255,000 were caught in those waters in 1983.

The Lake Erie Committee adopted recommendations from its Standing Technical Committee that the quota for 1983 in the western basin be set at 6.5 million walleyes (F = 0.285) and that a stock size of 20–25 million adults be maintained. Fisheries will be regulated to meet these recommendations.

The weakest walleye year class in 17 years was produced in 1983, following one of the strongest on record. Walleye growth continues to decline in the western basin, a decrease that may have, due to delayed recruitment, been partly responsible for a reduced catch. Ohio anglers caught only 1.8 million walleyes in 1983, compared with 3 million in 1982.

Tagging studies in Michigan's waters of Lake Erie indicated that most movements of walleye outside of the western basin were northward (78% of the returns were from within the basin). Of the fish moving outside the basin, 90% were taken from the connecting waters and 10% from the central basin.

Table 1. Lake Superior commercial fish production in pounds for 1983.

Species	Michigan	Wisconsin	Minnesota	U.S. Total	Ontario	Grand Total
Alewife	—	—	21	21	—	21
Burbot	5,043	255	40	5,338	—	5,338
Carp	47	—	—	47	—	47
Chubs	72,037	192,749	14,019	278,805	69,124	347,928
Lake herring	37,035	63,742	176,595	277,372	1,252,061	1,529,253
Lake sturgeon	—	—	—	—	355	355
Lake trout	117,614	281,162	37,343	436,119	411,821	847,940
Lake whitefish	1,434,349	165,640	234	1,600,223	296,693	1,896,916
Northern pike	—	—	—	—	6,013	6,013
Pacific salmon	1	—	—	1	9,509	9,510
Round whitefish	984	788	4	1,776	29,040	30,817
Smelt	69	174,460	264,064	438,593	838	439,431
Suckers	52,071	1,480	370	53,921	232,615	286,116
Walleye	—	—	—	—	372	372
Yellow perch	2,932	—	—	2,932	89,794	92,726
Total	1,722,182	880,276	492,690	3,095,148	2,398,235	5,492,783

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Lake herring	37,035	63,742	176,595	277,372	1,252,061	1,529,253
Lake sturgeon	—	—	—	—	355	355
Lake trout	117,614	281,162	37,343	436,119	411,821	847,940
Lake whitefish	1,434,349	165,640	234	1,600,223	296,693	1,896,916
Northern pike	—	—	—	—	6,013	6,013
Pacific salmon	1	—	—	1	9,509	9,510
Round whitefish	984	788	4	1,776	29,040	30,817
Smelt	69	174,460	264,064	438,593	838	439,431
Suckers	52,071	1,480	370	53,921	232,615	286,116
Walleye	—	—	—	—	372	372
Yellow perch	2,932	—	—	2,932	89,794	92,726
Total	1,722,182	880,276	492,690	3,095,148	2,398,235	5,492,783

Table 2. Lake Michigan commercial fish production in pounds for 1983.

	Michigan			Wisconsin					
Species	Green Bay MM-1	Michigan proper	Total	Green Bay WM-1,2	Michigan proper	Total	Illinois	Indiana	Grand Total
Alewife	2,104,510	—	2,104,510	4,032,117	19,044,549	23,076,666	—	—	25,181,176
Bullheads	—	—	—	29,946	—	29,946	—	—	29,946
Burbot	17,350	1,150	18,500	45,409	151	45,560	—	297	64,357
Carp	3,216	1,191	4,407	1,033,336	6,061	1,039,397	—	—	1,043,804
Channel catfish	12	5,891	5,903	312	—	312	—	75	6,290
Chubs	—	665,678	665,678	15,832	2,598,413	2,614,245	274,009	25,218	3,579,150
Lake herring	—	70	70	296	1	297	—	—	367
Lake trout	—	322,440	322,440	—	—	—	—	—	322,440
Lake whitefish	2,339,813	3,825,969	6,165,782	361,167	369,744	730,911	—	401	6,897,094
Northern pike	—	—	—	5,968	—	5,968	—	—	5,968
Pacific salmon	—	2,997	2,997	—	—	—	—	—	2,997
Round whitefish	—	152,672	152,672	1,337	55,854	57,191	—	—	209,863
Sheepshead	—	600	—	15	—	615	—	21	636
Smelt	6,333,584	673	6,334,257	203,899	583,420	787,319	—	4,979	7,126,555
Suckers	2,158,770	24,837	2,183,607	174,211	6,261	180,472	—	4,705	2,368,784
Walleye	—	1,612	1,612	898	—	898	—	29	2,539
White bass	—	—	—	11,629	—	11,629	—	—	11,629
Yellow perch	—	67,048	67,048	149,742	155,928	305,670	68,335	555,635	996,688
Total	12,957,255	5,072,228	18,029,483	6,066,114	22,820,982	28,887,096	342,344	591,360	47,850,283

Table 3. Lake Huron commercial fish production in pounds for 1983.

Species	Michigan			Ontario				
	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	—	2,956	2,956	6,577	—	—	6,577	9,533
Bowfin	—	212	212	—	—	—	—	212
Buffalo fish	—	3,353	3,353	—	—	—	—	3,353
Bullheads	—	7,096	7,096	—	1,642	951	2,593	9,689
Burbot	1,594	184	1,778	16,705	4,135	3,135	24,020	25,798
Carp	256	511,149	511,405	27,060	2,069	1,116	30,245	541,650
Channel catfish	6,002	664,075	670,077	60,338	135	8	60,481	730,558
Chubs	41,652	—	41,652	559,867	276,218	270	836,355	878,007
Crappie	—	9,187	9,187	—	—	—	—	9,187
Eel	—	—	—	6	—	—	6	6
Garfish	—	80	80	—	—	—	—	80
Gizzared Shad	—	84	84	—	—	—	—	84
Lake herring	2,204	—	2,204	24,094	23,006	4,707	51,807	54,011
Lake sturgeon	—	—	—	3,099	—	4,930	8,029	8,029
Lake trout	249,482	—	249,482	125,264	429	4,012	129,705	379,187
Lake whitefish	1,862,071	89,227	1,951,298	2,888,510	81,439	444,147	3,414,096	5,365,394
Northern pike	—	—	—	223	7,375	16,142	23,740	23,740
Pacific salmon	9,580	—	9,580	19,223	665	73,984	93,872	103,452
Quillback	—	53,546	53,546	—	—	—	—	53,546
Rock bass	—	19	19	393	275	1,129	1,797	1,816
Round whitefish	7,306	31,741	39,047	9,863	14,437	35,600	59,900	98,947
Sheepshead	5	20,677	20,682	56,061	—	11	56,072	76,754
Smelt	—	—	—	291	25	37	353	353
Splake	—	—	—	1,299	51,828	6,808	59,935	59,935
Suckers	10,592	145,641	156,233	65,906	48,055	38,269	152,230	308,463
Walleye	8,070	—	8,070	286,901	15,592	21,501	323,994	332,064
White bass	—	8,861	8,861	14,880	220	38	15,138	23,999
White perch	—	19	19	538	—	—	538	557
Yellow perch	2,917	136,904	139,821	505,456	65,231	83,605	654,292	794,113
Unidentified	—	—	—	52,636	6,877	135,912	195,425	195,425
Total	2,201,731	1,685,011	3,886,742	4,725,235	599,653	876,312	6,201,200	10,087,942

Table 4. Lake Erie commercial fish production in pounds for 1983.

Species	Michigan	New York	Ohio	Pennsylvania	U.S. Total	Ontario	Grand Total
Alewife	—	—	—	1,800	1,800	252,225	254,025
Bowfin	—	—	—	—	—	82,495	82,495
Buffalo	7,837	—	43,870	—	51,707	—	51,707
Bullheads	997	535	63,949	84	65,565	75,475	141,040
Burbot	—	10	—	1,916	1,926	6,146	8,072
Carp	622,604	390	929,297	98	1,553,019	196,821	1,749,840
Channel catfish	28,990	172	215,587	466	245,215	80,308	325,523
Crappie	—	1,220	—	—	1,220	20,553	21,773
Eel	—	—	—	—	—	309	309
Gizzard shad	665,000	106,303	505,335	98,379	1,375,017	—	1,375,017
Goldfish	—	—	6,073	—	6,073	—	6,073
Lake sturgeon	—	—	—	—	—	2,297	2,297
Lake trout	—	—	—	4	4	—	4
Lake whitefish	—	6	—	2,611	2,617	24,843	27,460
Northern pike	—	—	—	—	—	15,816	15,816
Pacific salmon	—	—	—	—	—	49,344	49,344
Quillback	1,510	—	101,125	—	102,635	—	102,635
Rock bass	—	143	—	—	143	44,869	45,012
Sheepshead	3,555	36,061	877,993	89,353	1,006,962	321,374	1,328,336
Shiners	—	—	—	8,218	8,218	—	8,218
Smelt	—	264	70	6,370	6,704	29,487,891	29,494,595
Suckers	185	14,618	49,773	10,457	75,033	28,612	103,645
Sunfish	—	—	—	—	—	59,945	59,945
Walleye	—	64,373	—	15,007	79,380	3,111,260	3,190,640
White bass	12,042	19,458	810,101	23,300	864,901	4,576,753	5,441,654
White perch	—	4,112	113,193	3,377	120,682	85,984	206,666
Yellow perch	—	59,516	263,221	65,011	387,748	5,641,598	6,029,346
Total	1,342,720	307,181	3,980,217	326,451	5,956,569	44,164,918	50,121,487

Table 5. Lake Ontario commercial fish production in pounds for 1983.

Species	New York	Ontario	Grand Total
Bowfin	—	11	11
Bullheads	28,385	295,104	323,489
Carp	558	96,300	96,858
Channel catfish	288	16,985	17,273
Crappie	2,334	31,365	33,699
Eel	1,128	148,398	149,526
Gizzard shad	500	—	500
Lake herring	39	5,772	5,811
Lake sturgeon	—	440	440
Lake whitefish	39	13,754	13,793
Northern pike	110	15,609	15,719
Pacific salmon	—	140	140
Rock bass	6,370	17,475	23,845
Round whitefish	—	78	78
Sheepshead	210	4,260	4,470
Smelt	—	97,833	97,833
Suckers	1,885	26,724	28,609
Sunfish	3,950	129,792	133,742
Walleye	21	4,396	4,417
White bass	30	8,056	8,086
White perch	27,020	64,141	91,161
Yellow perch	124,173	1,288,375	1,412,548
Total	197,040	2,265,008	2,462,048

Table 5. Lake Ontario commercial fish production in pounds for 1983.

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Bullheads	28,385	295,104	323,489
Carp	558	96,300	96,858
Channel catfish	288	16,985	17,273
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Gizzard shad	500	—	500
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Lake sturgeon	—	440	440
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Pacific salmon	—	140	140
Rock bass	6,370	17,475	23,845
Round whitefish	—	78	78
Sheepshead	210	4,260	4,470
Smelt	—	97,833	97,833
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Sunfish	3,950	129,792	133,742
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GREAT LAKES FISH DISEASE CONTROL COMMITTEE REPORT

T. G. Carey, Chairman
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Fisheries Research Branch
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Ottawa, Ontario K1A 0E6

In 1982, the Great Lakes Fish Disease Control Committee (GLFDCC) completed its book on "A Guide to Integrated Fish Health Management in the Great Lakes Basin." The major thrust of this book is to foster development of broad, integrated plans as an effective approach for control of fish diseases. In keeping with this theme, the Committee has initiated a long-term project to develop an integrated plan for controlling bacterial kidney disease (BKD), one of the widely distributed diseases in the region. A Sub-committee chaired by Brian Souter, Canada, has been established to coordinate activities related to this project. This is an important initiative, firstly because of its focus on an existing fish health problem within the Great Lakes basin, rather than on preventing introduction of new diseases to the region. Secondly, it recognizes that the need foreseen for research and development in this field exceeds the level of investment that any one agency can afford, and that more can be accomplished through inter-agency collaboration.

A Subcommittee on Early Mortality of Chinook Salmon, established by the GLFDCC in 1982 under the chairmanship of John Schachte, New York Department of Environmental Conservation, has completed its investigations. Mortality during the early rearing period of chinook salmon in Great Lakes basin hatcheries ranged from 6–8 percent, with some agencies recording mortalities as high as 30–50 percent. The Sub-committee recommended that emphasis on feeds and feeding practices offered the most promising method of managing around the early mortality problem.

A useful summary of fish and egg importation, transportation and stocking permit requirements has been prepared and circulated to all agency and private sector representatives in the GLFDCC. This summary provides

up-to-date information, on a state/province basis, related to fish transfers, health certifications, stocking permit requirements and agencies to contact on fish health matters. A brochure outlining the objectives and activities of the GLFDCC is also nearing completion.

Jim Warren, Chairman of the GLFDCC since its inception in 1975, was transferred within the U.S. Fish and Wildlife Service to the West Coast in 1983. Jim was largely instrumental in guiding the Committee to its present stage of development, and many of the significant achievements to date can be attributed to his personal effort and leadership. The Committee would like to acknowledge Jim's fine contribution, and wish him every success in his new position.

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 1983, about 38 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 spawning, 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 eggs to produce backcrosses. It was believed these fish would retain the advantages of early maturity and fast growth. The first backcrosses were produced in the fall of 1971 and planted in Lake Huron as yearlings in the spring of 1973, and the program was 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 now figures large in future hatchery programming, and in management plans.

Table 1 summarizes annual plantings of lake trout and hybrids in the

Great Lakes, and Table 2 details the 1983 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 1983 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 1983 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 1972–1983.

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 1983, and Table 10 details the 1983 plantings. Table 11 summarizes annual plantings of brown trout for 1975 through 1983, and Table 12 details the 1983 plantings. Brook trout plantings were included for the first time in 1976 (Table 13). Table 14 details the 1983 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. Currest estimates of Great Lakes fisheries values: 1979 status report. Great Lakes Fishery Commission. Ann Arbor, Michigan. Rep. 79-1: 17 pp. (Mimeo.)

Table 1 Annual plantings (in thousands) of lake trout, splake[1] [2] and backcrosses[3] in the Great Lakes, 1958–1983.

	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	2,385
1983	809	448	392	1,256	2,907
Subtotal	27,036	10,484	6,335	15,916	59,771

	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.)

LAKE MICHIGAN

Year	Michigan	Wisconsin	Illinois	Indiana	Total
1981	1,459	831	173	172	2,635
1982	1,305	1,022	204	216	2,746
1983	1,071	720	166	157	2,115
Subtotal	21,760	17,901	2,326	2,486	44,470

LAKE HURON

	Michigan			Ontario			
Year	Lake trout	Splake	Backcrosses	Lake trout	Splake	Backcrosses	Total
1969	—	—	—	—	35	—	35
1970	—	43	—	—	247	—	290
1971	—	74	—	—	468	—	542
1972	—	215	—	—	333	—	548
1973	629	—	486	—	412	—	1,527
1974	793	—	—	—	299	—	1,092
1975	1,053	—	—	—	523	—	1,576
1976	1,024	—	—	—	658	—	1,682
1977	1,033	—	250	15	879	61	2,238
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
1983	1,061	—	—	18	—	856	1,934
Subtotal	12,209	332	736	121	6,994	917	21,306

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
1983	93	128	222
Subtotal	944	1,560	2,504

Table 1 (Cont'd.)

LAKE ONTARIO

	Ontario		New York	
Year	Splake	Lake trout	Lake trout	Total
1972	48	—	—	48
1973	39	—	66	105
1974	26	—	644	670
1975	—	—	514	514
1976	6	194	337	537
1977	—	288	298	586
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
1983	—	372	1,098	1,469
Subtotal	119	2,416	8,285	10,819
Great Lakes Total, lake trout, splake and backcrosses, 1958–1983				138,870

[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[1,2] in the Great Lakes, 1983.

Location	Grid Number	Numbers	Age	Fin Clip/Mark
		LAKE SUPERIOR-LAKE TROUT		
Michigan waters				
Anna River	1633	25,000[4]	Y	adipose
Big Bay Reef	1328	50,000[4]	Y	adipose
Black River	1413	30,000[4]	Y	none
Copper Harbor	0926	25,000[4]	Y	adipose
Grand Marais	1438	32,920[4]	Y	adipose
Laughing Fish Point	1531	50,000[4]	Y	both pectoral
Laughing Whitefish Point	1532	74,500[3]	Y	adipose
Loma Farms	1428	75,000[4]	Y	adipose
McLain State Park	1122	50,000[4]	Y	adipose
Ontonagon River	1318	25,000[4]	Y	adipose
Partridge Island Reef	1529	101,100[3]	Y	adipose-right pectoral
Presque Isle Harbor	1529	50,000[4]	Y	both pectoral
Pt. Abbaye Reef	1325	75,000[4]	Y	adipose
Shelter Bay	1632	50,000[4]	Y	adipose
Traverse Island Reef	1224	70,700[3]	Y	adipose
Union Bay	1316	25,000[4]	Y	adipose
Subtotal		809,220		
Minnesota waters				
Good Harbor Bay	811	42,720[4]	Y	adipose-right pectoral
Good Harbor Bay	811	15,400[4]	Y	adipose-right pectoral
Little Marais	1007	82,950	Y	adipose
Split Rock River	1106	50,009	Y	adipose-right pectoral
Split Rock River	1106	43,740	Y	adipose
Stoney Point	1303	82,050	Y	adipose
Taconite Harbor	908	75,000	Y	adipose
Subtotal		391,869		
Ontario waters				
Battle Island	228	6,420[3]	Y	adipose
Beetle Point	228	10,013	Y	adipose
Buck Island	320	71,280[3]	Y	adipose
Burnt Point	126	380	6 yrs	adipose
Caribou Island	320	55,840[3]	Y	adipose
Channel Island	229	10,013[3]	Y	adipose
Cobinosh Island	228	7,310[3]	Y	adipose
Coldwell	234	61,096	Y	adipose
Cooper Point	124	160	6 yrs	adipose
Copper Island	230	24,463[3]	Y	adipose
Crichton Island	124	53[3]	6 yrs	adipose
Druid Rock	126	41,800	FF	left ventral
Dublin Creek	126	40	6 yrs	adipose
Goulais Bay	1446	46,800	Y	adipose
Harmony Bay	1347	27,000	Y	adipose
Harry Island	228	6,420[3]	Y	adipose

Table 2. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Healey Island	229	10,013[3]	Y	adipose
Ile, La Grange NW	124	45,360[3]	FF	left ventral
Jackpine River	475	10	6 yrs	adipose
Kama Point	124	160	6 yrs	adipose
Lapoint's Point	1447	49,082	Y	adipose
Lindsay Harbour	229	10,013	Y	adipose
Little Lake Harbour	228	4,997	Y	adipose
Mamainse Point	1245	26,881	Y	adipose
Mary Island	320	101,379[3]	Y	adipose
Montreal River	1145	51,809	Y	adipose
McKenzie Bay	320	55,955	Y	adipose
Michipicoten Harbour	744	49,500	Y	adipose
Minnie Island	228	23,353[3]	Y	adipose
Morn Harbour	228	10,013	Y	adipose
Nipigon Straits	124	150	6 yrs	adipose
Old Woman River	844	23,650	Y	adipose
Outan Island	124	38,880[3]	FF	left ventral
Prairie Cove	233	47,355	Y	adipose
Quarry Island	228	10,013	Y	adipose
Rolette Shoal	228	10,013	Y	adipose
Silver Harbour	320	23,760	Y	adipose
Sinclair Cove	1045	25,000	Y	adipose
Sturdee Cove	235	47,355	Y	adipose
Tracy Shoal	228	10,013	Y	adipose
Terrace Bay	230	50,412	Y	adipose
Terrace Bay	230	4,033	2 yrs	right ventral
Vert Island	124	129,600[3]	FF	left ventral
Vert-Outan Island	124	16,200[3]	FF	left ventral
Wilson Island	228	12,326[3]	Y	adipose
Subtotal		1,256,373		
Wisconsin waters				
Bayfield	1409	131,800	Y	adipose
Bayfield	1409	25,200[4]	Y	adipose
Bayfield	1409	175,329[4]	FF	left pectoral-right ventral
Superior Entry	1401	117,400	Y	adipose
Subtotal		449,729		
Total, Lake Superior		2,907,191		
		LAKE MICHIGAN-LAKE TROUT		
Illinois waters				
Julians's Reef	2403	166,400[3]	Y	both ventrals
Indiana waters				
Burn's Harbor	2706	79,500	Y	dorsal
East Chicago	2704	38,000	Y	dorsal
Michigan City	2707	39,500	Y	dorsal
Subtotal		157,000		

Table 2. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Michigan waters				
Acme	916	75,500	Y	dorsal
Charlevoix	616	71,100	Y	left pectoral-right ventral
Frankfort	1011	75,600	Y	dorsal
Good Harbor Bay	814	25,000[3]	Y	left pectoral-right ventral
Grand Haven	1911	90,600	Y	dorsal
Greilickville	915	78,900	Y	dorsal
Holland	2111	90,000	Y	left pectoral-right ventral
Ludington	1410	78,700	Y	dorsal
Manistee	1211	76,800	Y	dorsal
Montague	1710	88,000	Y	dorsal
Muskegon River	1810	25,000	Y	dorsal
Pentwater Lake	1510	90,500	Y	dorsal
South Fox Island	513	25,000[3]	Y	left pectoral-right ventral
South Haven	2311	90,000	Y	dorsal
St. Joseph	2509	90,000	Y	dorsal
Subtotal		1,070,700		
Wisconsin waters				
Black Can Reef	905	106,700[3]	Y	both ventrals
Kewaunee	1104	111,400[3]	Y	both ventrals
Sheboygan Reef	1706	502,390[3]	Y	right pectoral-left ventral
Subtotal		720,490		
Total, Lake Michigan		2,114,590		

LAKE HURON-LAKE TROUT AND SPLAKE

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Michigan waters (lake trout)				
Adams Point	608	70,100	Y	left ventral
Black River Island	1010	69,400[3]	Y	left ventral
Greenbush	1110	69,800	Y	left ventral
Grindstone City	1412	105,000	Y	left ventral
Hammond Bay	505	70,000	Y	left ventral
Harbor Beach	1514	100,000	Y	left ventral
Lexington	1915	25,000	Y	left ventral
Middle Island	710	70,000[3]	Y	left ventral
Oscoda	1210	98,500	Y	left ventral
Point Lookout	1408	70,000	Y	left ventral
Port Austin	1411	52,000	Y	left ventral
Port Sanilac	1814	50,000	Y	left ventral
Scarecrow Island	910	70,200[3]	Y	left ventral
Sturgeon Point	1010	70,500[3]	Y	left ventral
Tawas Point	1309	70,000	Y	left ventral
Subtotal		1,060,500		
Ontario waters (lake trout)				
Iroquois Bay	219	3,000	Y	right pectoral
South Bay	418	7,500	Y	adipose
South Bay	418	7,500	Y	adipose-right ventral
Subtotal		18,000		

Table 2. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Ontario waters (backcross splake)				
Big Sound	0629	43,867	Y	right ventral
Boucher Point	1126	30,057	Y	right ventral
Cape Dundas	0925	18,923	Y	right ventral
Dyer Bay	0721	63,188	Y	right pectoral
Griffith Island	1024	21,006[3]	Y	right ventral
Heywood Island	318	115,014[3]	Y	right ventral
Jackson Shoal	0822	68,885	Y	right ventral
Killbear Park	0628	16,133	Y	right ventral
Mary Ward Shoal	1228	107,770[3]	Y	right ventral
Meaford Range	1025	97,087	Y	right ventral
North Keppel	1024	3,584	Y	right ventral
Pyette Point	1025	101,560	Y	right ventral
South Bay	0617	14,994	Y	right ventral
Vail Point	1025	84,842	Y	right ventral
White Cloud Island	1024	69,038[3]	Y	right ventral
Subtotal		855,948		
Total, Lake Huron		1,934,448		

LAKE ERIE-LAKE TROUT

Location	Grid Number	Numbers	Age	Fin Clip/Mark
New York waters				
Barcelona	424	14,000	Y	adipose-CWT(60)42/25
Barcelona	424	29,000[3]	Y	adipose-CWT(60)42/25
Barcelona	424	41,700[3]	Y	adipose-CWT(60)42/24
Barcelona	424	35,200	Y	right pectoral
Barcelona	424	8,550	FF	right ventral
Subtotal		128,450		
Pennsylvania waters				
New York border	522	8,550	FF	right ventral
New York border	522	42,500[3]	Y	adipose-CWT(60)42/15
New York border	522	42,150[3]	Y	adipose-CWT(60)42/23
Subtotal		93,200		
Total, Lake Erie		221,650		

LAKE ONTARIO-LAKE TROUT

Location	Grid Number	Numbers	Age	Fin Clip/Mark
New York waters				
Dablon Point	322	14,000	Y	adipose-CWT(60)42/09
Dablon Point	322	28,850[3]	Y	adipose-CWT(60)42/09
Dablon Point	322	40,500[3]	Y	adipose-CWT(60)42/12
Dablon Point	322	51,100[3]	Y	adipose-CWT(60)42/28
Dablon Point	322	52,000[3]	Y	left pectoral
Hamlin	713	40,500	Y	adipose-CWT(60)42/10
Hamlin	713	23,000[3]	Y	adipose-CWT(60)42/17
Hamlin	713	18,000	Y	adipose-CWT(60)42/17
Hamlin	713	41,000[3]	Y	adipose-CWT(60)42/20

Table 2. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Hamlin	713	51,400[3]	Y	left pectoral
Niagara	806	36,000[3]	Y	adipose-CWT(60)42/14
Niagara	806	6,000	Y	adipose-CWT(60)42/14
Niagara	806	37,390[3]	Y	adipose-CWT(60)42/18
Niagara	806	43,170[3]	Y	adipose-CWT(60)42/19
Niagara	806	38,000[3]	Y	left pectoral
Niagara	806	13,000	Y	left pectoral
Selkirk	623	40,500	Y	adipose-CWT(60)42/11
Selkirk	623	41,000[3]	Y	adipose-CWT(60)42/22
Selkirk	623	51,000[3]	Y	adipose-CWT(60)42/30
Selkirk	623	51,500[3]	Y	left pectoral
Sodus	818	41,000[3]	Y	adipose-CWT(60)42/16
Sodus	818	41,000[3]	Y	adipose-CWT(60)42/21
Sodus	818	51,000[3]	Y	adipose-CWT(60)42/31
Sodus	818	51,000[3]	Y	left pectoral
Stony Point	422	10,600	FF	adipose-CWT(60)42/36
Stony Point	422	41,250[3]	Y	adipose-CWT(60)42/08
Stony Point	422	42,000[3]	Y	adipose-CWT(60)42/13
Stony Point	422	51,000[3]	Y	adipose-CWT(60)42/29
Stony Point	422	51,000[3]	Y	left pectoral
Subtotal		1,097,760		
Ontario waters				
Bath	320	3,900	Y	right ventral
Grimsby Harbour	804	84,615	Y	right ventral
Main Duck Islands	421	182,985[3]	Y	right ventral-CWT(63)36/1
Port Hope	411	100,002	Y	right ventral
Subtotal		371,502		
Total, Lake Ontario		1,469,262		
Great Lakes Total		8,647,141		

[1]Lake trout × brook trout hybrid.
[2]Excludes small local splake plants for nearshore fishery (see Table 3).
[3]Offshore plants.
[4]State plants-all other U.S. plants by U.S. Fish and Wildlife Service.

Table 3. Plantings of F^1 splake in Lakes Superior and Michigan, 1971 to 1983. The 1977 plant was of backcrosses.

Year	State	Location	Grid No.	Numbers	Age	Fin Clip
		LAKE SUPERIOR				
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
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	24,000	F	none
		Washburn Coal Dock	1509	16,000	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
	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

Table 3. (Cont'd.)

1983	Wisconsin	Washburn	1509	30,000	F	none
		Ashland	1509	30,000	F	adipose
		Ashland	1509	40,000	Y	none
		Bark Point	1307	10,000	Y	none
		Cornucopia	1307	10,000	Y	none
		Pikes Bay	1409	9,750	F	adipose
		Pikes Bay	1409	8,000	Y	none
		Washburn	1509	30,000	F	adipose
		Washburn	1509	40,000	Y	none
	Subtotal			1,032,006		
			LAKE MICHIGAN			
1983	Wisconsin	Marinette	703	20,000	F	adipose-left maxillary
	Great Lakes Total			1,052,006		

Table 4. Annual plantings (in thousands) of coho salmon in the Great Lakes, 1966–1983.

		LAKE SUPERIOR		
Year	Michigan	Minnesota	Ontario	Total
1966	192	—	—	192
1967	467	—	—	467
1968	382	—	—	382
1969	526	110	20	656
1970	507	111	31	649
1971	402	188	27	617
1972	152	145	—	297
1973	100	35	—	135
1974	455	74	—	529
1975	275	—	—	275
1976	400	—	—	400
1977	627	—	—	627
1978	140	—	—	140
1979	200	—	—	200
1980	350	—	—	350
1981	227	—	—	227
1982	236	—	—	236
1983	325	—	—	325
Subtotal	5,963	663	78	6,704

		LAKE MICHIGAN			
Year	Michigan	Wisconsin	Indiana	Illinois	Total
1966	660	—	—	—	660
1967	1,732	—	—	—	1,732
1968	1,176	25	—	—	1,201
1969	3,054	217	—	9	3,280
1970	3,155	340	48	—	3,543
1971	2,411	267	68	5	2,751
1972	2,269	258	96	—	2,643
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	319	102	324	2,451
1982	1,645	216	160	159	2,181
1983	1,880	357	128	—	2,364
Subtotal	38,452	5,457	1,523	1,292	46,723

Table 4. (Cont'd.)

LAKE HURON

Year	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
1983	425	425
Subtotal	7,751	7,751

LAKE ERIE

Year	Michigan	Ohio	Pennsylvania	New York	Total
1968	—	20	86	5	111
1969	—	92	134	10	236
1970	—	253	197	74	525
1971	—	122	152	95	369
1972	—	38	131	50	219
1973	—	96	315	—	411
1974	200	188	366	29	783
1975	101	231	363	125	819
1976	199	568	248	477	1,491
1977	645	282	636	269	1,832
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
1983	289	279	1,153	181	1,902
Subtotal	3,101	3,574	7,257	1,769	15,698

Table 4. (Cont'd.)

LAKE ONTARIO

Year	Ontario	New York	Total
1968	—	40	40
1969	130	109	239
1970	145	294	439
1971	160	122	282
1972	122	230	352
1973	272	240	512
1974	438	217	655
1975	226	812	1,038
1976	166	178	343
1977	313	39	352
1978	201	80	281
1979	286	344	630
1980	77	299	377
1981	363	—	363
1982	112	367	479
1983	218	447	664
Subtotal	3,229	3,818	7,046

Great Lakes Total, coho salmon, 1966–1983			83,928

Table 5. Plantings of coho salmon in the Great Lakes, 1983

Location	Grid Number	Numbers	Age	Fin Clip/Mark
LAKE SUPERIOR-COHO SALMON				
Michigan waters				
Black River	1413	75,058	Y	none
Dead River	1529	150,088	Y	none
Munising Bay	1634	50,004	Y	none
Sucker River	1439	50,047	Y	none
Subtotal		325,197		
Total, Lake Superior		325,197		
LAKE MICHIGAN-COHO SALMON				
Indiana waters				
Little Calumet River	2705	75,479	FF	none
Trail Creek	2707	52,076	FF	none
Subtotal		127,555		
Michigan waters				
Grand River	1911	400,000	Y	none
Little Manistee River	1211	429,612	Y	none
Platte River	912	953,499	Y	none
Thompson Creek	211	96,846	Y	none
Subtotal		1,879,957		
Wisconsin waters				
Kenosha	2202	29,040	Y	none
Milwaukee	1901	99,120	Y	none
Port Washington	1701	78,000	Y	none
Racine	2101	44,980	Y	none
Sheboygan	1502	105,360		none
Subtotal		356,500		
Total, Lake Michigan		2,364,012		
LAKE HURON-COHO SALMON				
Michigan waters				
Diamond Creek	1513	100,000	Y	none
Swan River	607	250,138	Y	none
Tawas River	1308	75,000	Y	none
Subtotal		425,138		
Total, Lake Huron		425,138		
LAKE ERIE-COHO SALMON				
Michigan waters				
Detroit River	603	200,021	Y	none
Huron River	702	88,834	Y	none
Subtotal		288,855		

Table 5 (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
New York waters				
Canadaway Creek	425	18,000	Y	none
Cattaraugus Creek	327	82,120	Y	none
Chautauqua Creek	424	40,000	Y	none
Eighteen Mile Creek	228	40,500	Y	none
Subtotal		180,620		
Ohio waters				
Chagrin River	813	64,000	Y	left pectoral
Chagrin River	813	79,000[1]	Y	left ventral
Chagrin River	813	32,000	Y	none
Huron River	1006	52,000[1]	Y	adipose
Huron River	1006	52,000	Y	right pectoral
Subtotal		279,000		
Pennsylvania waters				
Crooked Creek	619	52,845	Y	none
Elk Creek	619	15,000	Y	adipose
Elk Creek	619	104,000	Y	none
Godfrey Run	619	137,000	Y	none
Orchard Beach Run	523	40,000	Y	none
Orchard Beach Run	523	20,360[2]	Y	none
Presque Isle Bay	521	275,000	Y	none
Raccoon Creek	619	43,921	Y	none
Sixteen Mile Creek	523	50,000	Y	none
Trout Run	620	150,000	Y	none
Twelve Mile Creek	522	50,000	Y	none
Twelve Mile Nursery	522	15,000[2]	Y	none
Twenty Mile Creek	523	50,000	Y	none
Walnut Creek	620	150,000	Y	none
Subtotal		1,153,126		
Total, Lake Erie		1,901,601		
LAKE ONTARIO-COHO SALMON				
New York waters				
Beaverdam Brook	623	176,000	Y	none
Black River	424	27,700	Y	left pectoral
Eighteen Mile Creek	708	41,800	Y	none
North Sandy Creek	523	13,900	Y	none
Oak Orchard Creek	711	41,800	Y	none
Salmon River	623	27,000	Y	left ventral
Salmon River	623	24,900	FF	left ventral
Sandy Creek	713	53,700	Y	none
Selkirk Shores State Park	623	26,000	FF	left pectoral
South Sandy Creek	523	13,900	Y	none
Subtotal		446,700		

Table 5. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Ontario waters				
Bronte Creek	602	24,449	Y	right ventral
Credit River	602	93,237	Y	adipose
Twelve Mile Creek	805	24,182	Y	right pectoral
Twelve Mile Creek	805	75,840	FF	right pectoral
Subtotal		217,708		
Total, Lake Ontario		664,408		
Great Lakes Total		5,680,356		

[1]Imprinted with morpholine.
[2]Raised and released by participant in cooperative nursery program.

Table 6. Annual plantings (in thousands) of chinook salmon in the Great Lakes, 1967–1983.

	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	50	278	478
1979	100	60	341	501
1980	276	60	393	729
1981	250	60	52	362
1982	330	60	920	1,313
1983	372	80	446	898
Subtotal	3,859	405	3,052	7,320

	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
1983	2,976	2,792	238	534	6,539
Subtotal	33,472	18,767	3,060	4,547	59,844

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
1983	2,696	2,696
Subtotal	77,223	77,223

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
1983	—	—	24	510	534
Subtotal	1,810	1,928	5,294	1,829	10,861

Table 6. (Cont'd.)

LAKE ONTARIO

Year	Ontario	New York	Total
1969	—	70	70
1970	—	141	141
1971	89	149	238
1972	190	427	617
1973	—	696	696
1974	225	963	1,188
1975	—	920	920
1976	—	593	593
1977	—	—	—
1978	393	—	393
1979	147	222	369
1980	118	788	906
1981	12	1,468	1,480
1982	270	1,808	2,078
1983	125	2,759	2,883
Subtotal	1,569	11,004	12,572

Great Lakes Total, chinook salmon, 1967–1983 167,830

Table 7. Plantings of chinook salmon in the Great Lakes, 1983.

Location	Grid Number	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	222,350	SF	none
Subtotal		372,350		
Minnesota waters				
Baptism River	1106	95,160	SF	none
Cascade River	811	104,710	SF	none
French River	1302	145,581	Y	none
Lester River	1302	70,400	SF	none
Rosebush Creek	812	29,920	SF	none
Temperance River	908	(379,143)	fry	none
Subtotal		445,771 (379,143 fry)		
Wisconsin waters				
Ashland	1509	5,000	Y	none
Black River	1401	75,000	Y	none
Subtotal		80,000		
Total, Lake Superior		898,121 (379,143 fry)		
LAKE MICHIGAN-CHINOOK SALMON				
Illinois waters				
Chicago	2703	282,400	SF	none
Chicago	2703	50,000	SF	left ventral
Waukegan	2302	201,200	SF	none
Subtotal		533,600		
Indiana waters				
Burns Harbor	2705	64,720	SF	none
East Chicago	2704	88,360	SF	none
Trail Creek	2707	85,303	SF	none
Subtotal		238,383		
Michigan waters				
Black River	2311	75,000	SF	none
Grand River	1911	643,085	SF	none
Jordan River	616	315,495	SF	none
Kalamazoo River	2211	100,000	SF	none
Little Manistee River	1211	677,250	SF	none
Manistee River	1211	210,000	SF	none

Table 7. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Manistique River	211	50,000	SF	none
Muskegon River	1810	200,000	SF	none
No Name Creek	206	104,900	SF	none
Portage Lake	1111	100,000	SF	none
Sable River	1410	200,000	SF	none
St. Joseph River	2509	300,000	SF	none
Subtotal		2,975,730		
Wisconsin waters				
Ahnapee River	1104	182,200	F	none
East Twin River	1303	75,000	F	none
Gills Rock	606	150,000	F	none
Kenosha	2202	200,000	F	none
Kewaunee	1104	280,000	F	none
Little Manitowoc River	1303	285,000	F	none
Menominee River	703	180,000	F	none
Menominee River	703	20,000	F	adipose-CWT(31)16/5
Milwaukee	1901	212,000	F	none
Oconto Park	802	100,000	F	none
Port Washington	1701	139,500	F	none
Racine	2101	250,000	F	none
Racine	2102	20,000	F	adipose-CWT(31)16/8
Sheboygan	1502	187,000	F	none
Sheboygan	1502	20,000	F	adipose-CWT(31)16/7
Strawberry Creek	905	331,000	F	none
Strawberry Creek	905	20,000	F	adipose-CWT(31)16/6
West Twin River	1303	140,000	F	none
Subtotal		2,791,700		
Total, Lake Michigan		6,539,413		
LAKE HURON-CHINOOK SALMON				
Michigan waters				
Au Gres River	1408	75,000	SF	none
Au Sable River	1210	500,000	SF	none
Carp River	202	75,000	SF	none
Harbor Beach	1514	300,000	SF	none
Harrisville	1110	300,000	SF	none
Lexington Harbor	1915	250,000	SF	none
Port Austin	1411	124,000	SF	none
Port Sanilac	1814	100,000	SF	none
St. Marys River	105	100,000	SF	none
Swan River	607	770,000	SF	none
Tawas River	1308	101,800	SF	none
Subtotal		2,695,800		
Total, Lake Huron		2,695,800		

Table 7. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
LAKE ERIE-CHINOOK SALMON				
New York waters				
Cattaraugus Creek	327	510,000	SF	none
Pennsylvania waters				
Lake Erie	619	24,000[2]	F	adipose
Total, Lake Erie		534,000		
LAKE ONTARIO-CHINOOK SALMON				
New York waters				
Black River	424	210,000	SF	none
Eighteen Mile Creek	708	205,000	SF	none
Genesee River	815	307,600	SF	none
Little Sodus Bay	720	199,500	SF	none
Niagara River	806	250,000	SF	none
North Sandy Creek	523	106,100	SF	none
Oak Orchard Creek	711	300,200	SF	none
Oswego River	721	259,100	SF	none
Salmon River	623	40,000	SF	right ventral
Salmon River	623	40,000	SF	left ventral
Salmon River	623	534,000	SF	none
Sodus Bay	819	201,400	SF	none
South Sandy Creek	523	105,600	SF	none
Subtotal		2,758,500		
Ontario waters				
Credit River	603	124,581	F	none
Total, Lake Ontario		2,883,081		
Great Lakes Total		13,550,515 (379,143 fry)		

[1]Imprinted with morpholine.
[2]Raised and released by participant in cooperative nursery program.

Table 8. Plantings of Atlantic salmon in the Great Lakes, 1972 to 1983.

Year	State	Location	Grid No.	Numbers	Age	Fin Clip
		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
		French River	1302	9,668	Y	adipose-left ventral
		French River	1302	234	A	left pectoral
1983	Minnesota	French River	1302	11,025	Y	adipose-right ventral
		French River	1302	286	A	adipose-right ventral
		French River	1302	37	A	none
		French River	1302	5,268	SF	none
	Total			128,264		
		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
		Boyne River	616	3,430[3]	A	right ventral
1976	Michigan	Boyne River	616	20,438[4]	Y	none
		Boyne River	616	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	1211	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
1982	Michigan	Little Manistee River	1211	25,030[1]	Y	adipose
		Pere Marquette River	1410	20,000[1]	Y	adipose
	Total			219,122		
		LAKE HURON				
1972	Michigan	AuSable River	1210	9,000[4]	Y	none
1982	Michigan	Thunder Bay (Part Pt.)	809	26,694[4]	FF	none
		Thunder Bay (Part Pt.)	809	600[4]	A	none
		Thunder Bay (Part Pt.)	809	110[4]	A	left ventral
	Total			36,404		

Table 8. (Cont'd.)

Year	State	Location	Grid No.	Numbers	Age	Fin Clip
		LAKE ONTARIO				
1983	New York	Irondequoit Creek	815	17,600[1]	Y	none
		Lindsey Creek	623	11,100[1]	Y	none
		Little Sandy Creek	623	20,200[1]	Y	none
	Total			48,900		
	Great Lakes Total, 1972–1983			432,690		

[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, 1975–1983.

LAKE SUPERIOR

Year	Michigan	Wisconsin	Minnesota	Total
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
1983	146	5	266	416
Subtotal	424	1,037	2,491	3,953

LAKE MICHIGAN

Year	Michigan	Wisconsin	Indiana	Illinois	Total
1975	701	397	217	253	1,568
1976	601	964	217	45	1,827
1977	305	683	48	276	1,312
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
1983	748	1,468	378	—	2,595
Subtotal	7,422	8,522	1,720	1,298	18,960

LAKE HURON

Year	Michigan	Ontario	Total
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
1983	400	74	474
Subtotal	2,839	897	3,735

Table 9. (Cont'd.)

LAKE ST CLAIR

Year	Michigan	Total
1982	40	40
1983	40	40
Subtotal	80	80

LAKE ERIE

Year	Michigan	Ontario	New York	Ohio	Pennsylvania	Total
1975	10	223	—	277	19	529
1976	60	250	25	196	113	644
1977	10	287	13	247	181	737
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
1983	50	12	126	370	554	1,112
Subtotal	305	1,657	407	2,087	2,681	7,133

LAKE ONTARIO

Year	New York	Ontario	Total
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
1983	464	105	569
Subtotal	3,179	1,467	4,649

Great Lakes Total, rainbow, steelhead, and palomino trout, 1975–1983 38,510

[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, 1983.

Location	Grid Number	Numbers	Age	Fin Clip/Mark
LAKE SUPERIOR-RAINBOW AND STEELHEAD TROUT				
Michigan waters (rainbow trout)				
Anna River	1633	20,000	Y	None
Marquette Bay	1529	10,000	Y	right pectoral
Two Hearted River	1441	30,000	Y	adipose
Subtotal		60,000		
Michigan waters (steelhead trout)				
Big Huron River	1325	15,000	Y	none
Black River	1413	15,016	Y	none
Chocolay River	1530	20,450	Y	left pectoral
Marquette	1529	10,130	Y	adipose-left pectoral
Ravine River	1424	10,000	Y	none
Two Hearted River	1441	15,000	Y	none
Subtotal		85,596		
Minnesota waters (rainbow trout)				
Baptism River	1106	16,405	Y	adipose-left maxillary
Beaver River	1106	9,995	Y	adipose-left maxillary
Brule River	813	12,600	Y	adipose-left maxillary
Carlson Creek	714	(10,685)	fry	none
Cascade River	811	(68,365)	fry	none
Cascade River	811	12,600	Y	adipose-left maxillary
Cascade River	811	3,386	Y	none
Devil Track River	812	(92,250)	fry	none
Flute Reed River	814	(26,435)	fry	none
French River	1302	3,451	Y	adipose-left ventral
French River	1302	5,078	Y	adipose-right maxillary
Kadunce Creek	813	(10,000)	fry	none
Kimball Creek	813	(15,761)	fry	none
Lester River	1302	37,070	Y	adipose-left maxillary
North Bluebird Lodge	1303	74,749	Y	adipose-left maxillary
Split Rock River	1106	9,996	Y	adipose-left maxillary
Stewart River	1204	39,081	Y	adipose-left maxillary
Sucker River	1302	41,663	Y	adipose-left maxillary
Temperance River	908	(10,041)	fry	none
Unnamed Creek	811	(2,000)	fry	none
Subtotal		266,074 (235,537 fry)		
Minnesota waters (steelhead trout)				
Baptism River	1106	(121,866)	fry	none
Beaver River	1106	(78,194)	fry	none
Brule River	813	(100,475)	fry	none
Caribou River	1007	(10,400)	fry	none
Carlson Creek	714	(42,185)	fry	none
Cascade River	811	(83,724)	fry	none

Table 10. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Cross River	908	(15,600)	fry	none
Cutface Creek	811	(5,260)	fry	none
Deer Yard Creek	811	(15,750)	fry	none
French River	1302	(99,129)	fry	none
Gooseberry River	1205	(75,000)	fry	none
Jonvick Creek	910	(5,250)	fry	none
Kadunce Creek	813	(31,500)	fry	none
Kimball Creek	813	(42,000)	fry	none
Knife River	1303	(25,075)	fry	none
Lester River	1302	(109,735)	fry	none
Onion River	909	(21,000)	fry	none
Silver River	1204	(54,000)	fry	none
Splitrock River	1106	(113,508)	fry	none
Talmadge River	1302	(15,214)	fry	none
Temperance River	908	(134,000)	fry	none
Two Island River	908	(21,219)	fry	none
Subtotal		(1,220,084 fry)		
Wisconsin waters (rainbow trout)				
Little Brule River	1404	4,740	Y	none
Total, Lake Superior		416,410 (1,455,621 fry)		

LAKE MICHIGAN-RAINBOW AND STEELHEAD TROUT

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Indiana waters (steelhead trout)				
Little Calumet River	2705	95,128	F	none
Little Calumet River	2705	45,086	Y	none
Little Calumet River	2705	97,236	F	left pectoral
Trail Creek	2707	27,702	F	none
Trail Creek	2707	41,754	Y	none
Trail Creek	2707	71,438	F	left pectoral
Subtotal		378,344		
Michigan waters (rainbow trout)				
Harbor Springs	519	20,000	Y	none
Menominee River	703	10,000	Y	none
Thompson Creek	211	10,000	Y	none
Wells State Park	504	10,000	Y	none
Subtotal		50,000		
Michigan waters (steelhead trout)				
Bear River	519	10,000	Y	none
Betsie River	1011	23,359	Y	none
Big Cedar River	504	20,000	Y	none
Big Rabbit River	2211	10,000	Y	none
Black River	2311	20,000	Y	none

Table 10. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Boardman River	915	15,000	Y	none
Boyne River	616	10,000	Y	none
E. Grand Traverse Bay	915	15,000	Y	none
Elk River	816	10,000	Y	none
Farmer Creek	2509	64,341	FF	none
Galien River	2708	15,000	Y	none
Grand River	1911	10,000	Y	none
Jordan River	616	10,000	Y	none
Little Manistee River	1211	8,214	Y	dorsal
Little Manistee River	1211	1,000	Y	right pectoral-left ventral
Little Manistee River	1211	7,214	Y	adipose-dorsal
Manistee River	1211	30,044	Y	none
Manistique River	211	15,000	Y	none
Menominee River	703	15,000	Y	none
Muskegon River	1810	95,015	Y	none
Pentwater River	1510	10,000	Y	none
Pipestone Creek	2509	30,000	FF	none
Rapid River	816	10,000	Y	none
St. Joseph River	2509	164,277	FF	none
St. Joseph River	2509	40,000	Y	none
White River	1710	25,000	Y	none
Whitefish River	208	15,000	Y	none
Subtotal		698,464		
Wisconsin waters (rainbow trout)				
Algoma	1004	30,000	F	none
Algoma	1004	18,050	Y	none
Baileys Harbor	706	7,700	Y	none
Coast Guard Station	905	50,000	F	none
Ellison Bay	606	15,750	F	none
Gills Rock	606	20,000	F	none
Gills Rock	606	5,000	Y	none
Kenosha	2202	63,000	F	none
Kenosha	2202	53,000	Y	none
Kewaunee	1104	40,000	F	none
Kewaunee	1104	18,700	Y	none
Little River	703	20,000	F	none
Little River	703	20,000	Y	none
Manitowoc River	1303	62,183	F	none
Manitowoc River	1303	27,900	Y	none
Milwaukee	1901	170,444	F	none
Milwaukee	1901	24,000	Y	none
Moonlight Bay	706	7,460	Y	none
Oconto River	802	43,000	F	none
Oconto River	802	20,000	Y	none
Peshtigo River	803	10,000	Y	none
Port Washington	1701	257,109	F	none
Port Washington	1701	50,618	Y	none
Racine	2101	35,000	F	none
Racine	2101	76,300	Y	none

Table 10. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Sheboygan	1502	149,690	F	none
Schaur Park	805	40,000	F	none
Sturgeon Bay	905	19,000	F	none
Two Rivers	1303	62,500	F	none
Two Rivers	1303	21,400	Y	none
Wester's	805	10,000	Y	none
Whitefish Bay	805	20,000	Y	none
Subtotal		1,467,804		
Total, Lake Michigan		2,594,612		
LAKE HURON-RAINBOW AND STEELHEAD TROUT				
Michigan waters (rainbow trout)				
Grindstone City	1412	20,000	Y	none
Harbor Beach	1514	20,000	Y	none
Harrisville	1110	10,000	Y	none
Lexington	1915	20,000	Y	none
Port Hope	1813	20,000	Y	none
Port Sanilac	1814	20,000	Y	none
Rogers City	607	10,000	Y	none
Tawas Bay	1309	20,000	Y	none
Subtotal		140,000		
Michigan waters (steelhead trout)				
Au Sable River	1210	125,000	Y	none
Carp River	202	10,000	Y	none
Cheboygan River	403	20,000	Y	none
Ocqueoc River	505	10,000	Y	none
Pigeon River	1510	15,000	Y	none
Pinnebog River	1411	10,000	Y	none
St. Marys River	105	30,000	Y	none
Sturgeon River	403	10,000	Y	none
Thunder Bay	809	20,000	Y	none
Whitney Drain	1408	10,000	Y	none
Subtotal		260,000		
Ontario waters (rainbow trout)				
Blyth Creek	1619	4,000	Y	adipose
Holmesville Creek	1619	4,000	Y	adipose
Perch Creek	2015	4,000	Y	none
Sarnia Harbour	2015	36,000	Y	none
Southhampton	1221	26,050	Y	none
Subtotal		74,050		
Total, Lake Huron		474,050		

Table 10. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
LAKE ST. CLAIR-STEELHEAD TROUT				
Michigan waters				
Belle River	0000	20,000	Y	none
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	701	50,000	Y	none
New York waters (rainbow trout)				
Buffalo	228	23,800	Y	none
Chautauqua Creek	424	50,000	F	none
Center Road	326	18,000	Y	none
Sturgeon Point	227	19,050	Y	none
Subtotal		110,850		
New York waters (steelhead trout)				
Chautauqua Creek	424	15,000	Y	adipose
Ohio waters (rainbow trout)				
Arcola Creek	814	18,750	F	none
Chagrin River	813	50,000	F	none
Conneaut Creek	718	112,500	F	none
Grand River	814	101,880	F	none
Rocky River	911	50,000	F	none
Vermilion River	1008	18,000	F	none
Wheeler Creek	717	18,750	F	none
Subtotal		369,880		
Ontario waters (rainbow trout)				
Big Creek	318	12,000	Y	none
Pennsylvania waters (rainbow trout)				
Conneaut Creek	718	517[2]	Y	none
Conneaut Creek	718	79[2]	2 yr	none
Conneaut Creek	718	1,400	Y	none
Crooked Creek	619	1,300	Y	none
Elk Creek	619	5,285	Y	none
Elk Creek	619	500[2]	Y	none
Racoon Creek	619	550[2]	Y	none
Racoon Creek	619	200[2]	2 yr	none

Table 10. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Temple Run	718	200[2]	Y	none
Temple Run	718	7,543[2]	Y	none
Temple Run	718	271[2]	2 yr	none
Twentymile Creek	523	1,800	Y	none
Walnut Creek	620	600[2]	Y	none
Walnut Creek	620	300[2]	2 yr	none
Subtotal		20,545		
Pennsylvania waters (steelhead trout)				
Elk Creek	619	75,000	Y	none
Godfrey Run	619	100,000	Y	none
Lake Erie	620	65,000[2]	Y	none
Sixteen Mile Creek	523	50,000	Y	none
Trout Run	620	100,000	Y	none
Twelve Mile Creek	522	50,000	Y	none
Walnut Creek	620	75,000	Y	none
Subtotal		515,000		
Pennsylvania waters (palomino trout)				
Conneaut Creek	718	500	Y	none
Crooked Creek	619	100	Y	none
Elk Creek	619	1,115	Y, 2 yr	none
Lake Erie	620	17,000[2]	Y	none
Subtotal		18,715		
Total, Lake Erie		1,111,990		
LAKE ONTARIO-RAINBOW AND STEELHEAD TROUT				
Ontario waters (rainbow trout)				
Credit River	603	95,675	Y	none
Duffin Creek	506	9,240	Y	none
Subtotal		104,915		
New York waters (rainbow trout)				
Chaumont Bay	324	90,000	SF	none
Hamlin Beach	713	25,000	FF	adipose-left ventral
Hamlin Beach	713	43	4 yr	none
Hamlin Beach	713	10,000	Y	adipose-left pectoral
Hamlin Beach	713	10,000	Y	none
Henderson Bay	424	5,000	Y	Floy tag
Henderson Bay	424	19,350	Y	left pectoral
Irondequoit	815	25,000	SF	none
Olcott Harbor	708	10,000	FF	none
Olcott Harbor	708	9,000	Y	none
Selkirk	623	23,680	Y	none
Selkirk Shores	623	19,900	FF	none
Sodus	819	9,240	Y	none

Table 10. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Sodus Point	819	10,760	Y	adipose-left pectoral
Sodus Point	819	25,000	FF	adipose-left ventral
Sodus Point	819	15,000	FF	none
Wilson	707	25,000	SF	none
Wilson Harbor	707	10,500	Y	none
Wilson Harbor	707	10,000	FF	none
Subtotal		352,473		
New York waters (steelhead trout)				
Beaverdam Brook	623	82,000	Y	left ventral
Orwell Brook	623	10,000	Y	left ventral
Spring Brook Reservoir	623	10,000	Y	left ventral
Trout Brook	623	10,000	Y	left ventral
Subtotal		112,000		
Total, Lake Ontario		569,388		
Great Lakes Total		5,206,450 (1,455,621 fry)		

[1]Virginia Golden hybrid (small numbers planted by Pennsylvania only).
[2]Reared and released by participant in cooperative nursery program.

Table 11. Annual Plantings (in thousands) of brown and tiger[1] trout in the Great Lakes, 1975–1983.

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
1983	76	40	2	118
Subtotal	226	678	171	1,075

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	—	2,139
1983	574	1,555	51	—	2,180
Subtotal	2,531	9,054	318	702	12,607

LAKE HURON

Year	Michigan	Ontario	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
1983	659	8	667
Subtotal	2,204	8	2,212

Table 11 (Cont'd.)

LAKE ST CLAIR

Year	Michigan	Total
1982	48	48
1983	69	69
Subtotal	117	117

LAKE ERIE

Year	Ohio	Pennsylvania	New York	Total
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
1983	30	52	100	182
Subtotal	164	332	566	1,062

LAKE ONTARIO

Year	New York	Ontario	Total
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
1983	712	123	835
Subtotal	3,797	180	3,977

Great Lakes Total, brown and tiger trout, 1975–1983: 21,050

[1]Brown × brook trout hybrid.

Table 12. Plantings of brown trout and tiger[1] trout in the Great Lakes, 1983.

Location	Grid Number	Numbers	Age	Fin Clip/Mark
LAKE SUPERIOR-BROWN TROUT				
Michigan waters				
Anna River	1633	20,000	FF	dorsal
Anna River	1633	10,000	Y	adipose-left pectoral
Presque Isle Harbor	1529	15,000	Y	right pectoral
Presque Isle Harbor	1529	31,460	FF	adipose
Subtotal		76,460		
Minnesota waters				
Baptism River	1106	1,480	Y	none
Keene Creek	1401	500	Y	none
Subtotal		1,980		
Wisconsin waters				
Ashland	1509	20,000	F	right ventral
Ashland	1509	20,000	Y	left ventral
Ashland	1509	7	A	none
Subtotal		40,007		
Total, Lake Superior		118,447		
LAKE MICHIGAN-BROWN TROUT				
Illinois waters				
Chicago	2603	25,000	FF	none
Waukegan Harbor	2302	25,925	FF	none
Subtotal		50,925		
Michigan waters				
Betsie River	1011	20,000	FF	none
Betsie River	1011	10,000	Y	none
Brewery Creek	915	59,000	FF	none
E. Grand Traverse Bay	915	70,000	FF	none
Galien River	2708	10,000	Y	none
Grand Haven	1911	20,000	FF	none
Harbor Spring	519	38,999	FF	none
Harbor Spring	519	14,989	Y	none
Henes Park	703	15,000	FF	none
Henes Park	703	5,000	Y	none
Holland	2111	20,000	FF	none
Ludington	1410	20,000	FF	none
Ludington	1410	10,000	Y	none
Manistee River	1211	20,000	FF	none
Muskegon Lake Outlet	1810	25,000	SF	none
Pine River	616	27,500	Y	none
Portage Lake	1111	20,000	FF	none
Portage Lake	1111	10,000	Y	none

Table 12. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Rochereau Point	604	15,000	FF	none
Ruby Creek	1410	850	FF	none
St. Joseph River	2509	20,000	FF	none
St. Joseph River	2509	10,000	Y	none
Saunders Point	306	20,000	FF	none
Saunders Point	306	10,000	Y	none
South Haven	2311	20,062	SF	none
South Haven	2311	2,600	FF	none
South Haven	2311	10,006	Y	none
Thompson Creek	211	10,000	Y	none
Wells State Park	504	15,000	FF	none
Wells State Park	504	5,000	Y	none
White Lake Channel	1710	20,000	FF	none
Subtotal		574,006		
Wisconsin waters				
Algoma	1004	48,500	F	none
Algoma	1004	46,300	Y	none
Baileys Harbor	706	22,700	F	none
Baileys Harbor	706	16,100	Y	none
Braunsdorf Beach	905	7,300	F	none
Braunsdorf Beach	905	11,400	Y	none
Coast Guard Station	905	50,500	F	none
Coast Guard Station	905	24,900	Y	none
Egg Harbor	705	22,000	F	none
Egg Harbor	705	10,200	Y	none
Ellison	606	9,000	F	none
Ephraim	605	7,300	F	none
Ephraim	605	15,088	Y	none
Fish Creek	705	10,000	F	none
Fish Creek	705	10,000	Y	none
Gills Rock	606	28,800	F	none
Gills Rock	606	5,600	Y	none
Little River	703	50,000	F	none
Little River	703	31,300	Y	none
Kenosha	2202	46,000	F	none
Kenosha	2202	24,900	Y	none
Kewaunee	1104	27,500	F	none
Kewaunee	1104	35,000	Y	none
Manitowoc River	1303	59,900	F	none
Manitowoc River	1303	43,600	Y	none
Milwaukee	1901	63,100	F	none
Milwaukee	1901	10,440	Y	none
Moonlight Bay	706	17,300	F	none
Moonlight Bay	706	5,500	Y	none
Oconto Pier	802	37,500	F	none
Oconto River	802	22,500	F	none
Oconto River	802	30,000	Y	none
Port Washington	1701	95,763	F	none
Port Washington	1701	35,230	Y	none

Table 12. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Racine	2101	62,800	F	none
Racine	2101	24,000	Y	none
Red Arrow Park	703	11,520	Y	none
Rowleys Bay	607	10,000	F	none
Rowleys Bay	607	5,500	Y	none
Schaur Park	805	10,000	F	none
Schaur Park	805	15,000	Y	none
Sheboygan	1502	159,960	F	none
Sheboygan	1502	12,667	Y	none
Sister Bay	606	5,600	Y	none
Sturgeon Bay	905	20,000	F	none
Sturgeon Bay	905	31,000	Y	none
Two Rivers	1303	48,300	F	none
Two Rivers	1303	41,650	Y	none
Washington Island	607	33,600	F	none
Westers	805	10,000	F	none
Westers	805	21,000	F	none
Whitefish Bay	805	10,000	F	none
Whitefish Bay	805	10,000	Y	none
Winnegar Pond	803	10,000	F	none
Winnegar Pond	803	21,000	Y	none
Subtotal		1,554,818		
Total, Lake Michigan		2,179,749		
LAKE HURON-BROWN TROUT				
Michigan waters				
Au Sable River	1210	30,000	FF	none
Brulee Point	303	10,000	Y	none
Carp River	202	10,000	Y	none
Caseville	1510	15,000	FF	none
Grindstone City	1412	20,000	FF	none
Grindstone City	1412	10,000	Y	none
Hammond Bay	505	25,000	FF	none
Harbor Beach	1514	20,000	FF	none
Harbor Beach	1514	10,000	Y	none
Harrisville	1110	20,245	FF	none
Harrisville	1110	10,000	Y	none
Hessel	303	4,900	FF	none
Lake Huron	304	4,900	FF	none
Lake Huron	304	10,000	Y	none
Lexington	1915	20,000	FF	none
Part Point	809	90,000	Y	none
Part Point	809	100,342	FF	dorsal
Point Lookout	1408	35,000	FF	none
Port Austin	1411	15,000	FF	none
Port Sanilac	1814	20,000	FF	none
Port Sanilac	1814	10,000	Y	none
Rockport	709	25,000	Y	none

Table 12. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
Rogers City	607	20,000	FF	none
St. Marys River	105	9,900	FF	none
St. Marys River	105	10,000	Y	none
Tawas Bay	1309	49,000	FF	none
Tawas Bay	1309	10,000	Y	none
Whitestone Point	1408	10,000	Y	none
Whitney Drain	1408	25,000	FF	none
Whitney Drain	1408	10,000	Y	none
Subtotal		659,287		
Ontario waters				
Georgian Bay	1224	8,190	Y	adipose-left pectoral
Total, Lake Huron		667,477		
LAKE ST. CLAIR-BROWN TROUT				
Michigan waters				
Black River	0000	20,000	Y	none
St. Clair River-Deckers Landing	0000	49,000	FF	none
Subtotal		69,000		
Total, Lake St. Clair		69,000		
LAKE ERIE-BROWN TROUT				
New York waters				
Buffalo	228	4,600	Y	none
Cattaraugus Creek	327	22,800	Y	none
Dunkirk	425	22,800	Y	none
Dunkirk	425	25,000	FF	none
Sturgeon Point	227	25,000	FF	none
Subtotal		100,200		
Ohio waters				
Grand River	814	30,000	F	none
Pennsylvania waters				
Conneaut Creek	718	3,505[2]	2 yr	none
Crooked Creek	619	1,400	2 yr	none
Elk Creek	619	9,450	2 yr	none
Lake Erie	620	32,500[2]	2 yr	none
Temple Run	718	3,172	2 yr	none
Temple Run	718	329	3 yr	none
Twentymile Creek	523	1,450	2 yr	none
Subtotal		51,806		
Total, Lake Erie		182,006		

Table 12. (Cont'd.)

Location	Grid Number	Numbers	Age	Fin Clip/Mark
		LAKE ONTARIO-BROWN TROUT		
New York waters				
Braddocks Bay	815	22,800	Y	none
Fair Haven	720	32,000	Y	none
Hamlin Beach	713	16,300	Y	none
Hamlin Beach	713	6,600	Y	left pectoral
Hamlin Beach	713	6,700	Y	adipose-left pectoral
Hamlin Beach	713	6,700	Y	left ventral
Henderson	424	25,000	SF	none
Henderson Bay	424	25,400	Y	adipose
Henderson Bay	424	5,000	Y	Floy tag
Irondequoit	815	6,700	Y	left pectoral
Irondequoit	815	6,700	Y	adipose-left pectoral
Irondequoit	815	6,700	Y	left ventral
Irondequoit	815	4,500	Y	none
Kodak Water Plant	815	29,200	Y	none
Olcott	708	82,300	SF	none
Olcott	708	25,000	FF	none
Olcott	708	36,500	Y	none
Oswego	721	25,000	FF	none
Oswego	721	7,300	Y	none
Oswego	721	25,700	Y	adipose-left ventral
Oswego	721	5,000	Y	Floy tag
Point Breeze	711	36,500	Y	none
Pultneyville	817	22,800	Y	none
Ray Bay	523	41,400	Y	none
Selkirk	623	36,800	Y	none
Selkrik	623	25,000	SF	none
Sodus Point	819	17,500	Y	none
Sodus Point	819	25,000	FF	none
Sodus Point	819	13,400	Y	none
Webster	816	6,700	Y	left pectoral
Webster	816	6,700	Y	adipose-left pectoral
Webster	816	6,700	Y	left ventral
Webster	816	4,500	Y	none
Wilson	707	25,000	FF	none
Wilson	707	36,500	Y	none
Subtotal		711,600		
Ontario waters				
Bronte Creek	703	21,300	Y	right pectoral
Burlington	702	23,500	Y	right pectoral
Ganaraska River	411	5,000	Y	none
Humber River	604	21,700	Y	right pectoral
Kingston	221	29,800	Y	none
Twelve Mile Creek	805	22,000	Y	right pectoral
Subtotal		123,300		
Total, Lake Ontario		834,900		
Great Lakes Total		4,051,579		

[1]Brown × brook trout hybrid.
[2]Reared and released by participant in cooperative nursery program.

Table 13. Annual plantings (in thousands) of brook trout in the Great Lakes, 1976–1983.

Year	Wisconsin	Minnesota	Ontario	Total
		LAKE SUPERIOR		
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
1983	59	—	—	59
Subtotal	703	145	11	858

Year	Michigan	Wisconsin	Illinois	Total
		LAKE MICHIGAN		
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
1983	—	300	—	300
Subtotal	69	2,053	39	2,161

Year	Pennsylvania	Total
	LAKE ERIE	
1976	6	6
1977	2	2
1978	2	2
1979	—	—
1980	6	6
1981	—	—
1982	4	4
1983	7	7
Subtotal	27	27

Table 13. (Cont'd.)

Year	LAKE ONTARIO New York	Total
1976	—	—
1977	8	8
1978	—	—
1979	—	—
1980	326	326
1981	106	106
1982	—	—
1983	—	—
Subtotal	440	440
Great Lakes Total, brook trout, 1976–1983		3,486

Table 14. Plantings of brook trout in the Great Lakes, 1983.

Location	Grid Number	Numbers	Age	Fin Clip/Mark
	LAKE SUPERIOR-BROOK TROUT			
Wisconsin waters				
Ashland	1509	100	A	none
Bayfield	1409	5,000	F	left pectoral
Bayfield	1409	13,200	Y	right ventral
Bayfield	1409	10,000	Y	left ventral
Washburn	1509	5,000	F	left pectoral
Washburn	1509	16,000	Y	right ventral
Washburn	1509	10,000	Y	left ventral
Subtotal		59,300		
Total, Lake Superior		59,300		
	LAKE MICHIGAN-BROOK TROUT			
Wisconsin waters				
Algoma	1004	15,660	F	none
Algoma	1004	10,000	Y	none
Baileys Harbor	706	5,000	Y	right ventral
Baileys Harbor	706	5,000	Y	none
Coast Guard Station	905	15,000	Y	none
Kewaunee	1104	38,697	F	none
Kewaunee	1104	10,000	Y	none
Manitowoc River	1303	10,000	Y	none
Milwaukee	1901	8,000	F	none
Port Washington	1701	10,121	F	none
Port Washington	1701	1,574	Y	none
Sheboygan	1502	61,970	F	none
Sheboygan	1502	22,403	Y	none
Sturgeon Bay	905	38,366	F	none
Two Rivers	1303	38,367	F	none
Two Rivers	1303	10,000	Y	none
Subtotal		300,158		
Total, Lake Michigan		300,158		
	LAKE ERIE-BROOK TROUT			
Pennsylvania waters				
Bender Pond	620	150[1]	Y	none
Conneaut Creek	718	3,000	Y, 2 yr	none
Temple Run	718	2,668	Y	none
Twelve Mile Creek	522	150[1]	Y	none
Twentymile Creek	523	1,200	Y	none
Subtotal		7,168		
Total, Lake Erie		7,168		
Great Lakes Total		366,626		

[1]Reared and released by participant in cooperative nursery program.

SEA LAMPREY MANAGEMENT IN THE GREAT LAKES

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The activities in 1983 by the sea lamprey control units of Canada and the United States are summarized in this joint report. Sea lamprey management programs are in place on all the Great Lakes except Lake Erie, where effort is confined to monitoring spawning-phase sea lampreys in one stream. The sea lamprey management program consists of four activities: surveys, chemical treatments, assessment, and biological investigations. Surveys for presence or absence and distribution of larval lampreys are carried out by the use of electricity or chemicals, treatments of streams or other bodies of water require the controlled application of selective toxicants, and assessment of lamprey numbers is accomplished by means of weirs and traps and purchasing lampreys from fishermen. Biological studies are focused upon the distribution, movement, growth, and abundance of sea lampreys.

Activities of the sea lamprey management program conducted in the United States and Canada progressed well in 1983. No new populations of sea lampreys were detected by surveys. A total of 77 chemical treatments were completed (Table 1), including first treatments of the lower Nipigon River and Polly Creek. Assessment traps captured 43,151 sea lampreys from 38 tributaries of the Great Lakes. Biological data on these lampreys are presented in Table 2. Parasitic-phase lampreys are abundant in northern Lake Huron.

The following sections describe the management activities and biological investigations for each lake basin in 1983.

Table 1. Summary of chemical treatments in streams, lakes, and bay areas of the Great Lakes in 1983.

						Bayer 73			
		Discharge at mouth		TFM		Powder		Granules	
	Number of			Act. Ingr.		Act Ingr.		Total Used[a]	
Lake	treatments	m^3/s	f^3/s	kg	lbs	kg	lbs	kg	lbs
Superior	31	166.4	5,888	17,336	38,162	199	439	5,438	11,963
Michigan	17	72.7	2,565	19,024	41,886	65	143	—	—
Huron	19	154.6	5,463	20,725	45,672	77	169	2,183	4,802
Ontario	10	50.6	1,788	6,109	13,440	15	33	—	—
TOTAL	77	444.3	15,704	63,194	139,140	356	784	7,621	16,765

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

LAKE SUPERIOR

SURVEYS

Surveys were conducted on 98 tributaries and 2 lentic areas of Lake Superior in 1983 to assess larval sea lamprey populations. Pretreatment investigations were completed on 28 streams: 14 were later treated and the others are scheduled for treatment in the future. Reestablished populations are also present in another 24 south shore streams. The most significant reinfestations appear to be developing in the Firesteel River and upstream reaches of the Sucker River. Sea lampreys are reestablished in all north shore rivers treated in 1981 and 1982 except in the Little Gravel River.

Residual sea lamprey larvae were collected from 7 of 10 Canadian streams surveyed to assess the effectiveness of lampricide treatments conducted in 1982 and 1983. Although only a few residual sea lampreys were found in the Sable, Michipicoten, and Gravel rivers, collections from the other four streams suggest higher numbers present. Relatively high numbers of larvae survived treatment in the Goulais River. Residual lampreys found in the mouth of Cash Creek and in the estuary of the lower Nipigon River probably survived the TFM treatments due to dilution. In the Steel River, attenuation of the lampricide block because of low flow probably contributed to larval survival.

Residual sea lampreys were found in 18 streams along the south shore of Lake Superior. The populations in all but three streams appeared to be small and should require no remedial action. In the Betsy, Traverse, and Miners rivers, however, residual lampreys were more numerous, and these populations will be monitored regularly to ascertain if re-treatment dates should be moved ahead. Larvae in the Betsy (12 larvae, 46–113 mm long)

Table 2 Number and biological characteristics of adult sea lampreys captured in assessment traps in 38 tributaries of the Great Lakes in 1983.

Lake	Number of streams	Total captured	Number sampled	Percent males	Mean length (mm)		Mean weight (g)	
					Males	Females	Males	Females
Superior	9	1,464	1,283	30	416	407	162	157
Michigan	12	12,158	4,501	40	476	478	218	232
Huron	7	20,629	4,180	49	465	471	220	234
Erie	1	1,671	1,544	53	498	492	275	278
Ontario	9	7,229	3,220	60	463	459	221	230

Table 2. Number and biological characteristics of adult sea lampreys captured in assessment traps in 38 tributaries of the Great Lakes in 1983.

Lake	Number of streams	Total captured	Number sampled	Percent males	Mean length (mm)		Mean weight (g)	
					Males	Females	Males	Females
Superior	9	1,464	1,283	30	416	407	162	157
Michigan	12	12,158	4,501	40	476	478	218	232
Huron	7	20,629	4,180	49	465	471	220	234
Erie	1	1,671	1,544	53	498	492	275	278
Ontario	9	7,229	3,220	60	463	459	221	230

were scattered throughout the system and probably resulted from significant water level fluctuations during the last treatment in September 1982. The majority of residuals (28, 34–114 mm) in the Traverse River were collected near the confluence of a high water channel that apparently was not exposed to lethal concentrations of lampricide during the July 1982 treatment. Most survivors of the 1982 treatment of the Miners River were confined to the delta area of the inlet to Miners Lake, where 8 larvae (66–112 mm) were recovered.

Granular Bayer 73 was used to survey lentic waters of Lake Superior. Batchawana Bay has been surveyed frequently in recent years and granular Bayer 73 treatments conducted where sea lamprey abundance appeared highest—in 1983, the assessment effort was increased to improve our knowledge of spatial distribution and abundance. Five separate sites in Goulais Bay (11,152 m^2, 120,000 sq. ft.) were sampled with granular Bayer 73, and 1,007 larval lampreys, including 129 sea lampreys (range, 31–156 mm long) were collected. The sample sites selected were along the dropoff area near the multiple mouths of the river. Because of the large area of Goulais Bay, an extensive effort would be required to provide an accurate assessment of the larval sea lamprey population. Surveys of lentic areas with Bayer 73 and backpack shockers yielded small numbers of sea lamprey larvae off the mouths of the Sucker, Silver, and Black rivers, and in inland lakes which are part of Harlow Creek, Miners River, and Beaver Lake systems.

Surveys continued in the St. Louis River to monitor changes in the larval population that first became established in 1979. Sampling in 1983, as in previous years, indicated a low density population extending downstream from a barrier dam at Fond du Lac to the bridge at Oliver (about 9 km, 5.6 miles). A total of 24 sea lamprey ammocetes (43 to 162 mm) were recovered from 28 sites sampled with granular Bayer 73. Only two of the larvae were longer than 80 mm.

Surveys were conducted to assess the effectiveness of the barrier dams on Stokely Creek and Gimlet Creek, a tributary of the Pancake River. Sea lamprey larvae above the dam on Stokely Creek were of the 1981 and earlier year classes, indicating the dam stopped upstream migrations of sea lampreys.

TREATMENTS

During 1983, TFM was applied to 25 tributaries and granular Bayer 73 to areas of 2 inland lakes and 4 bays on Lake Superior (Table 3, Fig. 1). The treatment season was characterized by extreme water levels—excessive discharge in the spring and late fall and near drought during summer. Sea lamprey larvae were abundant in the Salmon-Trout (Marquette County), Brule, Big Garlic, and Batchawana rivers and Polly Creek; moderately abundant in the Lower Nipigon, Chippewa, Little Carp, Two Hearted, and

Table 3. Details on the application of lampricides to streams, lakes, or bays of Lake Superior, 1983. [Number in parentheses corresponds to location of stream, lake, or bay in Figure 1.]

Stream, lake, or bay	Date	Discharge at mouth		TFM Act. Ingr.		Bayer 73 Powder Act. Ingr.		Bayer 73 Granules Total used[a]		Stream treated		Area treated	
		m^3/s	f^3/s	kg	lbs	kg	lbs	kg	lbs	km	miles	ha	acres
CANADA													
Little Carp R. (15)	June 7	0.7	25	71	156	—	—	—	—	9.4	6	—	—
Stillwater Cr. (5)	June 12	0.3	10	49	108	—	—	—	—	4.5	3	—	—
Poly Cr. (7)	June 15	0.2	8	48	106	—	—	—	—	2.8	2	—	—
Cash Cr. (8)	June 18	1.2	42	376	827	—	—	8	18	22.6	14	—	—
Lower Nipigon R.[b] (6)	July 10	67.4	2,382	6,188	13,614	99	218	—	—	5.0	3	—	—
Steel R. (12)	Aug. 16	3.4	120	316	695	5	11	—	—	10.1	6	—	—
Kaministikwia R. (2)	Aug. 19	28.8	1,017	3,057	6,725	53	117	9	20	58.1	36	—	—
Black Sturgeon R. (4)	Aug. 24	7.3	258	1,108	2,438	17	37	6	13	16.2	10	—	—
Chippewa R. (14)	Sept. 13	2.8	100	200	440	3	7	—	—	2.9	2	—	—
Batchawana R. (13)	Sept. 28	14.4	508	983	2,163	—	—	—	—	13.0	8	—	—
Helen Lake (9)	July 8	—	—	—	—	—	—	808	1,778	—	—	3.3	8
Batchawana Bay (13)													
Chippewa R.	July 20	—	—	—	—	—	—	908	1,998	—	—	3.7	9
Sable R.	July 22	—	—	—	—	—	—	294	647	—	—	1.2	3
Batchawana R.	July 25	—	—	—	—	—	—	907	1,995	—	—	3.7	9
Sand Point	July 26	—	—	—	—	—	—	272	598	—	—	1.1	3
Stokely Cr.	July 29	—	—	—	—	—	—	363	798	—	—	1.5	4
Harmony R.	Aug. 2	—	—	—	—	—	—	272	598	—	—	1.1	3
Polly Lake[b] (7)	Aug. 17	—	—	—	—	—	—	227	500	—	—	0.9	2
Mackenzie Bay (3)	Aug. 22	—	—	—	—	—	—	454	999	—	—	1.9	5
Cypress Bay (10)	Aug. 24	—	—	—	—	—	—	364	800	—	—	1.4	4
Mountain Bay (11)	Aug. 24	—	—	—	—	—	—	546	1,201	—	—	2.2	5
Total		126.5	4,470	12,396	27,272	177	390	5,438	11,963	144.6	90	22.0	55
UNITED STATES													
Salmon Trout R. (26)	May 19	2.1	75	220	484	—	—	—	—	11.3	7	—	—
Iron R. (25)	June 29	4.0	140	329	726	—	—	—	—	3.2	2	—	—
Tahquamenon R. (17)	July 7	9.3	330	1,327	2,926	22	49	—	—	29.0	18	—	—
Galloway Cr. (16)	July 12	0.1	3	20	44	—	—	—	—	3.2	2	—	—
Little Two Hearted R. (18)	Aug. 5	1.0	37	100	220	—	—	—	—	14.5	9	—	—
Big Two Hearted R. (19)	Aug. 6	3.7	130	798	1,760	—	—	—	—	72.6	45	—	—
Laughing Whitefish R. (22)	Aug. 18	0.1	4	60	132	—	—	—	—	1.6	1	—	—
Furnace Cr. (21)	Aug. 21	0.2	8	20	44	—	—	—	—	1.6	1	—	—
Arrowhead R. (1)	Sept. 2	2.1	75	90	198	—	—	—	—	1.6	1	—	—
Brule R. (29)	Sept. 3	4.2	150	868	1,914	—	—	—	—	88.7	55	—	—
Big Garlic R. (24)	Oct. 7	0.8	30	100	220	—	—	—	—	9.7	6	—	—
Silver R. (28)	Oct. 18	5.2	185	469	1,034	—	—	—	—	4.8	3	—	—
Slate R. (27)	Oct. 18	1.6	56	60	132	—	—	—	—	1.6	1	—	—
Sucker R. (20)	Oct. 18	5.1	180	379	836	—	—	—	—	22.6	14	—	—
Harlow Cr. (23)	Nov. 2	0.4	15	100	220	—	—	—	—	6.5	4	—	—
Total		39.9	1,418	4,940	10,890	22	49	—	—	272.5	169	—	—
GRAND TOTAL		166.4	5,888	7,336	38,162	199	439	5,438	11,963	417.1	259	22.0	55

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

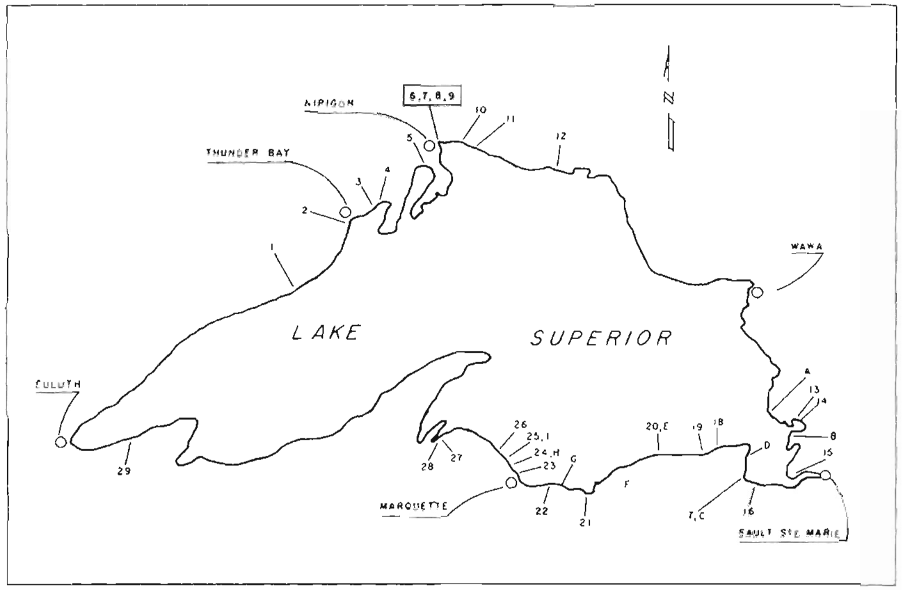

Figure 1. Location of streams, lakes, or bays of Lake Superior treated with lampricides (numerals; see Table 3 for names of streams or areas), and of streams where assessment traps were fished (letters; see Table 4 for names of streams) in 1983.

Silver rivers and Stillwater and Harlow creeks; and scarce in the remainder of the streams treated.

Polly Creek and the lower Nipigon River were treated for the first time. Polly Creek is tributary to a lake in the Nipigon River system and a large number of all age classes of ammocetes were present. The Nipigon River, from the outlet of Helen Lake to Lake Superior, was treated in July with the cooperation of Ontario Hydro who gave a controlled flow for 76 hours. Lake seiche and strong winds caused chemical application problems, but it is felt that the treatment was successful in killing the majority of larval sea lampreys in the river.

Granular Bayer 73 was applied to the mouth of the upper Nipigon River in Helen Lake during the period of controlled flow. The low water levels and good visibility resulted in the most efficient treatment of this area. Large numbers of sea lamprey ammocetes were observed and collected.

A concentrated effort was made in 1983 to attack the known lentic populations of larval sea lampreys within Batchawana Bay. Because of a hot, sunny summer, treatment conditions were excellent—bottom temperatures were the highest recorded for years—and relatively effective treatments were realized in all areas. Six areas in close proximity to known sea lamprey-producing streams were treated with Bayer 73 granules. Larval sea

lampreys were scarce off Harmony River and Stokely Creek, moderate off Sable and Batchawana rivers and Sand Point near the Batchawana River, and abundant off Chippewa River. Annual granular Bayer 73 treatments of the well-defined dropoff area off the Chippewa River, in conjunction with annual TFM treatments of the Chippewa River, are required to reduce this significant source of sea lamprey recruitment to Batchawana Bay.

SPAWNING-PHASE SEA LAMPREYS

Assessment traps were fished in nine tributaries of Lake Superior in 1983. The catch of adult sea lampreys was 1,464, compared with 1,325 in 1982 (Table 4. Fig. 1). The number of lampreys declined in the Tahquamenon, Betsy, and Pancake rivers and Stokely Creek in eastern Lake Superior. Catches of sea lampreys in all other streams increased with the exception of Miners River, which remained the same. The average length and weight of sea lampreys and the percentage of males decreased slightly in 1983 from those taken in 1982 (Table 4).

PARASITIC SEA LAMPREYS

A total of 491 sea lampreys were collected (487 by commercial and 4 by sport fishermen) in Lake Superior through September 1983 (490 in U.S. and 1 in Canada), compared with 300 taken in 1982. Fishermen from statistical district MS-4 (Munising, Michigan, area) and the statistical district of Wisconsin collected the largest number of sea lampreys from U.S. waters of Lake Superior in 1983—289 and 158, respectively, compared with 84 and 161 in 1982. The increase in number of sea lampreys captured in the Munising area is probably attributed to the additional effort by a commercial gill net fisherman, as spring wounding rates on lake trout remained the same for 1982 and 1983, 7.6% and 7.7% respectively. In September 1983, a commercial fisherman in Little Marais, Minnesota, area (M-2), recovered the first parasitic-phase sea lamprey for bounty from inside a lake trout which measured 82 cm (32 inches) long and weighed 6.3 kg (14 pounds).

Estimate of larval sea lamprey population in the Big Garlic River—A critical element in the Heimbuch/Youngs approach for determining the cost-benefit ratio for treating a stream infested with sea lamprey larvae is the ability to estimate the production of transformed lampreys within that stream. Since most streams are treated every 3 to 5 years, only a small percentage of the larvae reach the transformation stage and few of these are ever found. A more appropriate or realistic estimate to strive for may be the number of ammocetes in a population >120 mm, a length where transformation is likely to occur.

The decision to abandon the inclined-plane downstream trap in the Big Garlic River and chemically treat the stream presented an opportunity to estimate the population of larvae and the percentage >120 mm. Past at-

Table 4. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Superior, 1983. [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)	29	28	25	434	426	176	175
Stokely Cr. (B)	5	5	60	485	425	253	188
Total or average	34	33	30	449	426	199	176
UNITED STATES							
Tahquamenon R. (C)	182	182	50	430	431	174	180
Betsy R. (D)	58	56	21	394	395	135	150
Sucker R. (E)	183	32	38	408	388	154	147
Miners R. (F)	1	1	0	—	362	—	101
Rock R. (G)	608	581	28	412	407	154	153
Big Garlic R. (H)	361	361	23	407	402	160	154
Iron R. (I)	37	37	27	423	397	181	150
Total or average	1,430	1,250	30	415	407	161	156
GRAND TOTAL OR AVERAGE	1,464	1,283	30	416	407	162	157

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tempts to estimate the total number of larvae in a stream generally centered on mark/release trials over an entire stream length, often many kilometers. Such efforts may result in low recovery of marked animals and inadequate precision in the estimate. A more reliable approach may be to separate the stream into several zones based on distribution of larvae and types of habitat, then within each zone intensively study (mark/release experiment) a short representative section, expand the resulting estimate over the entire zone, and sum the numbers from the zones for the total stream estimate.

During July 1983, larval habitat in the infested length of the river upstream of the trap was mapped for potential use by ammocetes. The habitat was measured in square meters and, in general, classified as having areas of high potential for colonization (backwaters, silt, silt/detritus, silt/sand interfaces with vegetation, etc.), less potential (shifting sand in main stream flow), and little or no potential (bedrock, boulders, rubble, and gravel).

After the habitat mapping, the river was surveyed with backpack shockers to determine the relative distribution and abundance of larvae. Larvae were found over 8,504 m (27,900 ft.) of stream length. The river was divided into four zones based on larval abundance and changes in physical characteristics of the stream. Zone A extended from the trap upstream 640 m (2,100 ft.) and was characterized by slow flows with substrates primarily of sand and silt. Larvae were most dense in this zone and much of the habitat had a high potential for colonization. Zone B was 1,646 m (5,400 ft.) and had habitat somewhat similar to that in A, but larvae were relatively less dense. Zone C (3,200 m, 10,500 ft.) shifted more to that of a riffle/pool environment with occasional rapids and falls; larvae were abundant in the available habitat. Zone D (3,018 m, 9,900 ft.) was similar to C in stream character, but larvae were far less abundant.

A 228.6- to 457.2-m (750- to 1,500-ft.) section of stream within each zone, typifying the zone in character and relative density of larvae, was chosen for intensive population study during lampricide application. To prevent immigration and emigration of larvae into the short sections, barriers of fine mesh hardware cloth were constructed at the upstream and downstream limits 48 hours before treatment. From 175 to 742 larvae within each section were marked with fluorescent dye, released near where they were captured, and allowed to acclimate during the 48-hour period.

Larvae were collected during the treatments with fyke and dip nets. The percentage of marked larvae recaptured ranged from 26 in Zone B to 51 in Zone A, with an overall recovery rate of 42% (Table 5). Poorer collecting conditions in Zones B and C accounted for the rates lower than in A and D. A total of 8,747 dead or dying unmarked larvae were collected in the study area. The Petersen formula was used to estimate the number of larvae in each study section. This estimate was then expanded on the basis of total habitat in the zone and the resulting numbers were summed to give the total population. The stream had 91,007 (95% confidence intervals, 73,106–113,595) sea lamprey larvae during the treatment in 1983. Of these, 33% were of the size where transformation may occur.

Table 5. Variables used to determine the population estimate (95% confidence intervals in parentheses) of sea lamprey larvae and the percentage of larvae >120 mm in the Big Garlic River in 1983.
[Population estimate is calculated for each study area by the Petersen formula (number marked × number examined for marks divided by the number of marked recaptured), and then is expanded to an estimate for each zone based on the ratio of amount of habitable substrates in each study area to that in each zone. The total estimate for the stream is the sum of estimates for each zone.]

Zone	Zone length (ft.)	Study area in zone (ft.)	Marked larvae: Number released	Marked larvae: Recaptured: Number	Marked larvae: Recaptured: Percentage	Number unmarked collected	Study area: Area[a] (sq. ft.)	Study area: Population estimate	Total in zone: Area[a] (sq. ft.)	Total in zone: Population estimate[b]	Percentage[b] >120 mm
A	2,100	1,500	742	380	51	5,936	37,800	12,332	45,000	14,673 (13,270–16,193)	43
B	5,400	900	211	54	26	1,110	15,500	4,548	103,200	30,310 (23,220–39,537)	47
C	10,500	750	265	74	28	1,309	16,200	4,953	116,400	35,585 (28,342–44,702)	21
D	9,900	900	175	72	41	392	7,800	1,128	72,600	10,439 (8,274–13,163)	20
Total	27,900	4,050	1,393	580	42	8,747	77,300	22,961	337,200	91,007 (73,106–113,595)	33

[a]Refers to total area of substrate types in which larvae may be found.

[b]The percentage of larvae >120 mm was calculated as a separate estimate similar to that of the estimate of all larvae (i.e., number >120 mm marked × number >120 mm examined for marks divided by the number of marked >120 mm recaptured, and then expanded by total habitable substrates), but for simplicity, is represented as percentage of the total estimate.

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Zone	Zone length (ft.)	Study area in zone (ft.)	Marked larvae			Number unmarked collected	Study area		Total in zone		
			Number released	Recaptured			Area[a] (sq. ft.)	Population estimate	Area[a] (sq. ft.)	Population estimate[b]	Percentage[b] >120 mm
				Number	Percentage						
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[b]The percentage of larvae >120 mm was calculated as a separate estimate similar to that of the estimate of all larvae (i.e., number >120 mm marked × number >120 mm examined for marks divided by the number of marked >120 mm recaptured, and then expanded by total habitable substrates), but for simplicity, is represented as percentage of the total estimate.

Assessment of populations of sea lampreys in Batchawana Bay—On the Canadian side of Lake Superior, development of a process was begun to evaluate recruitment of larvae and escapement of transforming lampreys in populations in Batchawana Bay. Data on larvae collected since the inception of the chemical control program were reevaluated for spatial distribution and length-frequency composition. Changes in larval distribution, density, and mean length were examined in relation to lampricide treatments of adjacent tributaries which are major sea lamprey producers (Stokely Creek and Harmony, Chippewa, Batchawana, and Sable rivers). The scheduling of future treatments of these streams will be manipulated so that monitoring of the lentic larval populations off their mouths can provide an evaluation of the effects of these strategies.

Big Garlic trap—Three transformed sea lampreys and 6,609 ammocetes were captured at the downstream trap in the Big Garlic River in 1983, compared with 28 and 3,272, respectively, in 1982. Large larvae (>120 mm) collected in the spring were allowed to transform in warmwater aquaria, and then transferred to the Hammond Bay Biological Station. Ammocetes that did not transform were used for special studies of the evaluation unit and other investigators. Small larvae (<120 mm) were held for use in bioassays conducted by personnel of the Marquette chemical control units, or for use by other cooperating investigators. The stream was chemically treated in October, and no live lampreys were taken after treatment. The facility will be operated for approximately 2 weeks in the spring of 1984 to further evaluate treatment effectiveness, and then placed on standby status.

Treatment effects upon nontarget organisms—Onsite testing of nontarget organisms was carried on during treatments of the Brule and Tahquamenon rivers. Information from these studies is included in the Lake Michigan section of this report so that mortality can be compared by genera for all five streams studied (see Tables 8 and 9).

LAKE MICHIGAN

SURVEYS

Surveys to evaluate larval lamprey populations were conducted on 107 Lake Michigan tributaries in 1983.

Pretreatment work was completed on 20 Lake Michigan tributaries; 13 were later treated successfully and 7 (Jordan and Boyne rivers and Gibson, Duck, Hudson, Seiners, and Bursaw creeks) are scheduled for treatment in 1984. A moderate population was indicated in the Jordan River and smaller populations in the other streams scheduled for treatment in 1984. Treatment of Bursaw Creek is recommended because of a residual population remaining after an unsuccessful low water treatment in September 1983.

Reestablished populations were evident in 24 streams other than those examined for pretreatment purposes. The largest of these redeveloping populations appeared to be in the Muskegon, Fishdam, Sturgeon, and Peshtigo rivers. Young-of-the-year larvae were found in 17 streams. However, monitoring for the 1983 year class, especially in the Lower Peninsula, was reduced because of work commitments in New York, and larvae are probably present in several more streams.

Residual sea lampreys were collected from 16 streams to evaluate chemical treatments and monitor reestablished populations. Residual numbers were small except in Bursaw Creek and in areas of three larger systems (Sturgeon, Whitefish, and Cedar rivers), where most survivors could be attributed to treatment problems on small tributaries and backwater areas.

No sea lampreys were found during surveys of 10 historically negative streams. In one untreated stream, Fischer Creek, a single ammocete (152 mm long) was found.

Surveys above dams on the St. Joseph, Grand, and Manistique rivers yielded no sea lampreys. The possibility that fishways incorporated in dams on the St. Joseph and Grand rivers might not be effective in blocking adult sea lampreys and the past record of adults bypassing the barrier on the Manistique River prompted these surveys.

Lentic areas associated with seven streams were examined with granular Bayer and backpack shockers, and sea lamprey larvae were found in three instances. The only significant concentration appeared to be off the Manistique River where 42 ammocetes (37–132 mm long) were recovered.

For the past 5 years, observations have been made on a low-head barrier dam on Weston Creek, a tributary of the Manistique River. The barrier was created by inserting a gate 1.1 m (43 inches) high × 1 m (40 inches) wide in an existing structure. The water column created by the gate has ranged from an average of 79 to 102 cm (31 to 40 inches) over the 5 years. An electrical barrier was installed upstream to evaluate the effectiveness of this dam. Larval surveys also assessed the effectiveness of the barrier. No evidence has been found to indicate lampreys bypassed the dam. The combination of a 79-cm (31-inch) water column with a velocity about 2.7 m/s (8.8 ft./s) has prevented sea lampreys from bypassing the barrier while allowing passage of spawning rainbow trout.

TREATMENTS

Chemical treatments were performed on 17 streams during the field season (Table 6, Fig. 2). Wide fluctuations in water levels encountered during the year complicated many treatments.

The Whitefish River treatment was very involved. The treatment began in June and the entire system was not completed until October due to variations in water levels and concern for the effects of TFM on walleye fry. Some mortality of burrowing mayflies and spawning brook trout occurred in Scotts Creek, a tributary. Perhaps the barrier dam on the West Branch of the Whitefish River will eliminate the need for future treatments of Scotts Creek.

Other factors resulted in treatment problems. A combination of agricultural fertilizers, pesticides, irrigation, and the application of TFM was the likely cause for a moderate fish mortality in the Pentwater River. A moderate fish kill occurred in the lower Pere Marquette River due to inadequate mixing of Bayer 73 below a booster feeder. Relatively high minimum lethal concentrations were required to treat two tributaries of the Grand River, Crockery and Sand creeks, and contributed to a moderate fish kill. A low stream discharge in the Carp Lake River permitted only treatment of the lowest 1.6 km (1 mile). Other treatments were marginally effective because of low water levels and sluggish flow.

The Ford River was treated in two sections—the headwaters and Ten Mile Creek in early spring and the main river in September—to allow undisturbed spawning of game fishes in the stream. Extensive effort was expended to apply TFM to backwater areas in the Ford River which were heavily infested with sea lamprey ammocetes.

SPAWNING-PHASE SEA LAMPREYS

A total of 12,158 sea lampreys were captured in assessment traps in six west shore and six east shore tributaries of Lake Michigan (Table 7, Fig. 2). On the west shore, the catch in the Peshtigo River (590) increased from that in 1982 (475), whereas the catch in the Menominee River (73) was about the same as in 1982 (62). The number of sea lampreys captured in the Manistique River (10,480) declined slightly (8%) from that in 1982 (11,417). No sea lampreys were captured for the fifth successive year in the Fox River, and only 18 were taken at the newly constructed barrier dam in the West Branch of the Whitefish River.

Catches of sea lampreys in six streams along the east shore of Lake Michigan decreased from the catches in 1982 (997 compared with 1,532). Most of the decline occurred in the Carp Lake, Jordan, and Boardman rivers, where catches decreased by 334, 123, and 84, 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 captured at other sites in Lake Michigan and this trend continued in 1983. Sea lampreys from the Carp Lake River averaged 51 mm shorter and 55 g lighter than the average size of Lake Michigan lampreys; however, they average only 22 mm shorter and 31 g lighter than those sea lampreys captured in the Cheboygan river, a nearby stream in Lake Huron.

PARASITIC SEA LAMPREYS

Lake Michigan fishermen captured 222 sea lampreys (commercial fisheries, 200; sport fisheries, 22) through October 1983, as compared with 188 in the same period in 1982. Fisheries from the Epoufette, Michigan, area (MM-3), and the Fairport, Michigan, area (MM-1), contributed the largest number of sea lampreys in 1983, 66 and 53, respectively, compared

Table 6. Details on the application of lampricides to streams of Lake Michigan, 1983. [Number in parentheses corresponds to location of stream in Figure 2.]

Stream	Date	Discharge at mouth		TFM Act. Ingr		Bayer 73 powder Act. Ingr.		Stream treated	
		m^3/s	f^3/s	kg	lbs	kg	lbs	km	miles
Ford R. (2)									
Upper R.	May 7	5.7	200	738	1,628	—	—	16.1	10
Ten Mile Cr.	May 10	4.1	145	1,068	2,354	—	—	40.3	25
Lower R.	Sept. 30	5.7	200	2,784	6,072	—	—	161.3	100
Horton Cr (10)	May 10	0.6	20	120	264	—	—	1.6	1
Parent Cr. (5)	May 20	0.5	17	60	132	—	—	3.2	2
Rock R. (8)	May 22	0.5	18	70	154	—	—	3.2	2
Bark R. (1)	June 3	2.1	75	359	792	—	—	4.8	3
Whitefish R. (4)									
Haymeadow Cr	June 4	2.0	70	150	330	—	—	8.1	5
Pole Cr	June 6	1.6	56	110	242	—	—	8.1	5
Bills Cr	June 7	1.0	35	50	110	—	—	6.5	4
Whitefish R. (main stream)	June 18	7.1	250	2,475	5,456	—	—	61.3	38
Haymeadow Cr (re-treatment)	Oct. 25	0.8	30	130	286	—	—	8.1	5
Dexter Cr.	Oct. 26	0.6	20	120	264	—	—	11.3	7
Scotts Cr.	Oct. 27	0.3	12	210	462	—	—	4.8	3
Portage Cr. (3)	June 5	1.3	45	150	330	—	—	16.1	10
Burns Ditch (17)	June 5	1.8	65	479	1,056	—	—	33.9	21
Galien R. (16)	June 19	1.2	44	589	1,298	—	—	22.6	14
Pentwater R. (13)	June 29	1.7	60	399	880	—	—	30.6	19
White R. (14)	July 8	11.0	390	3,114	6,864	19	41	121.0	75
Pere Marquette R. (12)	July 24	15.6	550	3,792	8,360	38	84	248.4	154
Betsie R. (11)	Aug. 8	4.8	170	1,158	2,552	8	18	14.5	9
Bursaw Cr. (6)	Sept. 14	0.1	2	30	66	—	—	3.2	2
Point Patterson Cr. (7)	Sept. 16	0.1	2	20	44	—	—	1.6	1
Carp Lake R. (9)	Oct. 1	0.1	4	30	66	—	—	1.6	1
Grand R. (15)									
Sand Cr.	Oct. 28	0.5	19	230	506	—	—	3.2	2
Crockery Cr	Oct. 31	1.9	66	589	1,298	—	—	38.7	24
TOTALS		72.7	2,565	19,024	41,866	65	143	874.1	542

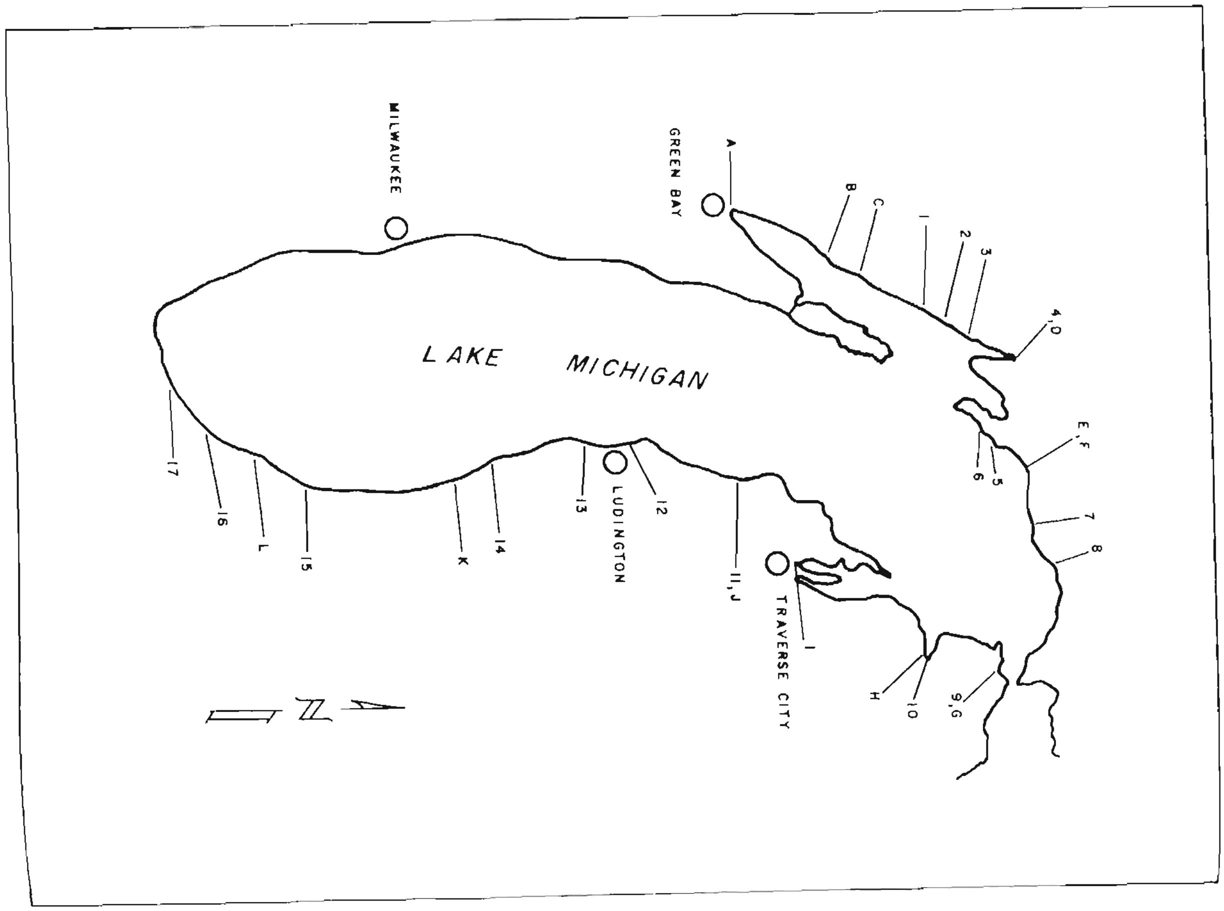

Figure 2. Location of streams tributary to Lake Michigan treated with lampricides (numerals, see Table 6 for names of streams), and of streams where assessment traps were fished (letters; see Table 7 for names of streams) in 1983.

Table 7. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Michigan, 1983. [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)	590	590	44	480	481	235	247
Menominee R. (C)	73	73	41	449	461	188	215
W. Br. Whitefish R. (D)	18	17	47	471	440	232	210
Manistique R. (E)	10,480	2,835	39	484	483	218	233
Weston Cr (F)	0	0	—		—	—	—
EAST SHORE							
Carp Lake R. (G)	241	241	39	424	427	165	171
Jordan R.							
Deer Cr. (H)	6	6	38	480	442	251	206
Boardman R (I)	88	88	40	455	455	216	221
Betsie R. (J)	235	225	41	453	460	217	230
Muskegon R. (K)	86	86	43	474	485	223	255
St. Josephs R. (L)	341	340	39	474	486	227	245
GRAND TOTAL OR AVERAGE	12,158	4,501	40	476	478	218	232

with 33 and 25, respectively, in 1982. Increases in northern Lake Michigan may indicate an influx of sea lampreys from large populations in Lake Huron.

The number of sea lampreys collected from the fisheries of Lake Michigan and fall wounding rates on lake trout indicate increases in lamprey populations in northern Lake Michigan and Green Bay. Northern Lake Michigan (excluding Green Bay) produced 103 sea lampreys in 1983, compared to 44 in 1982. Wounding rates in northern Lake Michigan for the same period increased from 2.1% to 3.4%. In Green Bay, similar increases were indicated by the number of sea lampreys collected, from 53 in 1982 to 88 in 1983, and wounding rates increased from 2.0% to 3.5%.

SPECIAL STUDIES

Population study in a lotic area—Point Patterson Creek is a relatively small, cool, trout stream, tributary to the north shore of Lake Michigan. The stream presented a unique opportunity for study because only a single year class of sea lampreys established between 1978 and 1983. The 1978 year class was first recovered in the fall of 1979 when six yearling sea lampreys were collected. The ammocete population was monitored by electrofishing through June 1983 for information on growth, relative abundance, transformation, and distribution.

Sea lamprey ammocetes of the 1978 spawning collected by electrofishing in Point Patterson Creek, 1979–83.

Month and year collected	Number of sea lampreys	Age	Length (mm) Range	Mean
Sept. 1979	6	I	32–44	40
July 1980	20	II	41–70	54
Aug. 1980	7	II	47–71	60
June 1981	2	III	72–82	77
Aug. 1981	11	III	74–106	84
Oct. 1981	50	III	72–110	88
May 1982	107	IV	76–134	104
June 1982	32	IV	87–129	107
Sept. 1982	51	IV	72–152	111
May 1983	43	V	96–160	119
June 1983	56	V	89–154	126
Total	385			

Ichthyomyzon larvae have never been collected in the stream; therefore, were used rather than marked sea lamprey larvae for the study. A total of 298 ammocetes about the same size as the sea lampreys in Point Patter-

Table 8. Percentage of fish dead or missing of those caged during treatments of five streams with lampricides in 1983.

Species of fish	Lake Superior: Brule River No.	Percentage Dead	Percentage Lost	Tahquamenon R. No.	Percentage Dead	Percentage Lost	Lake Michigan: Ford River No.	Percentage Dead	Percentage Lost	Pere Marquette R. No.	Percentage Dead	Percentage Lost	Whitefish River No.	Percentage Dead	Percentage Lost
Sea lamprey[a]															
Larvae													50	100	0
Metamorphosed larvae													2	100	0
Brook trout	5	0	0												
Chinook salmon										4	50	0			
Coho salmon										2	0	0			
Rainbow trout	8	0	12							21	0	25	1	0	0
Blacknose dace				1	0	0							3	67	0
Bluntnose minnow							1	0	0						
Common shiner							15	0	0						
Longnose dace				6	0	0	4	25	0				2	50	0
Northern redbelly dace													2	0	0
Northern hog sucker							1	0	0						
White sucker													1	0	0
Burbot				2	0	0							7	0	0
Brook stickleback													1	0	0
Rock bass				8	25	0	3	0	0						
Smallmouth bass							8	0	0						
Blackside darter				10	0	0	10	0	0						
Fantail darter							16	0	25				6	83	0
Johnny darter				10	0	25	10	0	0						
Logperch				7	0	0	3	0	0						
Mottled sculpin	1	0	0	10	0	10				5	0	0	19	0	0
Slimy sculpin										5	0	0			

[a]Sea lampreys were caged in Scott Creek, a tributary of the Whitefish River.

Table 8. Percentage of fish dead or missing of those caged during treatments of five streams with lampricides in 1983.

	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marquette R.			Whitefish River		
		Percentage			Percentage			Percentage			Percentage			Percentage	
Species of fish	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost
Sea lamprey[a]															
Larvae													50	100	0
Metamorphosed larvae													2	100	0
Brook trout	5	0	0												
Chinook salmon										4	50	0			
Coho salmon										2	0	0			
Rainbow trout	8	0	12							21	0	25	1	0	0
Blacknose dace				1	0	0							3	67	0
Bluntnose minnow							1	0	0						
Common shiner							15	0	0						
Longnose dace				6	0	0	4	25	0				2	50	0
Northern redbelly dace													2	0	0
Northern hog sucker							1	0	0						
White sucker													1	0	0
Burbot				2	0	0							7	0	0
Brook stickleback													1	0	0
Rock bass				8	25	0	3	0	0						
Smallmouth bass							8	0	0						
Blackside darter				10	0	0	10	0	0						
Fantail darter							16	0	25				6	83	0
Johnny darter				10	0	25	10	0	0						
Logperch				7	0	0	3	0	0						
Mottled sculpin	1	0	0	10	0	10				5	0	0	19	0	0
Slimy sculpin										5	0	0			

[a]Sea lampreys were caged in Scott Creek, a tributary of the Whitefish River.

son Creek were taken in September from a stream nearby. They were introduced at 10 sites within the infested portion of Point Patterson Creek, about 2.4 km (1.5 miles) of stream. Lampricide was applied to the stream in October, and a thorough collection effort yielded 497 sea lampreys and 81 *Ichthyomyzon* ammocetes. Thus, based on a recovery rate of 27.6%, the population of sea lamprey ammocetes numbered about 1,800.

Treatment effects upon nontarget organisms—Since 1980, the Control Units have intensified studies on the effects of TFM on nontarget organisms in response to public concerns. In 1983, an effort was made to establish a routine monitoring program on streams having a history of environmental complaints associated with previous treatments. Onsite testing of nontarget organisms was carried on in the Brule and Tahquamenon rivers (Lake Superior) and the Ford, Pere Marquette, and Whitefish rivers (Lake Michigan).

Before lampricide application, invertebrates and fish were caged in a portion of the stream that was to be treated and, as a control, in areas that would not be treated. Small fish (15.2 cm, <6 inches) were collected by electrofishing several days before treatment and caged in modified minnow traps. Invertebrates were dislodged from the substrate into a kick net and uninjured specimens were caged the day before treatment. Invertebrate cages (30.4 cm × 15.2 cm × 15.2 cm, 12 inches × 6 inches × 6 inches) were constructed of 6-mm (1/4-inch) Plexiglas with Nitex nylon screening on two sides to allow water to flow through the cage. The cages were anchored to the stream bottom by attaching bricks. Because of the small size of some organisms, escapement was a problem in early trials, but was largely controlled by inserting balls of screening into the cages and by placing greater emphasis on sealing the cages.

The lampricide had little effect on most of the 22 species of fish included in the tests (Table 8). Mortality was high for fantail darters and the few longnose dace and blacknose dace tested in the Whitefish River. Treatment of this stream coincided with the spawning period for these species. Mortality of fish in control cages in all streams was insignificant.

The treatment of Scotts Creek, a tributary of the Whitefish River, was the final application of the 1983 field season. Sea lamprey larvae (50) and recently transformed individuals (2) were placed in the stream to determine if cold water (5°C, 41°F) would alter the effectiveness of TFM. All caged lampreys died during treatment.

Organisms of 31 invertebrate genera (Table 9) were tested. Mortality was high (92%) for *Hexagenia* in Scotts Creek due to an extremely long chemical bank. Mortality of this susceptible organism was much lower in the Brule River (19%), and Pere Marquette River where mortality for nymphs, <15 mm long, was 22% and for those >15 mm was 10% (20% were missing).

Mortality of *Dolophilodes*, a net-spinning caddisfly, and *Glossosoma*, a case-building caddisfly, was also significant where these organisms were tested. The differences in mortality of *Campeloma* snails in the Tahquamenon (40%) and Ford (15%) rivers probably reflect the addition of powdered Bayer to TFM in the treatment of the Tahquamenon River, whereas the Ford River was treated with TFM only. Mortality of invertebrates in control cages was usually insignificant.

LAKE HURON

SURVEYS

A total of 80 tributaries of Lake Huron were surveyed to assess larval sea lamprey populations.

Pretreatment surveys were completed in 32 streams; 9 were later treated and the remainder are scheduled for future treatment.

Posttreatment surveys were conducted in 10 streams. Residual sea lamprey larvae were recovered in the Little Pigeon River, Elliot and Albany creeks, and in the mouths of the Mississagi and Manitou rivers.

Reestablished populations of sea lampreys were detected in 17 streams. Moderate populations are indicated in the Pine (Mackinac County) and Carp rivers and small populations in the others. Young-of-the-year sea lampreys were found in nine streams, including the Ocqueoc River where spring floods allowed spawning-phase sea lampreys to negotiate the low-head barrier in the lower river. Survey of Martineau Creek revealed the first reinfestation of this stream since treatment in 1977.

Surveys upstream of the barrier dams on the Kaskawong and Sturgeon rivers were negative, confirming the effectiveness of the dams. Sea lampreys have become reestablished, however, below the dam in each river.

Sea lamprey ammocetes were found in two of four lentic areas surveyed with Bayer 73 granules. No larvae were collected off the mouths of either McKay or Nuns creeks and only one small ammocete (38 mm long) was collected in the 0.8 acre sampled in the Pine River (Mackinac County) delta. Surveys in St. Martin Bay, offshore of the Carp River, yielded 1,186 larvae (31–156 mm long) and 1 transforming sea lamprey. Individuals of the 1982 year class predominated in these collections, indicating rapid recruitment from the river.

Surveys were conducted in southeastern Michigan streams to identify significant sources of sea lamprey recruitment to southern Lake Huron. A total of 1,223 sea lamprey larvae (8–136 mm long) were collected from eight (Tawas, East Au Gres, Au Gres, Rifle, Pine (St. Clair County), Saginaw, and St. Clair rivers and Mill Creek) of 13 streams examined. The numbers and lengths of ammocetes (only 98 larvae >120 mm) indicate that these streams presently have a low potential for contributing significant numbers of parasitic-phase sea lampreys to Lake Huron.

Results of surveys conducted in 1983 and previous years in southern Georgian Bay suggest that sea lampreys are failing to reestablish in streams formerly known to produce them. Hog, Silver, and Telfer creeks and the Nottawasaga River, each entering southern Georgian Bay, were surveyed

Table 9. Percentage of invertebrates dead or missing of those caged during treatments of five streams with lampricides in 1983.

	Lake Superior						Lake Michigan								
	Brule River			Tahquamenon R.			Ford River			Pere Marquette R.			Whitefish River		
		Percentage			Percentage			Percentage			Percentage			Percentage	
Taxon	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost	No.	Dead	Lost
Plecoptera															
Perlidae															
Acroneuria	7	0	0	7	0	0							3	0	0
Paragnetina				4	0	0							5	0	0
Phasganophora													2	0	0
Pteronarcidae															
Pteronarcys	3	0	0												
Ephemeroptera															
Ephemerellidae															
Ephemerella	2	0	0							7	0	0	10	0	20
Heptageniidae															
Epeorus													21	0	14
Stenonema				1	0	0	23	0	0						
Ephemeridae															
Hexagenia (≤15 mm)										25	8	20			
Hexagenia (>15 mm)										27	22	0			
Hexagenia	27	19	0										50[a]	92[a]	0[a]
Potamanthidae															
Potamanthus							20	0	5						
Siphlonuridae															
Isonychia							20	5	10	12	8	0			
Tricorythidae															
Tricorythodes										17	0	0			
Baetidae															
Baetis	15	33	7	7	14	14	3	0	0	1	0	0			
Centroptilum							2	0	0						
Pseudocloeon				5	20	20	16	0	0						
Leptophlebiidae															
Paraleptophlebia							3	0	0						
Trichoptera															
Philopotamidae															
Dolophilodes	10	100	0										21	19	81
Polycentropodidae															
Phylocentropus													17[a]	29[a]	0[a]
Hydropsychidae															
Cheumatopsyche				4	0	0	4	0	0						
Hydropsyche							1	0	0	15	0	0			
Macronema							1	0	0						
Symphitopsyche	10	0	0	17	4	0	3	0	0				11	0	67
Rhyacophilidae															
Rhyacophila	2	0	0										7	0	30
Glossosomatidae															
Glossosoma				2	0	0				19	42	10	20	45	5
Glossosoma (small)	10	20	80												
Glossosoma (large)	20	85	15												
Brachycentridae															
Brachycentrus	11	18	9							10	0	0			
Limnephilidae															
Pycnopsyche													10	0	0
Coleoptera															
Elmidae (larvae)							6	0	33						
Optioservus (adult)							15	0	0						
Stenelmis (adult)							5	0	0						
Diptera															
Athericidae															
Atherix	13	0	0							6	0	33			
Gastropoda															
Campeloma				10	40	0	20	15	0						

[a]Organisms were caged in Scott Creek, a tributary of the Whitefish River

with negative results. Hog Creek has been treated once, Telfer Creek six times, Nottawasaga River four times (not the total system each time), and Silver Creek three times. During the last treatment of Silver Creek in September 1982 no larvae of the 1981 or 1982 year classes were collected. The recent decline in reestablishment of sea lampreys in tributaries of southern Georgian Bay is significant, and will continue to be monitored.

Sea lamprey problems continue to mount in the Saginaw River system, a major tributary to Lake Huron. Riprap constructed along the Dow Chemical Company dam on the Tittabawasse River, a Saginaw River tributary, may facilitate the migration of spawning-phase sea lampreys to the upper river. Prior to riprapping, spring floods or late closure of the fish ladder permitted spawning sea lampreys upstream from the dam in 1981, 1982, and 1983. Three year classes now inhabit the Chippewa River, a major tributary to the Tittabawasse River, and two year classes inhabit Bluff Creek, a minor tributary.

During surveys in the Saginaw River system in 1983, sea lampreys were found in two previously uninfested tributaries—the Cass River where 1 metamorphosed and 16 larval sea lampreys (72–169 mm long) were taken and the Shiawassee River where 1 metamorphosed individual was collected. Although populations appear small, the establishment of sea lamprey larvae in a river that was severely polluted reflects an improvement in water quality. Tributaries of the Saginaw River that will require treatment in 1984 are Bluff Creek, Chippewa and Cass rivers, and possibly the Shiawassee River.

Larval surveys were conducted in the St. Clair and Detroit rivers and Lake St. Clair in 1983. Sampling in the St. Clair River with Bayer 73 granules produced 42 sea lamprey ammocetes (32–125 mm long) from 10 of 29 stations; no larvae were collected from three stations surveyed with backpack shockers. One of six stations surveyed with granules in Lake St. Clair produced two sea lamprey larvae (74 and 106 mm). Although sea lampreys were not collected from five sites surveyed with Bayer 73 granules in the Detroit River, American brook lampreys were collected at three of the sites, indicating that a limited capacity for sea lamprey production may exist and further investigations are warranted.

TREATMENTS

The lampricide TFM was applied to 14 streams of Lake Huron and the granulated formulation of Bayer 73 was applied to 4 areas of the St. Marys River and in Echo Lake in 1983 (Table 10, Fig. 3). Water levels in most streams were sufficient for lampricide application, except in McKay and Albany creeks where low water caused cancellation of the scheduled treatments. Sea lamprey ammocetes were numerous in the Au Sable, Mississagi, and Tawas rivers and Mulligan Creek and moderately abundant in Still and Rifle rivers.

Treatments of Elliot, Greene, Mulligan, and Schmidt creeks and the Pigeon River, a tributary of the Cheboygan River, were conducted during high stream discharges and at low lethal concentrations which resulted in negligible mortality of spawning white suckers.

Treatment of the Still River was conducted during late spring runoff and, consequently, it was not necessary to increase the discharge by manipulation of the dam at the outlet of Noganosh Lake. No problems were encountered during the treatment, and adequate levels of lampricide were maintained to the mouth. Sea lamprey ammocetes appeared to be absent above a small chute 11.7 km (7.3 miles) above the mouth, moderately abundant in the mid-section of the watershed, and scarce in the lower reaches. The Still River has sustained sporadic and marginal adult runs in recent years; however, a relatively high number of spawning adult lampreys was observed below the chute.

Treatment of the Mississagi River, a North Channel tributary and the most prolific sea lamprey producer on the Canadian side of Lake Huron, was facilitated by a controlled discharge provided by Ontario Hydro. Excellent lampricide coverage was obtained throughout three of the four channels in the vast mouth area, and substantial numbers of ammocetes were killed in the deltas. The effectiveness of the lampricide block on the most westerly channel was negated by strong winds and heavy seiche action, and posttreatment surveys indicated that some ammocetes survived in the lower 0.5 km (0.3 mile) of the channel. Some recruitment of metamorphosing specimens to the North Channel is expected.

An area directly off the mouth of the Echo River in Echo Lake was treated with Bayer 73 granules in 1983; large numbers of larval sea lampreys were observed. Periodic application of granules should provide an effective measure of control in this area.

Several large areas in the St. Marys River, from Whitefish Island to the mouth area of the Garden River, were again treated with Bayer 73 granules. Sea lamprey larvae were abundant in the area immediately below Whitefish Island and adjacent to the St. Marys Rapids. The number of sea lamprey larvae observed during treatments of this Whitefish Island area continues to fluctuate erratically and appears to be cyclic in nature—a year of high abundance succeeded by 2 or 3 years of declining numbers. Although treatment effectiveness undoubtedly plays a role in determining the numbers observed, a more influential aspect is spawning activity in the rapids area and subsequent downstream movement.

A large area extending along the shoreline of the St. Marys River, midway between Bellevue Park and the Sault Ste. Marie sewage treatment plant, identical to that treated in 1982, produced relatively large numbers of larval sea lampreys. However, numbers were considerably reduced from the 1982 treatment.

An area identical in size and location to that treated in 1980, 1981, and 1982 in the St. Marys River extending downstream from the mouth of the Garden River was again treated in 1983. Relatively large numbers of larval sea lampreys were observed, but a significant reduction in density has occurred since the original treatment in 1980.

Table 10. Details on the application of lampricides to streams, lakes, or bays of Lake Huron, 1983.
[Number in parentheses corresponds to location of stream, lake, or bay in Figure 3.]

Stream, lake, or bay	Date	Discharge at mouth		TFM		Bayer 73 Powder		Bayer 73 Granules		Stream treated		Area treated	
				Act. Ingr		Act. Ingr.		Total used[a]					
		m^3/s	f^3/s	kg	lbs	kg	lbs	kg	lbs	km	miles	ha	acres
CANADA													
Still R. (6)	June 3	5.9	207	156	343	—	—	—	—	19.7	12	—	—
Echo R. (3)	June 28	1.0	35	77	170	—	—	—	—	2.8	2	—	—
Lauzon Cr. (5)	July 28	0.6	23	25	55	—	—	—	—	0.8	1	—	—
Mississagi R. (4)	July 27	59.5	2,102	3,912	8,606	57	125	2	4	39.5	24	—	—
Echo Lake (3)	June 29	—	—	—	—	—	—	273	600	—	—	1.1	3
St. Marys R. (2)													
Garden R.	July 12	—	—	—	—	—	—	364	800	—	—	1.5	4
Station H.	July 20	—	—	—	—	—	—	749	1,650	—	—	3.0	7
Whitefish Island	July 22	—	—	—	—	—	—	681	1,498	—	—	2.7	7
Root R.	July 25	—	—	—	—	—	—	114	250	—	—	0.5	1
Total		67.0	2,367	4,170	9,174	57	125	2,183	4,802	62.8	39	8.8	22
UNITED STATES													
Elliot Cr. (8)	May 6	0.8	28	60	132	—	—	—	—	3.2	2	—	—
Cheboygan R. (7)													
Little Pigeon R.	May 11	1.2	42	299	660	—	—	—	—	4.8	3	—	—
Cheboygan R. (lower)	Oct. 3	20.0	707	3,672	8,096	2	5	—	—	1.6	1	—	—
Green Cr. (9)	May 21	0.5	18	50	110	—	—	—	—	3.2	2	—	—
Mulligan Cr. (10)	May 23	0.7	26	60	132	—	—	—	—	4.8	3	—	—
Schmidt Cr. (11)	May 25	1.0	35	100	220	—	—	—	—	1.6	1	—	—
Tawas R. (15)	Aug. 19	1.1	38	269	594	—	—	—	—	9.7	6	—	—
Au Sable R (13)	Aug. 23	37.9	1,340	7,624	16,808	—	—	—	—	22.6	14	—	—
Rifle R. (14)	Sept. 6	22.7	800	3,892	8,580	18	39	—	—	177.4	110	—	—
Flowers Cr (1)	Sept. 15	0.0	1	10	22	—	—	—	—	1.6	1	—	—
Swan R. (12)	Oct. 17	1.7	61	519	1,144	—	—	—	—	4.8	3	—	—
Total		87.6	3,096	16,555	36,498	20	44	—	—	235.3	146	—	—
GRAND TOTAL		154.6	5,463	20,725	45,672	77	169	2,183	4,802	298.1	185	8.8	22

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

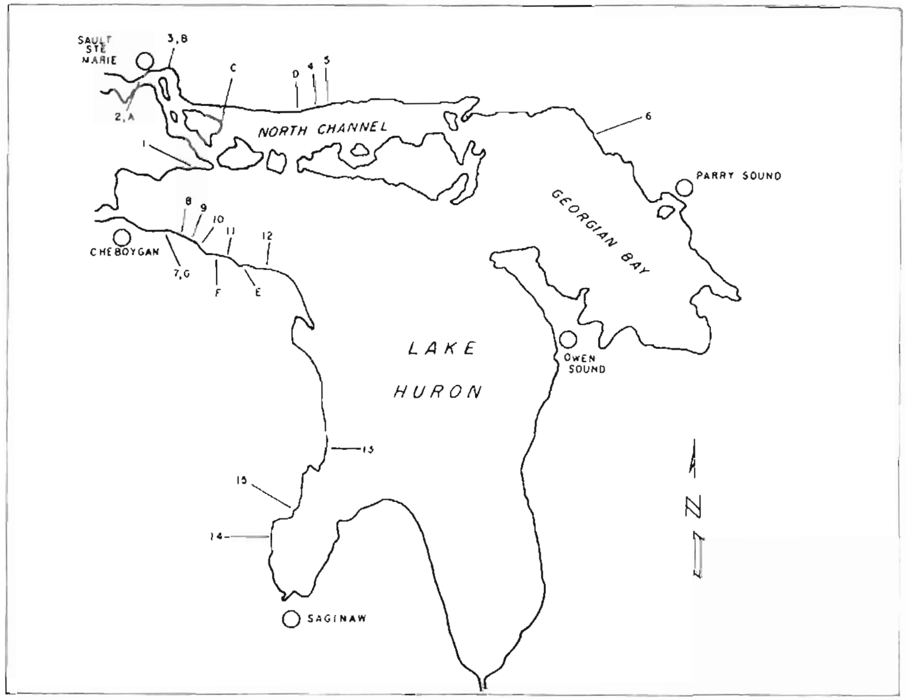

Figure 3. Location of streams, lakes, or bays of Lake Huron treated with lampricides (numbers; see Table 10 for names of streams or areas), and of streams where assessment traps were fished (letters; see Table 11 for names of streams) in 1983.

A granular Bayer 73 application in the delta off the Root River produced moderate numbers of larval sea lampreys, comparable to that of the previous 5 years.

SPAWNING-PHASE SEA LAMPREYS

During the 1983 spawning season, 20,629 sea lampreys were captured in assessment traps in tributaries of Lake Huron (Table 11, Fig. 3), a decline from the number taken in 1982 (21,197). The Cheboygan River accounted for 71% of the total. No experiments were conducted in this stream in 1983, and future catches will be comparable on a year-to-year basis. The 1983 catch in the Thessalon River was the largest since trapping began in 1979. This increase supports the contention of commercial fishermen that sea lamprey populations are increasing in the North Channel and northern Lake Huron. The decrease in the catch from the Kaskawong River (446 in 1982 to 170 in 1983) is due to a decreased effort from 1982 when a mechanical weir was fished in conjunction with the trap. Beaver impoundments downstream of the barrier may have deterred the upstream movement of sea lampreys.

Table 11. Number and biological characteristics of adult sea lampreys captured in assessment traps fished in tributaries of Lake Huron, 1983. [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							
St. Marys R. (A)	2,409	1,663	56	465	475	223	240
Echo R. (B)	0	—	—	—	—	—	—
Kaskawong R. (C)	170	170	35	439	455	187	211
Thessalon R. (D)	734	662	48	475	483	230	251
Total or average	3,313	2,495	53	466	475	223	241
UNITED STATES							
St. Marys R. (A)	1,590	682	44	486	484	239	249
Trout R. (E)	4	0	—	—	—	—	—
Ocqueoc R. (F)	1,010	0	—	—	—	—	—
Cheboygan R. (G)	14,712	1,003	41	445	451	196	204
Total or average	17,316	1,685	42	463	466	214	225
GRAND TOTAL OR AVERAGE	20,629	4,180	49	465	471	220	234

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Echo R. (B)	0	—	—	—	—	—	—
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St. Marys R. (A)	1,590	682	44	486	484	239	249
Trout R. (E)	4	0	—	—	—	—	—
Ocqueoc R. (F)	1,010	0	—	—	—	—	—
Cheboygan R. (G)	14,712	1,003	41	445	451	196	204
Total or average	17,316	1,685	42	463	466	214	225
GRAND TOTAL OR AVERAGE	20,629	4,180	49	465	471	220	234

Traps fished in U.S. and Canadian waters of the St. Marys River captured 3,999 sea lampreys, 20% of the Lake Huron total. The total catch represented a 4% increase over the 1982 catch (3,848). Although this increase is slight, the proportion collected in U.S. and Canadian waters changed considerably. Traps were not fished in Canadian waters during 1982 because of the construction of a hydroelectric plant by Great Lakes Power Corporation, but only eight lampreys (<1% of the total) were captured at the old powerhouse in 1981. The catch in U.S. waters of the St. Marys declined by 59% (3,848 in 1982 vs. 1,590 in 1983), whereas Canadian waters accounted for 2,409 sea lampreys (60% of the total) in 1983, by far the largest catch yet recorded there.

PARASITIC SEA LAMPREYS

A total of 2,705 sea lampreys were collected (2,356 by commercial and 349 by sport fishermen) in Lake Huron (1,876 in U.S. and 829 in Canada), compared with 967 taken in 1982. Of the 829 sea lampreys submitted by Canadian commercial fisheries, 532 were from the North Channel and 297 from Lake Huron proper.

Commercial fishermen from statistical district MH-1 (DeTour-Rogers City, Michigan, area) contributed 1,302 sea lampreys in 1983, compared with 589 in 1982, indicating a continued high abundance of sea lampreys in northern Lake Huron. Also, the number of sea lampreys collected by commercial fishermen in statistical district MH-2 (Alpena, Michigan, area) increased from 82 in 1982 to 158 in 1983. Collections of sea lampreys in MH-4 (Tawas City-Bay Port, Michigan, area) remained the same in 1982 (68) and 1983 (67).

In recent years, sport fishermen in southern Lake Huron expressed concerns about increased wounds and scars on salmonids. Since 1982, sport fishermen from Port Austin and Harbor Beach, Michigan, and in 1983, fishermen from Grindstone City, Michigan, cooperated in the collection of parasitic-phase sea lampreys. A total of 349 sea lampreys were collected in 1983—305 from MH-4 (140 from Port Austin and 165 from Grindstone City, Michigan, area) and 44 from MH-5 (Harbor Beach, Michigan, area). Of the 150 lampreys from Port Austin and Harbor Beach, for which prey species were reported in 1983, 66% were attached to salmon and 34% were attached to lake trout; in 1982, 54% of 48 lampreys were attached to salmon and 46% to lake trout. The increased numbers of sea lampreys attached to salmon species indicate a shift in the predator-prey selection, or a decrease in the number of lake trout.

SPECIAL STUDIES

St. Marys River larval assessment—Evaluation of populations of larval sea lampreys in the St. Marys River continued in 1983. A total of 142 stations in U.S. and Canadian waters were surveyed with Bayer 73 granules, electroshockers, or a combination of both. Objectives were to define the abundance, lateral distribution, and length-frequency composition of ammocetes in the river. Other studies included examinations of larval and spawning habitats and preliminary investigations into food of larvae.

Surveys in the upper St. Marys River (upstream of the compensating gates), and upstream of any known sea lamprey-producing tributary, produced 32 sea lamprey larvae (41 to 141 mm long).

A total of 777 ammocetes (28–144 mm long) were taken from 26 of 32 areas examined in Lake Nicolet. Larvae were collected from the lake entrance to about 2 km (1.25 miles) north of Neebish Island (Fig. 4). Favorable larval habitat exists along the entire length of Sugar Island from a sand bench at the 1.8–2.4-m (6–8 ft.) contour to 4.6–6.1 m (15–20 ft.) where the bottom assumes the uniform silt-clay composition it retains to the shipping channel. Larvae were distributed laterally across this area from the shipping channel to 90 m (300 ft.) from Sugar Island. Habitat is less favorable west of the shipping channel where the bottom is relatively uniform and predominantly clay. The lateral distribution of larvae is not as extensive west of the channel.

Sea lamprey ammocetes were found for the first time in the West Neebish Channel. Twelve larvae (42–120 mm long) were collected from three of four areas examined upstream of the "rock cut," a narrow, bedrock-lined channel that separates Neebish Island and the U.S. mainland. No ammocetes were collected downstream of this area.

Sea lamprey ammocetes were first taken in the Middle Neebish Channel in 1978. Sampling since has centered near the "Hen and Chicken" island chain at the northeast corner of Neebish Island where ammocetes are collected regularly. Again in 1983, one area near the largest island yielded 48 sea lamprey larvae (41–128 mm long) and 1 transformed individual. Two areas down river were also examined, but did not yield ammocetes.

Sea lamprey larvae were found throughout Canadian waters of the Munuscong Channel. A total of 44 larvae (36–146 mm long), including two in early stages of transformation, were caught in seven positive surveys. No larvae were taken in two surveys in Munuscong Lake.

The section of the river north of Sugar Island to Lake George is heavily infested with larvae. Parts of this section of the river are treated annually on the Canadian side with Bayer 73 granules. U.S. waters in the channel were first examined in 1983, and 318 sea lamprey ammocetes were collected from 10 of 14 areas. The largest concentrations were in the upstream portion of the channel.

Larvae were relatively scarce in Lake George and in East Neebish and St. Joseph channels. Several larvae were taken in Lake George from the mouth to 2.5 km (1.5 miles) downstream, but none were captured in surveys throughout the remainder of the lake. A single larval sea lamprey was caught at the north end of St. Joseph Island, but judging from the direction of the flow in this area, it may have drifted from the Middle Neebish Channel.

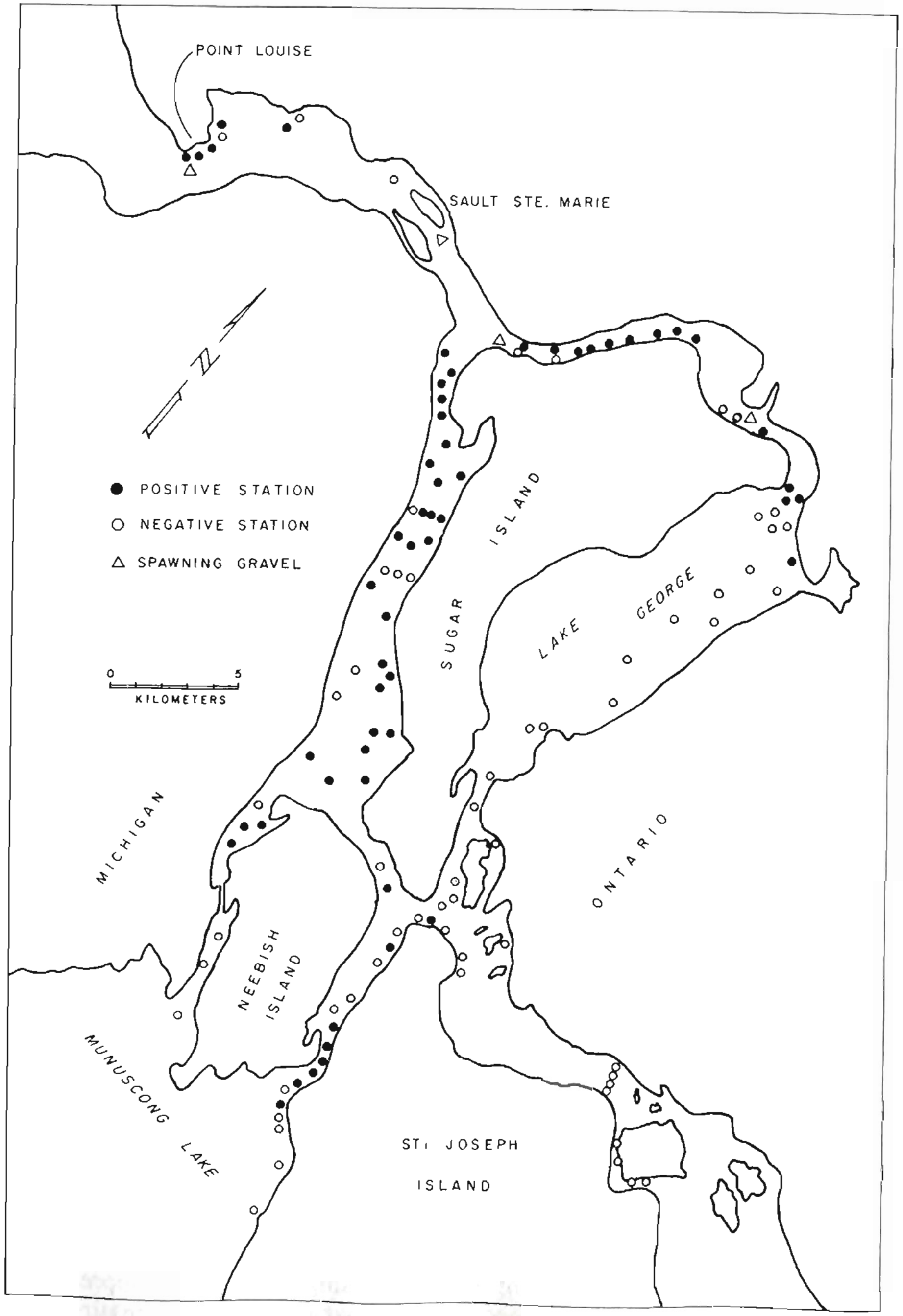

Figure 4. Location of sites surveyed with Bayer 73 granules or electroshockers for larval sea lampreys in the St. Marys River in 1983.

Fall collections from the Whitefish Channel are used as an index to determine growth rates of sea lamprey ammocetes in the St. Marys River. Collections in 1983 indicated that age classes 0–III attained mean total lengths of 22 mm, 37 mm, 61 mm, and 85 mm by late October.

Mean total lengths (mm) of sea lamprey ammocetes collected from the Whitefish Channel in October, 1981–83.

Year collected	Age group			
	0	I	II	III
1981	25	45	66	94
1982	16	42	61	78
1983	22	37	61	85

Similar growth patterns have been observed in many cold, brook trout-type streams of the Upper Great Lakes where transformation likely does not begin until age VI or VII.

Substrate samples were taken throughout Canadian waters of the river to locate potential spawning gravel and evaluate larval habitat. From Gros Cap in the upper river to south of St. Joseph Island, 553 hauls were made with a ponar dredge. Good spawning gravel was found at various sites sampled from Point Louise in the upper river to below the confluence with the Garden River in the lower river (Fig. 4). Suitable larval habitat was found in most areas checked in the river, but the area sampled is too small to provide a quantitative evaluation of larval habitat. Coincidentally, 19 sea lamprey larvae were caught during the dredging operations.

Periphyton and phytoplankton samples were collected at seven sites in Canadian waters of the river during July to investigate food availability. Larval sea lampreys were collected at three of the sites to determine food utilization from gut analyses. Data from these collections have not been analyzed.

Population studies in a lotic area—Estimates of abundance of sea lamprey ammocetes in the St. Marys River are essential for overall assessment of the system. Population estimates were obtained for two areas near Whitefish Island.

Scuba divers constructed two square grids of four equal-sized plots in each. Grid 1 was near the southern breakwall bordering the Canadian locks. Grid 2 was about 61 m (200 ft.) south of grid 1 and just east of the channel through Whitefish Island. Cord was strung between stakes at the corners and center to delineate the grids on the stream bottom, and floats defined the corners and center of each grid on the surface.

Sea lamprey ammocetes were marked in four distinct groups and a different marked group was released on the bottom at the center of the inner quarter section of each plot. After an acclimation of 48 hours, Bayer 73 granules were applied at two rates. Grid 1 received 224.2 kg/ha (200 lbs/acre) and grid 2, 112.1 kg/ha (100 lbs/acre). Ammocetes were netted on the surface and collected by divers on the bottom.

The recovery of marked ammocetes was more than three times greater in grid 1 (35%) than in grid 2 (11%), and estimates of abundance were calculated for each grid because of the apparent influence of application rates. Two steps were involved in each estimate. First, the recovery rate of the four marked groups released into each grid was averaged and then the estimate for the grid was calculated based on the ratio of marked to unmarked larvae. The estimates were 201 larvae in grid 1 and 3,637 in grid 2. The higher density of larvae in grid 2 is likely due to its proximity to the mouth of the channel north of Whitefish Island.

St. Marys River parasitic-phase assessment—Monitoring the emigration of recently metamorphosed sea lampreys from the St. Marys River has been recognized as an important aspect in lamprey assessment. Although fyke netting was considered in the past, it was historically rejected as impractical on river systems such as the St. Marys. Nevertheless, an effort was undertaken in 1983 to determine if this method could be applied.

Sixteen riffle fyke nets with openings from 0.7 to 1.7 m^2 (8 to 18 sq. ft.) and mesh of 0.64 cm (0.25 inch) were operated from late October to early December. The nets were attached to navigational buoys or trap net anchors with 30.5 m (100 feet) lengths of nylon rope, and set at various depths from top to bottom over a maximum water depth of 9.8 m (32 ft.). The fyke nets were fished from 3.2 km (2 miles) downstream of Mission Point to 2 km (1.25 miles) downstream of Nine Mile Point in Lake Nicolet and at the entrance of the river into Lake George.

A total of seven transformed sea lampreys were taken in three of the fyke nets placed in the area about 3.2 km (2 miles) downstream of Mission Point. All were taken within 0.9 to 1.5 m (3 to 5 ft.) of the surface in water 7.6 m (25 ft.) deep, when water temperature ranged from 5.6 to 8.3°C (42 to 47°F), and during November 5-19. A recently transformed American brook lamprey was taken in one of the nets at the head of Lake George.

Four modified Susquehanna hoop-trap nets were also used to fish inshore areas. These nets were of 0.64-cm (0.25-inch) mesh with square hearts of 3.3 m^2 (36 sq. ft.) and 15.2- × 1.8-m (50- × 6-ft.) wings. Cods consisted of five 0.91-m (3-ft.) diameter hoops with throats at the second and fourth hoops. Hoop-trap nets were fished throughout the water column in depths of 1.5 m (5 ft.) for 10 days in November at the following locations: 2.8 km (1.75 miles) downstream of Mission Point, Six Mile Point, and Nine Mile Point. No lampreys were taken in the hoop-trap nets.

The pilot netting operation conducted in the St. Marys River included more than 11,500 net hours of fishing and filtration of more than 10 million cubic meters of water (exclusive of the hoop-trap nets). Fyke nets are not precise scientific tools, but the capture of seven recently metamorphosed sea lampreys in light of a seemingly inefficient method is significant.

LAKE ERIE

No stream treatment program is in effect on Lake Erie, and no stream surveys were conducted in 1983.

SPAWNING-PHASE SEA LAMPREYS

Assessment traps fished for the fourth successive year in Cattaraugus Creek captured 1,671 sea lampreys, an increase of 75% from the number captured in 1982 (954). The mean length and weight of the spawning-run adults were about the same as those taken in 1981–82, but remained slightly smaller than the sea lampreys in 1980. The percentage of males increased from 50 in 1982 to 53 in 1983.

PARASITIC SEA LAMPREYS

Commercial fishermen from the eastern basin of Lake Erie collected 31 parasitic-phase sea lampreys. The eastern basin is the deepest area of Lake Erie and contains a salmonid population for sea lampreys to feed on.

LAKE ONTARIO

SURVEYS

Larval surveys were conducted on 37 of 52 Lake Ontario tributaries. Streams designated as non-producers were not surveyed.

Pretreatment surveys were completed on the Rouge and Salmon rivers and Wilmot, Graham, Skinner, and Lindsey creeks and Cobourg Brook in preparation for 1983 treatments and on the Credit River and Duffin, Lynde, Oshawa, and Farwell creeks scheduled for treatment in 1984.

Treatment evaluation surveys were conducted on 13 tributaries treated in 1982. Shelter Valley Brook, a difficult stream to treat effectively, contained a significant number of residual sea lamprey larvae. Low numbers of residual sea lampreys were recovered in the Little Salmon River and Little Sandy, Grindstone, Bronte, and Grafton creeks: no residual sea lampreys were collected from Port Britain, Lakeport, Salem, Smithfield, Stony, Ninemile, and Sterling creeks.

Sea lamprey larvae were reestablished in 11 of the above 13 streams. Surveys were conducted too soon in the year to determine whether larvae reestablished in Stony Creek and the Little Salmon River after treatment in late fall of 1982.

Blind Sodus Creek (treated in 1976 and 1978) and Gage Creek (last treated in 1971) were surveyed in 1983; sea lamprey larvae did not become reestablished in these streams.

Surveys with granular Bayer 73 off the mouth of Mayhew Creek, a tributary of the Trent River, yielded 69 sea lamprey larvae. Spawning-phase sea lampreys have been observed in the Trent River upstream of the mouth of Mayhew Creek, and the larvae collected may be progeny of lampreys spawned in Mayhew Creek, the Trent River, or both.

Surveys of the Oneida Lake drainage were completed in preparation for treatment in 1984. Sea lampreys were found only in three north shore tributaries (Fish, Scriba, and Big Bay creeks). No native lampreys were found. Fish Creek yielded 1,599 larval (16–180 mm long) and 98 transforming sea lampreys in 56 of 217 stations. The numerous oxbows and side channels were not as extensively infested as anticipated; 253 ammocetes (29–149 mm) and 36 transforming lampreys were collected in 11 of 32 oxbows. Lentic surveys off the mouth of Fish Creek produced four ammocetes (55–110 mm) and six metamorphosing lampreys in 5 of 12 stations. Big Bay Creek yielded 191 ammocetes (14–140 mm long) and 18 metamorphosed lampreys in 7 of 19 stations; no sea lampreys were found in four stations examined offshore. Only four ammocetes (54–63 mm long) were recovered from one of four stations examined in Scriba Creek and only one metamorphosed lamprey was collected from one of two stations examined offshore. None of the south shore tributaries examined contained sea lampreys probably due to the prevalence of municipal, industrial, and agricultural pollutants.

TREATMENTS

Chemical treatments were completed on 10 Lake Ontario streams during the field season (Table 12, Fig. 5).

Treatments of Bowmanville and Mayhew creeks and Cobourg Brook were conducted at optimum discharges, and a high mortality of ammocetes was achieved throughout the watersheds. Historically, the estuary of Bowmanville Creek has been thermally stratified which decreases the effectiveness of treatment; however, the higher discharge in 1983 resulted in an effective treatment.

Treatment of Graham Creek was complicated by low discharge and required numerous lampricide applications to maintain adequate TFM levels. The estuary was thermally stratified and an effective kill of ammocetes was not attained in that area. Surveys indicated that sea lamprey larvae were moderately abundant in this area. Mortality of nontarget fish was sporadic throughout the watershed; a few common white suckers, creek chubs, and longnose dace were killed.

The lampricide application to the main Salmon River was facilitated by a controlled discharge provided by Niagara Mohawk Power Corporation and initiated from a point immediately below the Salmon River Fish Hatchery water intake. Satisfactory concentrations of lampricide were achieved throughout the large estuary. Sea lamprey larvae were scarce in the main stem; only 194 specimens (26–151 mm long) were collected.

Tributaries of the Salmon River (Orwell, Beaverdam, and Trout brooks) were treated at high discharges before the main stream. The higher

Table 12. Details on the application of lampricides to streams of Lake Ontario, 1983.
[Number in parentheses corresponds to location of stream in Figure 5.]

Stream	Date	Discharge at mouth		TFM		Bayer 73				Stream treated	
						Powder		Granules			
				Act. Ingr.		Act. Ingr.		Total used[a]			
		m^3/s	f^3/s	kg	lbs	kg	lbs	kg	lbs	km	miles
CANADA											
Bowmanville Cr (2)	May 7	2.8	100	921	2,026	7	15	—	—	11.6	7
Cobourg Br (5)	June 8	1.3	46	466	1,025	—	—	—	—	11.2	7
Mayhew Cr. (6)	June 10	0.2	7	59	130	—	—	—	—	3.2	2
Graham Cr. (4)	June 12	0.3	11	219	482	—	—	—	—	16.4	10
Wilmot Cr. (3)	Oct. 20	0.7	24	487	1,071	—	—	—	—	22.0	14
Rouge R. (1)	Oct. 25	1.5	53	751	1,652	—	—	—	—	29.9	19
Total		6.8	241	2,903	6,386	7	15	—	—	94.3	59
UNITED STATES											
Skinner Cr. (8)	May 11	1.9	68	414	910	—	—	—	—	12.6	8
Salmon R. (10)	May 16	27.5	972	1,176	2,588	8	18	—	—	27.6	17
Orwell Br	May 7	2.0	71	189	416	—	—	—	—	4.2	3
Beaverdam Br.	May 9	2.2	78	180	396	—	—	—	—	5.4	4
Trout Br.	May 13	1.8	64	189	416	—	—	—	—	16.7	10
Lindsey Cr. (9)	May 14	0.8	29	152	334	—	—	—	—	14.5	9
South Sandy Cr (7)	Oct. 16	7.6	265	906	1,994	—	—	—	—	11.9	7
Total		43.8	1,547	3,206	7,054	8	18	—	—	92.9	58
GRAND TOTAL		50.6	1,788	6,109	13,440	15	33	—	—	187.2	117

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

Table 12. Details on the application of lampricides to streams of Lake Ontario, 1983. [Number in parentheses corresponds to location of stream in Figure 5.]

		Discharge at mouth		TFM		Bayer 73 Powder		Bayer 73 Granules		Stream treated	
				Act. Ingr.		Act. Ingr		Total used[a]			
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Mayhew Cr. (6)	June 10	0.2	7	59	130	—	—	—	—	3.2	2
Graham Cr. (4)	June 12	0.3	11	219	482	—	—	—	—	16.4	10
Wilmot Cr (3)	Oct. 20	0.7	24	487	1,071	—	—	—	—	22.0	14
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Beaverdam Br.	May 9	2.2	78	180	396	—	—	—	—	5.4	4
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[a]Sand granules coated with Bayer 73 at 5% by weight active ingredient.

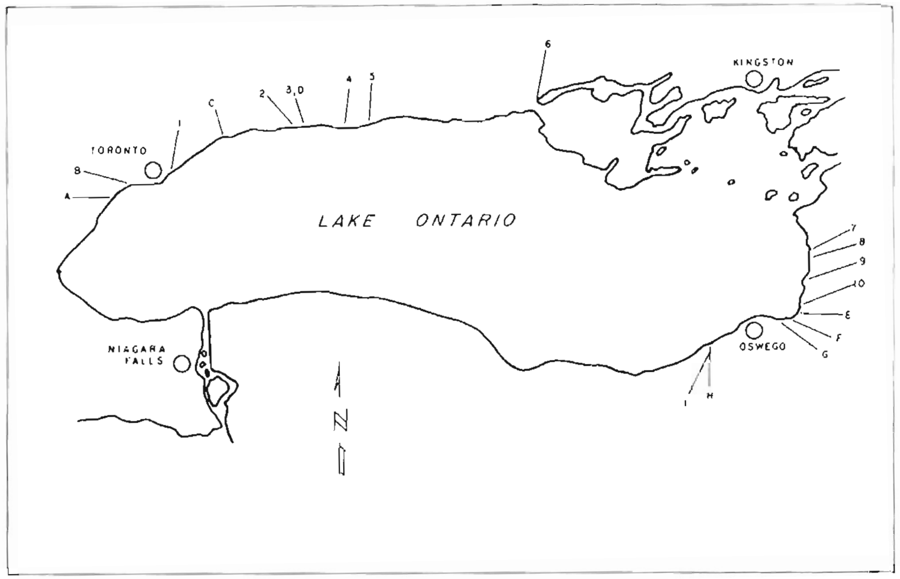

Figure 5. Location of streams tributary to Lake Ontario treated with lampricides (numerals; see Table 12 for names of streams), and of streams where assessment traps were fished (letters; see Table 13 for names of streams) in 1983.

discharges enhanced treatment and the lampricide was carried to large, inaccessible beaver ponds where significant escapement of larvae had occurred during the 1981 treatment. Sea lamprey ammocetes were moderately abundant in the tributaries and a significant number of residuals were collected.

The lampricide treatments of Skinner and Lindsey creeks were aided by good flows, and lethal concentrations of lampricide were attained to the stream mouths. The treatments were difficult because of rapid flow times, continual need to boost lampricide and cover tributaries, and the supplementary application requirements. Larval sea lampreys, including those of transformation size, were abundant in both streams, as were adult spawning-phase sea lampreys. Except for a short stretch of Big Deerlick Creek, a tributary of Skinner Creek, where about 1,000 mature bullheads were killed, nontarget fish mortality was negligible on both treatments.

Transforming sea lampreys were collected from South Sandy and Wilmot creeks and Rouge River during treatments in October. The largest number collected was in Rouge River, and justified scheduling the treatment 1 year in advance.

SPAWNING-PHASE SEA LAMPREYS

Traps fished in four tributaries of the north shore produced 5,898 spawning-phase sea lampreys in 1983 (Table 13, Fig. 5), more than a

Table 13. Number and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Ontario, 1983. [Letter in parentheses corresponds to location of stream in Figure 5.]

Stream	Number captured	Number sampled	Percent males	Mean length (mm)		Mean weight (g)	
				Males	Females	Males	Females
CANADA							
Humber R. (A)	4,626	1,670	59	457	452	212	224
Duffin Cr (B)	606	428	62	450	450	214	226
Bowmanville Cr. (C)	100	100	60	470	482	216	240
Wilmot Cr. (D)	566	542	61	465	460	235	239
Total or average	5,898	2,740	60	458	455	217	227
UNITED STATES							
Grindstone Cr (E)	678	2	50	455	447	192	274
Little Salmon R. (F)	7	6	67	472	495	250	308
Catfish Cr (G)	11	10	50	512	481	274	243
Sterling Valley Cr (H)	461	461	63	487	483	243	247
Sterling Cr (I)	174	1	100	447	—	195	—
Total or average	1,331	480	63	487	483	243	248
GRAND TOTAL OR AVERAGE	7,229	3,220	60	463	459	221	230

Table 12. Details on the application of lampricides to streams of Lake Ontario, 1983. [Number in parentheses corresponds to location of stream in Figure 5.]

Stream	Date	Discharge at mouth		TFM		Bayer 73 Powder		Bayer 73 Granules		Stream treated	
				Act. Ingr.		Act. Ingr		Total used[a]			
		m^3/s	f^3/s	kg	lbs	kg	lbs	kg	lbs	km	miles
CANADA											
Bowmanville Cr. (2)	May 7	2.8	100	921	2,026	7	15	—	—	11.6	7
Cobourg Br (5)	June 8	1.3	46	466	1,025	—	—	—	—	11.2	7
Mayhew Cr. (6)	June 10	0.2	7	59	130	—	—	—	—	3.2	2
Graham Cr. (4)	June 12	0.3	11	219	482	—	—	—	—	16.4	10
Wilmot Cr (3)	Oct. 20	0.7	24	487	1,071	—	—	—	—	22.0	14
Rouge R. (1)	Oct. 25	1.5	53	751	1,652	—		—	—	29.9	19
Total		6.8	241	2,903	6,386	7	15	—	—	94.3	59
UNITED STATES											
Skinner Cr. (8)	May 11	1.9	68	414	910	—	—	—	—	12.6	8
Salmon R (10)	May 16	27.5	972	1,176	2,588	8	18	—	—	27.6	17
Orwell Br	May 7	2.0	71	189	416	—	—	—	—	4.2	3
Beaverdam Br.	May 9	2.2	78	180	396	—	—	—	—	5.4	4
Trout Br.	May 13	1.8	64	189	416	—	—	—	—	16.7	10
Lindsey Cr. (9)	May 14	0.8	29	152	334	—	—	—	—	14.5	9
South Sandy Cr. (7)	Oct. 16	7.6	265	906	1,994	—	—	—	—	11.9	7
Total		43 8	1,547	3,206	7,054	8	18	—	—	92.9	58
GRAND TOTAL		50.6	1,788	6,109	13,440	15	33	—	—	187.2	117

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

four-fold increase over the number captured in 1982 (1,414). In contrast, traps fished in five south shore streams captured 1,331 sea lampreys, compared with 1,364 in 1982. A partial explanation for the increase in lampreys on the north shore is the doubling of the trapping effort on the Humber River. The second trap contributed 2,513 sea lampreys to the total.

Little change in biological characteristics was observed from those sampled in 1982. Males composed a majority (60%) of the lampreys examined, a characteristic of the population prevalent since the first year of sampling in 1978.

PARASITIC SEA LAMPREYS

No parasitic-phase sea lampreys were collected from the Lake Ontario commercial fisheries, but regulatory constraints direct the fishery away from preferred lamprey hosts.

SPECIAL STUDIES

Marking transforming sea lampreys in New York State—In the fall of 1982, a total of 1,588 sea lampreys from Fish and Big Bay creeks (tributaries to Oneida Lake, New York) were injected with a colored dye and released back into the creeks to determine whether these lampreys would find their way into Lake Ontario. Inspection of 99 parasitic sea lampreys taken from New York waters of Lake Ontario during the ELSO Derby in the spring of 1983 failed to indicate the presence of such a dye mark.

The study was continued in August 1983 when an additional 1,528 transforming sea lampreys were captured in Big Bay and Fish creeks, marked with dye injections, and released into the same waters. Predatory-phase sea lampreys collected from the Lake Ontario fisheries in 1984 and spawning-phase sea lampreys captured in 1985 will be examined for marks to identify any which originated in the Oneida Lake system.

Treatment effects upon nontarget organisms—A study on the effects of TFM upon the invertebrates of Fish Creek (Oneida Lake) was begun in the fall of 1983. The initial treatment of Fish Creek is scheduled for 1984. This untreated system can provide valuable information on the effects of TFM upon nontarget invertebrates. All past field studies were conducted on previously treated systems. Samples were collected in September 1983 to gather base line data. Sampling will continue before and after TFM applications during the summer and again in the fall 1984 to determine effects of TFM on invertebrate communities.

SEA LAMPREY AND RELATED RESEARCH AT NATIONAL FISHERY RESEARCH LABORATORY, HAMMOND BAY BIOLOGICAL STATION, AND MONELL CHEMICAL SENSES CENTER, 1983

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ABSTRACT

Personnel changes included three new people to the staff at the Hammond Bay Biological Station (HBBS). They are Ronald Scholefield, chemist; William Swink, fishery biologist, and Tom Lyons, biological aid. Clyde Barr and Ben Domke retired. Dr. Donald Hales, Assistant Laboratory Director at the La Crosse National Fishery Research Laboratory (LNFRL) accepted a position in the Division of Hatcheries and Fishery Resource Management, Washington, D.C.

The Environmental Protection Agency (EPA) accepted submitted data that describes the photolysis of lampricide TFM as part of the environmental fate requirements.

Through negotiations with EPA, no Experimental Use Permit (EUP) will be required to test a clay-pelleted lampricide, an antimycin bottom

formulation, or any pheromones. Registrations for such products can be obtained through amendments or minimum data requirements.

Results of a second teratology study further confirmed that TFM is neither fetotoxic nor teratogenic to rats when administered orally at rates of 125 mg/kg or less.

EPA notified the Fish and Wildlife Service (FWS) during the year that all requirements have been met for a legal label on TFM as a lampricide.

New matrix materials were substituted into a preparation to formulate TFM as a controlled-release bar; the new materials prevent the bar from melting at temperatures somewhat above 85°F.

Soil binding studies indicate that Bayer 73 is strongly adsorbed by sediments. This may help explain observed problems with loss of activity encountered during treatment of the Ford River system.

Exposures of early life stages of walleye eggs to TFM indicate that eggs, sac fry, and swim-up fry were considerably more resistant than sea lamprey ammocetes and that field treatments should not seriously impact fertilization, survival, or development of egg stages.

Field tests with granular Bayer 73, clay-pelleted TFM, and high-density liquid formulations of TFM suggest that poor results obtained with these experimental products may be related to current, to flow rates, or to substrate composition which may act to protect buried ammocoetes.

Exposures of three genera of lamprey (*Petromyzon*, *Ichthyomyzon*, and *Lampetra*) to TFM under different water alkalinity conditions confirmed earlier observations that native species are more resistant to the lampricide than sea lamprey. Therefore, the species of choice for use in pretreatment toxicity tests is the sea lamprey.

ADMINISTRATION AND PERSONNEL

NATIONAL FISHERY RESEARCH LABORATORY STAFF

Dr. Donald C. Hales, Assistant Director, left the La Crosse laboratory to accept a position in Washington, D.C. in the Division of Hatcheries and Fishery Resources Management. Dr. Hales had worked at the laboratory since 1980 and was particularly involved in work related to ecological studies on large river systems.

HAMMOND BAY SCIENTIFIC STAFF

Two scientists and a biological aid were hired at HBBS. Ronald Scholefield, a chemist, entered on duty in March, William Swink, a fishery biologist, entered on duty in April, and Tom Lyons, biological aid (fisheries) entered on duty in November.

Mr. Scholefield, 39, holds an M.S. degree from the Illinois Institute of Technology and a B.S. from Elmhurst College. He has been an instructor in chemistry at the U.S. Naval Academy at Annapolis, Maryland for the past two years. Other work experience includes eight years of service in the U.S. Navy, five years as a chemist in research and development engineering for Culligan water treatment systems, two years as a chemist for Scientific Control Laboratories, and several years as a graduate student.

Mr. Scholefield will be assigned responsibility for water chemistry-related studies at the station. In that capacity, he will conduct research of his own on such questions as release and dispersion rates of lampricides, possible acidification of Great Lakes tributary streams by acid rain, water chemistry variations among tributaries to the several Great Lakes, and influences of metals and other contaminants on the activity of lamprey control chemicals. His recent studies on tributyltin fluoride dovetail nicely with studies that have been done on this compound at Hammond Bay.

Mr. Swink, 29, is a graduate of Michigan State University and holds an M.S. degree from Michigan Technological University. Since 1979, he has been employed as a research fishery biologist for the National Reservoir Research Program at Bowling Green, Kentucky. Prior to that assignment, he worked as a Research Assistant for the Great Lakes Research Division of the University of Michigan, Ann Arbor. Swink has participated in the preparation of seven research publications related to interactions among fish, plankton and water chemistry; to fish population estimations; and the development of fisheries in tailwaters of dams.

Mr. Swink will be assigned research duties that are part of a program of studies on responses of lampreys to chemicals, effects of water chemistry on spawning stream selection, and on the transformation of sea lampreys from larval to feeding stages. The appointment of Swink completes plans for development of a well-balanced research team at the laboratory.

Tom Lyons, 29, began employment at HBBS in November 1983. Tom has a B.S. in biological sciences from Northern Michigan University. He has been with the sea lamprey control program at Marquette, Michigan for the past 6 years where he participated on the sea lamprey control evaluation team. Tom, a biological aid, assists in conducting toxicity tests of lampricides and also participates in population estimates of lampreys in various stream systems.

RETIREMENTS AT HAMMOND BAY

Clyde Barr, biological technician, retired in January 1983. Mr. Barr had 31 years of Federal service, 29 of which were at HBBS. He was one of the original employees at Hammond Bay and was involved in the development of TFM and Bayer 73 for the sea lamprey control program. He also played an important role in developing techniques for culturing sea lampreys.

Ben Domke, biological aid, retired in November 1983 after 30 years of Federal service, 26 years at Hammond Bay. Ben worked on the initial screening of candidate chemicals that led to the discovery of TFM. Throughout his career at Hammond Bay, he played a key role in the operation of electrical and mechanical barriers used to block upstream migrations of sea lamprey.

LAMPRICIDE REGISTRATION ACTIVITIES

PHOTOLYSIS DATA ON TFM ACCEPTED

On 20 October 1983, EPA advised the FWS that the photolysis data on TFM had been accepted. EPA stated that the data "adequately addressed our concerns. Therefore, the photolysis study requirement has been *satisfied for* the sea lamprey larvicide use." When data from the soil binding study by the LNFRL are accepted by EPA, all environmental fate requirements for TFM will have been met.

Registration Application for TFM Bar—In December 1982, the FWS submitted an 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 the sea lamprey. EPA reviewed the application and asked for clarification of chemistry, toxicity, and use directions and suggested rewording of the labeling. The LNFRL responded to all of the EPA requests and is awaiting a final response.

Registration Activities on Lampricides—The LNFRL negotiated with EPA in regard to data requirements for possible registration of clay-pelleted lampricides, antimycin bottom formulations, pheromones, and hormones. No Experimental Use Permits will be required for field testing. If the field testing proves successful, amended pesticide registration applications can be submitted for the lampricides; a pheromone registration would require a minimum of studies, costing about $25,000. Minimum requirements for hormones are the same as for pheromones; thus, if a usable synthetic hormone that could be used for management of the sea lamprey were to be identified, it could be registered in a fairly short period of time.

TFM Tolerance—At the request of EPA, a teratology study on TFM was conducted in a second species (rats) as part of the requirements to establish a food additive tolerance. The final report of that study was completed in March 1983. Results further confirmed that TFM is neither fetotoxic nor teratogenic when administered orally to rats for extended periods at rates equal to or less than 125 mg/kg. EPA is now evaluating the TFM data base to determine if the suggested tolerances in potable water, meat, milk, and fish are acceptable. It is expected that the final report of the rat teratology study will complete the data requirements for EPA to establish requested tolerances. Tolerances would establish the allowable levels in water and organisms to be consumed by humans.

Final TFM Label—Over the past several years, the LNFRL has worked to consolidate all approved lampricide uses of TFM into a single combined label. In May 1983, EPA notified the FWS that all requirements for a proper, legal composite label have finally been met (after 7 years of effort).

SEA LAMPREY CONTROL RESEARCH—LA CROSSE

FORMULATION DEVELOPMENT

Development of a solid bar formulation of TFM continued on several fronts. A testing trough was constructed that has a very linear flow with little turbulence and controllable water velocity. Tests were then conducted to determine the rate at which bars dissolved in different water velocities under controlled conditions. Results based on trials at each velocity in 12°C water showed the following dissolution relationships: 0.6 ft/sec–6.3 h, 0.4 ft/sec–7.2 h, 0.3 ft/sec–10 h, and 0.2 ft/sec–12.5 h. The affect of water velocity on the rate at which the bars dissolve can be accommodated in one of two ways: (1) a concentration can be chosen that will kill lampreys in the number of hours a bar is expected to last at a given velocity, or (2) the site for placement of the bars can be carefully chosen so the existing velocity will provide the preferred number of hours of treatment.

Progress was made toward registration and production of the bar formulation. Bell Laboratories of Madison, Wisconsin has agreed to produce the bars if the GLFC will supply the necessary 80% TFM concentrate.

Efforts to improve the TFM bar were begun in hopes of making it remain hard at the high temperatures that might be reached in a vehicle during the summer. New matrix materials were substituted in the formula and 25 new combinations were tested. A new formula was developed that remains firm at 115°F in contrast to the original formula which began to get soft at 95°F.

Development of special formulations to control larval lampreys in lentic habitats continued. A custom formulator in Verona, Wisconsin was contracted to produce granular formulations of antimycin coated with materials that would prevent release of active ingredient as the granules sink and then dissolve after the product reaches the bottom.

LAMPRICIDE SOIL BINDING

The adsorption of lampricides by sediments is recognized as one of the factors that causes premature loss of activity during treatments. Since adsorption or desorption of lampricides also affects the environmental fate of the chemicals, such data are required by EPA to support continued registration.

The adsorption of ^{14}C-labeled TFM, R-TFM, and Bayer 73 was evaluated using bottom sediments from the Cedar, Ford, and Tahquamenon Rivers in Michigan. Solutions of the chemicals were mixed with selected sediments and allowed to come to equilibrium on an orbital shaker. The solutions were then centrifuged and analyzed for residues of the chemicals. Temperature was controlled by an environmental chamber and pH's were maintained using phosphate or carbonate buffers.

Generally less TFM or Bayer 73 was adsorbed at high pH's than at low pH's with each of the three sediments. The adsorption of R-TFM was influenced very little by pH. The lowest pH used with Bayer 73 was 6.5. At pH 6.0, tests could not be run because of the extremely low solubility and apparent precipitation of Bayer 73. Therefore, the Bayer 73 data used for comparison with TFM and R-TFM at pH 6.0 were those collected at pH 6.5 (Figs. 1–3). The relatively strong adsorption of Bayer 73 by sediments, especially those from the Ford River, may help explain the loss of Bayer 73 concentrations encountered during treatment of that river system. The adsorption of solutions containing 1 mg/L of each of the chemicals was compared for sediments from the Cedar (silt), Ford (silt/sand), and Tahquamenon (sand) rivers at pH 7.0 (Fig. 4).

The adsorption of ^{14}C-labeled TFM, Bayer 73, and R-TFM was evaluated against bottom sediments from the Cedar, Ford, and Tahquamenon rivers at both 5° and 20°C to determine differences due to temperature. Regardless of sediment type or temperature, Bayer 73 was more efficiently adsorbed from solution than the other chemicals. Slightly more of each compound is adsorbed by sediments at 5° than at 20°C (Figs. 5–7).

After equilibrium was established in the adsorption study, the solutions were centrifuged and decanted. Fresh, lampricide-free solution was added and the mixture was again placed on the shaker until a new equilibrium was established in order to determine the rate of desorption. Little desorption of Bayer 73 occurred from sediments from the Ford River or Tahquamenon River. By contrast, TFM was completely desorbed from Tahquamenon

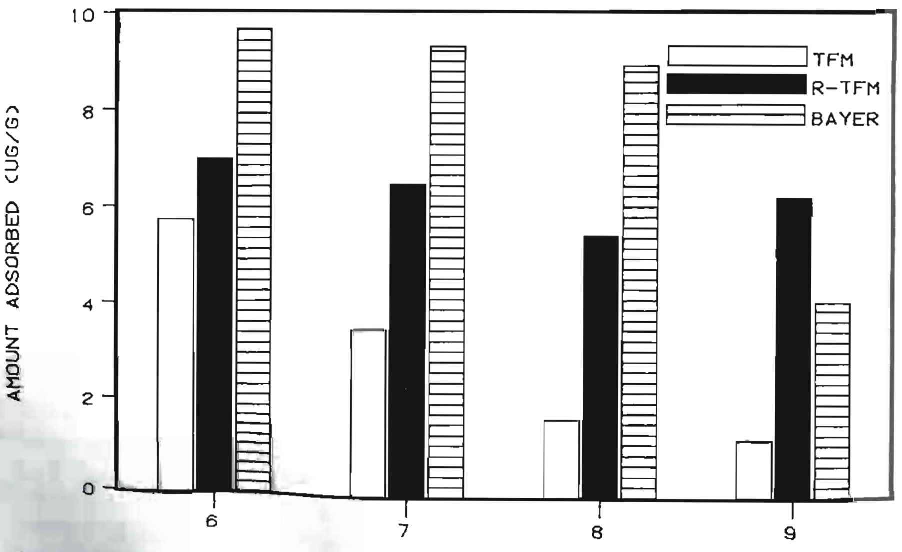

Figure 1. Adsorption of 1 mg/L solutions of ^{14}C-TFM, ^{14}C-R-TFM, and ^{14}C-Bayer 73 on Cedar River sediments at selected pH's.

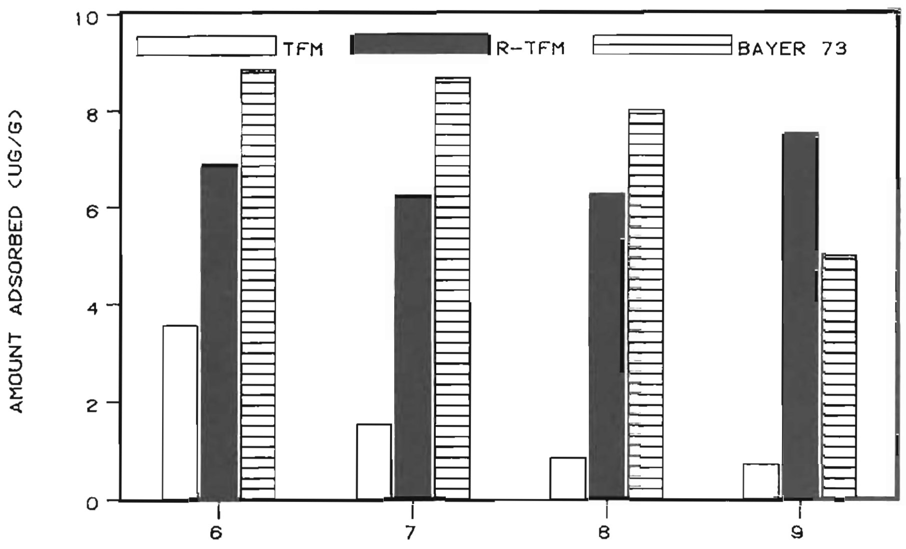

Figure 2. Adsorption of 1 mg/L solutions of ^{14}C-TFM, ^{14}C-R-TFM, and ^{14}C-Bayer 73 on Ford River sediments at selected pH's.

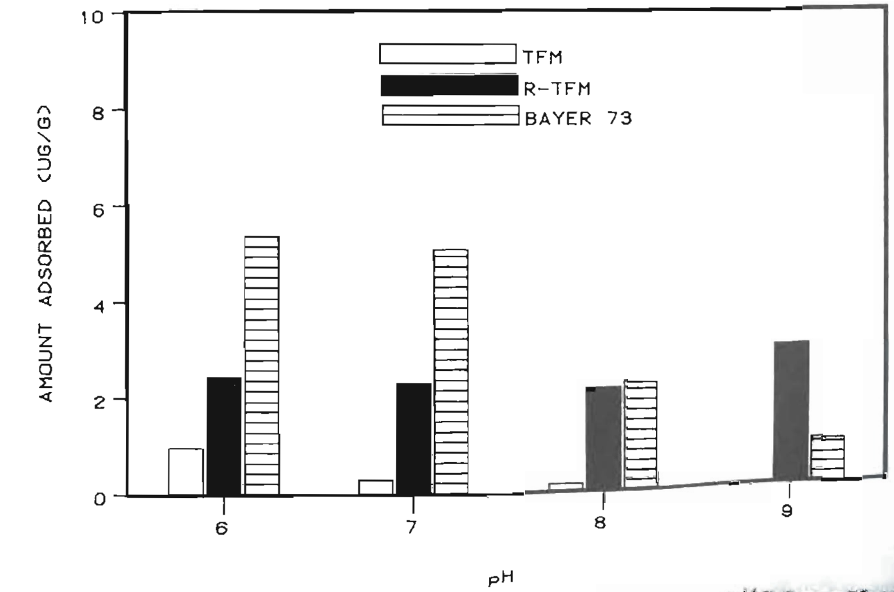

Figure 3. Adsorption of 1 mg/L solutions of ^{14}C-TFM, ^{14}C-R-TFM, and ^{14}C-Bayer 73 on Tahquamenon River sediments at selected pH's.

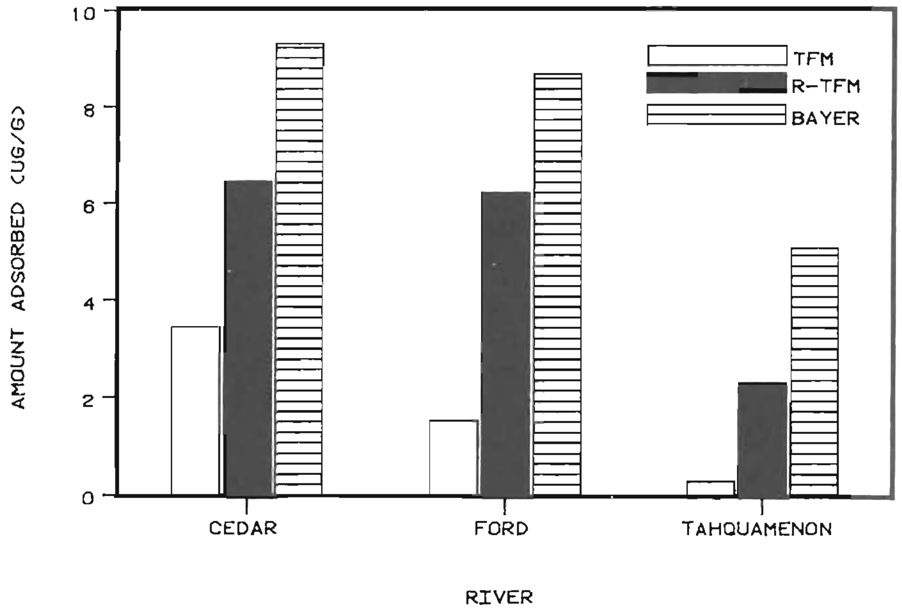

Figure 4. Comparative adsorption of 1 mg/L solutions of ^{14}C-TFM, ^{14}C-R-TFM, and ^{14}C-Bayer 73 on Cedar River (silt), Ford River (silt/sand), and Tahquamenon River (sand) sediments at pH 7.

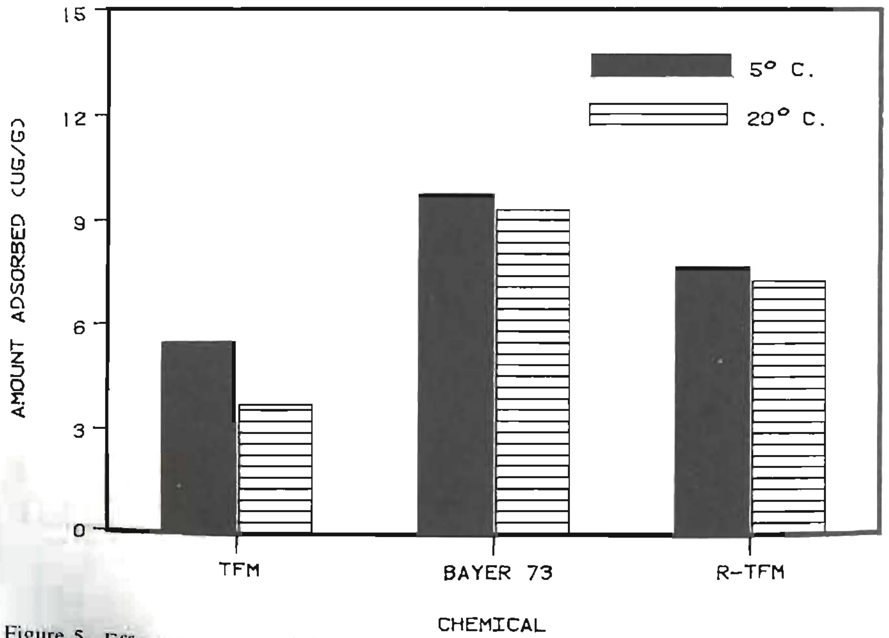

Figure 5. Effect of temperature on adsorption of 1 mg/L solutions of ^{14}C-TFM, ^{14}C-Bayer 73, and ^{14}C-R-TFM on Cedar River sediments at pH 7

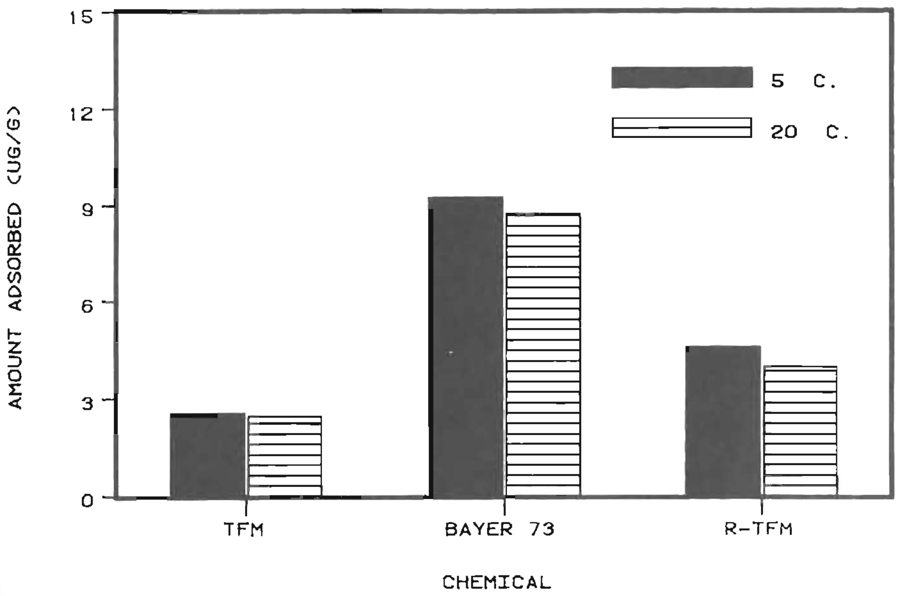

Figure 6. Effect of temperature on adsorption of 1 mg/L solutions of ^{14}C-TFM, ^{14}C-Bayer 73, and ^{14}C-R-TFM on Ford River sediments at pH 7

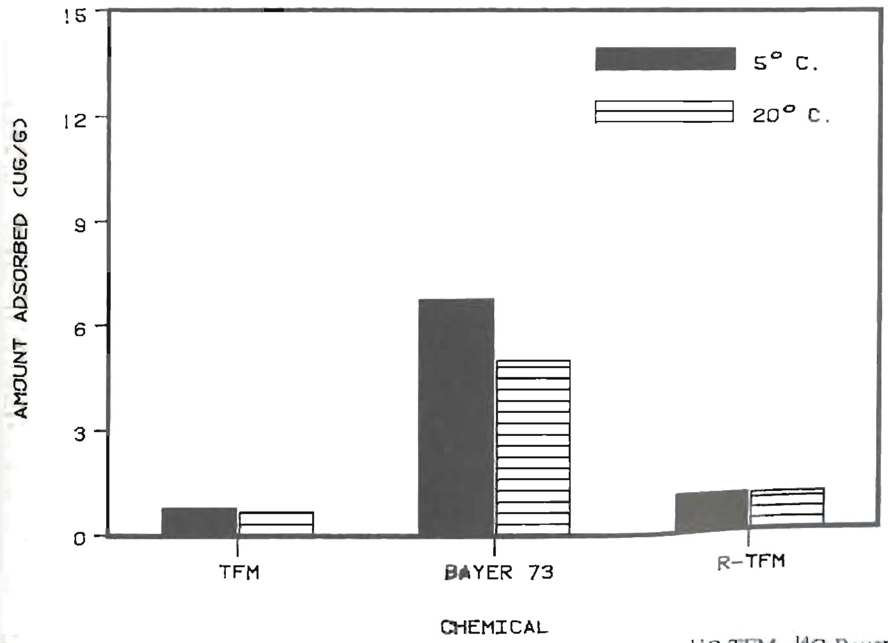

Figure 7. Effect of temperature on adsorption of 1 mg/L solutions of ^{14}C-TFM, ^{14}C-Bayer 73, and ^{14}C-R-TFM on Tahquamenon River sediments at pH 7.

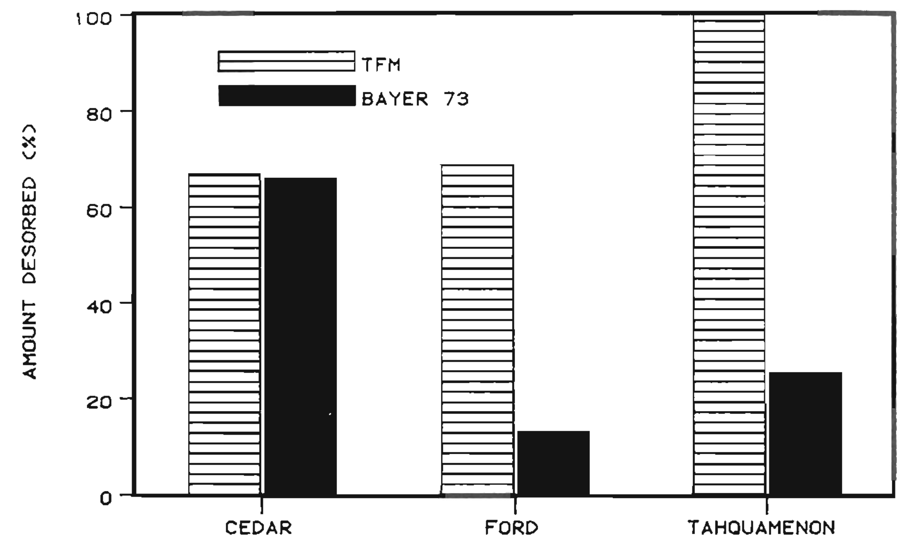

Figure 8. Comparative desorption (%) of adsorbed ^{14}C-TFM and ^{14}C-Bayer from Cedar River (silt), Ford River (silt/sand), and Tahquamenon River (sand) sediments.

River sediment (Fig. 8). The release of each bound chemical was greater at 20° than at 5°C, regardless of sediment type (Figs. 9–11).

BISAZIR RESIDUES

Bisazir is being considered for use as a chemosterilant in the control of sea lampreys. Earlier studies using ^{14}C-labeled bisazir showed that 90% or more of the residues of bisazir in sea lampreys are eliminated within the first 24 hours of withdrawal from the chemical. Residues remaining in the lampreys after a use-pattern treatment must be identified as part of the bisazir safety evaluation. Residues were extracted from sea lampreys treated with ^{14}C-labeled bisazir using both polar and non-polar solvents. Radiometric analysis showed the presence of both polar and non-polar residues. Subsequent analyses of these extracts by gas chromatography with flame photometric detection showed the presence of a small amount of bisazir, as well as two other residues that contain sulfur and phosphorus.

Hexane extracts of sea lamprey exposed to 100 mg/L of bisazir for 2 hours and sampled immediately after the exposure contained more radioactivity than ethyl ether or methanol extracts. The residues in hexane are quite non-polar. Methanol extracts contained more radioactive residue than ethyl ether indicating the presence of polar metabolites of bisazir. Samples are being extracted and cleaned up for analysis by selective gas chromatography and gas chromatography/mass spectroscopy.

Preliminary analyses of technical bisazir by gas chromatography/mass

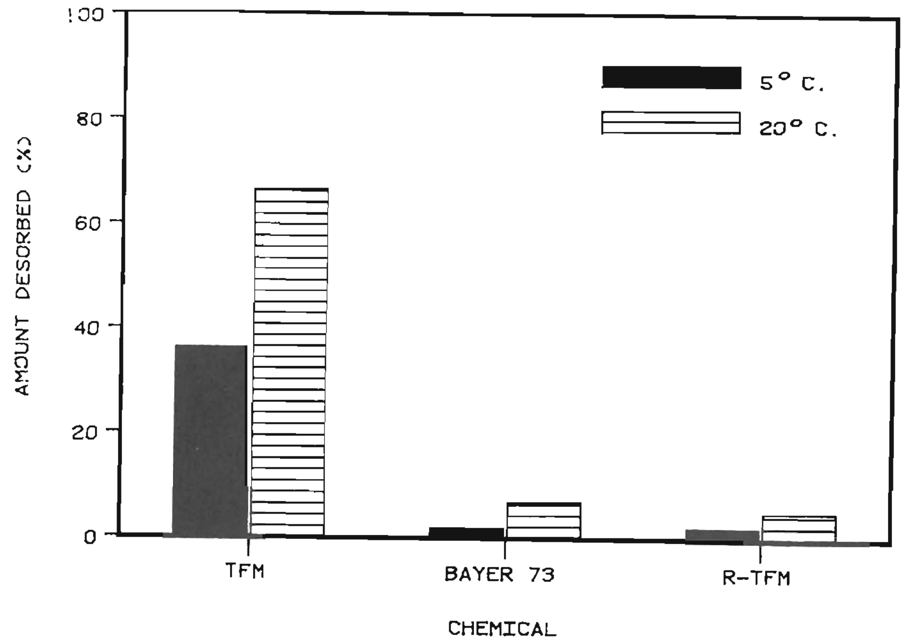

Figure 9. Effect of temperature on desorption of adsorbed ^{14}C-TFM, ^{14}C-Bayer 73, and ^{14}C-R-TFM from Cedar River sediments at pH 7.

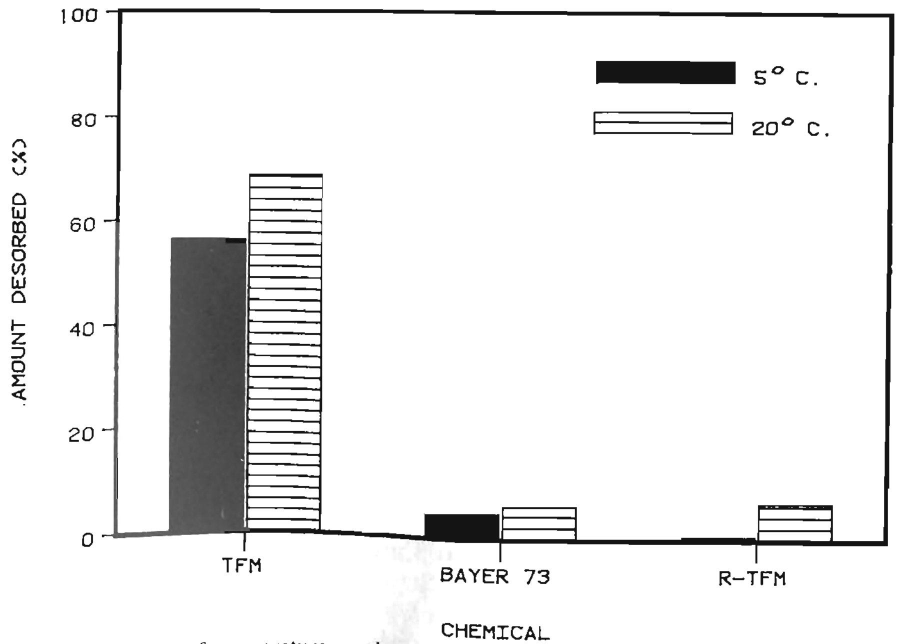

Figure 10. Effect of temperature on desorption of adsorbed ^{14}C-TFM, ^{14}C-Bayer 73, and ^{14}C-R-TFM from Ford River sediments at pH 7.

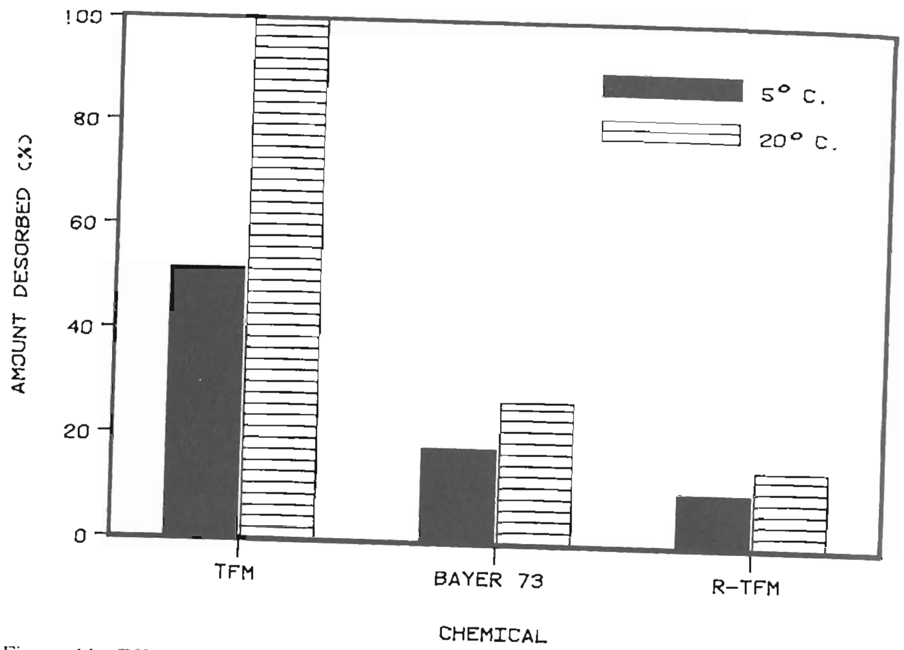

Figure 11. Effect of temperature on desorption of adsorbed ^{14}C-TFM, ^{14}C-Bayer 73, and ^{14}C-R-TFM from Tahquamenon River sediments at pH 7.

spectroscopy were run in cooperation with the National Fishery Research Laboratory, Columbia, Missouri. The results indicated good purity of the technical material and a strong response for the molecular ion. The spectra were run using electron impact ionization, and several fragments which will be helpful in identification of bisazir, were also detected. This analysis indicates that sensitivity in the pico gram range should be achievable, depending on the presence of interfering substances in sample extracts.

LITTLE IMPACT OF LAMPRICIDE TFM ON EARLY LIFE STAGES OF WALLEYE

Resource managers in the Great Lakes region expressed concern for the safety of early life stages of walleye during field applications of lampricide TFM (3-trifluoromethyl-4-nitrophenol). A study was conducted to measure possible impacts of lampricide treatments on gametes, fertilized eggs, larvae, and fry of walleye. Toxicity tests were conducted in aerated Lake Huron water (total hardness of 108 mg/L as $CaCO_3$; alkalinity = 87 mg/L) at the Hammond Bay Biological Station, Millersburg, Michigan, and in unaerated soft water (total hardness of 44 mg/L as $CaCO_3$; alkalinity = 32 mg/L) at the La Crosse National Fishery Research Laboratory, La Crosse, Wisconsin. The study at Hammond Bay duplicated field treatment conditions as closely as possible by exposing eyed eggs, sac fry, and swim-up fry to TFM in aerated water for 8 or 16 hours, bracketing standard treatment times. At the La Crosse facility, newly fertilized eggs, green eggs, eyed eggs, and sac fry were exposed to TFM for 12 hours. These tests followed EPA procedures for determining maximum toxicity values.

The effects of TFM on the fertilization process were measured by stripping eggs and sperm from sexually mature fish into solutions of TFM ranging from 0 to 12.3 mg/L at the La Crosse laboratory. The fertilization process was unaffected by concentrations up to 3.0 mg/L. This concentration is nearly 3 times the amount of TFM required to produce a 12-hour LC99.9 for sea lamprey ammocetes (LC99.9 = 1.00 mg/L) under the same test conditions.

The effects of TFM on walleye eggs during water hardening were measured by stripping eggs and sperm into vessels containing 2 liters of untreated water and immediately adding TFM from a stock solution to yield concentrations ranging from 0 to 12.3 mg/L. Fertilized eggs were unaffected by concentrations of TFM used for stream treatments in soft water.

Toxicity tests with eggs during incubation showed this stage was very resistant to TFM in both water hardnesses. Green eggs incubated for 12 hours in unaerated soft water were found to be the most sensitive; (LC25 = 2.34 mg/L). Even so, the toxicity to walleye was still well below the 12-hour LC99.9 for sea lamprey ammocetes under similar test conditions. Eggs exposed to 4.00 mg/L of TFM for 8 hours, at stages from one day after fertilization until hatching, showed no mortality as a result of exposure to TFM in aerated Lake Huron water. Toxicity tests with eggs 7 days after fertilization yielded an LC25 of >14.0 mg/L, which is several times greater than the LC99.9 for sea lamprey ammocetes in the same water.

Sac fry were quite tolerant to TFM in both soft and Lake Huron water with LC25's of 5.8 mg/L and 9.8 mg/L, respectively. The LC99.9 for sea lamprey in these waters was less than one fifth the LC25 for walleye sac fry. For swim-up fry exposed in aerated Lake Huron water, the LC25 was 6.3 mg/L, several times greater than the LC99.9 for sea lamprey.

The above results indicate that walleye eggs, sac fry, and swim-up fry are considerably more resistant to TFM than sea lamprey ammocetes. Therefore, concentrations of TFM which are lethal to sea lamprey ammocetes in the field should not seriously impact the fertilization, survival, or development of egg stages and should not affect the survival of sac fry or swim-up larvae of walleyes.

TECHNICAL ASSISTANCE—LA CROSSE

PURITY CHECKS ON BAYER 73 SAMPLES

Two samples of 5% Bayer 73 granules and two samples of 70% Bayer 73 wettable powder sent to us by the Ludington Biological Station were assayed for percent active ingredient by high performance liquid chromatograph and were found to contain from 97.5–104.9% of the Bayer 73 declared on the label.

TECHNICAL INFORMATION EXCHANGE

The Environmental Effects Branch, Hazard Evaluation Division of EPA, requested additional information on potential health effects of TFM in August 1983. The LNFRL provided an analysis of data on environmental factors affecting general toxicity, toxicity to birds and mammals, methods of detection, and use patterns.

The National Academy of Sciences of Canada has formed a special, blue-ribbon panel to develop an objective review of the use and environmental effects of TFM as a lampricide. The review is intended to summarize all known existing data and to identify data gaps. The panel has completed the first draft of its report. Dr. Fred P. Meyer is a member of the panel.

SEA LAMPREY CONTROL RESEARCH—HAMMOND BAY

EFFICACY OF NEW FORMULATIONS OF REGISTERED TOXICANTS AGAINST LARVAL SEA LAMPREYS

Four hundred pounds of experimental clay-pelleted formulations of TFM and of a mixture of TFM and Bayer 73 were received from Hopkins Agricultural Chemical Company, Madison, Wisconsin. These materials contained approximately 10% (by weight) of active ingredient and were selected for field testing on the basis of results from toxicity tests conducted earlier on laboratory-produced samples.

Samples of the Hopkins formulations were tested against granular Bayer 73 and against a pellet reference standard to compare efficacy and provide a check on quality control of the Hopkins production batches. Analysis for active ingredient by HPLC confirmed the declared percentage of active ingredient in the Hopkins formulations.

Repetitive tests, however, indicated that at least 200 lbs/A of total formulation of these materials would be required to produce the required effect on sea lamprey ammocoetes in lentic habitats. Uniform lampricide coverage on the bottom substrate is essential to produce an effective toxic concentration for ammocoetes. To provide this coverage, more pellets per unit area and relatively high application rates would be required.

In laboratory studies, a dilute formulation of TFM mixed in a 1% NaCl solution formed a dense, thin layer of liquid when applied on the substrate. It covered quickly and maintained its integrity satisfactorily when subjected to a water flow of 1.1 cm/min. When tested against granular Bayer 73 and the experimental pelleted formulations, the liquid formulation outperformed these materials by causing faster emergence, immobilization, and rate of kill of exposed ammocoetes.

A field trial was conducted in Hammond Bay of Lake Huron to compare the efficacies of granular Bayer 73, clay-pelleted TFM, and high-density liquid TFM formulations. This field test was carried out with the assistance of the staff from the Ludington and Marquette Biological Stations. Lamprey ammocoetes were placed by divers throughout three 1/4 acre areas near the mouth of the Ocqueoc River in Lake Huron. Nine baskets containing 10 ammocoetes and three baskets containing 10 rainbow trout were placed in each test area. Water depth varied between 1.5 and 2.7 meters. The caged ammocoetes were left in the sand for 3 days before the lampricides were applied. Two of the areas were treated with new formulations of TFM. The clay-pelleted TFM and the liquid TFM, with sodium chloride added, were applied at a rate of 20 lbs. of active ingredient per acre. The third area was treated with Bayer 73 granules at a rate of 5 lbs. of active ingredient per acre. The Bayer granules killed about 35% of the ammocoetes while the two new formulations of TFM killed no ammocoetes. No caged fish were killed in any of the plots. Some dead sculpins were observed on the bottom in the Bayer area. Several explanations are plausible, but we think two factors may have adversely affected the efficacies of the experimental formulations. The water current in all three sites was quite swift (estimated at 2 to 3 cm/sec) on the day we treated, causing the lampricide to be swept away from the burrowed ammocoetes before it penetrated their burrows. A second factor which could have reduced effectiveness was the fineness of the sand particle size in the test area that made it difficult for the ammocoetes to maintain an open burrow, limited water interchange, and thereby limited ammocoete contact with the lampricides. Another field test was conducted with the liquid formulation containing TFM and NaCl. This test was conducted off the mouth of the Carp River, Mackinac County, Michigan—an area known to harbor a large population of sea lamprey ammocoetes. Cages containing free-swimming ammocoetes were placed on the bottom of the treatment plot with no substrate in which to burrow. The test formulation was applied at the same rate (20 lbs. active ingredient per acre) as in the Hammond Bay trial. Again, the application was ineffective in killing caged sea lamprey ammocoetes. Residual ammocoetes were also unaffected since none were seen surfacing. In this instance, it is believed that water currents across the treated area dissipated or diluted the lampricide before an effective concentration of contact time was established.

In a continuing search to find a formulation of TFM, or TFM and Bayer 73, that is effective in killing larval sea lamprey in lentic areas, several additional laboratory tests were conducted. Using raceways to simulate a low velocity current over the bottom, such as might be encountered in a lake, the efficacy of liquid TFM with sodium chloride added was tested. Ammocoetes that were burrowed in the sand were all dead within 3 hours after an application of 22 lbs. of active TFM per acre.

Additional toxicity tests were conducted with free-swimming ammocoetes to test the efficacy of the liquid TFM with sodium chloride added. Bayer 73 was added at concentrations of 60, 120, and 180 μg/L to see if the addition of this compound would measurably decrease the contact time needed to kill sea lamprey. The addition of 60 μg/L of Bayer 73 did not measurably increase the effectiveness of the TFM:NaCl mixture. Additions of 120 and 180 µg/L of Bayer 73 resulted in a 10–15 min decrease in the contact time necessary to kill all sea lamprey in the test populations. Additional experiments are being planned to test the efficacy of these and other formulations in the laboratory in preparation for additional field trials next summer.

DEVELOPMENT OF METHODS FOR STERILIZING ADULT SEA LAMPREYS

Cobalt-60—Spawning-run sea lamprey from the Cheboygan River were exposed to radiation dosages of 1,000, 1,500, 2,000, 2,500, 3,000, or 3,500 rads from a cobalt-60 source located at the Phoenix Memorial Laboratory at the University of Michigan. Lamprey were placed in a 30 × 30 × 30 cm Nalgene tank containing 30 cm of water. Water temperature during exposure ranged from 50–52°F and oxygen levels were maintained near saturation with aeration. The rate of exposure to the radiation was 120.8 rads/min.

Doses received by the lamprey during the irradiation were measured on the front and back of the holding containers. Nearly five times as much dosage was measured at the front of the container than at the back. Because of this large variation, it was likely that the dosage received by individual lampreys also varied considerably.

Ten lampreys from each group were weighed, finclipped, and placed in the artificial spawning stream at Hammond Bay Biological Station (HBBS) along with normal males and females. The lamprey were observed periodically and all irradiated males observed spawning were artificially spawned with normal females. A portion of the eggs from each female also was fertilized with sperm from a normal male to provide a control. The eggs were incubated for 21 days, all dead eggs were removed, and the numbers of live, abnormal, and normal prolarvae produced were recorded. Prolarvae judged to be abnormal were usually so grossly deformed that survival was improbable.

Some sterility was induced at all dosages tested (Table 1). As expected, we found considerable variability in the sterilization effect of the radiation among lamprey that were exposed to the cobalt-60 source for the same amount of time.

Cesium-137—When we became aware of the problem with inconsistent dosages produced in the cobalt-60 irradiator, we decided to conduct additional experiments with a Gammacell 40, cesium-137 irradiator at Wayne State University. This radiation source offers consistent dosages because the cesium-137 surrounds the material being irradiated.

Lamprey were collected from traps in the St. Mary's River on 29 and 30 June. On 1 July, groups of 10 male sea lamprey were exposed to radiation dosages of 1,000, 2,000, or 3,000 rads. Three layers of plastic bags were placed in the holding tray and 10 lamprey were placed in the bags

Table 1. Summary of effects of exposure of male spawning-run sea lampreys to selected doses of cobalt-60 radiation on the production of normal prolarvae after 21 days of 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.

Dose rate in rads (ranges in parentheses)[a]	Number spawned artificially	Average number of eggs per spawning (ranges in parentheses)	Average percentage per spawning (ranges in parentheses)		
			Dead	Live, abnormal prolarvae	Live, normal prolarvae
1,000 (289–1,554)	9	291 (176–384)	81.7 (60.5–99.7)	4.8 (0.0–12.5)	13.5 (0.3–35.3)
Control	9	289 (185–496)	31.5 (4.1–87.0)	0.7 (0.0–2.2)	67.8 (12.6–95.9)
1,500 (434–2,330)	6	235 (165–267)	96.1 (87.9–100.0)	0.4 (0.0–1.2)	3.5 (0.0–11.5)
Control	6	373 (202–715)	36.5 (2.5–85.9)	0.9 (0.0–4.0)	62.6 (14.1–96.8)
2,000 (579–3,109)	2	210 (173–246)	97.2 (95.5–98.8)	1.0 (0.0–2.0)	1.8 (1.2–2.4)
Control	2	197 (151–242)	41.5 (6.2–76.8)	1.4 (0.7–2.1)	57.1 (22.5–91.7)
2,500 (724–3,887)	6	406 (194–545)	90.5 (78.5–100.0)	2.4 (0.0–10.0)	7.0 (0.0–20.4)
Control	6	312 (183–566)	23.8 (3.3–47.2)	0.6 (0.0–1.1)	75.7 (52.3–95.7)
3,000 (869–4,665)	3	350 (198–595)	97.3 (91.9–100.0)	1.5 (0.0–4.4)	1.2 (0.0–3.7)
Control	3	386 (249–552)	36.9 (10.9–78.7)	0.4 (0.0–1.1)	62.6 (21.3–88.0)
3,500 (1,014–5,443)	6	198 (147–336)	87.1 (63.2–100.0)	7.0 (0.0–30.7)	5.9 (0.0–21.7)
Control	6	293 (207–399)	24.8 (2.4–100.0)	0.6 (0.0–1.3)	74.7 (0.0–97.1)

[a]Dosimeters were placed on each container during irradiation. Low value is the amount of radiation received at the back of the container and high value is the amount of radiation received at the front of the container

with 8 cm of water. Lampreys were irradiated at a rate of 115 rads/min. Water temperature during irradiation was 57–58°F and no aeration was provided during exposures. Irradiated lamprey were returned to HBBS and placed in the artificial stream. Those males observed spawning in the artificial stream were artificially spawned with non-irradiated females. Developing embryos were incubated for 21 days at a constant temperature of 18.3°C and development and mortality rates were closely followed.

Mortality among treated males in the various groups was low. Eight of 10 males exposed to the highest dosage (3,000 rads) were observed spawning and were artificially spawned. A high level of sterility occurred at all dose rates (Table 2). A few live, normal prolarvae developed from eggs

Table 2. Summary of effects of exposure of male spawning-run sea lampreys to selected doses of cesium 137 radiation on the production of normal prolarvae after 21 days of 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.

Dose rate in rads	Number spawned artificially	Average number of eggs per spawning (ranges in parentheses)	Average percentage per spawning (ranges in parentheses)		
			Dead	Live, abnormal prolarvae	Live, normal prolarvae
1,000	6	349 (224–611)	96.7 (89.9–100.0)	1.8 (0.0–7.4)	1.6 (0.0–3.6)
Control	6	375 (223–602)	33.8 (7.2–74.2)	0.6 (0.0–1.3)	65.7 (25.8–91.9)
2,000	6	499 (298–117)	98.4 (92.8–100.0)	1.4 (0.0–6.3)	0.3 (0.0–1.0)
Control	6	359 (234–505)	23.9 (6.9–56.1)	1.4 (0.0–5.6)	74.7 (43.9–92.0)
3,000	8	482 (215–724)	99.8 (98.6–100.0)	0.2 (0.0–1.5)	0.0 (0.0–0.0)
Control	8	376 (148–661)	14.5 (1.4–36.3)	2.0 (0.7–7.7)	83.6 (62.5–94.7)

fertilized by males irradiated with 1,000 or 2,000 rads. No live, normal prolarvae were produced from eggs fertilized by males irradiated with a dosage of 3,000 rads.

The results of this study are encouraging. However, since the lampreys were not irradiated until 1 July, the effects of radiation on males captured during the early part of the spawning run will have to be determined in laboratory studies. A small-scale field test will be conducted to determine if the radiation treatment has a noticeable effect on nest building and spawning behavior of treated lampreys or if it affects their mating competitiveness in any way.

DEVELOPMENT OF ALTERNATIVE SEA LAMPREY LARVICIDES

Data from the initial screening of chemicals to identify a selective lampricide were reviewed for identification of chemicals, other than TFM, that show potential as selective lampricides. Screening data indicated that the following four compounds were selectively toxic to sea lamprey at concentrations <1 mg/L and that additional screening may be warranted:

1. 2,5-trifluormethyl-4-nitrophenol
2. 2,5-dichloro-4-nitrophenol
3. 5-chloro-2,2′-dihydroxy-4′-nitrobenzanide
4. 5-chloro-2′,4-dimethyl-5′-nitrosalicylanilide

FIELD TESTS OF ATTRACTANTS AND REPELLENTS FOR POTENCY AGAINST ADULT SEA LAMPREYS

A review of the literature indicated that sound or low-level electromagnetic energy may have some potential for attracting or repelling sea lamprey.

No potential attractant or repellent was provided to HBBS by the Monell Chemical Senses Center for field testing. Assistance was provided to the Monell team during their laboratory studies at HBBS.

TECHNICAL ASSISTANCE—HAMMOND BAY

COMPARATIVE TOXICITIES OF TFM AND MIXTURES OF TFM AND BAYER 73 TO SEA LAMPREY AND NONTARGET ORGANISMS IN WATERS OF DIFFERENT ALKALINITIES

Treatments of streams for sea lamprey ammocetes have been conducted with TFM or a mixture of TFM and Bayer 73 using a combination of pretreatment toxicity tests data and predictive regression charts to select the treatment concentrations. Regression lines for TFM concentration versus alkalinity were developed from pretreatment toxicity tests data and have been quite reliable for predicting the minimum lethal concentration of TFM for sea lamprey. Predictive charts for the maximum allowable concentration were prepared based on data from rainbow trout toxicity tests in the U.S. and a combination of species in Canada. Neither the Canadian nor U.S. control agent has reliable data to predict the amount of Bayer 73 that can be safely used under different water alkalinities. In addition, little information is available to show the potential effects of the combination of TFM and Bayer 73 on nontarget organisms under different water conditions. The use of Bayer 73 has been promoted where conditions (stream flow rates, water quality, etc.) are appropriate to provide a substantial savings due to a decrease in the amount of TFM required for an effective treatment. The treatment supervisors have hesitated to use Bayer 73 on a large number of treatments (mainly in the U.S.) because little is known about the potential for impacting nontarget species.

In an attempt to alleviate this problem, a cooperative study was conducted by Hammond Bay Biological Station personnel and representatives of the sea lamprey control stations at Marquette and Ludington, Michigan, and Sault Ste. Marie, Ontario, Canada. The objectives were to measure the toxicity of several combinations of TFM and Bayer 73 to sea lamprey and six species of nontarget organisms under a range of alkalinities, and to construct a series of charts using the LC 100 for sea lamprey and LC 25 for nontarget organisms. About 100 toxicity tests were completed in reconstituted water of 40, 60, 100, and 200 mg/L as $CaCO_3$ total alkalinity against rainbow trout, fathead minnows, and sea lampreys. Additional tests are planned for white suckers, black bullheads, walleye, and mayflies as they become available.

COMPARATIVE SUSCEPTIBILITY OF THREE GENERA OF LARVAL LAMPREYS TO TFM

During the early period of the sea lamprey control program, it was a common practice to use only sea lamprey (*Petromyzon marinus*) larvae in field pretreatment toxicity tests. As the use of TFM increased and the control program expanded throughout the Great Lakes, larval sea lamprey populations were drastically reduced and sea lampreys for pretreatment toxicity tests were no longer conveniently available. Consequently, the use of native lampreys (available from untreated areas) increased considerably and were used almost exclusively by both U.S. control units. These larvae were from the two native genera, *Lampetra* and *Ichthyomyzon*.

Results from two early independent laboratory studies indicated some variability in the susceptibility among the Great Lakes lamprey genera to TFM. One study indicated the native lampreys, particularly *Lampetra*, were more tolerant to TFM than *Petromyzon* larvae. The results from the other study were inconclusive. The results from the two studies were not in agreement in respect to the comparative sensitivity of these genera to TFM and did not adequately delineate the minimum lethal concentrations for sea lamprey larvae. When native species were used in pretreatment toxicity tests to determine stream treatment concentrations, there may have been instances in which higher treatment concentrations were used than were actually necessary.

Because of environmental and economic concerns, it has become increasingly important to minimize the quantities of lampricides used. Since earlier observations suggested that larvae of the native genera were somewhat more resistant to TFM than larval sea lampreys and the results from two early laboratory studies conflicted, a more definitive study was warranted.

The objectives of the new study were to more accurately define the relative susceptibility of the three genera of lampreys in the Great Lakes to TFM; to increase the reliability of data from pretreatment toxicity tests; and to determine the feasibility of using native lamprey larvae in pretreatment toxicity tests.

We exposed larvae of the three lamprey genera to TFM in reconstituted waters of 45, 90, and 180 mg/L total alkalinities. Test temperatures were controlled at 7°C and 17.0°C. The LC 99.9 values in mg/L TFM for larval lampreys exposed for 9 hours were as follows:

Test water total alkalinity	*Petromyzon*		*Ichthyomyzon*		*Lampetra*	
(mg/L $CaCO_3$)	7.0°C	17.0°C	7.0°C	17.0°C	7.0°C	17.0°C
45	1.4	1.6	2.0	1.7	2.5	1.7
90	3.0	3.0	4.0	3.8	5.0	4.0
180	6.4	7.5	8.4	8.2	9.8	9.2

These data confirm and clarify earlier observations regarding a higher tolerance of the native lampreys to TFM (particularly *Lampetra*). The study indicates that the exclusive use of sea lamprey larvae in pretreatment toxicity tests should be standard practice.

FIELD TOXICITY TEST DATA

Data from 50 toxicity tests conducted by the Ludington and Marquette treatment crews during the last field season were evaluated on the HBBS computer. The data were subjected to Litchfield-Wilcoxon data reduction techniques. The results of these analyses show that the field data are similar to the laboratory data used to develop the toxicity prediction tables developed at the HBBS last winter.

BAYER 73 LOSS

Studies were conducted for the Ludington Biological Station to measure loss of Bayer 73 in their toxicity test vessels. About 80 water samples were analyzed by the HBBS to determine Bayer 73 concentrations present.

REVIEW OF FIELD WATER CHEMISTRY DATA

An examination of the sea lamprey control data was initiated to ascertain if they could be used to identify both long-term and seasonal changes in alkalinity and pH in the Great Lakes tributaries. Due to the sparcity of the data, no long- or short-term trends in alkalinity or pH were measurable using the data from the control agents. A report was submitted to the Great Lakes Fishery Commission's Board of Technical Experts.

CASS AND SHIAWASSEE RIVER STUDIES

At the request of the Ludington sea lamprey control unit, we conducted toxicity tests using water from the Cass and Shiawassee Rivers to develop preliminary information on the activity of TFM in these waters. Toxicity tests were originally conducted at 24°C (temperature at the water collection site). The raw data were not definitive and TFM toxicity and selectivity could not be determined. High water temperature, silt loading, and other factors contributed to the poor results of this toxicity test.

A second series of river water samples was collected and TFM toxicity tests were run at 12°C. The data from the second set of toxicity tests indicated reduced toxicity and loss of selectivity of TFM for both the Cass and Shiawassee Rivers.

The minimum lethal concentration (MLC 99.9) for lampreys in Cass River water was 8.0 mg/L, about 2.2 mg/L higher than indicated from alkalinity-derived prediction tables. The maximum allowable concentration (MAX 25) for rainbow trout was 13.0 mg/L, about 3.0 mg/L lower than predicted; thus indicating reduced selectivity.

Similar data were also found for the Shiawassee River. The MLC 99.9 for lampreys was 13.5 mg/L, which was about 3.6 mg/L higher than expected, and the MAC 25 for rainbow trout was 20.0 mg/L, about 1.2 mg/L less than expected.

OCQUEOC RIVER BARRIER DAM AND TRAPS

Spawning-run sea lamprey were captured in traps below the low-head barrier dam on the Ocqueoc River in the spring of 1983. The large, permanent trap captured 297 lampreys and a portable trap captured 713.

LIVE LAMPREYS

Live lampreys were provided to the following investigators: Dr. Greg Busacker (University of Minnesota, St. Paul, Minnesota), Dr. Leonard Banaszak (Washington Unviersity, St. Louis, Missouri), Dr. Stacia Sower (University of Washington, Seattle, Washington), Dr. Leo Pezzementi (Oberlin College, Oberlin, Ohio), Dr. Gary Litman, (Sloan-Kettering Institute, Rye, New York), Dr. Thomas Hardt (University of Medicine and Dentistry of New Jersey, Piscataway, New Jersey), Dr. John Teeter (Monell Senses Center, Philadelphia, Pennsylvania), Dr. G. C. Gaik (Loyola University of Chicago, Maywood, Illinois), and Dr. Michael Selzer (University of Pennsylvania Medical School, Philadelphia, Pennsylvania).

EFFECT OF SEA LAMPREY PREDATION ON LAKE TROUT

Knowledge of the impact of sea lamprey populations on important fish stocks is needed to attain a cost-effective degree of sea lamprey control. The relationship between sea lamprey wounding on lake trout and sea lamprey-induced mortality is not fully understood. A laboratory study was initiated to determine what percentage of sea lamprey attacks are lethal to lake trout.

A single sea lamprey and a lake trout were placed together in each of ten 40-gallon aquaria. Each sea lamprey was allowed to make one feeding attachment on the lake trout. When the sea lamprey released its prey, the duration of attachment, growth of the sea lamprey, and condition of the lake trout (i.e., alive or dead, wound size, and location of wound) were recorded. The lake trout was then replaced by a new individual.

Between 26 April and 21 July, 33 sea lamprey attachments were recorded. Sea lamprey attacks resulted in lake trout mortality in two instances (6% of attacks) and may have been the cause of death in five others (15%) of attacks). Duration of feeding attachments ranged from 49 to 1,368 h and averaged 400 h (16.7 days). Mean sea lamprey growth per attachment was 12.6 g and ranged from 0.2 to 63.3 g. Maximum sea lamprey growth occurred between temperatures of 13.6° and 15.6°C.

Lake Huron water temperatures were much higher than normal during the summer of 1983. Sea lamprey wounding studies were suspended in mid-July because of sustained high water temperatures (>21.1°C) that resulted in higher than usual lake trout mortalities.

Studies were resumed in November after water temperatures had declined. Of 20 attachments recorded between 3 November and 20 December, 4 (20% of attacks) resulted in lake trout mortality. Duration of feeding attachments ranged from 7.0 to 224.5 h and averaged 96 h. Mean sea lamprey growth per attachment was 13.0 g and ranged from -3.1 to 43.7 g.

ATTRACTANT AND REPELLENT RESEARCH—MONELL CHEMICAL SENSES CENTER

ISOLATION AND IDENTIFICATION OF SEA LAMPREY PHEROMONES

The report summarizes the results of experiments conducted during 1983 at the Monell Chemical Senses Center and at HBBS to identify and characterized 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.

During the past several years, we have accumulated convincing evidence that pheromones play a role in sea lamprey migration and reproductive behavior. On the basis of observations in a variety of two-choice preference tanks, we have inferred the existence of at least three, and perhaps four, pheromones. Two of them, one released by males and the other by females, have been classified as sex attractants. The male pheromone is released in the urine of sexually mature males and elicits a preference response in spawning-run females. The female pheromone is associated with ovarian fluid of sexually mature females and elicits a preference response in spawning-run males. The third pheromone is released by sea lamprey larvae and appears to attract sexually immature spawning-run adults. Sexually mature males avoid water in which other males have been held, suggesting that a fourth pheromone may be used. It is not known if the substance released by males which attracts females is the same substance avoided by other males.

The precise functional significance of these chemical signals remains to be determined; however, several possibilities are apparent. The male and female pheromones are probably involved in short-range communication between sexually mature adults, perhaps during pair-formation or in release of spawning behavior. Spawning-run females which have not fully matured also respond to urine from mature males. This suggests that the presence of a small number of sexually mature males, even early in the spawning season when most of the animals are not sexually mature, could result in aggregation of females prior to upstream migration, maintenance of a group during migration, or act as a cue for selection of a tributary. It also suggests that it may be possible to use a synthetic male pheromone as a long-range attractant for spawning-run females throughout the season. The avoidance, by sexually mature males, of substances released by other males, may be involved in dispersing the males over the available spawning habitat. It suggests that substances in male urine may be used to both repel males and attract females. The response of immature spawning-run adults to water from tanks containing sea lamprey larvae suggests that the resident larval population in a stream may provide a chemical cue which aids early (immature) spawning-run adults in selecting a suitable stream in which to spawn. This response appears to be lost once the adults are sexually mature.

During the past several spawning seasons, we have concentrated on isolating the active components in male urine which attract females. The goal has been to fractionate behaviorally active (pheromone-containing) male urine by a variety of techniques until an active fraction is obtained which contains a single compound. Sufficient pure material can then be prepared for structural studies using spectroscopic techniques. Once the pheromone is identified, a decision can be made whether or not to proceed with field trials. If field tests are desirable, a sufficient quantity of pheromone will have to be bought or synthesized.

During the 1983 spawning season, preference tests were conducted with over 1,700 female sea lampreys to assess the behavioral activity of samples of male urine and urine fractions. Of the 800 mL of urine collected from over 1,200 male sea lampreys, about 300 mL was found to elicit preference responses in females. Chromatographic procedures for fractionating male urine were further refined and fractions of urine have been prepared, which elicit preference responses in females and appear to consist of one major component. In addition, four steroids (progesterone, dihydrotestosterone, androsterone, and estradiol) identified in behaviorally active male urine by radioimmunoassay, were tested in the preference tanks with female sea lampreys. None of these compounds elicited any observable response in females when presented at physiological concentrations.

1984 SPAWNING SEASON

Through the process of repeated fractionation of male urine and bioassay of each fraction for preference responses using females, we have obtained a behaviorally active (female attracting) fraction which appears to contain a single major component. Attempts will be made this spring to determine if this fraction contains a single compound.

Large quantities of behaviorally active (pheromone-containing) male urine (at least 1 L) will be collected to provide sufficient material for structural studies. In addition to collecting urine from landlocked males using our normal procedure, an attempt will be made to chronically implant catheters in large anadromous males. If successful, this should increase our

yield of active urine considerably. Previous behavioral tests have shown that landlocked females respond to substances released by anadromous males, indicating that the same substance is released by both landlocked and anadromous males.

Weather and time permitting, preliminary preference tests will be conducted under more natural conditions using Cornell University's outdoor raceways on Cayuga Lake. These tests will provide information critical for the design of field tests with identified components of the male pheromone.

Time permitting, organic substances released by sea lamprey ammocoetes will be collected on large columns packed with XAD II resin. Fractions of this material will be prepared and tested in the preference tanks with sexually immature adults. In addition, extracts of eggs collected from ovulated and unovulated females will be prepared and tested with sexually mature males.

1985 SPAWNING SEASON

Fractions of ammocoete holding water will be tested in Cornell University's raceways using sexually immature spawning-run adults.

Any additional pure compounds isolated from male urine and samples of synthetic male pheromone, if available, will be tested in the preference tanks with females.

Preliminary field tests with synthetic male pheromone, if available, will be begun.

1986 SPAWNING SEASON

Begin full field trials with synthetic male pheromone.

Test fractions of ammocoete holding water and of female pheromone-containing samples in the preference tanks.

PUBLICATIONS AND SPECIAL REPORTS

PUBLICATIONS ON LAMPREY CONTROL AND RELATED AREAS

Meyer, F. P., and R. A. Schnick. 1983. Sea lamprey control techniques: past, present, and future. Journal of Great Lakes Research 9(3):354–358.

Meyer, F. P., J. W. Warren, and T. G. Carey (ed). 1983. A guide to integrated fish health management in the Great Lakes basin. Great Lakes Fishery Commission, Special Publication 83-2. 262 pp.

SPECIAL REPORTS ON LAMPREY CONTROL AND RELATED AREAS

Bills, T. D., and J. G. Seelye. 1984. Study finds little impact of lampricide TFM on early life stages of walleye. Research Information Bulletin No. 84-23, January 1984.

Hanson, L. H., and E. J. King, Jr. 1983. Recapture of spawning-run sea lampreys (*Petromyzon marinus*) marked soon after metamorphosis and released in a Lake Huron tributary Research Completion Report. 10 pp.
Meyer, F P. 1983. Use patterns, methods of detection, environmental factors affecting toxicity, and mammalian safety studies on TFM and Bayer 73. Submitted to the National Research Council of Canada, 19 May 1983. 66 pp.
Meyer, F. P., and staff. 1983. Memorandum of Compliance to 1982 MOA between Fish and Wildlife Service and Great Lakes Fishery Commission. Submitted to Regional Director, Twin Cities, Minnesota, 29 March 1983. 8 pp.
Meyer, F. P. and staff. 1983. Research and budget report to Sea Lamprey Committee. Submitted at Sea Lamprey Committee Meeting on 13–14 April 1983. 13 pp.
Meyer, F. P., and staff. 1983. Annual report to Great Lakes Fishery Commission: Registration activities and sea lamprey control research on lampricides in 1982. Submitted to Great Lakes Fishery Commission, May 1983. 42 pp.
Meyer, F. P., and staff. 1983. Interim report to the Great Lakes Fishery Commission. Submitted to the Great Lakes Fishery Commission on 19 November 1983. 22 pp.
Meyer, F. P., and staff. 1983. Progress report to Great Lakes Fishery Commission. Submitted to the Great Lakes Fishery Commission on 19 November 1983. 22 pp.
Purvis, H. A., and E. L. King, Jr. 1983. Artificial light enhances trapping efficiency of adult sea lampreys. Research Information Bulletin.
Schnick, R. A. 1983. Additional submission to EPA regarding the data requirements for the photodegradation of TFM. Submitted to the FWS Division of Fishery Research on 4 May 1983 for forwarding to EPA. 7 pp.
Scholefield, R. J., and J. G. Seelye. 1983. An evaluation of data collected by U.S sea lamprey control groups for measuring changes in alkalinity and pH in tributaries to the Great Lakes. Special Report to Board of Technical Experts, Great Lakes Fishery Commission. 4 pp.
Seelye, J. G., E. L. King, Jr., and L. H. Hanson. 1983. Toxicity of 3-trifluoromethyl-4-nitrophenol (TFM) to early life stages of walleye (*Stizostedion vitreum*). Report to Marquette Biological Station, Marquette, Michigan. 10 pp.

ADMINISTRATIVE REPORT FOR 1983

MEETINGS

The Commission held its 1983 Annual Meeting in Burlington, Ontario on 11-12 May and its Interim Meeting in Ann Arbor, Michigan on 29-30 November. In addition, both Canadian and U.S. Sections met in plenary session on 12 May in conjunction with the Annual Meeting in Burlington. The Commission held executive meetings of commissioners and staff as follows:

10 May	Burlington, Ontario
29 July	Toronto, Ontario
25–26 October	Bridgeport, New York
28 November	Ann Arbor, Michigan

Meetings of standing committees during 1983 were:

Lakes Erie and Ontario Committees, Buffalo, New York, 1–3 March
Lakes Huron, Michigan, and Superior Committees, Milwaukee, Wisconsin, 8–10 March
Council of Lake Committees, Detroit, Michigan, 12 April
Great Lakes Fish Disease Control Committee, Syracuse, New York, 12–14 April
Sea Lamprey Committee, Detroit, Michigan, 13–14 April
Board of Technical Experts, Burlington, Ontario, 9 May and Ann Arbor, Michigan, 27–28 October

Attendance at other Commission-related meetings included the sea lamprey control agents' annual sea lamprey conference, TFM Effects Committee, Sea Lamprey Hormones Committee, Conference on Lake Trout Research (CLAR), Law Enforcement Workshop, International Symposium on Stock Assessment and Yield Prediction (ASPY) Steering Committee, Lake Trout Technical Committees, Fish Habitat Advisory Board, and Workshop for Evaluating Sea Lamprey Populations Steering Committee.

OFFICERS AND STAFF

Chairman Loftus and Vice Chairman Horn continued their terms of office through 1983. One change in Commission membership occurred during 1983. J. M. Ridenour, Director, Indiana Department of Natural Resources, was appointed commissioner effective 11 March.

A change in staff membership occurred in 1983 when K. S. Shomin accepted a position as secretary.

Committee assignments established in 1982 remained unchanged except for the addition of Commissioner Ridenour to the Fisheries and Environment Committee.

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, Chairman	R. L. Eshenroder
P. S. Chamut	M. A. Ross
J. M. Ridenour	C. M. Fetterolf

Sea Lamprey Committee

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

BOTE Liaison

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 continued to serve as Canadian Section Chairman and Commissioner Ver Duin continued as U.S. 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 1983 the staff participated in the following conferences, meetings, and activities:

- American Fisheries Society
- Artificial Reef Workshop
- Canadian Committee for Fisheries Research
- Ecosystem Workshop
- Great Lakes Commission
- International Association for Great Lakes Research
- International Joint Commission (IJC)
- IJC Science Advisory Board
- Michigan Fish Producers
- Michigan Sea Grant
- National Marine Fisheries Service
- National Research Council of Canada
- Ontario Council of Commercial Fisheries
- Salmonid Reproduction Symposium
- Urban Fishing Symposium

REPORTS AND PUBLICATIONS

In 1983, the Commission published Annual Reports for 1980 and 1981, two Special Publications, and one brochure.

Quota management of Lake Erie fisheries, by J. F. Koonce (ed.), D. Jester, B. Henderson, R. Hatch, and M. Jones. 1983. Great Lakes Fish. Comm. Spec. Pub. 83-1. 39 p.

A guide to integrated fish health management in the Great Lakes basin, F. P. Meyer, J. W. Warren, and T. G. Carey (eds.). 1983. Great Lakes Fish. Comm. Spec. Pub. 83-2. 262 p.

Lake trout rehabilitation in the Great Lakes. 1983. Great Lakes Fish. Comm. Brochure.

ACCOUNTS AND AUDITS

The Commission's accounts for the fiscal year ending 30 September 1983 were audited by Icerman, Johnson, and Hoffman of Ann Arbor. The firm's reports are appended.

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, streams surveys to locate the 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 $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 the 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 was 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

The Commission negotiated a Memorandum of Agreement with its U.S. agent, the U.S. Fish and Wildlife Service, for work costing $3,458,300. The Commission also supplied lampricides, funding for barrier dams, and for contingency studies for registration-oriented research on lampricides totaling $901,500.

A Memorandum of Agreement was also executed with its Canadian agent, the Department of Fisheries and Oceans, for service costing $1,784,700, including funding of barrier dams projects and lampricides.

At the end of the fiscal year, the U.S. agent refunded $161,384. The Canadian agent reported an underexpenditure in operations of $31,377. In addition the Commission earned $302,700 in bank interest during fiscal year 1983. These monies were used to further the Commission's mandate in the Great Lakes such as the Great Lakes Ecosystem Rehabilitation Project, Conference on Lake Trout Research, International Symposium on Stock Assessment and Yield Prediction, and several other research projects, as well as reducing future requests for funding.

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 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 $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 was to be $6,475,700 shared by the Canadian and U.S. Governments according to contribution formulas.

The funding by governments for fiscal year 1984 is scheduled as follows:

	U.S.	*Canada*	*Total*
Sea Lamprey Control and Research	$4,060,700	$1,824,400	$5,885,100
Administration and General Research	295,300	295,300	590,600
Total	$4,356,000	$2,119,700	$6,475,700

PROGRAM AND BUDGET FOR FISCAL YEAR 1985

At the 1983 Annual Meeting, the Commission adopted a program and budget for sea lamprey control and research in fiscal year 1985 estimated to cost $6,799,900. 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 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 $662,000 was adopted for administration and general research for a total program cost of $7,461,900. The Commission approved the use of $300,000 from fiscal year 1983 unobligated funds to reduce funding requests to governments. Thus, the total request was to be $7,161,900 shared by the Canadian and U.S. governments according to contribution formulas.

ijh Icerman, Johnson & Hoffman
CERTIFIED PUBLIC ACCOUNTANTS

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J. S. BUATT, C.P.A.
C. J. MOREHOUSE, C.P.A.
D. B. BOOTH JR., C.P.A.
J. R. SUITS, C.P.A.
D. L. BREDERNITZ, C.P.A.
H. P. WAGNER JR., C.P.A.
G. W. DUNBAR, C.P.A.
L. R. WAHL, C.P.A.
G. E. BOREL, C.P.A.
R. B. 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, 1983, 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, 1983, 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.

Icerman Johnson & Hoffman

Ann Arbor, Michigan
December 21, 1983

GREAT LAKES FISHERY COMMISSION

STATEMENTS OF CERTAIN ASSETS, LIABILITIES AND FUND BALANCES
RESULTING FROM CASH TRANSACTIONS
September 30, 1983

ASSETS	Administration and General Research Fund	Sea Lamprey Management and Research Fund	Totals (Memorandum Only)
Cash, including short-term investments of $2,598,525	$1,415,539	1,322,934	2,738,473
Due from United States Fish and Wildlife Service (Note 2)	--	161,384	161,384
Due from Canadian Department of Fisheries and Oceans (Note 2)	--	85,616	85,616
Due from Sea Lamprey Management and Research Fund (Note 2)	228,339	--	228,339
Total Assets	$1,643,878	1,569,934	3,213,812
LIABILITIES AND FUND BALANCES			
Liabilities:			
Due to Administration and General Research Fund (Note 2)	$ -o-	228,339	228,339
Fund Balances:			
Reserved for specific projects (Note 3)	432,353	--	432,353
Reserved for barrier dam projects	--	1,477,643	1,477,643
Designated for subsequent years' expenditures (Note 5)	509,800	--	509,800
Undesignated	701,725	(136,048)	565,677
Total Fund Balances	1,643,878	1,341,595	2,985,473
Total Liabilities and Fund Balances	$1,643,878	1,569,934	3,213,812

See Notes to Financial Statements.

GREAT LAKES FISHERY COMMISSION

STATEMENTS OF CASH RECEIPTS AND DISBURSEMENTS AND CHANGES IN FUND BALANCES
Year Ended September 30, 1983

	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	$ 285,700	285,700	--	1,809,000	1,614,309	(194,691)	2,094,700	1,900,009	(194,691)
United States government	285,700	285,700	--	4,026,600	4,026,600	--	4,312,300	4,312,300	--
Interest earned	--	302,727	302,727	--	--	--	--	302,727	302,727
Miscellaneous	--	4,860	4,860	--	--	--	--	4,860	4,860
	571,400	878,987	307,587	5,835,600	5,640,909	(194,691)	6,407,000	6,519,896	112,896
Disbursements:									
Canadian Department of Fisheries and Oceans	--	--	--	1,420,000	1,372,249	47,751	1,420,000	1,372,249	47,751
United States Fish and Wildlife Service	--	--	--	3,458,300	3,296,916	161,384	3,458,300	3,296,916	161,384
Lampricide purchases	--	--	--	680,500	921,729	(241,229)	680,500	921,729	(241,229)
Special studies	--	--	--	50,000	-o-	50,000	50,000	--	50,000
Barrier Dams	--	--	--	535,700	165,512	370,188	535,700	165,512	370,188
Administration	393,600	383,104	10,496	--	--	--	393,600	383,104	10,496
General research	461,015	260,206	200,809	--	--	--	461,015	260,206	200,809
	854,615	643,310	211,305	6,144,500	5,756,406	388,094	6,999,115	6,399,716	599,399
Excess of Receipts Over (Under) Disbursements	(283,215)	235,677	518,892	(308,900)	(115,497)	193,403	(592,115)	120,180	712,295
Other Sources (Uses):									
Foreign exchange gains (losses)	--	(130)	(130)	--	810	810	--	680	680
Interfund transfers (Note 2)	--	228,339	228,339	--	(228,339)	(228,339)	--	--	--
	-o-	228,209	228,209	-o-	(227,529)	(227,529)	-o-	680	680
Excess of Receipts and Other Sources Over (Under) Disbursements and Other Uses	(283,215)	463,886	747,101	(308,900)	(343,026)	(34,126)	(592,115)	120,860	712,975
FUND BALANCE - October 1, 1982	1,179,992	1,179,992	-o-	1,684,621	1,684,621	-o-	2,864,613	2,864,613	-o-
FUND BALANCE - September 30, 1983	$ 896,777	1,643,878	747,101	1,375,721	1,341,595	(34,126)	2,272,498	2,985,473	712,975

See Notes to Financial Statements.

GREAT LAKES FISHERY COMMISSION

STATEMENTS OF CASH RECEIPTS AND DISBURSEMENTS AND CHANGES IN FUND BALANCES
Year Ended September 30, 1983

	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	$ 285,700	285,700	--	1,809,000	1,614,309	(194,691)	2,094,700	1,900,009	(194,691)
United States government	285,700	285,700	--	4,026,600	4,026,600	--	4,312,300	4,312,300	--
Interest earned	--	302,727	302,727	--	--	--	--	302,727	302,727
Miscellaneous	--	4,860	4,860	--	--	--	--	4,860	4,860
	571,400	878,987	307,587	5,835,600	5,640,909	(194,691)	6,407,000	6,519,896	112,896
Disbursements:									
Canadian Department of Fisheries and Oceans	--	--	--	1,420,000	1,372,249	47,751	1,420,000	1,372,249	47,751
United States Fish and Wildlife Service	--	--	--	3,458,300	3,296,916	161,384	3,458,300	3,296,916	161,384
Lampricide purchases	--	--	--	680,500	921,729	(241,229)	680,500	921,729	(241,229)
Special studies	--	--	--	50,000	-0-	50,000	50,000	--	50,000
Barrier Dams	--	--	--	535,700	165,512	370,188	535,700	165,512	370,188
Administration	393,600	383,104	10,496	--	--	--	393,600	383,104	10,496
General research	461,015	260,206	200,809	--	--	--	461,015	260,206	200,809
	854,615	643,310	211,305	6,144,500	5,756,406	388,094	6,999,115	6,399,716	599,399
Excess of Receipts Over (Under) Disbursements	(283,215)	235,677	518,892	(308,900)	(115,497)	193,403	(592,115)	120,180	712,295
Other Sources (Uses):									
Foreign exchange gains (losses)	--	(130)	(130)	--	810	810	--	680	680
Interfund transfers (Note 2)	--	228,339	228,339	--	(228,339)	(228,339)	--	--	--
	-0-	228,209	228,209	-0-	(227,529)	(227,529)	-0-	680	680
Excess of Receipts and Other Sources Over (Under) Disbursements and Other Uses	(283,215)	463,886	747,101	(308,900)	(343,026)	(34,126)	(592,115)	120,860	712,975
FUND BALANCE - October 1, 1982	1,179,992	1,179,992	-0-	1,684,621	1,684,621	-0-	2,864,613	2,864,613	-0-
FUND BALANCE - September 30, 1983	$ 896,777	1,643,878	747,101	1,375,721	1,341,595	(34,126)	2,272,498	2,985,473	712,975

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.

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, 1983 consists of $228,339 in United States and Canadian refunds. Approximately $102,000 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, 1983. Sea Lamprey Management and Research Funds of approximately $12,159 have been retained by the Canadian Government for an ADP proposal and is not included in the refund receivable as of September 30, 1983.

Note 3. FUND BALANCE RESERVES

Commitments related to incomplete projects are recorded as reservations of fund balance. As of September 30, 1983, 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 9-30-82	Expenditures During Year Ended 9-30-83	Reserved @ 9-30-83
SGLFMP	$ 54,235	44,235	--	10,000
Monroe	10,550	3,040	--	7,510
Gorbman	53,250	35,500	13,312	4,438
Lampricide Impact Review	10,000	--	288	9,712
Talhelm's Extra Market Values	7,200	3,964	866	2,370
Christie's Fish Archiving	4,125	--	--	4,125
Mathisen's Acoustic Study on Sea Lamprey	2,500	--	1,875	625
Grima	20,000	--	--	20,000
Planning Process for Integrated Management of Sea Lamprey	5,000	682	413	3,905
Smith-Lamprey History and Typing	5,600	--	--	5,600
Spangler/Krueger - Genetic Analysis	20,293	15,220	--	5,073
Talhelm Study (Part of GLERR II)	15,000	7,154	152	7,694
Meyer's LaCrosse Study on Bisazir Residues	88,850	--	44,425	44,425
Fisheries Assessment Symposium	152,500	--	34,020	118,480
Sea Lamprey Hormones	5,000	--	2,115	2,885
"Contaminants Effects" Purchase	3,375	--	--	3,375
Pheromone Research Committee	5,000	--	--	5,000
Lamprey Populations Workshop Planning	4,000	--	--	4,000
Law Enforcement (Fish Management Workshop)	17,500	--	6,431	11,069
Phillips Study	18,622	--	12,466	6,156
Adelman	33,418	--	25,064	8,354
Heimbuch Review	2,000	--	--	2,000

NOTES TO FINANCIAL STATEMENTS (Concluded)

Note 3. FUND BALANCE RESERVES (Concluded)

Project Name	Total Budgeted	Expenditures Through 9-30-82	Expenditures During Year Ended 9-30-83	Reserved @ 9-30-83
AEA Evaluation	$ 5,000	--	--	5,000
Spangler (AEA)	25,000	--	--	25,000
Lake Ontario Workshop	6,000	--	--	6,000
TFM Bar Purchase	64,250	--	--	64,250
GLERR III Study	50,000	24,965	11,145	13,890
Talhelm's National Fishing Surveys	3,300	--	--	3,300
Volk's Aging Method	9,636	--	7,227	2,409
Talhelm's Phase II Angling Report	2,550	765	--	1,785
Sower - Gorbman	5,106	--	3,830	1,276
Socio-economic Workshop Planning	3,000	--	--	3,000
Lake Erie Workshop	16,212	10,754	--	5,458
CLAR Workshop	39,626	275	25,162	14,189
	$767,698	146,554	188,791	432,353

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 $29,281 for the year ended September 30, 1983. There is no unfunded liability as of September 30, 1983.

Note 5. UNRESERVED FUND BALANCE DESIGNATIONS

The excess of expenditures over revenues budgeted for the fiscal year ending September 30, 1984 is to be funded by the fund balance in the Administration and General Research Fund. The excess of budgeted expenditures over budgeted revenues is approximately $509,800 for the year ending September 30, 1984.

COMMITTEE MEMBERS—1983

Commissioners in Italics

BOARD OF TECHNICAL EXPERTS

CANADA

A. P. Grima, V. Chm.
F. W. H. Beamish
W. J. Christie
J. Cooley
K. H. Loftus
C. K. Minns
R. A. Ryder

UNITED STATES

G. Spangler, Chm.
D. Borgeson
J. L. Forney
W. Hartman
N. Kevern
W. M. Lawrence
H. A. Purvis
J. Seelye
D. Talhelm

COUNCIL OF LAKE COMMITTEES

CANADA

V. Milne, V. Chm.

UNITED STATES

D. Borgeson, Chm.

Members are listed below under Lake Committees

LAKE COMMITTEES

LAKE HURON

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

LAKE ONTARIO

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

LAKE MICHIGAN

D. Borgeson, Chm.
J. T. Addis, V. Chm.
R. Hess
W. James

LAKE SUPERIOR

J. T. Addis, Chm.
L. Affleck, V. Chm.
D. Borgeson
R. Hassinger

LAKE ERIE

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

GREAT LAKES FISH DISEASE CONTROL COMMITTEE

T. G. Carey, Chm.
R. W. Ritzert, Secy.
T. Amundson
G. Armstrong
D. H. Bumgarner
J. M. Byrne
J. B. Dailey
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
R. Moccia
V. A. Mudrak
R. Nelson
J. J. O'Grodnick
L. Pettijohn
P. J. Pfister
R. Poff
J. H. Schachte, Jr.
A. J. Sippel
S. F. Snieszko
B. W. Souter
R. A. Williamson