Proceedings of the Roundtable on the Surveillance and Monitoring Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Basin Ecosystem

Committee on the Assessment of Human Health Effects of Great Lakes Water Quality

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Hazards Posed by Contaminants in the
Great Lakes Basin Ecosystem
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Roundtable on the Surveillance and Monitoring
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Hazards Posed by Contaminants in the
Great Lakes Basin Ecosystem

held March 17-18, 1982
East Lansing, Michigan

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Great Lakes Water Quality Board and
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through their
Committee on the
Assessment of Human Health Effects of
Great Lakes Water Quality

November 1982
Windsor, Ontario
Statements and views presented in these Proceedings are those of the Roundtable participants and do not necessarily reflect the views and policies of the International Joint Commission or those of its Water Quality Board or Science Advisory Board and Committees. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notice</td>
<td>i</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>iii</td>
</tr>
<tr>
<td>List of Tables</td>
<td>v</td>
</tr>
<tr>
<td>Preface and Acknowledgements</td>
<td>1</td>
</tr>
<tr>
<td>The International Joint Commission, Canada-United States</td>
<td>3</td>
</tr>
<tr>
<td>Summary</td>
<td>5</td>
</tr>
<tr>
<td>Recommendations</td>
<td>7</td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>9</td>
</tr>
<tr>
<td>2. EXISTING INTERNATIONAL SURVEILLANCE AND MONITORING PROGRAMS ON THE GREAT LAKES</td>
<td>11</td>
</tr>
<tr>
<td>3. SURVEILLANCE AND MONITORING: GENERAL CONSIDERATIONS</td>
<td>13</td>
</tr>
<tr>
<td>4. SURVEILLANCE AND MONITORING FOR ORGANIC AND INORGANIC CONTAMINANTS IN FISH</td>
<td>15</td>
</tr>
<tr>
<td>4.1 Considerations</td>
<td>15</td>
</tr>
<tr>
<td>4.2 Specific Requirements</td>
<td>15</td>
</tr>
<tr>
<td>4.2.1 Fish Species Sampled</td>
<td>15</td>
</tr>
<tr>
<td>4.2.2 Size Class and Sample Size</td>
<td>16</td>
</tr>
<tr>
<td>4.2.3 Location, Time and Frequency of Sampling</td>
<td>16</td>
</tr>
<tr>
<td>4.2.4 Analytical Considerations</td>
<td>17</td>
</tr>
<tr>
<td>4.2.5 Data Handling</td>
<td>17</td>
</tr>
<tr>
<td>4.2.6 Other Considerations</td>
<td>17</td>
</tr>
<tr>
<td>5. SURVEILLANCE AND MONITORING FOR ORGANIC AND INORGANIC CONTAMINANTS IN WATER</td>
<td>19</td>
</tr>
<tr>
<td>5.1 Considerations</td>
<td>19</td>
</tr>
<tr>
<td>5.2 Specific Requirements</td>
<td>20</td>
</tr>
<tr>
<td>5.2.1 Water To Be Analyzed</td>
<td>20</td>
</tr>
<tr>
<td>5.2.2 Location and Frequency of Sampling</td>
<td>20</td>
</tr>
<tr>
<td>5.2.3 Volume of Sample</td>
<td>20</td>
</tr>
<tr>
<td>5.2.4 Analytical Considerations</td>
<td>21</td>
</tr>
</tbody>
</table>
5.2.5 Data Handling 21
5.2.6 Other Considerations 21

6. SURVEILLANCE AND MONITORING FOR MICRO-BIOLOGICAL CONTAMINANTS IN WATER

6.1 Considerations 23
6.2 Specific Requirements 23
   6.2.1 Parameters 23
   6.2.2 Location and Frequency 24
   6.2.3 Analytical Considerations 26
   6.2.4 Data Handling 26

7. FUTURE CONSIDERATIONS 27

APPENDICES 29

A. List of Participants 31
B. Surveillance and Monitoring Programs of the Jurisdictions with Responsibility for Water and Fish Quality in the Great Lakes Basin 33
C. List of Chemicals for which Surveillance Should be Considered 57
D. Resolution of the "Edible Portion" Issue 61
E. List of Position Papers and References 65
F. Membership and Terms of Reference for the IJC Committee on the Assessment of Human Health Effects of Great Lakes Water Quality 69
### List of Tables

<table>
<thead>
<tr>
<th>Table No.</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Routine Parameters Used as Indicators of Microbiological Contamination of Water</td>
<td>25</td>
</tr>
<tr>
<td>2.</td>
<td>Potential Indicators of Microbiological Contamination of Water</td>
<td>25</td>
</tr>
<tr>
<td>3.</td>
<td>Appendix B. New York State Department of Environmental Conservation's Fish Contaminant Monitoring Program. 1981 Collections for Lake Ontario Trend Analysis</td>
<td>43</td>
</tr>
</tbody>
</table>
Preface and Acknowledgements

These proceedings present the findings of the Roundtable on the Surveillance Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Basin Ecosystem on March 17-18, 1982 in East Lansing, Michigan. The Roundtable was sponsored by the IJC Committee on the Assessment of Human Health Effects of Great Lakes Water Quality on behalf of the Great Lakes Water Quality Board and the Great Lakes Science Advisory Board of the IJC under the Commission's authority to implement the terms of the Great Lakes Water Quality Agreement of 1978.

The Roundtable recommendations were drafted by three Work Groups, constituted to address the topic with respect to surveillance and monitoring for organic and inorganic contaminants in fish and water and for microbiological contamination of water, respectively.

The Human Health Effects Committee expresses its appreciation to the Roundtable organizers and to the twelve participants listed in Appendix A, who contributed valuable time and expertise. The Committee is indebted to Dr. Andrew P. Gilman, Roundtable Chairman and to Dr. Andrew E. P. Watson, Roundtable Secretary, for their careful compilation and preparation of these Proceedings. Appreciation is also expressed to those members of the IJC Great Lakes Regional Office, Windsor, who made significant contributions to the Roundtable and assisted in the preparation of these Proceedings and to all those agencies with programs pertaining to Great Lakes environmental quality who commented on drafts of this report.
Flora and Fauna

The importance of conserving the environment and its biodiversity cannot be overstated. Therefore, concerted efforts are being made to protect and preserve various species that are threatened with extinction. The government has implemented several policies and initiatives to address this critical issue. These include the establishment of protected areas, the enforcement of wildlife laws, and the promotion of sustainable practices. By working together, we can ensure a future in which all species coexist harmoniously. The protection and conservation of the environment are not only essential for the survival of life on Earth but also for the well-being of future generations.
The International Joint Commission (IJC) was established under the Boundary Waters Treaty of 1909. It consists of six Commissioners, three from Canada and three from the United States. A Commissioner from each country is a Co-Chairman. The Commissioners act as a single body seeking common solutions, with decisions reached by majority.

The Treaty was established to aid in settling and preventing disputes regarding the use of boundary waters, by means of joint deliberations of the Commission. Headquarters of the Commission are located in Ottawa, Ontario and in Washington, D.C., for the Canadian and United States Sections, respectively.

Three categories of Commission responsibility derive from the 1909 Treaty:

- decisions regarding the approval of applications for the use, obstruction or diversion of boundary waters or of works affecting boundary water levels;
- undertaking investigations and studies of specific problems along the common frontier when requested by one or both Governments as a reference; and
- decisions on questions or matters of difference referred by the Governments.

The International Advisory Boards assist the Commission by organizing and preparing required technical studies and field work. Board reports to the Commission are made public and public hearings are held so that individuals, organizations and government may comment. The resulting information together with the Board report, is used when the Commission reports to both Governments with its recommendations. These reports are also made public.

In 1972 the Great Lakes Water Quality Agreement was signed by both countries. After extensive review a new Agreement was signed in 1978 to restore and enhance the water quality of the Great Lakes. The Governments have given to the Commission specific responsibilities and functions to assist them in the implementation of the Agreement. Included in these responsibilities is the requirement to tender advice and recommendations. The Agreement also provided for two International Boards to assist the Commission, the Great Lakes Water Quality Board and the Science Advisory Board. Secretariat functions are provided by the IJC Regional Office, established under the Agreement in Windsor, Ontario in 1973.
Summary

The Committee on the Assessment of Human Health Effects of Great Lakes Water Quality emphasized in its 1981 Report, the need to consider the specific data required to evaluate human health impacts resulting from exposure to Great Lakes contaminants. Surveillance and monitoring programs of contaminants in fish and water provide large amounts of data that are of use for assessing health impact; however, the type, quantity and quality of the data have not always been adequate. The Committee convened a Roundtable in March of 1982 to discuss the data required from fish and water sampling programs and requested that a report be prepared to alert centres of responsibility in the Great Lakes Basin to these needs.

Extensive surveillance and monitoring programs that identify and measure the concentrations of chemical contaminants in several media and a variety of biota and that assess the degree of microbial contamination of raw and finished water, exist in or have been proposed by most Great Lakes' jurisdictions. However, a variety of objectives for surveillance and monitoring and different approaches toward sampling and analysis have resulted, in some cases, in a lack of comparability of data among the jurisdictions. Surveillance and monitoring programs that are to provide data suitable for the assessment of the impacts of environmental contaminants on man must determine the nature and degree of contamination, trends in the levels of contamination and they must address the contact media, i.e. consumed fish species, recreational water, drinking water, sediments, etc. As "new" chemicals are identified and trends in concentration of "old" chemicals are defined, programs must adjust their sampling to meet these changes; programs must be well coordinated, interactive and reactive. Details of the data requirements are provided in these Proceedings and are not summarized here.

Consideration of public health impact as a rationale for sampling fish and water does not imply that existing surveillance and monitoring programs be changed. Rather, it implies re-evaluation of existing programs designed, in part, to provide data suitable for health risk evaluation. Specific requirements detailed in this report provide the basis for such a re-evaluation. Furthermore, appendices to these Proceedings provide information on sampling programs in the Great Lakes jurisdictions and a list of chemicals that should be considered for inclusion in surveillance programs in the Great Lakes Basin.
Recommendations

General

It is recommended that the jurisdictions of the Great Lakes Basin:

1. recognize the need to assess the chronic health implications and the impact on reproduction of low level exposure of residents of the Great Lakes Basin to environmental chemicals;

2. increase the comparability of their data by:
   a) more frequent interagency communication and review of sampling, analytical and assessment methodologies; and
   b) implementing quality assurance programs;

3. a) report to the IJC at least annually the findings of surveillance and monitoring programs on the Great Lakes and provide complete details of sample collection, handling and analysis; and
   b) meet annually to discuss the significance of the data forthcoming from surveillance and monitoring programs and to propose changes in future programs as deemed scientifically appropriate;

4. evaluate their surveillance and monitoring programs that provide data pertaining to public health, in terms of the specific requirements listed in these Proceedings and alter their programs as required.

Surveillance and Monitoring of Fish and Water for Organic and Inorganic Chemicals:

It is recommended that the jurisdictions of the Great Lakes Basin:

5. consider immediately surveillance for those chemicals identified by the Committee on the Assessment of Human Health Effects in Table 7.3 of its 1982 Report (see Appendix C) but not to the exclusion of those listed in Table 7.5 of the 1982 Report;

6. address the issue of the human health impact of chemicals in drinking water;

7. a) conduct compliance monitoring programs of commercial and sport fish species caught for consumption; and
   b) augment surveillance programs for the identification of "new" chemicals and the determination of trends of "old" chemicals;
8. continue to gather data on the fish consumption patterns of Great Lakes Basin residents in order that monitoring programs can be tailored to meet consumption patterns and health risk assessments be based on sound exposure figures; and

9. resolve the "edible portion" issue (see Appendix D) by
   a) agreeing on a "standard" edible portion; or
   b) conducting research on the relationships between different portions of different species of fish such that data from different jurisdictions can be compared.

Surveillance and Monitoring for Microbiological Contaminants in Water

It is recommended that the jurisdictions of the Great Lakes Basin:

10. a) improve their reporting of water-borne disease outbreaks; and
    b) monitor, more frequently, effluent discharges in areas where waterborne disease outbreaks have occurred;

11. investigate the hazard to health of bathing waters by
    a) ensuring that current monitoring programs for bathing waters are utilizing the best indicators of contamination;
    b) gathering data on those organisms identified as potentially useful indicators of microbiological contamination of water; and
    c) conducting research on the role between the microbiological quality of bathing water sediments and the transmission of disease to bathers.
I. Introduction

The Committee on the Assessment of Human Health Effects of Great Lakes Water Quality noted in its 1981 Report the current philosophy of the IJC to obtain a clearer understanding of the relationship between contaminants in the Great Lakes Basin and the health of man. Furthermore, the Committee's report emphasized the need to consider the data requirements necessary to evaluate human health impacts resulting from exposure to these contaminants and the surveillance and monitoring specifications necessary to provide data for conducting health risk assessments. Adoption of an ecosystem approach to the problems of contaminants in the Great Lakes implicates several media, i.e., air, water, sediment and soil and demands sophisticated integration of monitoring and surveillance of both the levels and effects of contaminants in man and the ecosystem. Implicit in this ecosystem approach is consideration of contaminants in the food chain.

There is a multitude of rationales for monitoring and surveillance programs in the Great Lakes Basin; concern for human health is one of these rationales but not always a primary reason for the program. The Great Lakes International Surveillance Plan (IJC, Windsor, 1978) identifies public health concern as a factor in the assessment of the impact of man's activities on the Great Lakes Basin ecosystem. However, the surveillance and monitoring data required to conduct meaningful assessments of the health hazards posed by contaminants present in the Great Lakes have not always been adequate. To date, the specific type, quantity and quality of data needed have not been clearly identified by health officials.

Assessment of the health hazard posed by an environmental chemical is based on the toxicological data available for laboratory mammals and man and the degree of exposure. Hence an exceedingly toxic chemical may pose little hazard to health if levels of exposure are far below the threshold for toxic effects determined in laboratory studies. Risk assessment involves assignment of a probability to an adverse health effect. For example, the risk of any given level of a specific chemical may be 3 cancers per 100,000 of population. Risk estimates are derived mathematically from mammalian test data and sometimes from epidemiology data. A health impact assessment usually defines the actual effect of the chemical under study on an existing and exposed population. Epidemiological methods are used to assess impact.

The objectives of the Roundtable meeting held on March 17-18, 1982, in East Lansing, Michigan were to:

1. Identify the data requirements for adequate assessment of the human health hazards posed by contaminants in the Great Lakes Basin Ecosystem; and

2. Recommend surveillance and monitoring programs (new or existing) that would meet the identified data requirements.
The scope of the Roundtable was limited to a consideration of data needs from surveillance and monitoring programs for organic and inorganic chemicals in fish and in water and for microbiological contaminants in water. The data requirements for surveillance and monitoring programs for contaminants in air and other food were not considered at this meeting.

Surveillance was defined as: the repeated measurement of a variable in order that a trend may be detected.

Monitoring was defined as: measurement of fixed variables chosen to provide data on how well regulations are working and how far standards are being met.

Participants at the Roundtable (Appendix A) represented several disciplines, i.e., toxicology, epidemiology, water chemistry, microbiology, and fish biology and held positions with international, federal, state or provincial agencies or a university.

The primary basis for discussion was the Great Lakes International Surveillance Program (GLISP) of 1978. The merits and limitations of this and other existing surveillance and monitoring programs on the Great Lakes were discussed in the context of the basic objectives of the Roundtable and suggestions made as to how to upgrade the overall process of data collection and information transfer.

Recommendations from the Roundtable were made in regard to the perceived requirements for surveillance programs as a step toward the development of an overall strategy for the management of toxic substances in the Great Lakes Basin and are reproduced elsewhere in this publication. The findings from the Roundtable, published in this report, are intended for workers in the field and will provide the basis for discussion with a wide variety of groups, which will include managers of:

- surveillance and monitoring programs concerned with the incorporation of contaminants newly-identified in the ecosystem;
- analytical service laboratories;
- toxic substances control programs; and
- public health protection programs;

in addition to advisors on ecosystem objectives for the Great Lakes Basin and participants in the subsequent process of setting intervention levels for specific contaminants.
2. Existing International Surveillance and Monitoring Programs on the Great Lakes

Extensive surveillance and monitoring programs exist or have been proposed through a variety of federal, state, provincial and international agencies with jurisdictions on or surrounding the Great Lakes. These programs measure the concentrations of known chemical contaminants in several media and a variety of biota, detect new or previously unidentified chemicals and also the degree of microbial contamination of raw and finished water. Development of current surveillance and monitoring strategies has been closely tied to the Great Lakes International Surveillance Plan (GLISP) which was prepared over a period of years by the International Joint Commission as required by the 1978 Water Quality Agreement between the United States and Canada. GLISP is flexible in nature and provides a long-term strategy to coordinate monitoring activities of the many participating agencies in a cost-effective fashion. As programs have matured and new needs have been perceived, individual surveillance and monitoring plans have been redesigned to meet changing requirements.

Summaries of existing fish surveillance and monitoring programs for twelve jurisdictions are provided in Appendix B. Review of these programs indicates the extensive nature of surveillance and monitoring activities; however, it also reveals differences in some of the objectives of these programs and divergent approaches in the areas of sampling and analyses.
3. Surveillance and Monitoring: General Consideration

Surveillance and monitoring programs that are to provide data suitable for the assessment of the impacts of environmental contaminants on man, must determine the nature and degree of contamination, the trends in levels of contamination and they must address the contact media, i.e., consumed fish species, recreational water, drinking water, sediments, etc. Information obtained from these programs will serve the needs of several aspects of the overall risk assessment process. The identification of previously unidentified ("new") contaminants leads to the initiation of preliminary assessments, literature searches, research programs and quantity and use data-gathering exercises. Trend data on well known ("old") contaminants contribute to the refinement of the health hazard assessment and may lead to the initiation of a detailed exposure analysis and subsequently a risk assessment. The ability to prioritize assessment, research and data gathering activities is enhanced and the utilization of limited resources optimized. Ultimately, reliable monitoring data can provide reassurance for the public that fish consumption guidelines and drinking water guidelines are not being exceeded and that contaminant control programs are effective.

Media and biota sampling programs complement each other by providing a variety of data necessary for health hazard assessment; individually these programs are unable to provide an adequate data base for assessment. Sampling of biota (e.g. fish) is most useful for detecting low level chemical contaminants that accumulate in tissue. These contaminants, (e.g. dioxins, mirex, etc.) are virtually undetectable in water using routine extraction and analytical methodologies. Fish and other biota are also capable of ingesting contaminants over time; hence, chemicals that have widely varying concentrations on a day-to-day or week-to-week basis, as a result of periodic runoff or municipal and industrial effluents, can often be detected in tissue at times when they would be undetectable in water. Water sampling offers the advantage of identifying chemical pollutants that do not accumulate in tissue. Water samples collected near effluent discharges enable identification and quantitation of a variety of chemicals entering the lakes and permits calculation of loading rates.

Surveillance of the effects of environmental contaminants on biota has proven to be a useful tool to assess the impact of contaminants on populations of plants and animals; however, the direct relevance of effects observed in the field in animal populations to human health risk assessment is limited. From the human health perspective the most significant aspect of data on biotic effects is the finding that a chemical substance(s) is capable of exerting a recognizable and significant effect in a living organism (e.g. reproductive failure in fish-eating birds or tumors in fish) at prevailing concentrations of contaminants. The implications for human health are tenuous; differences in diet, exposure, habits, metabolic pathways, etc., are usually vast between humans and other biological species.
It is essential that surveillance and monitoring programs be interactive and reactive. As new contaminants are identified and old contaminants characterized, programs must shift resources to expand surveillance for some which have potential for significant impact and reduce efforts to monitor for others that are assessed as posing minimal risk to health. This approach to surveillance and monitoring has commonly been referred to as the "smart-program" approach because resource utilization is maximized through conscientious review of current and past data bases. Special emphasis should be placed on the interpretation of extreme values determined infrequently in media and biota; their significance should not be underrated.

There are already 24 chemicals or classes of chemicals for which water quality objectives or fish intervention levels have been set in the United States or Canada. Monitoring of these chemicals in water and fish in the basin is essential. The Committee on the Assessment of Human Health Effects of Great Lakes Water Quality recommended, in its 1981 and 1982 reports, additional chemicals that warranted consideration for inclusion in surveillance programs based on their potential impact on human health (Appendix C). Surveillance data forthcoming from programs examining the levels and trends of these chemicals will be used to assess the health hazard they pose and the need for further surveillance.

Consideration of public health impact as a rationale for monitoring does not imply that existing surveillance and monitoring programs be changed. Rather, evaluation of existing programs is required to ensure that programs expected to provide data suitable for health risk evaluation meet this objective. Specific requirements provided in these Proceedings should form the basis for such an evaluation.
4. Surveillance and Monitoring for Organic and Inorganic Contaminants in Fish

4.1 Considerations

Monitoring programs that utilize fish tissue (or tissue of other biota) are useful primarily for the detection and quantitation of lipid soluble organic contaminants. Lipophilic contaminants (e.g. PCB, mirex, hexachlorobenzene, DDE, etc.) often accumulate in individual fish; concentrations of these contaminants occur in predatory species further up the food chain and are frequently several orders of magnitude above concentrations in water. Alkylated (e.g. methyl mercury) and other metal complexes may also be present in fish tissue; however, metallic ions rarely accumulate in fish tissue to high levels and are more readily observed in water and sediment.

There are three major objectives for fish surveillance and monitoring programs that relate directly to public health concerns and one for monitoring programs:

- Surveillance of fish species to identify new or previously unrecognized contaminants;
- Surveillance of fish species over time to establish temporal trends in tissue concentrations of well known contaminants;
- Compliance monitoring of commercial and sport fish to determine whether or not fish residue levels exceed established guidelines; and
- Surveillance of short-lived, local fish species to identify point-sources of contamination.

For example, whole fish analyses provide data on the levels of numerous toxic substances in the aquatic ecosystem and the levels are frequently 25% to 60% higher than those found in edible portions. Thus, whole fish are more frequently used for detecting trends and new contaminants and edible portion data for compliance.

These objectives dictate the type of fish chosen, the number and portion analysed, the time, location and frequency of sampling and the analyses carried out. The following section provides details of program elements that must be included if data arising from these programs are to be used for health hazard evaluation.

4.2 Specific Requirements

4.2.1 Fish Species Sampled

- Compliance monitoring programs must select fish that are consumed by the public. It is not necessary to analyse every sport and commercial species from every location; however, the more commonly caught species must be analysed.
Surveillance for new, previously unrecognized contaminants or the determination of trends requires the selection of long-lived top predators, (e.g. lake trout, coho salmon) and forage species, (e.g., rainbow smelt, chub). Species selected should represent whole lake conditions, i.e. they should be integrators of contaminants found over a wide area.

Development of the use of nearshore species, (e.g. spottail shiner) capable of accumulating contaminants found in local areas, (e.g. near municipal water intake facilities) is encouraged.

4.2.2 Size Class and Sample Size

Compliance monitoring should provide data on a minimum of three (3) size classes per species whenever possible. The size classes must be representative of the usual range of sizes of that species caught for consumption.

Selection of size classes that could be utilized by all jurisdictions would greatly improve comparability of data.

Identification of new contaminants in top predators should be utilized for the larger size classes of fish available. For example, the use of 4 + year old lake trout is recommended.

Current levels of contaminants in the Great Lakes and within species variation indicate that sample size should not be less than 20 individuals of any one size class from any single location. A 20-fish sample is capable of detecting a 10-20% change in most contaminant levels in a species from one year to the next. (GLISP)

Pools or composites of fish are acceptable when individuals of the species are small (e.g. smelt, chub, shiner) or extraction of large amounts of contaminants is required.

4.2.3 Location, Time and Frequency of Sampling

Sampling for compliance must take place where fish are caught for consumption by the public, i.e., major sport fishing areas and commercial fishery operations.

Sampling for compliance must also take place when fish are caught for consumption by the public. Ideal sampling schedules should coincide with peak catch periods for the various species consumed.

Frequency of sampling for compliance is dependent on the number of peak catch periods per species. If variations in contaminant levels within a species are minor between peak catch periods then sampling of fish during all time periods is unnecessary.

Localized areas known to contain or suspected to contain contaminants at levels of concern to health should be surveyed more frequently using appropriate nearshore and whole lake species.
Location, time and frequency of sampling of fish species for "old" contaminant surveillance should be coordinated between the jurisdictions to minimize duplication of effort and to enhance comparability of data.

4.2.4 Analytical Considerations

Compliance monitoring programs must analyze "edible portions" of fish if they are to address health concerns. Definition of "edible portion" has become a contentious issue within and between analytical groups and jurisdictions and concurrence on a "standard edible portion" or the development of appropriate conversion factors is urgently required to enhance comparability of data and consistency in health hazard assessments.

Methods of analysis need not always be standardized, but rigorous intra- and interlaboratory comparisons via a sample check program are essential to retain public confidence in analytical capability and ensure the validity of analysis results. Participation in existing and future quality assurance programs is strongly recommended.

4.2.5 Data Handling

Improved reporting of data is required to optimize its use. Emphasis must be placed on the reporting of "new" contaminants and trends in levels of "old" contaminants for health officials to revise or conduct preliminary assessments, to set guidelines and to recommend changes in monitoring and surveillance programs. Summary reports of surveillance and monitoring activities should be provided to the IJC each year and should include details of sample collection, processing and analysis.

A central registry of data for contaminants in fish in the Great Lakes would be useful for all jurisdictions. Currently there are several computerized data bases in the jurisdictions that handle fish contaminant data, e.g., OFIS (Ontario Fish Information System) in Ontario and STORET in several states. A data system should be capable of providing rapid retrieval of information.

4.2.6 Other Considerations

It is essential to have information on the amounts (meal size and frequency) of various fish species consumed by residents of the Great Lakes Basin (males and females), the peak consumption periods and the preferences of special groups, i.e., ethnic, religious, socio-economic, native subpopulations, for certain species. Application of this knowledge to the selection of species for surveillance and monitoring and to the calculation of average intakes of a variety of contaminants, will greatly enhance the relevance of surveillance and monitoring programs to public health.

Tissue banking is of value for retrospective analyses of contaminant levels (and past human exposure) and efforts to develop fish tissue banks should continue. Special attention should be paid to the storage conditions and their adequacy.
5. Surveillance and Monitoring for Organic and Inorganic Contaminants in Water

5.1 Considerations

In this century, the justification for the chlorination of water supplies has been the perceived success in controlling microbiological pathogens. Waterborne disease control is now taken for granted in most areas of North America, hence the public's concerns have shifted and now focus on the chemical quality of drinking water, i.e., the presence of environmental contaminants (natural and anthropogenic) and use of water treatment chemicals (e.g. chlorine, pH adjusters, alum, etc.) and of elective water additives (e.g. fluorides). The implementation of existing and proposed drinking water guidelines does not imply the production of a drinking water of standard composition, i.e., water with identical pH, hardness, taste, colour, turbidity, odour and chemical content; rather, it promotes the production of water with individual measured parameters that do not exceed acceptable levels. The measurement of organic and inorganic chemicals in water is an important monitoring tool for identifying exposure to humans. Since the measurement of exposure to chemicals consumed in fish is carried out directly on fish tissues, the main requirements for surveillance and monitoring for chemicals in water are in the raw and finished drinking waters. The impact of recreational exposures to chemicals in raw water is considered relatively minor and will not be considered further.

Analyses of raw and finished drinking waters are carried out on a routine and special-case basis by the responsible jurisdictions as required by current drinking water guidelines and regulations in the United States and Canada. Limits for several organic chemicals have been established and are generally met in current water supplies. Unfortunately, the results of most compliance monitoring programs of finished water are reported as either mean values without data on sample size, sampling location or time, the standard deviation or standard error, or they are reported as percent of samples meeting the drinking water guidelines. Thus, meaningful calculations of exposure are almost impossible. The Province of Ontario is addressing this problem by developing a system to record all sampling data. It is hoped that this central facility will be able to provide data useful for exposure calculations.

Compliance monitoring for known environmental chemicals in every municipal water supply is expensive and time consuming. Currently one analysis per year per site is common and practical. Ideally, compliance monitoring programs should adjust to allow for less frequent sampling of non-detectable contaminants and increase the sampling frequency for those chemicals found at unacceptably high levels.

When chemicals for which no guidelines have been established are determined in appreciable quantities in water or are found in fish tissue (indicating their presence in water) it is important that the jurisdictions be able to conduct an assessment of the potential health risks and if indicated, take appropriate action to reduce human exposure. To conduct such an evaluation the jurisdictions must have data on the levels and distribution of
the contaminant(s) in raw and finished water and data on the consumption patterns (quantity, sources) of the exposed population. Often, sampling frequency will need to be increased on a contingency basis to meet special requirements for data.

The objectives of surveillance and monitoring programs for water are similar to those listed for fish sampling programs. Compliance monitoring is extensive but local and considers mainly finished water. Surveillance data on levels of chemicals in raw waters are essential and can be compared with data on levels in finished water to determine what is removed and what is added by water treatment facilities. Surveillance for "new" chemicals is equally important because not all chemical contaminants accumulate in tissue and may not be identified in fish surveillance programs.

5.2 Specific Requirements

5.2.1 Water To Be Analysed

- Compliance monitoring for chemical contaminants in finished drinking water should continue as described in jurisdictional guidelines such as are found in Guidelines for Canadian Drinking Water Quality, 1978 and in the National Interim Primary Drinking Water Regulations, U.S. EPA, 1976.

- Raw water supplies should be surveyed for levels of known contaminants and the presence of "new" chemicals. Furthermore those chemicals indicated in Appendix C should be included in analysis schedules.

5.2.2 Location and Frequency of Sampling

- Compliance monitoring should take place at the treatment facility or the distribution centre. Water characteristics should be monitored on a year-round basis but chemical parameters on a yearly basis. In the event of a known contamination problem, additional monitoring or surveillance should be considered.

- Sampling of raw water should take place at some municipal water intakes in spring (during high runoff periods), midsummer (during high volume use of water) and winter (after water freeze-up). Intakes to be sampled should be selected based on the presence or probable presence of known contaminants.

Sampling of ground water supplies should be conducted in areas of known or potential chemical contamination (due to spills, dump sites, runoff, industrial or municipal effluents, etc.).

5.2.3 Volume of Sample

- Large volume samples of raw water and occasionally finished water, should be obtained for chemical concentration (e.g. using XAD-2 macroreticular ion exchange columns, rotoevaporation, reverse osmosis, etc.) to determine low concentrations of otherwise undetectable contaminants.
5.2.4 Analytical Considerations

- Methods of analysis need not always be standardized between the jurisdictions provided data produced by the jurisdictions are comparable and there exists a rigorous quality assurance program within and between laboratories.

- The development and testing of methodologies that detect and measure levels of waterborne contaminants more accurately and efficiently should be encouraged.

5.2.5 Data Handling

- Monitoring data should appear as mean values per time period and state sample size, volume, standard deviation and standard error.

- Compliance data and data pertaining to trends in "old" contaminant levels and to "new" chemicals in raw and finished water should be reported to a central data collection agency. Annual reports should be made available to the jurisdictions and to the IJC.

5.2.6 Other Considerations

- Monitoring of pH and plumbing is necessary in areas where water pH is affected by environmental factors and there is extensive use of private water supplies. Private water supplies may have a low pH as a result of acidified rain water and may cause extensive corrosion of some plumbing systems. pH is routinely adjusted in municipal water supplies, hence, these water supplies are unlikely to contribute to the corrosion of household plumbing.

- Testing of water samples for mutagenicity may be useful for the assignment of priority for further analysis; however, water samples that show mutagenic activity are not necessarily harmful to health.

- Although the contribution of waterborne chemicals (including those added or formed during water treatment) to the total daily intake (TDI) of these substances via food and air is likely to be small, there is a need to examine the overall long-term effects of exposure to these chemicals in water on human health. This requirement by no means obviates the important need to disinfect drinking water supplies.
6. Surveillance and Monitoring for Microbiological Contaminants in Water

6.1 Considerations

Prior to the initiation of disinfection practices, contamination of water by pathogenic micro-organisms posed a major threat to human health. Conscientious effort and innovation have reduced the incidence of serious, widespread waterborne disease outbreaks in North America dramatically.

Waters and sediments may be classified into three groups on the basis of the magnitude of the impact they are likely to have on human health.

Group I. Finished and raw drinking waters and bathing waters. Drinking water has the greatest potential to impact on health because it is ingested in large quantity. Bathing waters. Bathing water is also ingested and provides extensive opportunity for dermal contact by microorganisms. Surveillance programs designed to assess the impact on health of bathing waters must examine both undisturbed water and bathing water with bathers present. These two approaches allow assessment of the background level of contamination entering or present in the bathing area and the contribution of the bathers themselves to the microbial load in the water.

Group II. Discharges to lake waters. Sewage and packing plant effluents contribute to the total load of microorganisms and usually contain organisms which can produce disease in humans, but are less likely to be in direct contact with man. Bathing water sediments. There is currently little information on the part played by bathing water sediments in the transmission of waterborne disease and the lack of standardized sampling and analytical methodology makes interpretation of existing data difficult. Research is required to resolve these difficulties and it is possible that with additional information, the health impact of bathing water sediments will have to be reassessed.

Group III. Open lake waters. These waters have the least impact on human health because human exposure to them is limited.

6.2 Specific Requirements

6.2.1 Parameters

The parameters for which measurements are required in the surveillance and monitoring of microbiological contaminants fall into three groups:

- parameters that are monitored on a routine basis (includes organisms which are used as indicators of the presence of human and/or animal pollution and therefore, the presence of human pathogens);
parameters that have the potential to be useful but for which, currently, only a limited data base exists. Insufficient information is available as to the utility of some of these parameters for health assessment, however, their inclusion into monitoring programs on a trial basis should be encouraged; and parameters that measure waterborne pathogens (includes bacteria, viruses and parasites).

The analytical requirements for each of these three parameter groups have been tabulated below using the classification of water into Groups I, II and III.

Table 1 lists the water group and the common indicators of water quality which are currently used. Each indicator organism is assigned a numerical ranking to denote its utility for a given water type, using 1 for essential parameters, 2 for very useful parameters and 3 for useful parameters.

Table 2 lists those organisms that may be of potential use for health risk assessment in the specific water groups shown. However, sampling and isolation methods for these organisms have not been refined or standardized and the interpretation of their presence in water in terms of human health impact remains equivocal. It is not necessary to investigate open waters for these parameters. The collection of more data on the occurrence of these microorganisms in these specific areas will enable their ultimate role in human health assessment to be determined.

Where an epidemiological study of a specific waterborne outbreak is undertaken, or where a defined population will be studied for evidence of waterborne disease, it may be necessary to undertake surveillance of one or more of the following waterborne pathogens:

- Aeromonas hydrophila
- Giardia lamblia
- Schistosoma species
- Pathogenic amoeba
- Campylobacter species
- Legionella species
- Salmonella species
- Shigella species
- Yersinia enterocolitica

The isolation and sampling methodologies for these organisms in water is not yet fully developed and in certain cases, the specific types that are virulent for humans cannot be identified. For these reasons, interpretation of any isolations must be made with extreme caution.

6.2.2 Location and Frequency

Monitoring of finished drinking water must be carried out to ensure the safety of drinking water and to indicate that efficient treatment procedures have been employed and that the integrity of the distribution system has been maintained. Minimum sampling regimes and
### TABLE 1. ROUTINE PARAMETERS USED AS INDICATORS OF MICROBIOLOGICAL CONTAMINATION OF WATER

<table>
<thead>
<tr>
<th>Group</th>
<th>Coliforms</th>
<th>Escherichia coli</th>
<th>Other&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Enterococcus&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Pseudomonas aeruginosa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Fecal&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I Drinking Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finished</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Raw</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Bathing Water</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>II Discharges</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Bathing Sediments</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>III Open Water</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>a</sup> Confirmatory test if total Coliform level is high.
<sup>b</sup> Klebsiella, Aeromonas, Citrobacter, Enterobacter
<sup>c</sup> Standard Methods for the Examination of Water and Wastewater, 14th ed., APHA, Washington, D.C., 1976

N.B. Parameters: 1-essential; 2-very useful; and 3-useful

### TABLE 2. POTENTIAL INDICATORS OF MICROBIOLOGICAL CONTAMINATION OF WATER

<table>
<thead>
<tr>
<th>ORGANISM</th>
<th>Staphylococcus aureus</th>
<th>Clostridium perfringens</th>
<th>Candida albicans</th>
<th>Coliphages</th>
<th>Bifidobacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking Water</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finished</td>
<td>-</td>
<td>X</td>
<td>-</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Raw</td>
<td>-</td>
<td>X</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Bathing Water</td>
<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>Discharges</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Bathing Sediments</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

X-recommendation for monitoring
methods are specified by the various jurisdictions and these are considered to be adequate at present. However, data on the levels of residual chlorine at the time of sampling would be very useful.

Routine monitoring of raw drinking water should be carried out to ensure that treatment methods will be adequate to prevent finished water contamination. The sampling frequency and method is specified by the jurisdictions; frequency will depend generally upon the microbiological history, the season of the year, the potential sources of pollution and the population at risk.

Minimum sampling frequencies for recreational waters are determined by the jurisdictions and in general adequately address health risk assessment for the duration of the recreational season. It should be recognized that a sanitary survey of an area is an essential component of any assessment of the health hazard to bathers. Samples of bathing beach water should be collected at representative areas at each beach and upstream of areas subject to influence from point source discharges. Multiple individual samples are preferred, but composite samples may be useful in screening programs. Routine sampling should be at a depth of 15-30 cm below the surface of water that is 1-1.5 m deep. In intensive sampling, water should be collected at various depths in the water column, throughout the defined bathing area. To better define bather contribution, samples from the surface film of the water may be useful. (This film not only would tend to concentrate organisms shed with the body oils and secretions, but is the area of water most usually in contact with the eyes, ears, nose and mouth of the bathers). The conditions under which samples are collected should be recorded, with such details as the estimated bather load at the time, so that appropriate interpretation of the results can be made.

6.2.3 Analytical Considerations

Sampling and analytical procedures for identification and quantitation of microbiological parameters should be as standardized as possible among the jurisdictions.

6.2.4 Data Handling

The method of sample collection and analysis should be provided with all data.

The poor quality of waterborne disease reporting is a problem common to all the jurisdictions and affects assessments of the health impact of water used for drinking and recreation. With the possible exception of Pennsylvania, investigation of suspected waterborne outbreaks of disease is not vigorously pursued and reporting tends to be inaccurate and fragmented among the various agencies concerned. More frequent and more complete reporting of waterborne disease outbreaks should be implemented. An annual summary report to the IJC is recommended.

26
7. Future Considerations

Discussions of the surveillance and monitoring requirements for assessing human health hazards posed by contaminants in the Great Lakes Basin ecosystem were limited to consideration of fish and water. Since the Roundtable meeting in March, 1981, several issues pertaining to fish and water sampling programs have surfaced; however, some are peripheral to the strict objectives of the Roundtable. These issues are presented here for future consideration.

- The implications for human health of contaminants in fish and water cannot be adequately assessed without due consideration of human exposure to contaminants via other media. Air and food (other than fish) contribute significantly to the total daily intake of environmental chemicals and microbiological agents. The data required from surveillance and monitoring programs for media other than fish and water must be defined.

- In addition to surveillance and monitoring of contaminant levels and effects in media and biota, there is a growing need for sensitive retrospective and prospective epidemiological surveys of adverse health effects in human residents of the Great Lakes Basin. Assessments of impact on health of environmental chemicals are usually based on animal toxicology studies, hence, they are predictive in nature. Case control studies of groups showing adverse health effects and short studies of the health status of exposed and unexposed groups would be most useful for identifying specific impacts.

- Surveillance of contaminant levels in human tissue and body fluids has only recently been explored (e.g. Canadian breast milk surveys, U.S. EPA chemical residue surveys in human biological media), although monitoring for specific contaminants in blood and urine is common. Surveillance programs in man are beneficial because they can identify and quantitate contaminants actually present in the body. To date, most human body burdens have been estimated from animal data and exposure patterns. With the aid of human surveillance data, animal toxicology studies could focus on those contaminants found in humans, rather than those thought to be present. Public, institutional and jurisdictional cooperation is vital for the success of a human surveillance program.

- Access to industrial production and use data for chemicals in the Great Lakes Basin is generally poor. No central facility is available to act as a clearing house for suitably "disguised" data collected by a wide range of agencies in the U.S.A. and Canada. Existing production and use data are out of date by several years. The success of assessment activities is largely dependent on accurate, up-to-date data on chemicals entering the basin. This information:
(a) provides a starting point for consideration of new chemicals entering the environment and their interaction in the ecosystem;

(b) assists in the identification of unknown peaks appearing on gas chromatographs;

(c) could be used to prepare mass spectra of all "known" chemicals entering the basin; and

(d) could assist researchers who must set priorities for expensive toxicology testing.

Surveillance activities need the support of vibrant basic research programs. Most discoveries of environmental contaminants and their effects have arisen from imaginative and dedicated research. Methylmercury, octachlorostyrene and photomirex are all derivatives of well known parent compounds; none are in commercial use. Polybrominated biphenyls were found in Michigan biota only after a lengthy extension of routine gas chromatographic scan time. Dibenzodioxins and dibenzofurans are contaminants of chemicals related to the chlorophenol family and have only been detected in environmental samples since the development of ultra-sensitive analytical methodology. Continued commitment by the jurisdictions to basic research is essential.

There is a growing need to address the topic of contaminant interactions. The public is frequently reminded of the possibility of synergistic, additive or subtractive effects of chemicals in air, water and food. Guidelines based on single contaminant toxicity research may be challenged.

Public confidence in the jurisdictions' abilities to assess health hazard has been jeopardized by a lack of agreement between the jurisdictions on setting contaminant guidelines. Consideration should be given to meetings of all Parties to set a single guideline for an environmental contaminant.
APPENDIX A

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(a) provide a starting point for the identification of new chemicals entering the environment and their interaction in the ecosystem.

(b) assist in the identification of unknown peaks appearing on gas chromatograms.

(c) could be used to provide mass spectra of all "known" chemicals affecting the public and.

(d) could assist researchers who have not priorities for expensive confirmatory testing.

Additional applications could be aspects of relevant basic research concerning number and structure of endogenous compounds and their function in cellular and molecular biology and molecular genetics. Additional applications could be aspects of relevant basic research concerning number and structure of endogenous compounds and their function in cellular and molecular biology and molecular genetics. Additional applications could be aspects of relevant basic research concerning number and structure of endogenous compounds and their function in cellular and molecular biology and molecular genetics. Additional applications could be aspects of relevant basic research concerning number and structure of endogenous compounds and their function in cellular and molecular biology and molecular genetics.
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APPENDIX B

SURVEILLANCE AND MONITORING PROGRAMS OF THE JURISDICTIONS WITH RESPONSIBILITY FOR WATER AND FISH QUALITY IN THE GREAT LAKES BASIN

1. Illinois
2. Indiana
3. Michigan
4. Minnesota
5. New York
6. Ohio
7. Ontario
8. Pennsylvania
9. Wisconsin
10. U.S. Environmental Protection Agency
11. U.S. Food and Drug Administration
12. Fisheries and Oceans Canada
AGENCIES

The Indiana Department of Natural Resources and the State Board of Health collect salmonids and other commercial species as part of the U.S. EPA monitoring program.

OBJECTIVES

1. To determine the suitability for human consumption of the fish sampled.
2. To evaluate trends in contaminant levels in Lake Michigan salmonids and other commercial species.

FISH SPECIES SAMPLED: Salmonids and other commercial species

SIZE AND CLASS SAMPLED: Commercial catch sizes

LOCATION OF SAMPLING: Lake Michigan and tributary streams

TIME/FREQUENCY OF SAMPLING: Usually in the fall

SAMPLE SIZE: Minimum of 3 salmonids per location and a minimum of 8 kg of fish

ANALYTICAL CONSIDERATIONS:

a) Composites of skin-on, 1" thick, cross-sectional steaks are used for salmonid analysis (8 kg minimum).

b) Individual whole fish of other commercial species are utilized (8 kg minimum).

DATA ANALYSIS AND REPORTING: EPA data provided to Indiana DNR

REMARKS:

a) Under U.S. EPA Fish Monitoring Program (Great Lakes National Program Office), the Indiana State Board of Health samples 19 stream stations.

b) Composites of whole fish are analysed.

c) An "edible portion" (usually a skin-off fillet) may also be analysed when whole fish are found to contain contaminants above U.S. FDA action levels.

REPRESENTATIVE FOR ADDITIONAL INFORMATION:

a) William James
Division of Fish and Wildlife
Indiana Department of Natural Resources
100 Senate Avenue
Indianapolis, Indiana 46206
Tel: (317) 232-4080

b) Lee Bridges
Indiana State Board of Health
1330 West Michigan Street
P. O. Box 1964
Indianapolis, Indiana 46206
Tel: (317) 633-0799

36
The State of Michigan Fish Contaminant Advisory Committee (FCAC) has developed a proposed fish contaminant monitoring plan to ensure coordination of the fish contaminant monitoring of the Michigan Departments of Agriculture (MDA), Natural Resources (DNR) and Public Health (DPH). Michigan participates in the U.S. EPA fish monitoring program.

Objectives:

1. To provide information for assessing potential human exposure to toxic materials due to consumption of commercial and sport fish.
2. To determine chronological trends in sport fish.
3. To identify new or previously unrecognized contaminant residues in fish.
4. To communicate results to appropriate government agencies for regulation of commercial food supplies, for determination of human exposure and public health advisories and for determination of the need for new remedial measures or the success of completed remedial measures. Also, to communicate any resulting public health advisories to the general public.

Fish Species Sampled:

Currently, sampling of commercial catches (MDA). Proposed: a wide range of sport fish (DNR).

Size and Class Sampled:

Generally representative of size of fish caught for consumption.

Location of Sampling:

Sampling for 1981 currently near the mouth of the Kalamazoo River in Lake Michigan, in various salmon - spawning tributaries of the Great Lakes in Michigan and in the Detroit River, through supportive funding by the U.S. EPA. Proposed: sport fish throughout the states portion of the Great Lakes Basin.

Time/Frequency of Sampling:

Currently, in the fall for U.S. EPA. Proposed: variable, depending on species and objective.

Sample Size:

Currently, sizes consumed by the public (for EPA). Proposed: variable, depending on species and objective.

Analytical Considerations:

The FCAC has proposed that:

1) there should be a standard edible portion which is specific for each species; and
2) "edible portion" definition is dependant on the outcome of the DNR Fish Eaters Survey.  
3) the "most likely case" should be used for analysis, (i.e.) the portion of raw fish which would actually be cooked and eaten.

Data Analysis and Reporting: Computerized file "STORET" (DNR) and hand files (MDA).

Remarks: Implementation of the FCAC Fish Contaminant Monitoring Plan in its entirety depends upon adequate funding.

Representative for Additional Information:
William E. McCracken
Water Quality Division
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, Michigan 48909
Tel: (517) 373-2867
Agencies/Program: The Minnesota Departments of Natural Resources and Public Health and the Minnesota Pollution Control Agency have developed a cooperative effort for fish contaminant monitoring. Minnesota also contributes to U.S. EPA program.

Objectives: A. Short-Term
1. To define locations, species and size of fish which contain residues exceeding safe consumption levels.
2. To assess the environmental integrity of the state's fish populations.
3. To locate discharger of priority pollutants.

B. Long-Term
1. The assessment of pollution abatement programs.
2. The compilation of a tissue data bank.

Fish Species Sampled: Fish species (sport, commercial, other) common to the area being sampled.

Size and Class Sampled: Sizes commonly caught by the angler or taken by the commercial fisherman.

Location of Sampling: Periodical sampling on the Cedar, Minnesota, Mississippi, Rainy, Red and St. Louis Rivers. Other sampling locations chosen as program requirements change.

Time/Frequency of Sampling: Normally sampled on a 2-3 year cycle. Sampling for the U.S. EPA is annual.

Sample Size: Five composites of each fish species caught.

Analytical Considerations: a) "Edible Portions" (Usually skin-off fillets) are used to assess human health impacts.

b) Whole fish are analysed to address the environmental integrity of the fishery.

c) In certain cases specific organs (e.g. liver, kidney) may be analysed to monitor pollutants known to selectively accumulate.

Data Analysis and Reporting: Computerized file "STORET" and a biannual compilation of data.

Remarks:

Representative for Additional Information: Daniel Helwig or Marvin E. Hora
Division of Water Quality
Minnesota Pollution Control Agency
1935 W. County Road B-2
Roseville, Minnesota 55113
Tel. (612) 296-7288
Agencies/Program: The New York State Department of Environmental Conservation (N.Y.S.D.E.C.) conducts three fish contaminant monitoring programs on the Great Lakes which are directed towards trend analysis and contaminant source identification for fish contaminants in Lakes Ontario and Erie and in the Niagara River, as indicated below.

Objectives: A. Statewide Toxic Substances Monitoring Program - fish sample analysis for:
1. General monitoring of persistent chemical contaminants in water subject to point source discharges.
2. Limited trend analysis.
3. Human health advice.


Size and Class Sampled: Legal size or sizes commonly consumed by the angler.

Location of Sampling: 1. Lake Erie - Lackawanna, Dunkirk.
2. Niagara River - Fort Niagara, below Lewiston and below Buffalo
3. Lake Ontario - Pultneyville, Hamlin Beach, Salmon River Estuary, Chaumont Bay

Time/Frequency of Sampling: Sampling and analysis conducted of fish from the above stations over a 3-year cycle.

Sample Size: A minimum of 20 fish and a maximum of 30 fish.

Analytical Considerations: a) Analyses are conducted on two composites of edible flesh from each species by location for the following chemical compounds: PCB; DDT and Metabolites; Dieldrin, Endrin, Heptachlor and Heptachlor epoxide; Lindane and other hexachlorocyclohexane isomers; Mirex; Chlordane; and Total Mercury.

Data Analysis and Reporting: N/A

Remarks: Detailed information on fish preparation procedures recommended by the N.Y.S.D.E.C. is available from the Departmental representative listed below.
Objectives: B. Lake Ontario Trend Analysis (1981):
1. To determine contaminant concentrations and their trends in Lake Ontario fish flesh.
2. To predict the future use of restricted fisheries.
3. To initiate analysis of other species historically containing original concentrations of contaminants which restrict fisheries usage.
4. To augment data in reproductive impairment studies independent of this project.

Fish Species Sampled: Lake Trout; Coho Salmon; White Perch; Brown Trout; Rainbow Trout; Alewife and/or Rainbow Smelt.

Size and Class Sampled: Various - see Table.

Location of Sampling: Lake Ontario - see Table.

Time/Frequency of Sampling: Seasonal and species-specific (see Table).

Sample Size: Species-specific (see Table).

Analytical Considerations: See "C" below.

Remarks: Detailed information on fish preparation procedures recommended by the N.Y.S.D.E.C. for contaminant analysis is available from the Departmental representative (q.v.).

Objectives: C. Niagara River Dioxin Investigation:
1. To determine the relative upstream extent of dioxin contamination of fish from the Niagara River.
2. To investigate dioxin sources in the Niagara River Drainage basin.

Fish Species Sampled: Fatty fish species collected - e.g. carp or goldfish for upstream work and spottail shiner or other minnows for source investigation.

Size and Class Sampled: Fish of the same size (not specified) to be sampled.

Location of Sampling: Obj.1.
1. In the Niagara River, New York State, at:
   1. near the City of Tonawanda water intake.
   2. near the City of Niagara Falls Water Treatment Plant
   3. upstream of Hooker Chemical Company, New York.

Analytical Considerations: Obj.2.
   a) Drainage systems, 10 locations, unspecified. Chemical analysis of dioxins is coordinated by Dr. Patrick O'Keefe, New York State Department of Health.
Analytical Considerations: (continued)

b) Samples will be composited into one sample for analysis for each location.

c) Each sample will be edible fish flesh as determined by the N.Y.S.D.E.C.'s "Standard Fillet" procedure or for shiner, whole fish.

d) Discretionary analysis for chlorinated dibenzofurans (CDFs) may also be performed as appropriate.

Remarks: Detailed information on fish preparation recommended by the N.Y.S.D.E.C. for contaminant analysis is available from the Departmental representative (q.v.).

Objectives: D. Niagara River Contaminants
1. To determine the presence and quantity of a wide range of pollutants in Niagara River fish.
2. To assist in the locating of the sources of these contaminants.
3. To cooperate with the Ontario Ministry of Environment.

Fish Species Sampled: Spottail Shiner
Size and Class Sampled: Full size yearlings.
Location of Sampling: 21 locations in the Niagara River and 5 locations (controls) in Lake Erie.
Time/Frequency of Sampling: Fall, 1982 (once only)
Sample size: 50 fish per location

Analytical Considerations: a) Analysis by contract through NYSDEC.

b) Cross check exchange with MOE of 10 whole fish composite.

c) Analysis initially to cover priority pollutants, PCB and chlorobenzenes in 5 x 10 fish composites from 7 locations.

d) Analysis at other locations to follow.

Representative for Additional Information: Lawrence C. Skinner
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<table>
<thead>
<tr>
<th>SPECIES</th>
<th>LOCATION</th>
<th>DATE OF COLLECTION</th>
<th>NUMBERS DESIRED</th>
<th>AGE/SIZE REQUIREMENTS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake trout</td>
<td>Galoo Island</td>
<td>Fall</td>
<td>40</td>
<td>3+</td>
<td>Whole fish analyses as individuals. Sample size calculated to reflect 80 percent chance of detecting 20 percent change at P 0.05</td>
</tr>
<tr>
<td>Coho salmon</td>
<td>Altmar</td>
<td>Fall</td>
<td>15</td>
<td>3+</td>
<td>Spawning Adults</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td></td>
<td>Egg samples composed of 4 oz. subsamples from ripe skeins only</td>
</tr>
<tr>
<td></td>
<td>Rochester</td>
<td>Spring</td>
<td>30</td>
<td>3+</td>
<td>Analyze standard fillets as individuals</td>
</tr>
<tr>
<td>White perch</td>
<td>Wilson</td>
<td>Summer</td>
<td>100</td>
<td>250 mm</td>
<td>Initially analyze from each location 50 individuals whole over age 4 through 8; 10 fish in each age group; decision to analyze remainder of collection dependent upon regression analysis of the first 50 fish (100 analyses).</td>
</tr>
<tr>
<td></td>
<td>Eastern Basin</td>
<td>Summer</td>
<td>250</td>
<td>250 mm</td>
<td></td>
</tr>
<tr>
<td>Brown trout</td>
<td>Rochester</td>
<td>Spring</td>
<td>30</td>
<td>2+, if available</td>
<td>Analyze standard fillets as individuals</td>
</tr>
<tr>
<td>Rainbow trout</td>
<td>Altmar</td>
<td>Fall</td>
<td>30</td>
<td>2+, if available</td>
<td>Analyze standards fillets as individuals</td>
</tr>
<tr>
<td>Alewife and/or</td>
<td>Western Basin</td>
<td>Spring</td>
<td>100</td>
<td>1+</td>
<td>Analyze whole; 10 composites of 10 fish each from each location and each species. This segment may be increased to substitute for white perch portion of the project dependent upon evaluation of initial results.</td>
</tr>
<tr>
<td>Rainbow smelt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Average and ranges indicate sizes collected in the past.
Agencies: The Ohio Department of Natural Resources in cooperation with U.S. EPA samples Coho Salmon annually.

Objectives: 1. To evaluate the hazard that toxic substances pose to the fish-consuming public.

Fish Species Sampled: Coho Salmon

Size and Class Sampled: Adults

Location of Sampling: Chagrin and Huron Rivers, Ohio

Time/Frequency of Sampling: Annually (in fall)

Sample Size: 15 fish collected

Analytical Considerations: a) Analysis conducted by the U.S. EPA.
   b) Skin-on fillets analysed.
   c) Analysis is of 3 composite samples of 5 fish each.

Data Analysis and Reporting: Ohio participates in elements 2 and 3 of the U.S. EPA program. See summary sheet for U.S. EPA.

Remarks: Barry Apgear
Representative for Additional Information:
Division of Wildlife
Ohio Department of Natural Resources
Fountain Square
Columbus, Ohio 43224
Tel: (614) 265-6343
Agencies/ Program: The Ontario Ministries of the Environment (MOE), Natural Resources (MNR) and Labour (MOL) conduct a co-ordinated program to collect, analyse and report publicly on contaminants in 9,000 sport fish from Ontario waters each year.

Objectives: 1. To provide contaminant data on sport fish for use in assessing the levels and long-term trends of contaminants in Ontario's aquatic environment.
2. To protect human health by reporting the results to the public by means of the annually revised "Guide to Eating Ontario Sport Fish".
3. To aid in the identification of sources of contaminants.
4. To provide legal evidence of contamination of the aquatic environment.
5. To provide an ongoing supply of sport fish tissue samples for development of analytical methods for new and previously undetermined contaminants.
6. To provide information on the occurrence of contaminants in sport fish for which there are no consumption guidelines in order that guidelines may be developed as required.

Fish Species Sampled: A wide range of sport fish species are sampled depending on occurrence and angling popularity. In the Great Lakes approximately 50 species are tested (see "Guide to Eating Ontario Sport Fish").

Size and Class Sampled: Samples requested are to cover the size range that occurs in the particular species from the particular waterbody being sampled. Emphasis is on the size classes available to the angler and fish consumer. In certain cases samples may be aged to provide more detailed data.

Location of Sampling: As of April 1, 1982 over 1,100 locations in Ontario had been sampled, however not all were in the Great Lakes Basin. Great Lakes sampling locations were:
1. L. Ontario, St. Lawrence & Niagara R. - 30
2. L. Erie & Detroit River - 20
3. L. St. Clair & St. Clair R. - 2
4. L. Huron, Georgian Bay, North Channel - 46
5. L. Superior - 38
Total - 136 locations.
Several new locations are being added in 1982.
Time/Frequency of Sampling: Depends on location, particular species involved and the nature of the recreational fishing. Efforts are made to collect trend samples at the same time each year. Collections of most sport species coincide with the availability of that species to potential consumers.

Sample Size: 20 to 30 specimens of each species across the size range occurring in the particular water body. Smaller numbers of analyses may be conducted on a sample where high cost of analysis is a factor (e.g. 2,3,7,8-TCDD).

Contaminants Analyzed: Virtually all fish are tested for mercury content. Levels of other heavy metals (copper, nickel, zinc, lead, cadmium, manganese, chromium, arsenic and selenium) are quantified when considered desirable. Great Lakes specimens are nearly all tested for PCB, mirex, DDT, heptachlor, aldrin and chlordane. Hexachlorobenzene and octachlorostyrene values are frequently added to this list. Analysis of several hundred samples for the chlorinated dioxin 2,3,7,8-TCDD have been completed in the past 2 years. Analysis of this chemical is now a routine part of the analytical package. Other dioxins will be on-line in 1983. Other analyses can be performed by special arrangement.

Analytical Considerations: a) All fish are analyzed as individuals except forage species such as smelt where composites of 10 edible portions are used.

b) Standard sample is a boneless, skinless portion of dorsal muscle. This portion has been used since 1970. Currently the data base contain data on 70,000 samples.

c) Analyses of all parameters are conducted at the Ontario Ministry of the Environment Laboratories, Toronto.

d) Many tissue extracts are archived for future retrospective work.

Data Analysis and Reporting: Data received from the analytical laboratory are checked against current Provincial (or Federal) fish guidelines. The information is then published in an Environmental Health Bulletin in the form of location-specific, species-by-species, size-by-size consumption
guideline tables. This bulletin is sent to all media outlets in the province of Ontario. Copies of the Bulletin together with data summaries are sent to Environment Canada, Health and Welfare Canada and the provincial ministries of Natural Resources, Labour, Health and Tourism. The data are also made available to Fisheries and Oceans Canada upon request. Interchange of data with U.S. State and Federal agencies is conducted on a case-by-case basis. Data available to February 1st each year are compiled in that year's "Guide to Eating Ontario Sport Fish", which is available to the public by late April of each year. Copies of the Guide are sent out to a wide range of federal, provincial, state and municipal agencies. The Guide has been published annually since 1978.

Remarks: This program has been in operation since 1976 as a coordinated sampling-analysis-reporting effort. All aspects of the program are reviewed annually. Modifications and improvements to the program are or can be made at any time during the year in order to:

i) obtain additional samples or another fish species from a routine location;
ii) analyze for new or additional contaminants;
iii) take action to obtain healthy guidelines for a new contaminant;
iv) inform Ministry of the Environment Abatement staff of a contaminant problem; and
v) extend the sampling/analytical/reporting program to cover an area not previously tested.

For example, a new project is just getting underway at MOE wherein 40 samples of selected fish species will be analyzed for a wide range of organics not usually tested for. These results will form the basis for improved routine analytical methods to allow large scale analysis for a number of these compounds to be done in the Sport Fish Testing program.

Representative for Additional Information
a) Allan F. Johnson
   Water Resources Branch
   Ontario Ministry of the Environment
   135 St. Clair Ave. W.
   Toronto, Ontario M4V 1P5
   Tel: (416) 965-6954
Agencies/Program: The Pennsylvania Department of Environmental Resources and the Erie County Health Department cooperate to provide fish samples for the U.S. EPA Basic Water Monitoring Program (BWMP) and the Great Lakes International Surveillance Plan (GLISP).

Objectives: 1. To determine trends in contaminant levels. 2. To assess human health impacts. 3. To evaluate the hazard that toxic substances pose to the fish-consuming public.

Fish Species Sampled: a) Perch (BWMP)  
 b) Coho Salmon (GLISP)

Size and Class Sampled: Sizes caught for consumption

Location of Sampling: For BWMP: Two locations on Lake Erie; City of Erie waterworks intake and between harbour entrance and municipal sewer outfall. For GLISP: One location on tributary to Trout Run at Fisheries Station.

Time/Frequency of Sampling: Collection made in late summer and early fall each year.

Sample Size: For perch, composites of 5 whole fish; for salmon 3 composites of 5 skin-on fillets (15 fillets total).

Analytical Considerations: a) Composites of whole perch are analysed to determine trends in contaminant levels.  
b) Whole-fish composites of perch are analysed to assess human health impacts.  
c) Skin-on fillets of Coho Salmon (under the GLISP) are analysed to evaluate the hazard posed by toxic substances to the fish-consuming public.

Data Analysis and Reporting: BWMP data stored in "STORET" and hand tabulated form. GLISP data hand tabulated only.

Remarks: These programs are in cooperation with U.S. EPA which performs analyses. For further information contact representatives below:
Representative for a) Robert Frey  
Division of Water Quality  
Pennsylvania Dept. of Environmental Resources  
P. O. Box 2063  
Harrisburg, PA 17120  
Tel.: (717) 787-9637  

b) Robert Wellington  
Erie County Pennsylvania Health Department  
606 W. Second Street  
Erie, Pennsylvania 16507  
Tel.: (814) 454-5811
Agencies/Program: The Wisconsin Department of Natural Resources monitors contaminants in fish from the Great Lakes and their tributaries and inland lakes and rivers.

Objectives: 1. To review and update the fish contaminant advisory.
2. To identify and eliminate point sources of contaminants.
3. To evaluate commercial fish stocks.

Fish Species Sampled: N/A

Size and Class Sampled: N/A

Location of Sampling: The Great Lakes (Lake Superior and Lake Michigan) and inland lakes and rivers in Wisconsin.

Time/Frequency of Sampling: N/A

Sample Size: N/A

Analytical Considerations: a) Both skin-on, boneless fillets and whole fish are analysed.

Data Analysis and Reporting: N/A

Remarks: a) The Wisconsin Department of Agriculture and Consumer Protection routinely monitors PCB concentrations in smoked fish and PCB and chlorinated pesticide concentrations in chubs taken from markets and commercial fisheries.
   b) A skin-off, boneless fillet is used for analysis.

Representative for Additional Information: a) Tom Sheffy
   Water Quality Eval. Sec.
   Wisconsin Dept. of Natural Resources
   P. O. Box 7921
   Madison, Wisconsin 53707
   Tel: (608) 267-7648

   b) Jerry Myrdal
   Wisconsin Dept. of Agriculture Laboratory
   P. O. Box 7883
   Madison, Wisconsin 53707
   Tel.: (608) 266-2761
The U.S. EPA Fish Contaminant Monitoring Program is a part of the Great Lakes International Surveillance Plan (GLISP) and a cooperative plan with 8 Great Lakes States, the U.S. FDA and the U.S. FWS. The Program has four elements (see below).

**Agencies/Program:**

- **Element 1.** To define contaminant trends and identify new contaminants through open lake fish monitoring.
- **Element 2.** To evaluate potential human health hazards from game fish.
- **Element 3.** To detect new problem areas and contaminants in Great Lakes tributaries and embayments.
- **Element 4.** To follow-up on data gathered for Element 3, above.

**Objectives:**

- **Element 1.** To define contaminant trends and identify new contaminants through open lake fish monitoring.
- **Element 2.** To evaluate potential human health hazards from game fish.
- **Element 3.** To detect new problem areas and contaminants in Great Lakes tributaries and embayments.
- **Element 4.** To follow-up on data gathered for Element 3, above.

**Fish Species Sampled:**

- **Element 1:** Lake trout/walleye, rainbow smelt
- **Element 2:** Coho salmon, some lake trout
- **Element 3:** Resident species

**Size and Class Sampled:**

- **Element 1:** Adults
- **Element 2:** Adults
- **Element 3 & 4:** Adults where available

**Location of Sampling:**

Sampling locations are provided on sheets describing eight state programs (this Appendix). Each state contributes samples to GLNPO for analysis.

**Time/Frequency of Sampling:**

- **Element 1 & 2:** Annually, in the fall
- **Element 3:** Usually once per site in late summer or fall. Questionable sites maybe repeated.
- **Element 4:** Negotiated at time need is identified.

**Sample Size:**

- **Element 1:** 50 whole fish per site, composited in 10 samples of 5 fish each.
- **Element 2:** 15 fillets (1 per fish) per site composited into 3 samples of 5 fillets each.
- **Element 3:** Depending on availability - 2 species per site. Each species is formed into 3 composites of 5 fish each.
- **Element 4:** Negotiated when need is identified.

**Analytical Considerations:**

- **Element 1.** Homogenized whole fish are analysed.
- **Element 2.** Skin-on fillets of game fish analysed.
- **Element 3.** Composites of whole fish are scanned for a broad range of organic and metal contaminants.
Contaminant concentrations found to be significantly above background levels of U.S. FDA action levels in the whole fish composites will then also be monitored in skin-on fillets of game fish from these problem sites.

Data Analysis and Reporting:

Element 1: Analysis by U.S. EPA. Data exchanged between U.S. EPA and U.S. FWS, Great Lakes' States and IJC. Significant results, trends, etc., published as U.S. EPA reports and/or journal articles.

Element 2: Analysis by U.S. FDA. Data reported to collecting state with annual report to all participating agencies. Publication of trends, significant findings.

Element 3: Analysis by U.S. EPA. Data reported to collecting state. Significant findings published as U.S. EPA and/or journal articles.

Element 4: Collecting state reports findings to U.S. EPA.

Remarks:

Representative for Additional Information:

Dave De Vault
Great Lakes National Program Office
U.S. Environmental Protection Agency
Region V
536 S. Clark Street
Chicago, Illinois 60605
Tel: (312) 353-1378
Agencies/ Program: The U.S. Food and Drug Administration currently samples commercial and potential commercial species from forty-eight Great Lakes locations.

Objectives: 1. Protection of human health through compliance with FDA fish intervention levels.

Fish Species Sampled: Carp, Catfish, Chub Coho and Chinook Salmon, Bass and others

Size and Class Sampled: Sizes caught for commercial sale

Location of Sampling: Numerous locations in Lakes Superior, Michigan, Erie and Ontario

Time/Frequency of Sampling: Year round

Sample Size: Minimum of 8 kg of fish and 3 fish

Analytical Considerations: a) Use of the "edible portion" for analysis. b) The "edible portion" refers to skin-on fillets, generally but often cross-sectional steaks or skin-off fillets are permitted. c) Prior to 1981, most samples were prepared as skin-off fillets.

Data Analysis and Reporting: Pesticide and Industrial Chemical Report System ("Pest data"). Information routinely provided to Michigan and Indiana by Detroit Office and to other states and agencies on request. Buffalo Office covers other states.

Remarks: Compliance monitoring for commercial fish in the Great Lakes is carried out by FDA in Detroit, Michigan and Buffalo, N.Y.

Representative for Additional Information: Felix Schneider Laboratory Services Division U.S. Food and Drug Administration 1500 E. Jefferson Street Detroit, Michigan 84207 Tel.: (313) 226-7658
Agencies/ Program: The Department of Fisheries and Oceans (DFO) conducts two fish contaminant programs.

**Program 1. Great Lakes Fisheries Research Branch**

Surveillance and monitoring program for contaminants and effects on fish of the Great Lakes, coordinated through the IJC with surveillance activities of USFWS, U.S. EPA and provincial and state agencies.

Objectives: To survey collectively, the concentration of contaminants in selected species of Great Lakes fish and other biota with the specific purpose of determining environmental trends in contaminant levels and relating these, where possible, to sources of such pollution, the effectiveness of remedial actions and the potential implications to Great Lakes fish stocks and other biota.

Fish Species Sampled: Top predators, e.g. Lake Trout (alternatively Rainbow Trout, Walleye, Splake, Coho Salmon) and forage species, e.g. Rainbow Smelt.

Size and Class Sampled: The largest size range possible is collected at each site.

Location of Sampling: Open lake sampling stations are established as follows: Lake Ontario (5); Lake Erie (3); Lake Huron (2); Georgian Bay (2); and Lake Superior (3).

Time/Frequency of Sampling: Late summer to early fall and once per year.

Sample Size:
- Top predators: 50 fish per site maximum
- Forage species: 12 composites (5 fish) per site.

Analytical Considerations:
- a) Top predators are analysed on an individual whole fish basis.
- b) Smelt (forage species) are analysed as 5 fish composites of whole fish.
- c) A whole fish/fillet analysis program has been established to periodically determine the relationships between contaminant levels in these two samples in several top predator species.
Data Analysis and Reporting: Reports sent to IJC Surveillance Work Group annually. Analyses data sent to OMNR (Fisheries Branch, John Allin) for inclusion in OFIS (Ontario Fish Information System) and to USEPA (Region V, Chicago) and USFWS (Great Lakes Fishery Laboratory, Ann Arbor).

Remarks: Apart from determining within and between lake variations and conducting time trend analyses for several contaminants (9 organic, 9 inorganic) DFO includes the following in its surveillance program:

a) study of impact of selected contaminants on Great Lakes fish and aquatic biota;

b) study of relationship between body burden and contaminant levels in scales (hopes to utilize archived scales for retrospective contaminant levels); and

c) study of stress indicators in forage fish.

Planned expansion of the program will include seasonal effects on tissue distribution of various contaminants and further development of biochemical indicators of contaminant impact.

Representative for Additional Information:
Mike Whittle
Department of Fisheries and Oceans
Canada Centre for Inland Waters
P.O. Box 5050
Burlington, Ontario L7R 4A6
Tel.: (416) 637-4565

Program 2. Fishing and Industry Services, Fish Inspection Branch
Compliance monitoring program for commercial fish species marketed within Canada or for export (in cooperation with provincial jurisdictions and the Department of National Health and Welfare).

Objectives: To ensure the safety of fish marketed for human consumption in Canada and abroad (export).

Fish Species Sampled: All commercial fish species for domestic or export markets are analysed for contaminant (chemical) residues.

Size and Class Sampled: Depends on the size of commercial fish for sale. Market size is generally uniform. Restrictions on size are imposed for some species in order to ensure market supply does not exceed maximum allowable contaminant residue levels.

Location of Sampling: There is a viable commercial fishery in all four Canadian Great Lakes, hence compliance monitoring occurs in all four lakes.
<table>
<thead>
<tr>
<th><strong>Time/Frequency of Sampling:</strong></th>
<th>Analyses are performed on samples offered for sale on a year-round basis. Species with levels of contaminants close to current fish contaminant guideline concentrations are sampled more frequently.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample Size:</strong></td>
<td>Approximately 6 kg of whole, dressed fish of similar length are provided for each species. 2 kg of edible tissue (usually skin-off fillet) are sampled from these fish as a single pool.</td>
</tr>
<tr>
<td><strong>Analytical Considerations:</strong></td>
<td>Analyses are of pooled fillets of several fish. Fillets already prepared for sale and frozen are analysed on a pooled, as is, basis.</td>
</tr>
<tr>
<td><strong>Data Analysis and Reporting:</strong></td>
<td>Data are maintained by regional offices of DFO for decisions of saleability of commercial fish catches. Data are provided on a request basis to NH &amp; W, the provinces, and the IJC.</td>
</tr>
<tr>
<td><strong>Representative for Additional Information:</strong></td>
<td>Adrien Gervais Inspection and Technology Branch Fisheries and Oceans Canada 240 Sparks Street Ottawa, Ontario K1A OE6 Tel.: (613) 995-2203</td>
</tr>
</tbody>
</table>
The following chemicals have shown chronic effects in animals and are not currently subject to regulatory monitoring. The Committee on the Evaluation of Human Health Effects of Certain Rice Oils and Oils of Fatty Acids (1982) recommended in the list of chemicals divided over the report (Table 7.5) that these chemicals be considered for addition to the lists of chemicals divided over the report. The Committee on the Evaluation of Human Health Effects of Certain Rice Oils and Oils of Fatty Acids (1982) recommended in the lists of chemicals divided over the report (Table 7.5) that these chemicals be considered for addition to the lists of chemicals divided over the report. The Committee on the Evaluation of Human Health Effects of Certain Rice Oils and Oils of Fatty Acids (1982) recommended in the list of chemicals divided over the report (Table 7.5) that these chemicals be considered for addition to the lists of chemicals divided over the report.

APPENDIX C

LIST OF CHEMICALS FOR WHICH SURVEILLANCE SHOULD BE CONSIDERED

<table>
<thead>
<tr>
<th>CHEMICAL NAME</th>
<th>REGISTRY NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endosulfan (thiosulfan)</td>
<td>157-18-6</td>
</tr>
<tr>
<td>Hexachlorobenzene</td>
<td>104-61-9</td>
</tr>
<tr>
<td>Dicyandiamide</td>
<td>62-28-8</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>88-93-3</td>
</tr>
<tr>
<td>2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)</td>
<td>55-99-1</td>
</tr>
<tr>
<td>HEXACHLOROPHENE</td>
<td>320-54-0</td>
</tr>
</tbody>
</table>

**Pesticides**

<table>
<thead>
<tr>
<th>CHEMICAL NAME</th>
<th>REGISTRY NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon tetrachloride</td>
<td>75-01-7</td>
</tr>
<tr>
<td>1,1-Dichloroethylene</td>
<td>75-09-2</td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td>75-00-3</td>
</tr>
<tr>
<td>Diethyl ether</td>
<td>60-29-7</td>
</tr>
<tr>
<td>Trichloroethylenediol</td>
<td>79-06-1</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>79-01-6</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>75-01-7</td>
</tr>
<tr>
<td>Vinyl bromide</td>
<td>75-48-0</td>
</tr>
<tr>
<td>1-Chloro-2-propanol</td>
<td>67-61-7</td>
</tr>
<tr>
<td>Pentaerythritol</td>
<td>110-83-4</td>
</tr>
<tr>
<td>Hexachlorobutadiene</td>
<td>108-73-5</td>
</tr>
<tr>
<td>Hexachlorobutadiene</td>
<td>108-73-5</td>
</tr>
<tr>
<td>Dichlorobutadiene</td>
<td>97-98-5</td>
</tr>
<tr>
<td>Dichlorobutadiene</td>
<td>97-98-5</td>
</tr>
<tr>
<td>Dichlorobutadiene (1,3)</td>
<td>105-22-1</td>
</tr>
<tr>
<td>Dichlorobutadiene (1,4)</td>
<td>105-22-1</td>
</tr>
<tr>
<td>Dichlorobutadiene (1,4)</td>
<td>105-22-1</td>
</tr>
<tr>
<td>Dichlorobutadiene (1,4)</td>
<td>105-22-1</td>
</tr>
<tr>
<td>Chlorinated napthalenes</td>
<td>319-04-4</td>
</tr>
<tr>
<td>Dechlorinated biphenyls</td>
<td>55-43-4</td>
</tr>
<tr>
<td>Dechlorinated biphenyls</td>
<td>55-43-4</td>
</tr>
</tbody>
</table>
Time/Frequency of Sampling:

Samples are obtained on an annual basis, or as required.

Sample Size:

One sample of whole, dressed fish or

Meat Length are provided for each

species. A kg of edible tissue is usually

randomly sampled from three fish

during a single pool.

Analytical Considerations:

Analytes are of pooled fillets of several

fish. Filters are prepared for each

species, and filters are analyzed on a pooled, A.P.

basis.

Data Analysis and Reporting:

Data are provided

on a species basis to the A.N.R. the provinces,

and the public.

For additional information:

Contact the author or the

Research Center or Technology Branch

Ministry of Agriculture and Rural Affairs

Ontario Research Centre

Policy and Information

Management
The following chemicals have known chronic effects in mammals and are not currently subject to regulatory monitoring. The Committee on the Assessment of Human Health Effects of Great Lakes Water Quality recommended in its 1982 report (Table 7.3) that these chemicals be considered for addition to the list(s) of chemicals already monitored by the jurisdictions. The kind of surveillance recommended for each chemical is provided. Chemicals listed in Table 7.5 of the Committee's 1982 Report could not be adequately assessed by the Committee due to the lack of chronic toxicity data and exposure information, however, they should not be excluded from consideration for surveillance. Review of all surveillance data forthcoming from programs that have included these chemicals will dictate whether intervention levels or guidelines are required and monitoring should be instituted.

<table>
<thead>
<tr>
<th>CHEMICAL NAME</th>
<th>CAS NO.</th>
<th>SURVEILLANCE RECOMMENDED**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PESTICIDES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endosulfan (thiosulfan)</td>
<td>115-29-7</td>
<td>NS WL</td>
</tr>
<tr>
<td>Hexachlorobenzene</td>
<td>118-74-1</td>
<td>WL</td>
</tr>
<tr>
<td>Oxychlordane+</td>
<td>26880-48-8</td>
<td>NS WL</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>87-86-5</td>
<td>NS WL;NS</td>
</tr>
<tr>
<td>2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)</td>
<td>93-76-5</td>
<td>NS WL</td>
</tr>
<tr>
<td><strong>HALOGENATED HYDROCARBONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>56-23-5</td>
<td>ID;NS WL</td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td>107-06-2</td>
<td>ID;NS WL</td>
</tr>
<tr>
<td>1,2-Dibromoethane</td>
<td>106-93-4</td>
<td>WS A</td>
</tr>
<tr>
<td>Hexachloroethane</td>
<td>67-72-1</td>
<td>NS WL</td>
</tr>
<tr>
<td>1,2-Dichloroethylene</td>
<td>540-59-0</td>
<td>ID;NS WL</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>79-01-6</td>
<td>NS WL</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
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<td>(1,3-)</td>
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<tr>
<td>(1,4-)</td>
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<td>α-Hexachlorocyclohexane</td>
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<td>Chlorinated naphthalenes</td>
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<td>Brominated biphenyls</td>
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<td>Chlorinated terphenyls</td>
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### AROMATIC HYDROCARBONS

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<td>Ethylbenzene</td>
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<td>Styrene</td>
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<td>Benzo(a)pyrene</td>
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<td>Chrysene</td>
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<td>Benzo(b)fluoranthene</td>
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<td>Trichlorophenol (2,4,6-)</td>
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### ETHERS

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### ACIDS AND ESTERS

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<tr>
<td>Phthalic acid, diisobutyl ester</td>
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<td>Phthalic acid, di(2-ethylhexyl) ester</td>
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### MISCELLANEOUS

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<td>3,3'-Dichlorobenzidine</td>
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### ELEMENTS

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<td>Nickel</td>
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* 'Potential to impact on health' based on all available data on toxicity, use and environmental levels.

** ID - industrial discharges

WL - Whole lake

NS - Near shore

A - Ambient

+ covered under parent compound in some jurisdictional guidelines.
APPENDIX D

RESOLUTION OF THE "EDIBLE PORTION" ISSUE
There is unanimous agreement among the jurisdictions of the Great Lakes of the need to analyse "edible portions" of fish when undertaking compliance monitoring that addresses public health concerns. There is little agreement on what constitutes the edible portion. Interagency meetings have failed in their attempt to establish an all-parties "edible portion".

Three general approaches have been adopted or proposed. Some jurisdictions describe how consumers should prepare their fish, i.e., fillet all fish, remove the skin and belly fat and drain cooked fillets carefully and then provide analytical data for some consistent portion of a fillet regardless of species or preferred method of preparation. This approach provides consistent sampling based on a single methodology and data that are comparable between years and directions to consumers on how to reduce their exposure to contaminants in fish.

A second approach is based on consumer preferences for cooking and eating fish. Emphasis is placed on determining how the average consumer prepares each species for consumption, i.e., skin-on, skin-off, steaks, fillets, etc. and the sampling and analysis are geared to mimic this average preparation method. Less effort is placed on persuading consumers to change their preparation and cooking habits.

The third general approach is to combine these two philosophies. Suggestions for preparing and cooking fish are available and sampling methods for analysis vary between a consistent and similar method for most species and a special technique for certain popular species traditionally prepared or offered for sale in a specific fashion.

A common approach in all jurisdictions toward the analysis of fish for the purposes of establishing compliance with guidelines, would significantly reduce total sampling and analytical costs incurred by the jurisdictions annually. Furthermore, data would be far more comparable provided conditions of sampling location, sampling time and sample analysis were already coordinated. Adoption of a common approach to sampling and analysis would also require adoption of a common approach to assessment. Some agencies use the "average" exposure, others the "worst case" for assessment purposes.

It is, however, unlikely that agreement on a standard edible portion will evolve. Several calls for uniformity by the Surveillance Subcommittee of the Water Quality Board have gone unheeded. Jurisdictions with large amounts of analytical data collected over several years are unwilling to change methods in mid-stream and jurisdictions with evolving programs may not be able to obtain adequate funds to implement and test new methodologies. Currently, there is no clear-cut evidence or rationale to support the adoption of any one method over the other. Each has advantages and disadvantages.

Despite a pessimistic forecast for agreement on sampling procedures, there is an urgent need for the jurisdictions to renew discussions on standardizing the edible portion. In the meantime, we must await the results of recent research activities that address the relationships between contaminants in whole fish and fillets and for high fat and low fat fish in the hope that they may provide conversion factors which would make data more comparable.
Furthermore, we must emphasize the importance of both quality assurance programs within laboratories and "round-robin" analyses among laboratories. Monitoring data could be used to determine trends in contaminant levels, despite the lack of a standard edible portion, provided within-agency analysis is consistent. Comparisons of trends observed by different agencies in the same fish species from the same lake may then be possible.
APPENDIX E

LIST OF POSITION PAPERS AND REFERENCES
Furthermore, we must emphasize the importance of both quality assurance programs within laboratories and "founder them" analysis among laboratories. Monitoring data could be used to detect trends in contaminant levels, despite the lack of a standard method. Second, provided wide-agency analysis is consistent, comparisons of trends observed by different agencies in the same fish species from the same area may then be possible.


APPENDIX F

MEMBERSHIP AND TERMS OF REFERENCE
FOR THE
IJC COMMITTEE ON THE ASSESSMENT OF HUMAN HEALTH EFFECTS
OF GREAT LAKES WATER QUALITY
The Committee will take the following under its purview:

1. assess the risk to health posed by contaminants in the Great Lakes ecosystem;
2. review action levels and guidelines for selected substances;
3. provide to the International Joint Commission through its Boards, interpretation and consultation on health matters; and
4. maintain awareness of current advances and knowledge as they relate to human health aspects of the Great Lakes ecosystem.