GREAT LAKES RESEARCH ADVISORY BOARD

ANNUAL REPORT

TO THE

INTERNATIONAL JOINT COMMISSION

PRESENTED

JULY 1975
June 1975

International Joint Commission
Canada and United States

Gentlemen:

The International Great Lakes Research Advisory Board, in partial fulfillment of its responsibility under the Water Quality Agreement of 1972, is submitting the following Annual Report on the activities of the Board and its working Committees.

Respectfully submitted,

Dr. A. R. LeFeuvre
Chairman

Dr. A. R. Bartsch
Chairman
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This report to the International Joint Commission describes the status of a variety of activities and accomplishments of the Great Lakes Research Advisory Board from October 1974 to April 1975.

A. Accomplishments

Reports on: "Asbestos in the Great Lakes Basin", and, "Evaluation of International Joint Commission Public Hearings" were completed and transmitted to the Commission. Acting upon a request from the Upper Lakes Reference Group, a report on "Total Dissolved Solids in the Upper Great Lakes" was presented to this Group.

Three major workshops were held during 1975 to review and define research strategy for Cladophora on the Great Lakes, on drift and dispersal characteristics of lakes and on the prediction of the biological activity of organic chemicals through correlations of structural parameters.
The 1975 Directory of Great Lakes Research Projects was published and distributed to all members of institutions under the Great Lakes Water Quality Agreement and to all contributors from the Great Lakes research community.

B. Current Activities

The Board has established a Research Needs Committee to develop a report at regular intervals on the research needs concerning the quality of the waters of the Great Lakes System. The first document will be published in 1976.

To aid in identifying deficiencies in research and applied research in public participation, the Board's Standing Committee on Social Sciences, Economic and Legal Aspects will sponsor a workshop on June 24-25, 1975.

The Scientific Basis for Water Quality Criteria Committee is performing a continuing advisory role to the Water Quality Objectives Subcommittee of the Water Quality Board in its assignment of developing recommendations for uniform water quality objectives for the Great Lakes.
The Board and its Standing Committees are planning workshops and seminars concerned with: eutrophication assessment; remote sensing of water quality; land disposal of sludge; and toxic effects of various forms of metals.

Oil spill remedial technology in fast flowing waters and surveillance of PCB's and radioactivity are among the topics addressed by the Board and deferred for later discussion. The Board is providing a critical review of the 1975 Directory of Great Lakes Research Activities to aid the development of the computerized system for information retrieval.

C. Board Operations

The Board has asked the Commission to request the Governments to describe their methods for conveying research needs to the agencies responsible for conducting research into environmental problems.
The Board may fill executive positions with people who...

The main issues concerning air, water, and other environmental...

The Board has asked the Commission to consider the...

The Commission is responsible for coordinating research...

Quality measures need to be developed to:

- Set water quality criteria in the Great Lakes region.
- Develop and implement measures to protect the region's water resources.
- Ensure that the region's water resources are used sustainably.

The Commission has established...
II CONCLUSIONS & RECOMMENDATIONS

ASBESTOS IN THE GREAT LAKES BASIN

Asbestos is a generic name for several fibrous silicates. The reported background level of asbestiform fibre concentration in the Great Lakes varies from less than one million to ten million fibres/litre. Sources of asbestiform fibres are natural erosion, mining and processing operations, and man's use of the manufactured products. That inhaled asbestos is related to an increased incidence of cancer is reasonably well known, but the effects of ingested asbestiform fibres have only recently come under study and the demonstrable hazard to health is not defined.

On the basis of the report "Asbestos in the Great Lakes Basin", the Board recommends that:

1) Extension of existing sampling and monitoring programs be limited until the most important sampling and analytical problems are resolved and there is more knowledge of health effects.

2) The Commission request our respective governments to set up a joint task force to initiate and
coordinate the investigation of sampling and analytical problems, and health effects.

**CLADOPHORA IN THE GREAT LAKES**

Widespread occurrence and production of the filamentous alga *Cladophora* in nuisance quantities is an important manifestation of eutrophication in the Great Lakes. While much general information is available on *Cladophora*, the significance of its role and place in ecosystem function and structure is not well defined. It is recommended that investigations be undertaken to define this role with particular emphasis on interrelationships with fish populations and fish productivity as well as biomagnification of pollutants through food chains. Additional investigative effort should be directed to clarify the societal impact of the present *Cladophora* problem and alternative remedial programs.

Further experimental work to identify potential uses for harvested *Cladophora* is needed.

**STRUCTURE-ACTIVITY CORRELATIONS IN STUDIES OF TOXICITY AND BIOCONCENTRATION WITH AQUATIC ORGANISMS**

There are useful correlations between the structures of organic chemicals and biological effects such as toxicity and bioaccumulation on aquatic organisms. It is recommended
that such correlations be used in the laboratory screening of new chemicals and that further work be undertaken to widen and improve such applications.

MEASUREMENTS OF LONG-TERM, LARGE-SCALE DRIFT AND DISPERsal PATTERNS IN THE GREAT LAKES

Transboundary pathways and scales of pollutant dispersal and diffusion in the Great Lakes are at present poorly known. Equipment and techniques for measuring drift and dispersal patterns with drogues are improving, particularly through the development of electronic navigation and communications systems. It is recommended that cooperative efforts by agencies in both countries be directed towards developing reliable operational data collection and processing facilities to measure long-term, large-scale drift and dispersion.

(c) identify additional research projects that should be undertaken;

(d) identify specific research programs for which international cooperation will be productive.

2) Provide advice and consolidations of scientific opinion to the Commission and its boards on particular problems referred to the Advisory Board by the Commission or its boards.
STRUCTURE-ACTIVITY CORRELATIONS IN STUDIES OF TOXICITY AND BIOACCUMULATION WITH AQUATIC ORGANISMS.

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INTRODUCTION

The Research Advisory Board was established under the provision of the April 1972 Canada-United States Agreement on Great Lakes Water Quality in order to:

1) Review at regular intervals research activities concerning the quality of the waters of the Great Lakes System in order to:
   (a) examine the adequacy and reliability of research results, their dissemination, and the effectiveness of their application;
   (b) identify deficiencies in their scope, and inadequacies in their funding and in completion schedules;
   (c) identify additional research projects that should be undertaken;
   (d) identify specific research programs for which international cooperation will be productive.

2) Provide advice and consolidations of scientific opinion to the Commission and its boards on particular problems referred to the Advisory Board by the Commission or its boards.
3) Facilitate both formal and informal international cooperation and coordination of research.

4) Make recommendations to the Commission.

The Board has since submitted four Semi-Annual Reports to the Commission, which have periodically reviewed Board activities and accomplishments in accordance with the noted Terms of Reference.

In January 1975, the Commission requested all institutions formed under the Water Quality Agreement to report on an annual basis rather than semi-annually.

This report is submitted in fulfillment of this request and covers Board activities and accomplishments to April 1975, since submitting its October 1974 Fourth Semi-Annual Report.
IV ACCOMPLISHMENTS

ASBESTOS IN THE GREAT LAKES BASIN

In response to a request by the Commission, the Board submitted a report entitled "Asbestos in the Great Lakes Basin" to the Commission in February 1975. The report presented chapters on the properties of asbestos; analytical methods; health effects; treatment and removal; distribution throughout the Great Lakes Basin, particularly in Lake Superior; research needs which are summarized in Chapter VI of this Annual Report; and conclusions which are summarized in Chapter II of this report. Appendices are included in the asbestos report, with information on current investigations and the Reserve Mining Case.

After approval of the document by the Commission, the report was publicly released.

TOTAL DISSOLVED SOLIDS REPORT

The Standing Committee on Analytical Sampling and Measurement Methods recommended to the Upper Lakes Reference
Group that specific conductance measurements replace conventional
gravimetric determinations of total dissolved solids in the
waters of the Upper Great Lakes. Following a review by the
Committee on Data Quality of the Upper Lakes Reference
Group, the report was adopted for use in the Upper Lakes.
Future measurements and nondegradation criteria will therefore
be in terms of specific conductance and where conversion to
a gravimetric value (mg l⁻¹) is required, a multiplication
factor of 0.65 μohm cm mg l⁻¹ will be used for all waters of
the Upper Lakes Basin.

REPORT ON THE VALUE OF THE INTERNATIONAL JOINT COMMISSION'S
PUBLIC HEARINGS

The report "An Evaluation of the International Joint
Commission's Public Hearings", September 20, was submitted
to the Commission at its October 1974 Semi-Annual Meeting.

Based on three sets of hearings covering the period
from December 1972 to December 1973, an analysis was made of
230 completed questionnaires received from attendees. The
twelve recommendations included: the appointment of a Public
Hearings Officer; the need for citizen representation on
International Joint Commission boards and committees;
holding evening meetings with improved briefing of the
Commissioners and adequate advance publicity, with due
consideration for effective timing. Also recommended was the provision of a "facts" sheet for attendees, improved communication between the Commissioners and the public during hearings and a summary report subsequent to the hearings, prepared for the attendees and the chairmen of the Boards and Reference Groups concerned.

Implementation of certain of these recommendations was made during the Commission's thirteen Lake Level Hearings, held during October to December 1974. A follow-up study, to evaluate the effect of these changes, was undertaken, with the questionnaire being distributed at these hearings.

**CLADOPHORA IN THE GREAT LAKES**

The Standing Committee on Eutrophication conducted a workshop on problems created by the alga *Cladophora* in the Great Lakes to identify research needs and priorities for action.

Because the proceedings are still under preparation, the eight specific topics addressed at this workshop are reviewed:

1) **History of Cladophora in the Great Lakes**

*Cladophora* is an alga native to the Great Lakes.
It was noted in Lake Erie as early as 1860-70 after the Great Black Swamp near Toledo was drained. Also, *Cladophora* growths were observed in Lake Superior in 1871 in Simmons Harbor and dredged in immense quantities at St. Ignace Island.

2) **Distribution**

Remote sensing offers a rapid and accurate means of measuring distribution. The Upper Lakes are affected in a number of areas of local enrichment. Lush *Cladophora* growths now cover all suitable substrates in the lower lakes, and are more widely distributed in Lake Ontario than Lake Erie.

3) **Biomass and Productions**

*Cladophora* produces a major crop in the spring and a second minor crop in the fall. Following the growth periods, it detaches and may be washed ashore in large quantities or is moved into deeper water where it settles to the bottom and decomposes. It was the consensus of the workshop that higher nearshore nutrient levels are the cause of run-away *Cladophora* growth and excessive growths of *Cladophora* are symptomatic of deteriorating lake water quality.

4) **Physical and Chemical Requirements**

There is a reasonable understanding of physical
requirements of Cladophora. The chemical requirements are not well understood, and no micro-elements or organic requirements have been identified as factors limiting its growth in Great Lakes waters. The availability of phosphorus is thought to be a key factor governing its distribution and biomass produced, though available nitrogen concentrations may play an important secondary role. Sufficient information is not at hand to clarify the relationship between water fertility and production. The participants were in full agreement nonetheless with the current program of phosphorus control, as it appears to be the most effective means of reducing Cladophora growths.

5) Nutrient Effects

A laboratory procedure has been developed to determine whether nutrient reductions are influencing Cladophora production, and preliminary field testing is underway.

6) Ecology of the Cladophora Niche

Knowledge of interactions within the "Cladophora niche" was found to be almost entirely lacking with respect to the quantity of invertebrate species produced and fish species benefiting
therefrom. *Cladophora* may be beneficial as it provides a feeding area for adult fish and both feeding and protection for fish larvae. Conversely, it may cover the clean rocky shoals required for spawning by some of the more highly prized species and encourage development of undesirable species.

The alga itself stores heavy metals, pesticides and radio-nuclides and probably plays an important role in biomagnification. The alga produces larvicidal compounds which have been shown to be toxic to mosquito larvae.

7) **Control**

The preference of *Cladophora* for open shorelines and water movement in lakes makes general chemical control impractical, owing to wide-spread distribution of the alga. In addition, no effective chemical is available. Control by viruses, fungi and the herbivores was discussed, but no specific studies are underway. Removal by mechanical means has been limited to beach areas. Nutrient control, i.e. elimination of agricultural and domestic organic wastes, would remove the essential nutrients and limit growth.
8) **Economic Impact**

Cost and loss of recreational opportunities as a result of unsightly and malodorous accumulations of *Cladophora* are difficult to assess quantitatively. Property values are adversely affected.

While *Cladophora* is a major problem to relatively few municipal and industrial water supplies, it can clog water intakes and add a greater load to the purification process. Limited studies indicate that attached *Cladophora* is beneficial to some species of fish. However, the influence of high *Cladophora* production to a variety of fish species of both lakewide and local importance has not been defined. Whether *Cladophora* is an asset or liability to fish production depends upon identification of its influence on the fish species important to the fishery management objectives for the water body or segment thereof.

*Cladophora* has a potential value as animal feed, compost, paper fibre and has some larvicidal properties to mosquitos. Quantitative information on cost/benefit of *Cladophora* is limited.
Following the presentations, specific research needs were identified and prioritized and these are included in Chapter VI of this report.

The proceedings of this workshop will be available for distribution in July 1975.

SYMPOSIUM ON "STRUCTURE-ACTIVITY CORRELATIONS IN STUDIES OF TOXICITY AND BIOCONCENTRATION WITH AQUATIC ORGANISMS"

A symposium to discuss the potential of structure-activity correlations in aquatic toxicity testing and bio-accumulation studies was sponsored by the Board's Standing Committee on the Scientific Basis for Water Quality Criteria. The conclusions of the symposium are summarized as follows:

1) The prediction of the biological activity of organic chemicals through correlations of structural parameters and the biological activity of related chemicals has been of considerable value to the pharmaceutical industry in the development of new drugs. The data presented and reviewed at this workshop has shown that the structure-activity correlations have been successfully applied to toxicity testing with aquatic organisms.

2) The structural parameters most useful in the
structure-activity correlations include the n-octanol/water partition coefficients, the Hammett σ constant, the field and resonance constants, and the pK. The methodology for the measurement and/or calculation of these parameters is adequate. A comprehensive database for structural parameters is available to researchers at Pomona College in Claremont, CA.

3) The structure-toxicity correlations can be applied to structurally related chemicals exhibiting the same mode of action and using the same biological endpoint.

4) The bioconcentration factors for organic chemicals in fish can be correlated to the n-octanol/water partition coefficient.

5) The structure-activity correlations are not likely to predict the toxicity of complex effluents even though the correlations may be valuable in multiple toxicity research.

6) There is a need in industry and regulatory agencies to screen large numbers of organic chemicals for potential hazards to the environment. The use of structure-activity correlations may greatly reduce the amount of laboratory testing required and serve as an early warning technique in a protocol
for the use of toxic chemicals.

7) The uptake rates of chemicals significantly affect the death rate in acute toxicity tests. Consequently, the partition coefficient of the chemicals tested is important in selecting the $LC_{50}$ endpoint (24, 48, 96 hr. etc.) for toxicity testing.

The identified research needs are written in Chapter VI, and the proceedings which are in preparation will be distributed in June 1975.

MEASUREMENT OF LONG-TERM, LARGE-SCALE DRIFT AND DISPER SAL PATTERNS IN THE GREAT LAKES

The Board's Standing Committee on Lake Dynamics sponsored a technical workshop to assess the feasibility of measuring currents on the Great Lakes, to provide fundamental data in order to gauge their contribution to transboundary pollution, using the concept of "continuous" tracking of a network of drogues.

The basic conclusions are:

1) Environmental Data Required

Drifting drogues can provide data on current velocity, depth and other variables. Further
telemetering development is required for ranges to several hundred miles at reasonable cost.

2) Navigational and Allied Technology for the Location and Tracking of Buoys

Very low frequency (10 to 130 kHz) differential OMEGA and LORAN-C radio location techniques are available for the Great Lakes. Good operational coverage of the Upper Great Lakes by LORAN-C is anticipated by 1980. The use of earth tracking systems, e.g. NIMBUS 4 and F should be continued, using high frequency radio retransmission. Range-Range drogue monitoring by boat and radar tracking by aircraft are other techniques successfully applied in lake and ocean environments, for short range (30 to 40 miles) observations.

3) Probable Lower Limits of Cost of "Expendable" Components

Drifting buoy and drogue equipment costs range from a few hundred to several thousand dollars, depending upon the degree of sophistication required and the number and variety of sensors fitted. The range and life of the radio transmission instruments affect the cost. These costs apply only to the drogue-buoy combination and not to the shore, aircraft,
satellite or other re-transmission, navigation or data collection and processing facility involved.

4) The Availability of Existing Equipment for Modification and Field Testing

Readily available and inexpensive precision components manufactured for balloon-borne meteorological RAWINDSONDE equipment were considered promising for adaptation to drifting drogue use.

DIRECTORY OF GREAT LAKES RESEARCH PROJECTS

The Board has published a 1975 Directory of Great Lakes Research Activities which provides baseline documentation of current research on water quality applicable to the Great Lakes Basin.

The Directory was prepared from the responses to a questionnaire distributed to approximately 1,300 research scientists and organizations.

The Research Advisory Board on the basis of the 1975 Directory is reviewing various methods of presentation of the research activities.
The development of uniform water quality objectives for the Great Lakes is recognized as one of the primary program elements of the Canada—United States Great Lakes Water Quality Agreement of 1972. These common objectives will provide direction for all water quality surveillance programs, will be of critical importance in evaluating the success of remedial programs, and should provide protection for designated uses.

The responsibility of the Commission to develop common water quality objectives was assigned to the Water Quality Board's Water Quality Objectives Subcommittee. The Subcommittee was charged to assess the adequacy, and propose refinement where necessary of the General and Specific Objectives in the Agreement, as well as to recommend specific objectives for water quality parameters not included in the Agreement.

Following a joint meeting in December 1974, it was decided that the Standing Committee on Scientific Basis...
for Water Quality Criteria could best function in an advisory role to the Water Quality Objectives Subcommittee, dealing especially with parameters for which the data base is not well established. Subsequent joint meetings were held during the months of January, February, March and April 1975.

During these meetings proposed new and revised specific water quality objectives have been developed and they are as follows:

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<th>NEW</th>
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<tr>
<td>Fluoride</td>
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<td>Aluminum</td>
<td>Oil and Petrochemicals</td>
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<td>Ammonia</td>
<td>Temperature</td>
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<td>Hydrogen Sulfide</td>
<td>Settleable and Suspended Solids and Light Transmission</td>
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<td>Selenium</td>
<td>Persistent Organic Contaminants</td>
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<td>Arsenic</td>
<td>pH Substances and Complex Effluents</td>
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A plan for limiting biological effects locally and on a waterbody-wide basis was conceived and is scheduled for further development. Specific numerical objectives for metals and for non-persistent toxic substances are being developed for proposal later this year.
Working with the Water Quality Objectives Subcommittee has aided this Committee in defining research needs for the attention of the Research Advisory Board. For example, to assist in the development of appropriate water quality objectives for complex organic effluents, a symposium was sponsored on the correlation of toxicity and bioaccumulation in aquatic organisms with the chemical structure of organic chemicals.

A comprehensive review of toxicity tests with aquatic organisms to determine effects of various metals further substantiated that the chemistry of metals in water as related to biological effect is inadequately understood. Large variations in toxic concentrations of the same metal are reported in the literature. The Committee is planning a workshop in late 1975 to address the problem of toxicity relationships of heavy metal speciation and complexes to aquatic organisms and to define research needs.

WORKSHOP ON PUBLIC PARTICIPATION

To help fill an identified deficiency in research and applied research in public participation, the Board's Social Sciences, Economic and Legal Aspects Committee will sponsor a two-day workshop in June 1975. The workshop will (a) investigate the presently used public involvement procedures
in order to determine needed specific research in this area of activity; (b) examine suitable improvements to existing International Joint Commission activities in the Great Lakes (and by extension, other agencies' programs operating in the Basin); (c) serve to educate the government representatives, cooperating public, and readers of the proceedings in techniques for improved information impact, improved responses on the parts of government and the public, and improved listening; and, (d) provide recommendations for improving two-way communication and public involvement.

SOCIAL SCIENCES, ECONOMIC AND LEGAL ASPECTS LITERATURE SEARCH

The Social Sciences, Economic and Legal Aspects Committee has underway a computerized literature search to identify past and present research projects in the socio-economic, legal and institutional fields, especially as they affect or are affected by Great Lakes water quality.

Members of the Committee have been assigned to carefully review citations within their own areas of interest and/or expertise.

Although the Committee has not formalized any recommendations, three preliminary observations were made:
1) **Citizen Involvement**

Two specific problems which require some concerted action involving citizen involvement are:

(a) development of techniques of involvement;

(b) communicating information effectively to the public.

Discussion of pertinent citations at a November 1974 meeting, resulted in this Committee's recommendations to the Board for the sponsorship of the previously noted workshop on citizen involvement.

2) **Human Resources in Environmental Management**

Based upon its consideration of social factors and the literature search, this Committee recognizes the lack of appropriate human resources in environmental management as a problem area. To date, most attention in environmental management has fallen on the structural aspects of pollution abatement and control. However, the human component, in terms of the adequate supply of qualified manpower and the effective utilization of existing manpower, is a critical element in the management process. This Committee will continue discussions in this area and will formalize its recommendations in the near future.
3) Future Studies and Alternative Forecasting Approaches

Given that water quality of the Great Lakes will be determined by ongoing socio-economic processes such as urbanization, economic growth, population growth and distribution in the Basin, this Committee feels that directed efforts must be made to develop better means of predicting the impact of these processes on water quality. Further, in light of the forecasting efforts being undertaken, it is important that the knowledge and expertise developed not be lost to the ongoing water quality management of the lakes.

OIL SPILL REMEDIAL TECHNOLOGY IN FAST FLOWING WATERS

The Board had requested the Regional Office to prepare a report on the existing state-of-the-art of oil spill contingency measures in fast flowing waters, by reviewing existing literature and contacting the Joint Contingency Plan agencies.

Following receipt and review of this report in the fall of 1975, the Board will determine the adequacy of existing technology and define research needs.
LAND DISPOSAL OF SLUDGES

The Water and Wastewater Treatment Committee has tabled before the Board a proposal to fund a study which will ascertain (a) whether regulations and codes of good practice of disposal of industrial and municipal sludges reflect the present state of the art, and (b) whether present research is adequately addressing the problems associated with current disposal practices.
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 following capital and grocery to development in the fall
 of 1975, the board will determine the direction of existing
technology and define research needs.
VI RESEARCH NEEDS

The Board at its Tenth Meeting established a Research Needs Committee to provide a focus for the development of a report, at regular intervals, on the research needs concerning the quality of the waters of the Great Lakes System. The report will identify problems, the reasons for their importance, the gaps in knowledge which the research will fill and the benefits which will result to the water quality of the Great Lakes and to society. The Terms of Reference of this Committee tie directly to the Terms of Reference of the Research Advisory Board, Section 2(a). Recognizing that the identification of research needs is a primary function of the various Standing Committees of the Research Advisory Board, that research needs are also identified by the Water Quality Board, and its Reference Groups, and other joint institutions formed under the Water Quality Agreement, the Research Needs Committee is established to provide a focal point for the organization, analysis and documentation of research needs information from all pertinent sources for the Research Advisory Board.

The first Research Needs report will be prepared in 1976.
The following are research needs developed by the participants of Research Advisory Board workshops and symposia, and from special reports. Such projects are the prime mechanism of the Board in fulfilling its Terms of Reference. The Board will submit these research needs formally to the Commission within the next few months for action by governments after they have been fully reviewed, amplified and arranged in order of priority.

ASBESTOS IN THE GREAT LAKES BASIN

Because research needs are discussed in the report on "Asbestos in the Great Lakes Basin", only a brief review is given in the Annual Report.

There are needs for a variety of expanded research efforts in the analytical, environmental, and public health aspects of asbestos in the Great Lakes. Specific research needs include:

1) Improvement of analytical procedures for identification and enumeration of asbestos fibres.

2) Determination of public health effects of asbestos fibres in drinking water.

3) Investigation of the manner in which asbestiform minerals weather and go into solution in Great Lakes waters.
4) Determination of asbestiform minerals in air and water with particular emphasis on drinking water supplies.

5) Determination of short and long term effects, if any, of such fibres on aquatic biota, microbiota and animal life.

6) Identification of the magnitude and sources of atmospheric contributions of asbestiform minerals to Great Lakes waters.

7) Determination of the significance of resuspension of asbestos from lake-bottom and from land.

8) Compilation of an inventory of production, use, disposal and ultimate fate of asbestos products.

9) Evaluation of present and predicted future levels of asbestos species, concentrations, and size distribution in air, surface waters, and sediments in the Great Lakes.

10) Improvement of the efficient removal of asbestiform fibres from drinking water supplies, with emphasis on sub-micron size particles.

11) Evaluation of the potentiating effect of asbestos fibres and the metals associated with them by pathogens including viruses.
The general objective of the Cladophora study and workshop was to identify gaps in knowledge that must be filled to enable the wise management of Cladophora growths and the measurement of the effects of controls.

The workshop concluded that if this objective is to be fulfilled, further information is required on:

1) **Growth Requirements, Physiology and Life History**

   Not enough is known of the basic biology of Cladophora including the relative importance of vegetative growth from perennial holdfasts, development from zoospores and the mechanisms of detachment. Studies on physical and chemical conditions for growth have been reported, but adequate information on the role of turbidity, substrates and water currents necessary to understand the basic requirements of the alga is still lacking. Interrelationships with other attached algae should be better understood.

2) **Nutritional Factors Limiting Growth**

   To control Cladophora through the management of lake fertility, the limiting levels of those nutrients which can be controlled must be known.
Phosphorus is considered the most important element, followed by nitrogen, and others such as iron and vitamins have been suggested as significant. Studies recommended to provide this information include bioassay procedures, and a careful comparison of existing nearshore data for nitrogen and phosphorus at different levels of productivity in different lakes. The phenomenon of luxury uptake should be studied to determine the significance of short-term enrichment on subsequent production.

3) Measurement of Present Distribution, Biomass and Production

From reports available and discussion at the workshop, it was generally concluded that the technology for measuring distribution is currently available using spectral scanning techniques and computer processing of results. Water clarity and surface conditions make overflights practical for only a few days during the period of maximum biomass. There is also the possibility that a measure of biomass can be obtained at the same time, but further development work is required. Measurements of biomass have been attempted by a number of investigators, but it was concluded the existing data are based on inadequate sampling procedures.
and thus not capable of measuring changes in response to controls. Remote sensing would provide an effective tool if the technique can be developed.

Methods for the measurement of production are also required to indicate changes within a lake and differences between lakes. While no clear recommendation developed from the discussion of production measurements, the use of artificial substrates appeared to offer the greatest potential.

4) Measurement and Prediction of Responses

A model for use in predicting responses to changing conditions of light (turbidity from erosion), temperature (effect of thermal discharges) and nutrients (effluent controls) would be a valuable tool. Work on light and temperature has been published but the key factor of nutrient requirements has not been introduced. To complete the model, basic information on limiting nutrient levels and the role of luxury uptake and water movement to nutrition and growth is required.

5) Significance of Cladophora in Great Lakes Ecosystems

Quantitative studies of fish species using the beds for spawning, feeding and protection are required to determine which species benefit
and which may be adversely affected. Information is also needed on the chemical, physical and biological phenomena occurring in the unique habitats created by the dense growth areas. The workshop concluded that the effects on dissolved oxygen and sediments in deeper water where the bulk of the crop decomposes were unknown, and that information was needed on the contribution of heavy metals, pesticides and radioactivity to the food chain from the benthic community associated with decomposing Cladophora.

6) Mechanical, Biological and Chemical Controls

It was noted that mechanical controls were being used on beach areas for simple cleanup operations. A method to collect accumulations of detached filaments from rocky shores and growth beds as well as underwater cropping of attached filaments would be of value. If useful products could be developed from Cladophora, there would be an incentive for the development of harvesting equipment. There is no work being done on biological controls. A number of possibilities were suggested, including hormones to promote premature release of the attached filaments, selective destruction of the holdfast, specific
viruses and fungi and a study of potential herbivores. Chemical control by algicides has been studied, but no safe products have yet been found capable of working in the rigorous open shoreline environment.

7) Socio-Economic Impact on Lake Activities and Uses

The workshop concluded that Cladophora imposes a large cost on society through interference with recreation, effects on water supplies and lowering of property values. It is not known whether the alga benefits or harms the fishery. The workshop concluded that if the socio-economic effect of Cladophora on the Great Lakes is to be measured, it should be done by specialists in that field.

STRUCTURE–ACTIVITY CORRELATIONS IN STUDIES OF TOXICITY AND BIOCONCENTRATION WITH AQUATIC ORGANISMS

To facilitate the use of structure–activity correlations in forecasting the relative potential hazards of organic chemicals and in deriving water quality objectives for complex organic effluents in the Great Lakes, it is recommended that the following research needs be addressed:

1) The toxicity of untested organic chemicals cannot be estimated reliably without an adequate data base
of structure-activity correlations. Due to the foreseeable immediate application of this tool, it is recommended that a systematic protocol be developed to:

(a) categorize and select organic chemicals for testing based on their structural properties;
(b) standardize the end points of toxicity testing and select a standard method for use in the structure-activity correlations;
(c) direct the generation and compilation of data from the specified tests into the structure-activity data base. This protocol must recognize the variation of the $LC_{50}$-time relationship with the log P of this chemical.

(2) It is recommended that an inventory of the organic chemicals produced and used in the Great Lakes Basin be made on a continuing basis. This inventory would include: total quantities of chemicals; a categorization of major uses; structural parameters from existing data bases; and a streamlined compilation of pertinent data of toxicity of biological activity.

3) It is recommended that an extensive exploration of trace organic chemicals in the fish of the Great Lakes be initiated immediately, with reference to
ongoing inventories of hazardous materials. When possible, the quantities of the organic chemicals should be measured in the water and fish populations to estimate bioconcentration factors in the Great Lakes environment and to relate these factors to the lipid content of fish and structural parameters of the chemical.

4) The above recommendations are concerned with immediate short-term problems with hazardous organic chemicals in the Great Lakes and other aquatic environments. A major, long-range research effort is urgently needed to address the problems of the toxicity of mixtures of hazardous organic and inorganic chemicals, with emphases on identifying the chemical properties which determine additive, synergistic and independent biological activity. This research is needed to develop predictive capabilities for complex effluents.

5) This workshop reviewed and discussed the "toxic unit" concept as a tool for use by the enforcement branches of regulatory agencies. There is a critical need to fully evaluate the "toxic unit" concept for regulating these discharges of hazardous chemicals.
To fill a serious knowledge gap concerning long-term and large-scale drift and dispersal patterns in the Great Lakes, it is recommended that studies be initiated to:

1) Design and develop improved drogue systems to measure the flow field of the lake.

2) Develop and field test commercially-available, multichannel, long-range positioning and telemetering systems for expendable drifting drogue buoys; and to improve their positioning accuracy, e.g. the LORAN-C or differential OMEGA systems, and systems involving earth satellites.

3) Evaluate the utility of short-range ship and aircraft tracking of buoys drifting in clusters, using radar, DECCA and visual methods.
MEASUREMENT OF TOXIC-TANK LAGOON SCALE-UP AND OPERATIONAL PATTERNS IN THE GREAT LAKES

To fill a detection-evaporative tank concentrating 10-day figures and to store water and also to store waste and clean up water in a filter for filtration for lakes, two 10-day figures of priority, in light blue, and far are semifinal estimates for filter systems and small systems for development. The filter systems for development, as well as for evaporative tank, are to be used to increase waste and storage, reclamation, and reclamation of waste and storage. The filter systems for development, as well as for evaporative tank, are to be used in the development of waste and storage. The filter systems for development, as well as for evaporative tank, are to be used in the development of waste and storage. The filter systems for development, as well as for evaporative tank, are to be used in the development of waste and storage. The filter systems for development, as well as for evaporative tank, are to be used in the development of waste and storage.

This workshop recently had discussed the "toxic unit" concept at a recent meeting by the environment protection agency. There is a critical need to fully evaluate the "toxic unit" concept for regulating these discharges of hazardous chemicals.
VII BOARD OPERATIONS

MEMBERSHIP

In December 1974, Dr. A. R. LeFeuvre, Director of The Canada Centre for Inland Waters was appointed Chairman for the Canadian Section of the Great Lakes Research Advisory Board, replacing Mr. J. P. Bruce.

Dr. LeFeuvre has been involved directly with the Research Advisory Board since its formation under the 1972 Water Quality Agreement in late 1972, and acted as Secretary for both the Research Advisory and Water Quality boards before Commission staff assumed these duties.

Also in December, Mr. Alvin R. Balden was appointed as a U.S. member of the Research Advisory Board, replacing Dr. G. E. Watkins. Mr. Balden recently retired from his position as an environmental engineer in the materials laboratories specializing in water and waste management at Chrysler Engineering. He served as a member of the Water Resources Commission for the State of Michigan during the years 1970-1973, and in 1973 was appointed by the Governor to the
Michigan Environmental Review Board.

In March 1975, Dr. J. C. N. Westwood, Head, Department of Microbiology and Immunology, Faculty of Medicine, University of Ottawa, was appointed as a Canadian member of the Research Advisory Board, replacing Dr. J. Kramer.

RULES OF PROCEDURE

Draft rules of procedure for Board meetings and Committee membership were distributed to Board members in March for review. In addition, rules of procedure, conforming with Directive #1 to the Board, on the structure of the Board and appointment of Board members were included.

Comments from Board members were invited and discussion on the rules of procedure has been tabled until summer, 1975.

RESPONSE OF GOVERNMENTS

The Board has by formal letter to the Commission queried the response of Governments to recommendations of the Commission. It had noted there was little or no evidence of Governments formally:
recommending to their agencies the concerns of the Commission;

- initiating research recommended by the Commission;
- bringing to the attention of the Commission pertinent ongoing research.

In addition, the Board requested clarification of the mechanisms of Federal, State and Provincial Government feedback to Commission recommendations, so that it may structure its documentation of research needs to the appropriate audiences.
Response of Government

The Board has by formal letter to the Commission queried the response of Governments to recommendations of the Commission. It had noted there was little or no evidence of Governments formally.
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