

REVIEW OF RECOMMENDATIONS MADE TO THE GREAT LAKES FISHERY
COMMISSION ON SEA LAMPREY CONTROL AND RESEARCH, 1975-1987

by

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CONTENTS

I. Introduction	Page 1
II. Recommendations with Current Status	2
III. Discussion	17
IV. Citations	19
V. Appendix (List of source material)	22

INTRODUCTION

The Great lakes Fishery Commission conducts a large-scale program of sea lamprey control in the Great Lakes as charged by the national governments of Canada and the United States. In formulating this program, the Commission relies extensively on the advice of various bodies and individuals. Advice of particular importance to the Commission are the recommendations documented in formal reports resulting from special studies, assessments, workshops, and symposia. These reports, whether solicited or not, represent a tremendous and costly effort from knowledgeable experts. Unfortunately, newer recommendations made to the Commission are often not related to those of the past. Consequently, a clear understanding of past accomplishment and direction is frequently wanting when it is most needed in the decision process. To provide a perspective of the past, we compiled and summarized the major recommendations made to the Commission on sea lamprey issues since 1975. In addition, we indicate progress made towards their implementation, and what appears to us to be the most important of those recommendations not yet implemented.

The earliest recommendations pertaining to the Great Lakes Fishery Commission's sea lamprey control program reviewed here are those in the 1975 report of the Scientific Advisory Committee (predecessor of the Board of Technical Experts) on the technical review of Great Lakes Fishery Commission funded research at Hammond Bay Biological Station (HBBS). This review was followed by a series of recommendations emanating from the Sea Lamprey International Symposium (SLIS) and reported to the Sea Lamprey Control and Research Committee in 1980 and to the Board of Technical Experts in 1981. A report of the Audit of the Commission's program of Sea Lamprey Control and Research, produced in 1980, and an addendum on liability of the Commission and its Agent completed in 1982 (SLAT) resulted in more recommendations. Consecutive U.S. Fish and Wildlife reports in 1981 and 1982 on Sea Lamprey Control Research Needs (SLCRN) produced another series of recommendations. In 1982, a Strategic Plan for Integrated Management of Sea Lamprey in the Great Lakes (SPIMSL) generated yet more recommendations for the Commission's lamprey program. A review of the impact of the lampricides TFM and

Bayer 73 on the environment was undertaken by the National Research Council Canada (NRC) and completed in 1985. The thrust of this review was directed toward the effects of the two lampricides and their metabolites on nontarget organisms, and it identified a number of concerns, expressed in the review as recommendations. Most recently, in 1987 a Commission sponsored Workshop to Evaluate Sea Lamprey Populations (WESLP), and a report of the St. Mary's River Sea Lamprey Task Force (SMRSLTF) contributed additional recommendations. These reports and recommendations provide the raw material for this review (see Appendix for list of reports).

We organized the recommendations from the above reports into 3 program areas of administration, management and assessment, and research. Within each program area the recommendations are grouped according to progress toward implementation as follows: implemented, partially implemented, and not implemented. Immediately following each recommendation is a summary of progress in implementation except for some recommendations where no progress was made. To condense the material, which includes 163 separate recommendations, we interpreted and summarized similar ideas and indicated the source using the acronyms given above. Many of the recommendations overlap, and thus those that were most frequently reported can be identified by the number of associated acronyms.

Some of the recommendations identified here may no longer be particularly relevant as considerable time has elapsed since they were formulated. Nevertheless, all recommendations from the reports are given because our goal was to present a complete record, and relevance in some instances may be debateable. However, to provide some insights on relevance, we identify in the discussion those recommendations that appear to us to most warrant future attention.

RECOMMENDATIONS WITH CURRENT STATUS

ADMINISTRATION

Implemented

1. The Commission should take steps to implement a sea lamprey program evaluation function by expanding the Secretariat, by modifying the role of Lake Committees, by establishing a Sea Lamprey Evaluation Board, or by contracting outside expertise. In addition, an audit of program efficiency should be conducted periodically by the Agents for Commission review (SLAT).

In 1987, the Commission established the Sea Lamprey Advisory Board to provide guidance on sea lamprey policy making, and this board may undertake evaluations of the program. The Agents do not periodically conduct audits of program efficiency, but financial audits of the control units by their respective agencies have been made. Results of the financial audits are not reported to the Commission. The Commission launched a program evaluation (audit), which includes the sea lamprey function, in 1987. This audit is expected to be completed in 1989.

2. The Commission should communicate formally with Control Unit staff

through the Agent. In addition, the Commission should examine the practice of having the U.S. Section sign the Memorandum of Agreement with the Fish and Wildlife Service and either justify this anomaly or change it (SLAT).

The Canadian MOA was modified in 1987 to indicate that the Area Manager in Burlington rather than the Center Manager at Sault Ste. Marie was empowered to act as Agent; a similar arrangement has been in effect for many years in the U.S. However, the U.S. Agent is represented by the U.S. Control Unit supervisor on the Sea Lamprey Advisory Board, which appears likely to become the major communication link between the Commission and the Agents. Beginning in FY 1983, the chairman of the GLFC rather than the Chairman of the U.S. Section signed the U.S. MOA.

3. The Commission should seek a detailed accounting of administrative and supervisory charges from the USFWS. Services considered unnecessary by the Commission should be terminated (SLAT).

The GLFC is provided a detailed accounting of administrative and supervisory charges from the USFWS. In FY 1986, a cut of 14% (amounts to \$64,000) was made in these charges, which remained level (no increase) in FY 1987.

4. The Commission should ask its Agents to determine the feasibility and economic benefits of leasing vehicles and equipment and enter into such agreements when justified (SLAT).

Benefits of leasing rather than purchasing equipment were investigated by the Agents. In the U.S., leasing was not found to be economical because of Government Service Administration procedures; in Canada vehicles are leased directly from private vendors in the name of the Commission.

5. The Memorandum of Agreement should be uniform with respect to requirements for insuring equipment and should clearly identify the equipment to be insured. The Commission should also evaluate the economic benefits of insuring equipment. The Commission should approach the Department of Fisheries and Oceans to request deletion of clause XIV in the Memorandum of Agreement. The Commission should approach the Department of External Affairs Canada regarding immunity from suit, and should adopt a policy that responsibility for claims arising from lamprey control activities should reside with the Agents (SLAT).

The economic benefits of insuring equipment were examined by the Agents. Equipment in the U.S. is in the name of the federal government and is, accordingly, not insured. Insurance is required on Canadian equipment purchased in the name of the Commission because it is used by some employees, who being hired in the Commission's name, are not protected under federal arrangements. Equipment leased in the Commission's name is insured as required by the vendor. Clause XIV (makes the Commission indemnify the crown for damages relating to control) was deleted from the

Canadian MOA, and an Order in Council (P.C. 1985-3189) provided immunity from suit in Canada in 1985.

Partially Implemented

6. The Commission should transmit its annual report to the Contracting Parties within six months after the end of the reporting year. This report should cover the fiscal year, include a joint report from the Agents, relate to the Memorandum of Agreement for the same period, clearly express how the Commission has discharged its responsibilities under the Convention, and provide clear policy and guidance for the Agents on program and administrative issues. In addition, the Agents should prepare a joint annual (calendar year) report and eliminate their individual reports prepared for the interim meeting (SLAT).

The Commission's annual report continues to be based on a calendar year whereas the Memorandum of Agreement (MOA) is on a fiscal year. Therefore, it is not convenient to use the annual report to monitor performance under the MOA. Also, the annual report is produced well after 6 months following the end of the reporting year, and it is therefore too outdated to provide policy and guidance to the Agents. The Agents document performance under the MOA in separate fiscal-year reports. Joint annual reports were produced in 1983, 1986, and 1987.

7. The Commission should encourage its Agents to integrate Control Unit staff within the mainstream activities of their agencies as well as into the scientific community-at-large (SLAT).

Integration of Control Unit staff within mainstream activities of the Agent is concerned with intra-agency transfers of control unit staff. Since SLAT was completed in 1980, no such transfers have been made by the Canadian Agent and 4 have been made by the U.S. Agent. Some progress in providing more contact for control unit staff with the scientific community-at-large has been made by improved coordination with the research staff at Hammond Bay, by housing DFO research within the Canadian control unit facility, and by control unit involvement in a number of BOTE workshops.

8. The Commission should seek legal counsel to develop appropriate language for the Memorandum of Agreement that will support the Commission's interest in keeping proceeds of sale and that will develop a reversionary right to property (SLAT).

Appropriate language to keep proceeds of sale and a reversionary right to property was developed for the U.S. MOA. This issue remains under consideration in Canada.

9. Permanent staff of the U.S. Control Unit exposed to lampricides should receive annual medical examinations. Medical records of control staff in

both the U.S. and Canada should be carefully archived (SLAT).

There are no special provisions for staff at the U.S. Control Unit exposed to lampricides to receive annual physicals. In Canada, annual physicals are required for those with field jobs. Health and Welfare Canada coordinates the physicals and maintains the records.

Not Implemented

10. To advertise the beneficial effects of the control program, the Commission should allocate funds for the contracting of public relations expertise (SLIS, SPIMSL).

The GLFC does not routinely allocate funds to advertise the beneficial effects of its control program, but it has supported ad hoc efforts such as the production of 2 slide-tape shows, one in 1980 and another in 1982, and various brochures.

11. The Commission should not permit its Agents to employ personnel in the name of the Commission nor to continually hire seasonal employees for the Control Units (SLAT).

The practice of hiring control unit seasonal staff in the name of the Commission to circumvent agency ceilings on person-year allotments was only done in Canada, and there the practice actually was expanded to include 3 full-time administrative staff under consecutive one-year contracts. This practice of hiring seasonals is expected to continue, but efforts are being made to provide regular positions for the fulltime persons now working in the name of the Commission.

SEA LAMPREY MANAGEMENT AND ASSESSMENT

Implemented

12. The Secretariat should take a more direct and active role in communicating with Environment Canada and the Environmental Protection Agency (USA) concerning experimental use permits and registration of chemicals used in sea lamprey control and research (HBBS).

The Secretariat does not take a direct, active role in communicating with Agriculture Canada (Note: the recommendation incorrectly assumes that Environment Canada rather than Agriculture Canada is the lead agency for registration of chemicals) and USEPA concerning use permits and registration of lampricides, nor does it feel that this would be productive and appropriate. The USFWS at La Crosse and DFO at Burlington are responsible for communications in this area for their respective countries.

13. Larval rearing should be transferred from the Hammond Bay Biological Station to a hatchery better suited to mass culture. Hammond Bay should

continue to operate the barrier on the Ocqueoc River to collect adult lampreys for experiments, it should resolve the problem of non-service on weekends to provide better assessment, and it should continue to operate the fyke net on the Ocqueoc, but concentrate the effort during periods when migration is greatest. The downstream trap in the Big Garlic River should be maintained for the collection of transformers for use in control activities. A feasibility study is needed to determine the optimum source of sea lamprey larvae needed for assessment and research purposes. Also, the Commission should explore the sale of lampreys to outside investigators to defray collection or rearing costs, and these funds should be used to develop supplies of lampreys for all users (HBBS).

Sea lamprey larvae continue to be reared at HBBS, but mass culture has never been undertaken so the recommendation on transferring mass culture is difficult to resolve. The upstream trap (for adults) on the Ocqueoc continues to be fished each year, and the problem of non-service on weekends has been solved by altering trap design. The downstream trap on the Ocqueoc was not fished after 1984, because with chemical control the few transformers caught did not justify the trapping effort. Results from the downstream trapping effort are given in a manuscript undergoing review. In 1983 the downstream trap on the Big Garlic River was deactivated with the approval of the GLFC. A feasibility study of the optimum source of sea lamprey larvae for research and assessment has never been undertaken, nor has an accounting of needs been made. Lake Champlain has been used as a source for sea lamprey, but if the treatment by New York and Vermont is undertaken, the proposed feasibility study could be important. Outside investigators are not charged (except shipping charges) for lampreys supplied by the Agents because the Commission encourages research on sea lampreys.

14. The Commission should determine minimum prudent lampricide inventories, request that the Control Units reconcile lampricide use with amounts purchased, including an annual inventory, and arrange for alternative lampricide storage facilities (SIAT).

In 1981 the Commission adopted a policy that a minimum prudent inventory of lampricide was a 2 year supply. Each year the Control Units reconcile (report to the Commission) lampricide use with purchases and inventory. An alternative lampricide storage facility was recommended for the Canadian Control Unit because of environmental concerns with the existing storage on St. Marys Island. A major accident could result in spillage into the St. Marys River. An additional storage facility was built in 1983, but it is also adjacent to the St. Marys River.

15. The Commission should endorse the work of the Sea Lamprey Control Standardization Committee, request that it be appraised of progress, and ask it to determine the optimum size of a treatment crew (SIAT).

The Sea Lamprey Control Standardization Committee functioned through 1984, when it was replaced by an informal work group of specialists from

19. The Commission should develop engineering guidelines for barrier dams to cover several levels of flood stage, and conduct periodic post-construction investigations including cost/benefit analysis, engineering evaluations, fish passage analysis, and assessments of their effectiveness for lamprey control. Sea lamprey barriers or control mechanisms should be incorporated within any stream improvement plan that increases lamprey habitat (SLAT, SLSC).

Engineering guidelines have not been established for barrier dams, but in 1987 the Commission funded engineering studies for an experimental barrier dam and budgeted for its construction in FY's 1989 and 1990. This facility is expected to answer many of the engineering, including fish passage, questions germane to the barrier dam program. A cost-benefit analysis on barrier dams is provided in the final report of the barrier dam task force, which is presently in the final stages of editing. The Agents try to obtain consideration for blocking sea lampreys in plans for stream improvements, especially when old power dams are being removed, but this effort has not always been successful because of jurisdictional constraints.

20. The control program should encourage the integration of Canadian and U.S. programs especially in the areas of data compatibility and storage, assessment methodology, control procedures, and activities requiring the application of control effort to areas of concern. Institutional arrangements should be made to encourage data compatibility among sea lamprey and fishery management agencies, and relevant information collected by other investigators and agencies should be added to this data base. The information should be made available to Commission approved investigators (SLIS, SLAT, SPIMSL).

Integration of sea lamprey assessment methodology, control procedures, data processing, and special activities between the Control Units has not been accomplished. However, Control Unit data collected recently are electronically accessible largely because of industry improvements in data processing technology. Computers were not secured by the Agents with compatibility as a goal. Accessed data must be reentered before it can be used, because each Control Unit uses different lamprey assessment procedures, data formatting, and software. Some recent progress has been made in standardizing pretreatment bioassay procedures, and the Control Units working with Hammond Bay Biological Station staff are beginning to develop standardized treatment procedures. Lamprey data are routinely made available to Commission-approved investigators.

Fishery agencies have made some institutional arrangements (technical committees) that encourage data compatibility, but complete compatibility (assessment procedures, data formatting, and software) has not been achieved so it is unrealistic at present to expect compatibility between sea lamprey and fishery agencies. If the fishery and sea lamprey agencies perceive that the system models being developed in 1988 are helpful as policy development tools, then the data requirements for the models will tend to encourage compatibility and the building of a common

data base.

21. The agents should ensure that scientific competence and resources for short term research are available to the Control Units to deal with problems associated with chemical control (HBBS, SLAT).

The USFWS made increased scientific competence available to the control units by transferring administration of the Hammond Bay Biological Station to its La Crosse laboratory in 1981 and by establishing specific work units to handle technical services at both laboratories beginning in FY 1982. Funding of technical services totaled \$77,000 in FY 1982 and \$82,000 in FY 1988 - a very modest increase. Research administrators at these laboratories indicate that the actual level of technical services provided exceeds the amount budgeted. The issue of what is an appropriate level of support remains unresolved. The fact that technical services seldom result in publishable research, which is a key measure of productivity for laboratories, tends to discourage major involvement in these activities.

22. A process should be initiated to examine the expected benefits of extraordinary lamprey treatments (SIAT).

A single process that establishes needs for extraordinary lamprey treatments has not been established. Recent extensions of the control program into Oneida Lake (1984) and Lake Erie (1986) were based on recommendations from the related Lake Committees. However, these recommendations and their supporting documentation were not given further review. A Commission task force recently completed (1987) an assessment of the need for control measures on the St. Marys River. In the future, the Sea Lamprey Advisory Board will probably evaluate the need for special treatments.

23. The Commission should examine the potential benefits arising from a relocation of the control stations and a redistribution of their geographic areas of responsibilities (SIAT).

In 1987 the Commission appointed a task force to evaluate the benefits of relocating the control stations and redistributing their areas of responsibility. A report is expected in May 1988.

24. Natural mortality rates of sea lampreys from hatching to transformation, including the rate of transformation and the numbers surviving treatment, should be assessed in streams and in lakes for both treated and untreated populations. To facilitate these studies, compatible data bases; habitat maps; improved sampling gear for large larvae, transformers, and deepwater larvae; better marking methods; and supplies of larvae for marking are needed. The long term goal of these studies is to determine the sources and numbers of transformed sea lamprey entering the lakes as well as to develop economical and effective treatment schedules (WESLP,

SLCRN).

Natural mortality rates for sea lamprey larvae have not been determined nor are good estimates for the number surviving treatment available. Expansion of control into Lake Erie in 1986 has resulted in estimates of transformation rates in previously untreated streams. Habitat maps have been prepared for only 2 streams - the Big Garlic and St. Marys Rivers. Improved marking methods, supplies of larvae, and deepwater sampling gear are still wanting, but planning efforts are currently underway to design and test deepwater sampling gear.

25. Assessments of parasitic-phase sea lamprey are needed to complete a life table for sea lamprey and to define impacts on key host species such as lake trout. A variety of methods including recoveries of lamprey from sport and commercial fisheries, marking-attachment data, recovery of dead, parasitized host fish, and mark and recapture techniques are recommended. To facilitate these assessments lakes should be divided into management units, marking procedures need to be improved, and effects of prey density and size on lamprey growth and survival need to be determined (SPIMSL, WESLP, SLCRN).

Better assessments of parasitic-phase sea lamprey and their impacts on lake trout have been undertaken in Lakes Superior (Koonce and Pycha 1985A; Koonce and Pycha 1985B; Koonce 1986), Ontario (Koonce 1987; 1987 Report of the Lake Ontario Committee), and Huron (Heinrich et. al. 1985). Lamprey-prey fish interactions are also being studied in Seneca and Cayuga Lakes, New York as part of a study of the benefits from experimental treatments undertaken in the early 1980s. Laboratory studies (Swink and Hansen 1986; Swink and Hansen - accepted for publication) have provided useful information on lethality of attack. In addition, the U.S. Control Unit gathers sea lamprey marking-attachment data from an extensive network of charter boat operators. A preliminary division of the lakes into management units was proposed at WESLP, and further division is expected as the Integrated Management of Sea Lamprey process begins. It will be extremely difficult to study the effects of prey density on sea lamprey growth and survival, because prey density is high everywhere. The proposed initial treatment of Lake Champlain in 1989 provides an opportunity to research prey density effects; however, there are no plans for Commission involvement in Lake Champlain, if that lake is treated.

26. Obtaining estimates of the lakewide abundance of spawning-phase sea lamprey is identified as a primary assessment goal. These estimates require expansion of trapping effort to more spawning streams and an ability to relate abundance in trapped streams to abundance in untrapped streams. An alternative approach to estimating abundance of spawners involves releasing marked animals back into a lake. In association with assessments of spawner abundance, monitoring of biological characteristics of the spawners is also recommended (WESLP).

Estimating the lakewide abundance of spawning sea lamprey is a high

30. Candidate alternate lampricides such as TBT should be explored and, if promising, bottom release formulations should be developed for application in lentic regions (SLCRN).

A product manufacturer, Environmental Chemicals, Inc., was identified and meetings were held with sea lamprey control and research personnel. Toxicity tests were conducted by the Hammond Bay Biological Station in 1981-82. Further research on TBT was discontinued because of toxicity to non-target organisms and the unlikelihood of registration for sea lamprey control. Ten other compounds were screened for selective toxicity to sea lampreys. None of these chemicals showed selectivity. Chemical synthesis of other potentially useful compounds is being pursued.

31. Impact of lampricides on community structure and individual populations of nontarget organisms should be evaluated in the field (NRC).

A number of relevant studies (field and laboratory) have been undertaken and the results described in the scientific literature since publication of the National Research Council report "TFM and Bayer 73: Lampricides in the Aquatic Environment" as follows: Bills et al. 1985; King and Gabel 1985; Jeffrey et al. 1986; Kolton et al. 1986; Beamish et al. 1987; MacMahon et al. 1987; Meyer 1987; Seelye et al. ___ A; Seelye et al. ___ B). In addition, results of some unpublished field studies were given in Annual Reports of the Commission.

32. The Commission should review a proposal from the National Fish Health Research Laboratory to investigate immunological approaches to lamprey control by seeking expert comment from the Sea Lamprey Control and Research Committee and the Board of Technical Experts (SLAT).

A cooperative study was conducted by the National Fish Health Research Laboratory (Leetown, Virginia) and the Hammond Bay Biological Station to investigate the potential for developing an immunological method for sterilizing male spawning-run lamprey. Results were negative and further research was terminated in 1983-84.

Partially Implemented

33. **Research** on sea lamprey biology and control should be expanded through **new funds** or a reallocation of existing Commission funds. The Commission should adopt a solicitation procedure for priority topics and monitor the implementation of SLIS recommendations. The Sea Lamprey Control and Research Committee should assume a stronger role in recommending research priorities. The Commission should encourage greater involvement with the scientific community by advertising sea lamprey related research needs, by making available its historic data base, and by supporting applications to granting agencies for research funds (SLAT).

Research on sea lamprey biology and control has not been expanded nor has there been a reallocation of Commission funds. The Commission has not

adopted a solicitation procedure for priority topics nor has it monitored implementation of SLIS recommendations. The Sea Lamprey Control and Research Committee was disbanded in 1981, but the Commission has formed a Sea Lamprey Advisory Board which is charged with the responsibility of recommending research priorities. The first meeting of the Board was held on February 24, 1988.

The Commission has not advertised sea lamprey related research needs to the scientific community, but has encouraged cooperation in research and resource sharing at the Hammond Bay Biological Station. A number of scientists from across the U.S.A. have been attracted to the Hammond Bay Station in recent years (e.g. Dr. J. Mallatt, Washington State University; Dr. S. Sower, University of New Hampshire; Dr. G. Piavis, University of Maryland). During the last 5 years, the station has been involved in cooperative research with 26 organizations.

34. The facilities and staff capabilities at the Hammond Bay Biological Station should be examined by the U.S. Fish and Wildlife Service with the aim of improving sea lamprey control research. Past research, such as the competitive displacement studies between native and sea lampreys, should be published or documented. Failure to upgrade research output and facilities should be accompanied by a redirection of research funds to other facilities capable of addressing priority topics (SLAT, HBBS).

The Hammond Bay Biological Station has greatly upgraded its facilities, staff capabilities, and research publication record since this recommendation was made. The facilities have been improved to the extent of approximately \$750,000 from the Service and the Commission. New or improved facilities include: new pipeline (\$300,000 USFWS); pumps (\$15,000 Commission); pollution abatement system and remodelled main laboratory area (\$240,000 USFWS); chemistry laboratory (\$10,000 Commission); laboratory equipment including H.P.L.C., A.A. and G.C. (\$65,000 USFWS and Commission); paved parking lot, security fence, shop building maintenance (\$38,000 USFWS); painted and re-roofed building (\$20,000 Commission); vehicles have been replaced and upgraded (\$40,000 USFWS); and two boats have been purchased (\$15,000 USFWS).

When the SLAT recommendations were made, a number of the 9 staff positions at the Hammond Bay Biological Station were unfilled. Currently all 9 positions have been filled with one new position being added. The latter is used to employ seasonal people. The station has upgraded its positions to include 5 professionals (4 biologists and 1 chemist). Additionally, the station has been successful in attracting 17 summer students to work on station projects over the past 5 years. Students have been employed through programs operated by the Michigan Youth Corp. and the U.S. Youth Conservation Corp.

The station has published 9 papers on sea lamprey since 1982 and has cleared from its files virtually all publishable material. In addition, 15 papers not related to sea lamprey were published as carry-over research by new staff. Scientists at the station are now working with biologists from the sea lamprey control stations to analyze and prepare for publication other relevant information.

35. Wounding and healing studies should be conducted on host fish at ecologically relevant temperatures. Information on wounding should be used to develop models on the impact of lampreys on various prey species. The role of water chemistry, particularly ionic strength, in prey survival could explain differential survival rates and should be studied (SLIS, HBBS).

Several wounding and healing studies have been conducted since this recommendation was made (King and Edsall 1979; Kinnunen and Johnson 1985; Kinnunen and Johnson 1986; and Eshenroder and Koonce 1984). Studies by Swink and Hanson (1986) and Swink and Hanson (accepted for publication) were done at ecologically relevant temperatures. Wounding information has been applied to the development of several models dealing with the impact of lampreys on prey species (Koonce 1982; Koonce et al. 1982; Koonce and Pycha 1985A; Spangler and Jacobson 1985; Koonce 1986; Koonce 1987; and O'Gorman et al. _____). The impact of sea lamprey on prey species from wounding information was applied by the St. Marys River task group (Eshenroder 1987). Wounding information has provided an important component to the application of the current model for lake and basin wide integrated management of sea lamprey. The role of water chemistry, particularly ionic strength, in prey survival was investigated by a Commission-funded initiative and the results are described by Adelman (1984).

36. A change in sea lamprey resistance to TFM, Bayer 73, and mixtures of the two should be examined (NRC).

The results of one relevant study have been published (Seelye et al. _____ A). Presently Hammond Bay Biological Station is examining changes in toxicity of TFM to sea lamprey ammocoetes using trend analysis on the data collected over 30 years.

37. The sterile male technique should be evaluated as an alternate or supplemental method of controlling lampreys (SLCRN, HBBS).

A search was initiated early in 1980 to identify sterilants which would destroy the viability of male gonadal products without reducing sex drive or mating instincts among spawning-run sea lampreys. Candidates were examined from three categories: chemical, gamma radiation and immunological techniques. Chemicals such as Bestradiol, depo-testosterone cypionate, methallibure, and bisazir were identified as potential sterilants. Of these only bisazir was found to be effective, and it can be administered either by injection or bath immersion. Bisazir residues (or its metabolites) decline to sufficiently low concentrations within 48 hours of treatment to pose no human health hazard in field application (Allen and Dawson 1987). The use of bisazir to sterilize male spawning-run sea lamprey has been approved by the Food and Drug Administration, the federal authority (USA) in this matter.

Ionizing radiation using a cesium-137 or gamma-40 irradiator was effective in sterilizing male lampreys during the latter portion of the spawning run but less effective on early migrants (Manion et al. accepted

for publication). The results of immunological techniques were negative and the cooperative research between the Hammond Bay Biological Station and the National Fish Health Research Laboratory (Leetown, Virginia) terminated.

The Commission formed a Sterile Male Release Technique Task Force, which is presently developing a proposal for the construction of a sterilization facility to be located at the Hammond Bay Biological Station. Two sites for field testing have been selected, the St. Marys River and Lake Superior. Preliminary field studies are recommended for 1988-1990 with implementation in 1991.

38. The elemental composition of sea lamprey statoliths should be measured and evaluated as a means of identifying the natal streams of sea lamprey (WESLP).

Elemental composition of statoliths has been investigated using state-of-the-art technology (Brothers 1987; Brothers 1988). Of the five techniques applied, I.C.P. mass spectra analysis appears worthy of further study although the preliminary results are by no means conclusive. This may have been due to sample contamination which can be overcome with slightly more sophisticated equipment and improved technology.

39. The composition of TFM and Bayer formulations need to be elucidated and any impurities identified. The interrelationships between Bayer 73 and Bayer 2353 should be examined and the active species determined. The levels of TFM photoproducts need to be determined under field conditions and the persistence and toxicity of TFM and Bayer 73 and their metabolites to representative nontarget species (plants, invertebrates, amphibians, reptiles and early life stages of fish) should be examined in the laboratory over a range of temperatures. Other factors affecting sediment binding and incorporation into sediments should also be studied (NRC, SLCRN).

Impurities in formulations of TFM have been identified and the results prepared for publication (Carey et al.). Studies have not been conducted on the interrelationships between Bayer 73 and Bayer 2353. Two studies have been completed on the levels of TFM photoproducts under field conditions (Carey et al. ___; Dawson et al. 1986). Seelye et al. (___ A) studied effects of mixtures of lampricides on selected nontarget organisms, Seelye et al. (___ B) reported effects of TFM on walleye, and King and Gabel (1985) researched effects of TFM on native lampreys. Ho and Gloss (1987) studied the persistence of Bayer in Seneca Lake, New York. Information is still scarce on the toxicity of TFM and Bayer 73 and their metabolites to representative nontarget species over a range of temperatures. Incorporation of TFM and Bayer 73 onto sediments is described by Dawson et al. (1986).

40. Further studies are required to elucidate the mode of action of lampricides as well as the biotransformation ability of representative

species of plants and nontarget animals (NRC).

The Commission has funded one study pertaining to the mode of action of TFM on sea lamprey larvae and rainbow trout fry which suggests that lampreys are unable to neutralize and excrete TFM or Bayer via the biliary or renal route, but do so via the ion-uptake cells in the gills. The subsequent gill poisoning contributes to the death of the lamprey perhaps as a consequence of ionoregulatory malfunction (Mallatt 1987). No other relevant recent work has been identified pertaining to this recommendation.

Not Implemented

41. Prey preference throughout the parasitic life of sea lamprey should be described to ensure the security of the forage base (SLIS).

While this recommendation has not been undertaken it is thought that the portion of the forage base which is susceptible to lamprey predation is healthy throughout the upper Great Lakes except in northern Lake Huron.

42. The Commission should encourage implementation of large scale experiments on the effects of reduced lamprey control and overfishing (SLIS).
43. Studies should be conducted on the physiology and control of transformation as a step in identifying a method of biological control (SLCRN).

Discussions between a Commission ad hoc committee and endocrinology experts from the U.S.A. and Canada were held in 1983 and 1984 to examine the feasibility of identifying a hormone or other substance which could be applied to prevent metamorphosis. The consensus was that this was not likely to be a profitable direction to pursue. Some very preliminary research on the biological activity of GnRH on juvenile sea lamprey was undertaken in 1987 at Hammond Bay Biological Station (Sower 1987).

44. A thorough review should be made of the topic of imprinting before proposed studies of lamprey imprinting are initiated (HBBS).
45. In a search for natural lamprey control, comprehensive chemical, physical, and biological analysis should be made of streams that do and do not produce sea lampreys, including those streams tributary to the Atlantic Ocean (HBBS, SLIS).

Researchers at Hammond Bay Biological Station examined 14 physiochemical variables for their effect on spawner abundance in selected Lake Superior tributaries, and found correlation only with stream discharge. This study was based on available data. A more comprehensive study incorporating variables, which require new data, would be very expensive.

research and assessment techniques will be needed. Alternative or supplemental methods of control will also be important in integrated management to reduce treatment costs and the nontarget effects of lampricides.

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APPENDIX

Source List of Recommendations Pertaining to the Control of
Sea Lampreys and the Use of Lampricides in the Great Lakes.

	Number of Recommendations
1. Report of the Scientific Advisory Committee on the technical review of Great Lakes Fishery Commission funded research at Hammond Bay Biological Station, 1975 (HBBS)	30
2. Recommendations from the Sea Lamprey International Symposium reported to the attendees at the Sea Lamprey Control and Research Committee, 1980 <u>and</u> Report on SLIS recommendations to BOTE from the Sea Lamprey Subcommittee, 1981 (SLIS).	14
3. Report of the Audit of the Great Lakes Fishery Commission's program of sea lamprey control and research, 1980 and addendum on liability of the Commission and its Agents, 1982 (SLAT)	65
4. Report of the meeting on Sea Lamprey Control Research Needs, 1981 <u>and</u> 1982 (SLCRN)	10
5. A strategic plan for integrated management of sea lamprey in the Great Lakes, 1982 (SPIMSL).	13
6. National Research Council Canada's review entitled TFM and Bayer 73: Lampricides in the Aquatic Environment, 1985 (NRC).	11
7. Workshop to evaluation sea lamprey populations, 1987 (WESLP)	19
8. Great Lakes Fishery Commission Report of the St Mary's River sea lamprey task force, 1987 (SMRSLTF)	1
Total	163