Lake Superior Binational Program

L A K E S U P E R I O R
B I N A T I O N A L
M O N I T O R I N G
W O R K S H O P

Proceedings: Directions for Measuring Progress

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The following Individuals were responsible for the planning and executing the workshop:

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- Richard Hassinger, Assistant to Director, Fish and Wildlife, Minnesota DNR

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Executive Summary

Sixty people from government, industry and local environmental groups met to examine existing monitoring activities within the Lake Superior basin, with a view to developing a co-ordinated, long-term monitoring program. This co-ordinated program would incorporate Lake Superior Binational Program's indicators. The workshop represented the first time that monitoring data and indicators were considered at this scale of ecosystem organization for Lake Superior.

The tasks of the workshop were five-fold:

1. To review the list of current 'best bet' indicators,
2. To review and update a metadata summary of current monitoring programs,
3. To match monitoring efforts with indicators and identify gaps and overlaps,
4. To identify potential funding sources for future monitoring and co-ordination,
5. To solicit agency interest and support for future monitoring and co-ordination efforts.

Participants reached consensus on nine key recommendations for future co-ordination of monitoring and reporting structure for Lake Superior.

Workshop Recommendations:

1. Develop a co-ordinated monitoring strategy for the Lake Superior basin. All of the Lake Superior Binational Program agencies will participate and seek resources for implementation. The monitoring strategy will be peer reviewed and presented in the LaMP 2002.

2. Prepare a revised list of 'better bet' indicators for each theme committee.

3. Build a more complete metadata summary. This will involve 3 steps:

    i) Include additional metadata identified at the workshop in the existing summary table (see Appendix VI, of this report);

    ii) Approach the International Joint Commission regarding input of complete Lake Superior metadata list to their website.

    iii) Search for additional metadata.

4. Form *ad hoc* groups to address sampling protocols, sample analysis and data reporting standardization and comparability identified by theme committees.

5. Identify monitoring gaps and make recommendations on those that are most critical, see Section 3.0 of this report).

6. Facilitate greater co-ordination among agencies and theme groups to address common issues (for examples, see section 4.0 of the report). Establish a co-ordination committee to address these issues.

7. Identify funding necessary to address monitoring gaps and co-ordination of monitoring activities, (see Chapter 5.0 and Appendix VII of this report).

8. Report monitoring results in the LaMP 2002.

9. Adjust the existing Lake Superior Binational Work Group functions to achieve items 1 – 8.

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1.0 The Lake Superior Binational Program Ecosystem Principles and Objectives

1.1 Workshop Goals and Objectives

The purpose of this workshop was to bring together managers and indicator experts from agencies responsible for ongoing monitoring activities within the Lake Superior basin. Approximately 60 people from government, industry and local environmental groups met to examine existing monitoring activities with a view to developing a co-ordinated, long-term monitoring program for the Lake (See Appendix I for a participant contact list). This co-ordinated program would incorporate the Lake Superior Binational Program's indicators. The workshop represented the first time that monitoring programs and indicators were considered at the same time at this scale of ecosystem organization for Lake Superior.

Specifically, the goals of the workshop were to:

1. Review the Lake Committee Work Group 'best bet' indicators;
2. Review and update a metadata summary of current monitoring programs within the basin;
3. Match current monitoring efforts with the suite of best bet indicators to identify monitoring gaps and overlaps;
4. Identify potential funding sources for future monitoring and co-ordination efforts;
5. Solicit agency interest/support for future monitoring and co-ordination efforts, and;
6. Make recommendations for co-ordination of monitoring and reporting structure.

The workshop agenda is found in Appendix II.

Annex 2 of the Great Lakes Water Quality Agreement (GLWQA) requires Lakewide Management Plans (LaMP) to include "a description of surveillance and monitoring to track the effectiveness of remedial measures". Senior management of Lakewide Management Plans for Lake Superior, Michigan and Erie have embraced a commitment to report progress every two years and will begin reporting in a co-ordinated manner. Beginning in 2002, monitoring results will be reported. This workshop was important for clarifying the needs for a Lake Superior monitoring program.

2.0 Session I: Setting the Stage for Lake Superior
Chairs: Janet Pellegrini, United States Environmental Protection Agency, Darrell Piekarz, Environment Canada

2.1 A Brief Overview of Lake Superior Ecosystem, Principles and Objectives
Speaker: Bob Kavetsky, U.S. Fish and Wildlife Service

In 1989, the International Joint Commission recommended that Lake Superior be designated as 'a demonstration area where no point source of any persistent, toxic substance will be permitted' (IJC, 1989). The U.S. and Canada responded to this recommendation by forming the Binational Program to Restore and Protect the Lake Superior Basin in 1991. Zero Discharge is an important element of Lake Superior Binational Monitoring Program. Three groups were formed to implement and guide the Binational Program:

- The Lake Superior Task Force made up of senior managers from government and Environmental Agencies;
- The Lake Superior Work Group, comprised of representatives from government, environmental and natural resource agencies to provide guidance, policy and technical direction and;
- The Lake Superior Binational Forum comprised of representatives from the public and industry.

The Binational Program originated from *1987 Amendments to the GLWQA, Annex 1, and Supplement 3a.* This document proposed the development of an oligotrophic indicator, specifically lake trout (*Salvelinus namaycush*) and amphipods (*Diporeia)*. The Lake Superior Binational Forum drafted a vision for the lake in 1992 and *"Ecosystem Principles and Objectives"* were drafted in 1993. The vision statement endorsed by the Forum on January 31, 1992, stresses the desire for a Lake Superior watershed that is free of toxic substances, supports healthy populations, a sustainable economy, and emphasizes the importance of citizen responsibility and co-ordination (Lake Superior Binational Program, 1998).

In 1994, interested subgroups and partners of the Superior Work Group drafted ecosystem indicators and targets for Lake Superior. They focussed on simple, easily communicated indicators of complex ecological and cultural phenomena which became *"Indicators and Targets"* published in 1995. In 1996, the Superior Work Group Committee merged with the Monitoring Committee. The broader Program then examined the six objective areas to form the Organizing Principles and worked them into "Themes" including "Chemicals of Concern" which were subsequently added to the list. The six theme committees of the Work Group that have been formed to address key areas are:

1. Chemical Contaminants;
2. Aquatic Communities;
3. Terrestrial Wildlife Communities;
4. Habitat;
5. Human Health and;
6. Developing Sustainability.

A co-chair from Canada and a co-chair from the U.S.A. headed each committee. These committees have proposed a set of objectives and 'best bet' indicators to monitor progress on these objectives. These objectives and sub-objectives are summarized in Appendix III and a list of the indicators chosen by each of the six committees is summarized in Appendix IV. Ecosystem indicators and targets were selected to meet the following criteria:

- Relevance to ecosystem objectives established in Ecosystem Principles and Objectives for Lake Superior;
- Scientifically credible and based on recent scientific literature on ecosystem monitoring;
- Simple, reliable for their stated purpose;
- Thoroughly documented with regard to purpose, technical characteristics, limitations and interpretation;
- Suitable for serious consideration by U.S. and Canadian agencies with a mandate for environmental monitoring.

These are taken from a revised document on Ecosystem Principles and Objectives for Lake Superior (Lake Superior Binational Program, 1998). This document can be found on the web at: www.cciw.ca/glimr/lakes/superior/pdf/lsupind5.pdf**.**

Prior to the workshop, individuals were asked to complete a form summarizing their ongoing monitoring programs within the Lake Superior basin (Appendix V). Details of these monitoring programs (i.e. metadata) are summarized Appendix VI.

2.2 Important Elements in Monitoring and Assessing the Lake Superior Ecosystem Integrity

Speaker: Stephen Lozano, U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) initiated the Environmental Monitoring and Assessment Program (EMAP) to:

- Monitor the condition of ecological resources;
- Evaluate the effectiveness of policies and programs and;
- Identify emerging problems before they become widespread or irreversible.

EMAP was designed to encourage research and monitoring partnerships and provide annual statistical summaries and assessments of current status and trends. Several key elements constitute a good monitoring program, including:

- Appropriately designed assessment questions (e.g. what percentage of Lake Superior's deepwater benthic community is in good condition?);
- The development of conceptual model (i.e. how indicators relate to assessment questions);
- Careful selection of indicators (e.g. key species, presence of exotic species) and;
- Attention to design considerations (for EMAP, probability-based designs are geo-referenced, adaptable and flexible enough to address new, emerging issues and questions).

EMAP, like all successful monitoring programs, includes the following elements:

- Based on sound science;
- Information management;
- Provides a program fit (i.e. research is designed to fit other organizations' objectives);
- Responsive to customers.

Of these elements, information management and communication are key. Information management must ensure a uniform data structure, provide a means for sharing and preserving data and be subject to rigorous quality assurance/quality control (QA/QC) measures.
Good communications involves publicizing results in a wide variety of media, including scientific journals and reports, presentations at scientific meetings, media releases and through engaging scientific colleagues.

EMAP has been effective in evaluating long-term ecological changes in Lake Ontario over the past two decades. EMAP monitoring in Lake Superior has been ongoing since 1993.

3.0 Session II: Indicator Feasibility and Metadata Summary

Session II was intended to bring together the individual Superior Work Group committees to review the list of 'best bet' indicators developed and present a summary of ongoing monitoring projects relevant to the indicator list. The chairs of the six breakout groups (chemical contaminants, aquatic communities, terrestrial wildlife, human health, habitat and developing sustainability) were instructed to:

1. Present each groups' set of 'best bet indicators', and rank each of the indicators based on feasibility (low, moderate or high), to be saved for session III;
2. Present the summary of ongoing research projects relevant to each group (metadata summary);
3. Identify additional monitoring information not included in the metadata summary, distribute metadata forms to those present, and identify additional contacts.
4. Match the monitoring information from step 3 with the list of 'best bet indicators' (step 1) in tabular form, to be saved for session III;
5. Prepare a brief summary for presentation to the Plenary Session.

Each of the breakout groups went on to identify key gaps or indicators for which data were sparse, missing or unknown. This information is summarized below by theme group.

3.1 Chemical Contaminants
Chair: Janet Pellegrini, U.S. Environmental Protection Agency

The breakout group identified several modifications/additions to the set of 'best bet' indicators as follows:

- The chemical lists need to be reviewed and updated (e.g. pesticides, EDC's);
- Trends in deposition to forested canopy and retention in terrestrial component;
- Trends in sediment cores in watershed as a surrogate for Lake Superior;
- Revise indicators 3, 5, 6 indicated in Table 1 to include concentrations in biota;
- Revise indicators based on availability of data from other sources.

Additional Issues were identified for consideration in the Session III breakout:

- Chemical lists, Nitrogen and Phosphorus levels - aquatic community/habitat and organic loadings, BOD, new emerging issues adding/deleting;
- Surrogate chemical indicators (sustainability), social indicators - sludge and garbage;
- Co-ordination of efforts to determine contaminant levels in other components: soil, groundwater and forested canopy;
- Metadata - one time only studies vs. ongoing efforts --> how to compare apples with apples in future;
- Contaminant trends and chemical effects in aquatic communities (fish and wildlife), human health, biotic vs. abiotic;
- Terrestrial wildlife, aquatic communities - contaminant effects on biota? basin vs. nearshore vs. open-lake;
- Terrestrial inputs of contaminants.

Table 1 summarizes the ongoing monitoring activities and critical issues for each of the chemical contaminant Indicators.

Table 1: Chemical Contaminant Indicators

Indicator	***Monitoring Programs****	***Feasibility***	***Critical Issues/Gaps***
1. Progress Towards Zero Discharge & Zero Emission	2. MISA Program 22. Michigan's Fish Contaminant Monitoring Program 44. Watershed Export and Speciation of Trace Metals in the Lake Superior Basin 65. Contaminants in Lake Superior Fish	All activities listed are feasible, but for the most part not monitored. Some small pilot studies underway.	Lower detection limits for effluent monitoring; Air emissions (Cdn) and U.S. (except mercury); Sludge concentration: Mercury containing products; "Clean sweep" information;
2. Atmospheric Deposition Trends for Zero Discharge Chemicals[1]	15. Turkey Lakes Watershed 34. Integrated Atmospheric Deposition Network (IU) 35. Integrated Atmospheric Deposition Network (EC)	All monitoring programs are considered highly feasible.	Data for all chemicals not available; Sample frequency; Dry deposition; No. of sites (urban);

3. Open Lake Concentrations of Zero Discharge & Lakewide Remediation Chemicals[2]	2. MISA Program – Municipal Industrial Strategy for Abatement 17. Great Lakes Water Quality Survey Studies 18. Great Lakes Fish Monitoring Program 21. Minnesota Fish Contaminants Program 22. Michigan's Fish Contaminant Monitoring Program. 23b. Fish Contaminant Monitoring Program (IFAP) 29. National Contaminant Biomonitoring Program 33. Great Lakes Surveillance Program 44. Great Lakes Fish Contaminant Surveillance Program	All monitoring programs are considered highly feasible.	Data for all chemicals not available; Data collected infrequently; Detection limit issues;

Table 1: Chemical Contaminant Indicators (continued).

Indicator	*Monitoring Programs**	*Feasibility*	*Critical Issues/Gaps*
4. Sediment Concentrations of Zero Discharge, Lakewide Remediation & Local Remediation[3] Chemicals	15. Turkey Lakes Watershed 39. Quantifying Vertical Motion Along the North Shore of Lake Superior	Not determined.	Available for all Areas of Concern (AOC)?
64. Ambient concentration Trends of Prevention/ Monitoring Pollutants[4] in Water, Sediment, Air/Precipitation	33. Great Lakes Surveillance Program 17. Great Lakes Water Quality Survey Studies 46. 18. Great Lakes Fish Monitoring Program 29. National Contaminant Biomonitoring Program 23b. Fish Contaminant Monitoring Program (IFAP) 21. Minnesota Fish Contaminants Program 22. Michigan's Fish Contaminant Monitoring Program. 63. Toxaphene in the St. Louis River 64. Loads of Toxic Contaminants in the St. Louis River	All listed monitoring programs are considered to have low feasibility.	Not all chemicals are being monitored;

6.Prevention/ Investigation Chemicals[5]	17. Great Lakes Water Quality Survey Studies 18. Great Lakes Fish Monitoring Program 21. Minnesota Fish Contaminants Program 22. Michigan's Fish Contaminant Monitoring Program 23b. Fish Contaminant Monitoring Program(IFAP) 29. National Contaminant Biomonitoring Program 32. Environmental Effects of Industrial Effluents 33. Great Lakes Surveillance Program 38. Persistence and Fate of Pesticides and Industrial Chemicals in Water 46. Great Lakes Fish Contaminant Surveillance Program 64. Loads of Toxic Contaminants in the St. Louis River	All monitoring programs are considered to have low feasibility.	Not all chemicals are being monitored

* see Appendix VI for details of monitoring programs.

1 Zero Discharge Chemicals: chlordane, DDT, dieldrin, dioxin, hexachlorobenzene, mercury octachlorostyrene, PCBs, toxaphene;

2 Lakewide Remediation Chemicals: PAHs, alpha-BHC, cadmium, heptachlor, heptachlor epoxide;

3 Local Remediation Chemicals: aluminum, arsenic, chromium, copper, iron, lead, manganese, nickel, zinc;

4 Prevention/Monitor Pollutants: 1,4-dichlorobenzene, 1,2,3,4-tetrachlorobenzene, mirex/photo-mirex, pentachlorobenzene, pentachlorphenol, gamma-BHC

5 Prevention/Investigation Chemicals: 1,2,3,5-pentachlorobenzene, 3,3-dichlorobenzidine, 2-chloroaniline, tributyl tin, beta & delta BHC, hexachlorobutadiene.

3.2 Aquatic Communities

Chairs: Ken Cullis, Ontario Ministry of Natural Resources, Don Schreiner, Ontario Ministry of Natural Resources

The Aquatic Group identified several issues, which cut across one or more of the six committees. These included:

- Chemical contaminants in fish (examined more extensively in Session III);
- Abiotic vs. biotic indicators - should the aquatic committee consider fish only?;
- Changes in human behaviour and the impacts on chemical loading and emissions;
- Throughfall of contaminants through the terrestrial ecosystem;
- Open lake concentrations of chemical contaminants and drinking water (human health concerns);
- Predator (bald eagle, loon, and herring gull) consumption of small fishes (30-58 cm) (GLNPO program only monitor's top predators).

The Aquatic Group also considered critical sampling protocol issues, which require further discussion and co-ordination across monitoring agencies. These included:

- Sampling time and locations;
- Random vs. index selection of sites;

- Are sites representative of the zone under consideration?
- Lack of all necessary parameters (e.g. river flow data) for mass balance studies.

Two key areas requiring further data and study were the issue of nutrients in suspended sediments and their effect on water quality, and how contaminants affect aquatic organisms (physiology, tumors, disease). Further critical data gaps are identified in Table 2 below.

Table 2: Aquatic Community Indicators

Indicator	*Monitoring Programs**	*Critical Issues/Gaps*
1. Offshore Community (> 80 m)	3. Forage Fish Trawling Survey 4. Sport Fish Monitoring 5. Lake Superior Fisheries Monitoring in Minnesota Waters 6. USEPA Environmental Monitoring and Assessment Program (EMAP) 14a. Exotic Species Monitoring Program – Zebra Mussels 14b. Exotic Species Monitoring Program – Ruffe Monitoring 20. State-wide Lake and Stream Management Planning 23a. Tribal Commercial Fish Assessments 26. Assessment of Lake Trout Populations in Michigan Waters of Lake Superior	Need Acoustic Tech. Research
2. Nearshore Community (< 80 m)	3. Forage Fish Trawling Survey 4. Sport Fish Monitoring 5. Lake Superior Fisheries Monitoring in Minnesota Waters 6. USEPA Environmental Monitoring and Assessment Program (EMAP) 14a. Exotic Species Monitoring Program – Zebra Mussels. 14b. Exotic Species Monitoring Program – Ruffe Monitoring 15. Turkey Lakes Watershed 20. State-wide Lake and Stream Management Planning 23a. Tribal Commercial Fish Assessments 26. Assessment of Lake Trout Populations in Michigan Waters of Lake Superior 43. US Canada Great Lakes Islands Project 45. Wildlife Lake Surveys	Benthos and phytoplankton data are variable – co-ordination/ standardization are required;
3. Harbour/ Embayments/ Estuaries	4. Sport Fish Monitoring 5. Lake Superior Fisheries Monitoring in Minnesota Waters 14a. Exotic Species Monitoring Program - Zebra Mussles 14b. Exotic Species Monitoring Program – Ruffe 26. Assesment of Lake Trout Populations in Michigan Waters of Lake Superior 39. Quantifying Vertical Motion Along the North Shore of Lake Superior	Habitat, wetland data very limited; Linkages required between various sampling programs; Require co-ordination of native mussel sampling;

Table 2: Aquatic Community Indicators (continued).

Indicator	*Monitoring Programs**	*Critical Issues/Gaps*
4. Tributary Communities	4. Sport Fish Monitoring 5. Lake Superior Fisheries Monitoring in Minnesota Waters 12. Indicies of Biological Integrity Development 20. State-wide Lake and Stream Management Planning 21. Minnesota Fish Contaminants Program 61. USGS – Streamgaging Network. 62. Minnesota Milestone Monitoring 63. Toxaphene in the St. Louis River	Need standardized reporting of stream inventory, electrofishing and harvest data;
5. Toxic Contaminants in Aquatic Biota	5. Lake Superior Fisheries Monitoring in Minnesota Waters 6. USEPA Environmental Monitoring and Assessment Program 17. Great Lakes Water Quality Survey Studies 18. Great Lakes Fish Monitoring Program 21. Minnesota Fish Contaminants Program 22. Michigan's Fish Contaminant Monitoring Program 23b. Fish Contaminant Monitoring Program (IFAP) 29. National Contaminant Biomonitoring Program 32. Environmental Effects of Industrial Effluents 37. National Contaminants Information System 38. Persistence and Fate of Pesticides and Industrial Chemicals in Water 46. Great Lakes Fish Contaminant Surveillance Program 47. Great Lakes Fisheries Specimen Bank 63. Toxaphene in the St. Louis R 64. Loads of Toxic Contaminants in the St. Louis River 65. Contaminants in Lake Superior Fish	

* see Appendix VI for details of monitoring programs.

The aquatic community group also identified three key areas where monitoring overlaps occurred:

1. Wetland inventory data;
2. Chemical contaminants;
3. Stream benthic invertebrate, water quality and production data.

3.3 Terrestrial Wildlife

Chair: Pam Dryer, U.S. Fish and Wildlife Service

The Terrestrial Wildlife group reviewed the committee's mission, goals and principles. Several areas requiring work were identified to adequately address the list of 'best bet' indicators. Data gaps were identified for several wildlife species or groups, and areas requiring better sampling and data reporting co-ordination. Good sampling protocols for some indicators were identified, including breeding birds, herring gulls, bald eagles, loons (for contaminants and colour marking) and land use/cover. Other indicators required further development of adequate sampling protocols, including loon population surveys, amphibians, medium-sized carnivores and land use classification. Table 3 below summarizes these issues:

Table 3: Terrestrial Wildlife Indicators

Indicator	***Monitoring Programs****	***Feasibility***	***Critical Issues/Gaps***
1. Breeding Birds	1. Wildlife Assessment Program 24. Forest Bird monitoring in the Great lakes National Forests, Forest Bird Diversity Initiative 30. Effects of Organochlorine Contaminants on Avian Endocrine Sytems 56. Owls 58. Breeding Birds Population and Community Monitoring Program	All programs are considered highly feasible.	Require more intense coverage, especially of Breeding Bird survey routes in Canada;
2. Amphibians	1. Wildlife Assessment Program 11. Wisconsin Herpetological Atlas Project 59. Frog and Toad Monitoring	All programs are considered highly feasible.	Require better data coverage and uniform protocols; Need for co-ordination between sampling agencies;
3. Rare & Important Plants	66. Minnesota County Biological Survey	This program is considered as low feasibility.	Identified as "back burner" indicator;
4. Land use Change	24. Forest Bird Monitoring on the Great Lakes National Forests, Forest Bird Diversity Initiative 43. US Canada Great Lakes Islands Project 58. Breeding Birds Population and Community Monitoring Program	All programs are considered highly feasible.	Require smaller scale resolution (50 m) basin wide; Wetland inventory for Ontario lacking; Update of land cover classification (including water) required;
6.Tree Swallows	1.Wildlife Assessment Program. 24. Forest Bird Monitoring on the Great Lakes National Forests, Forest Bird Diversity Initiative 27. Tree Swallow Contaminant Monitoring	All programs are considered low feasibility.	Identified as "back burner" indicator;

Table 3: Terrestrial Wildlife Indicators (continued).

Indicator	*Monitoring Programs**	*Feasibility*	*Critical Issues/Gaps*
7. Snapping Turtles	11.Wisconsin Herpetological Atlas Project 13c. Surveillance of Toxic Chemicals in Herpitiles of the Great Lakes.	All programs are considered low feasibility.	Identified as "back burner" indicator;
8. Colonial Birds	1. Wildlife Assessment Program. 13a. Herring Gull Egg Monitoring Program. 13b. Colonial Waterbirds of Great Lakes Population Surveys. 30. Effects of Organochlorine Contaminants on Avian Endocrine Systems. 60. Colonial Birds Populations and Contaminant Monitoring	All programs are considered highly feasible.	
9. Nocturnal Owls	1. Wildlife Assessments Program 56. Owls	All programs are considered moderately feasible.	Require full basin coverage; Co-ordination regarding uniform sampling protocol required;
10. Threatened & Endangered Species	55. Federally Threatened and Endangered Species Monitoring Program. 66. Minnesota County Biological Survey	All programs are considered highly feasible.	Lack of sufficient data for all threatened & endangered species, particularly in Ontario;
11. Exotic Plants & Terrestrial Animals	50. Beech Bark Disease Monitoring Program 52. Asian Longhorn Beetle Monitoring Program 53. Pine Shoot Beetle Monitoring Program 54. European Gypsy Moth Monitoring Program 58. Breeding Birds Population and Community Monitoring Program	All programs are considered highly feasible.	Require systematic approach to define problem; Lack of sufficient data for exotic terrestrial plants;

Table 3: Terrestrial Wildlife Indicators (continued).

Indicator	*Monitoring Programs**	*Feasibility*	*Critical Issues/Gaps*
12. Medium-sized Carnivores		All programs would be considered highly feasible.	Little survey data available, consider using trapping data; Need for co-ordination among sampling agencies;
13. Ungulates (deer, moose, caribou)	16.Status of Wildlife Populations 49. White-tailed Deer Monitoring	All programs are considered highly feasible.	More frequent sampling for moose populations required;
14. Ruffed Grouse	48. Ruffed Grouse Monitoring	This program is considered highly feasible.	Lack of Ontario data; Co-ordination regarding sampling protocol required;
15. Lichens/ Mosses/ Fungi	50. Beech Bark Disease Program 51. Hemlock Wooly Adelgid Monitoring Program	All programs are considered low feasibility.	Identified as “back burner” indicator;
16. Common Loons	10b. Michigan Common Loon Survey 57. Common Loon Monitoring	All programs are considered highly feasible.	
17. Bald Eagles	10a. Bald Eagle Biosentinel Project	This program is considered highly feasible.	

* see Appendix VI for details of monitoring programs.

For several key indicators, data availability was further assessed for population, productivity, demographics and contaminants on a lake wide and basin wide basis. These are summarized in Table 4.

Table 4: Key Indicators

Monitoring Program	***Common Loon***	***Breeding Birds***	***Bald Eagle***	***Amphibians***	***Colonial Birds***	***Ungulates***	***Threatened & Endangered Species.***
1. Population	X	X	X	Roadside Counts	ON*, WI*	Deer, moose	X
2. Productivity	MI*, MN*, ON, WI		X				X
3. Demographics	MI, WI						
4. Contaminants	MI, WI		X				
Lake Superior only					X		
Basin wide	X	X		X		X	
Both			X				X

* MI = Michigan, MN = Minnesota, ON = Ontario, WI = Wisconsin.

3.4 Habitat
Chair: Pat Collins, Minnesota Department of Natural Resources.

The Habitat Committee considered several critical needs and monitoring gaps, which they identified as action items. These included:

- Adding several metadata projects to the inventory, including U.S. Geological Survey stream flow data, National Water Institute, Urban and Municipal Storm Water Runoff on South Shore, North Shore Highlands Biosurvey, Michigan Water Quality, Fish Creek Geomorphology, Wild Rice Lake Mapping (1854), Bay Mills Biosurvey, Habitat committees Geographic Information System Project, Substrate Mapping for Lake Superior; RiverWatch and NPDES Permits;
- Reviewing additional metadata;
- Improving interagency co-ordination to define data parameter collection and interpretation, improving access to data and dissemination;

Critical gaps included:

- International stream flow data and on the web (add National Wetland Inventory,1995);
- Need a national wetland inventory for Canada.

Critical gaps and issues are summarized in Table 5.

Table 5: Habitat Indicators

Indicator	*Monitoring Programs**	*Feasibility*	*Critical Issues/Gaps*
1. Stream Flow/ Sedimentation	12. Indices of Biological Intensity 61. USGS – Streamgaging Network	Both programs are considered highly feasible.	Maintenance and future operation of real time gauging stations on key tributaries is critical; What differences exist between U.S. & Canadian data? Consensus on what key tributaries are required;
2. Benthic Invertebrates	14a. Exotic Species Monitoring Program – Zebra Mussels 20. Statewide Lake and Stream Management Planning 40. Remedial Action Plan Update 43. US/Canada Great Lakes Island Project	All programs are considered highly feasible.	Consensus required on sampling sites and protocols; Co-ordination between agencies is critical; Require more complete metadata summary; Information on reference populations required;
3. Inland Lake Transparencies	20. Statewide Lake and Stream Management Planning 40. Remedial Action Plan Update 45. Wildlife Lake Surveys	All programs are considered highly feasible.	Requirement to compile information on basin wide perspective; Need to differentiate trends based on individual watersheds; Reconcile differences in international data collection protocols;
4. Forest Fragmentation	7. Forestry Aerial Survey 8. Landsat Vegetation Mapping and Change Detection 9. Forest Inventory on State Lands 25. Forest Landscape Monitoring with Remote Sensing 40. Remedial Action Plan Update 43. US/Canada Great Lakes Islands Project	All programs are considered highly feasible.	Tremendous overlap in data collected; Require details of sampling protocols for standardization; Data analysis protocols require standardization;
5. Accessible Stream Length/ Wetland Area	20. Statewide Lake and Stream Management Planning 31. Effects of Global Climate Change on Great Lakes Wetlands 40. Remedial Action Plan Update	All programs are considered highly feasible.	Canada needs to map wetlands and develop shoreline inventory; Co-ordination and consolidation of data are required;

* see Appendix VI for details of monitoring programs.

The Habitat Group also identified the need to pull together available data, identify international differences in data availability and compile a complete list of information available for the Lake Superior basin for all indicators.

3.5 Human Health
Chair: Joyce Mortimer, Health Canada

Health Canada originally developed these indicators, but there is now much more diverse involvement within this committee providing increased opportunities for critically evaluation of the proposed indicators. The group emphasized the need to focus on three areas of human health indicators:

- Environmental exposure as an indirect measure of human exposure (air, water – drinking and recreational, food – fish, and soil);
- Tissue levels as a direct measure of human exposure;
- Health outcomes as result of exposure to environmental contaminants.

The main gaps identified were:

- Monitoring of private groundwater for drinking water quality;
- The need for a centralized reporting system for microbial data from recreational beaches;
- The need to tailor the air quality pollutant list to Lake Superior (i.e. mercury, PCB, toxaphene);
- Research on contaminant body burdens, health effects and cohort indicators of exposure and effects, all of which were identified as highly relevant, but difficult to conduct (therefore of low to moderate feasibility).

The group suggested that the radionuclides indication be dropped, since no nuclear plants are located within the basin, hence the low relevance of this type of data.
Table 6 summarizes these issues.

Table 6: Human Health Indicators

Indicator	*Monitoring Programs**	*Feasibility***	*Critical Issues/Gaps*
1. Fish Contaminants	5. Lake Superior Fisheries Monitoring in Minnesota Waters 18. Great Lakes Fish Monitoring Program 21. Minnesota Fish Contaminants Program 22. Michigan's Fish Contaminant Monitoring Program 23b. Fish Contaminant Monitoring Program – IFAP 29. National Contaminant Monitoring Program 32. Environmental Effects of Industrial Effluents 36. Trends in Disease Incidents and Mortality Rates 37. National Contaminants Information System 38. Persistence and Fate of Pesticides and Industrial Chemicals in Water 46. Great Lakes Fish Contaminant Surveillance Program 47. Great Lakes Fisheries Specimen Bank 65. Contaminants in Lake Superior Fish	All monitoring programs are considered highly feasible.	Addressed in Session III summary;
2. Drinking Water Quality		H – Municipal Sources L- Private Sources	Missing local monitoring for specific contamination problems, especially private groundwater
3. Recreational Water Quality		M	Require centralized reporting system for microbial measurements
4. Air Quality	42. Source Apportionment of Human Exposure to Urban Air Toxins	M – H	Need to tailor pollutant list to Lake Superior situation, (eg. Mercury, PCB,s, toxaphene) of concern to fish eaters;

Table 6: Human Health Indicators (continued)

Indicator	*Monitoring Programs**	*Feasibility***	*Critical Issues/Gaps*
5. Radionuclides	No metadata available other than cow's milk data (not relevant to exposure via nuclear plants)	L	Suggest dropping indicator due to low relevance (no nuclear plants in L. Superior basin)
6. Body Burdens	28. Assessment of Human Tissue Levels in Great Lakes Population	L – M (but highly relevant)	Limited or no data in Minnesota, other states? High relevance, but very costly and invasive research
7. Health Effects	41. Remedial Action Plan (RAPs) and Lakewide Management Plans (LaMPs) Co-ordination	L-M (but highly relevant)	Most relevant research, but very difficult to do
8. Cohort Indicator of Exposure and Effects	28. Assessment of Human Tissue Levels in Great Lakes Population. 41. Remedial Action Plan (RAPs)and Lakewide Management Plans (LaMPs) Co-ordination	L (but highly relevant)	

* see Appendix VI for details of monitoring programs.
** H = High, M = Moderate, L = Low.

3.6 Developing Sustainability
Chair: Jim Cantrill, Northern Michigan University

The group considering sustainability issues and reviewed the diverse set of indicators. Indicator feasibility, data availability and critical issues as summarized below in Table 7.

Table 7: Developing Sustainability Indicators

Indicator	**Sub Indicator / Monitoring Program[1]**	*Feasibility[2]*	*Data Collection / Availability*	*Critical Issues/Gaps*

1. Reinvestment of Natural Capital	a. Sustainable forestry (7) b. Watershed management (20, 41,) c. Native fisheries (4, 5, 26) d. Wildlife stocking e. Exotics control (14a, 14b) f. Reclamation of mines g. Wetland replacement and diversity (66)	H M/L ND ND M L M	GLFC, MNR Automated? Available Yes? Sparse, Lakehead U MNR, MNDM DOE?	 Consistency Overlap? Overlap?

Table 7: Developing Sustainability Indicators (continued).

Indicator	**Sub Indicator / Monitoring Program[1]**	***Feasibility*** [2]	***Data Collection / Availability***	***Critical Issues/Gaps***
2. Quality of Human Life	a. Crime incidence	M	Stats Can	N.S. issue?
	b. Migration	H	Yes	
	c. Demands for Social Services	L	? Difficult	
	d. Transportation & communication infrastructure	L	?	What to measure? Tells what?
	e. Recreation & cultural opportunities	M	Stats Can, provincial/local	Scattered data
	f. Citizen involvement	?	?	
	g. Access to Lakeshore	L	Muncipal?	N.S. issue?
	h. Population density	H	Stats Can.	Issue here
3. Resource Consumption Patterns	a. Water use	H	DOE survey	
	b. Water efficiency	M	Site by site	
	c. Energy consumption/use	M	Stats Can	Disaggregate
	d. Types of power generation	M	MNR, federal	Disaggregate
	e. Incineration			
	f. Solid waste generation	L	Site by site	
	g. Recycling programs			
	h. Forestry and mining (7, 8, 9, 25)	L	Site by site	Overlap
	i. Water quality			Overlap
	j. Wildlife depletion?	L	Site by site	Overlap
	i. Tourism?			
	j. Urban Sprawl			
4. Awareness of Capacity for Sustainability	a. School curricula		Wisconsin Environmental Education Board	Info. in different spots?
	b. Promotion of resource conservation			
	c. Building codes			
	d. Zoning			
	e. Support for environmental regulations			
	f. Community outreach			
	k. Media coverage			
	l. ISO 14000			

Table 7: Developing Sustainability Indicators (continued).

Indicator	**Sub Indicator / Monitoring Program[1]**	***Feasibility*** [2]	***Data Collection / Availability***	***Critical Issues / Gaps***
5. Economic Vitality Measures	a. Per capita income	H	Stats Can.	
	b. Cost of living	H		
	c. Poverty level	H	Local?	
	d. Employment	H		
	e. Regional trade balance	M	EDC?	
	f. Diversity of economies	H		
	g. Transition economics	L	Difficult	
	h. Value added?	L	Site by Site	
	i. Tax base	H	Stats Can.	

[1] see Appendix VI for details of monitoring programs.
[2] H = High, M = Moderate, L=Low, ND = Not Determined.

4.0 Session III: Exploring Monitoring Overlaps and Gaps between Groups

The purpose of Session III was to explore areas where monitoring gaps and overlaps occurred across one or more groups. For this session, three larger breakout groups were formed to address:

1. The human health effects of fish contamination;
2. Wildlife contaminant issues and;
3. Biological, non-chemical issues.

The chair of each group was instructed to:

1. Identify potential for collaboration between agencies where monitoring overlaps occur (using table from session II);

2. For 'best bet' indicators identified as feasible in Session II, identify serious monitoring gaps (using table from session II), and rank them from most critical to least critical. These results were to be saved for Session V;

3. For indicators identified as "low feasibility" in Session II, suggest ways to revise indicators, if applicable;

4. Prepare a brief summary for presentation to the Plenary Session.

Findings for the three breakout groups are summarized below.

4.1 Fish Contamination / Human Health Issues
Chair: Joyce Mortimer, Health Canada

Members of the Aquatic, Human Health and Contaminant groups examined the issue of human health impacts from consumption of fish with contaminant body burdens in Lake Superior. The group acknowledged the need to examine a two-track approach: contaminant body burdens in fish and human dietary choices (i.e. what fish species and sizes are consumed, where are the fish caught, and how often they are consumed). Loons were also considered as a surrogate for exposure to contaminants in fish. However, the Ontario database was not designed to monitor trends in loon contaminant body burdens.

Fish Consumption Advisories: Sampling programs for fish consumption advisories was not intended to indicate trends in contaminant levels over time. What types of monitoring could be used instead? Trends in contaminant levels in similar species and sizes over time (percantage change over time), for example the edible portion of fish, for each region within the lake would be suitable.

The group considered requirements for soliciting data in order to develop a fish contaminant indicator. A minimum data requirement would need to be identified. Consideration was also given to archiving samples in a tissue bank for retrospective studies as new analytical approaches are developed. The Great Lakes Laboratory for Fisheries & Aquatic Sciences in

Burlington, Ontario maintains such a tissue bank. There was considerable discussion over whether a decline in number of fish advisories over time could be used to monitor fish contaminant trends. However, this approach would be difficult because of different criteria for advisories in different regions. In some cases, declines in contaminant levels would not result in a change to consumption advisories.

Fish contaminant monitoring is an area, which would benefit from a co-ordinated sampling, analytical and data reporting program. Currently there is a lack of consistency in what is classified as "edible" portion of a fish. Can such inconsistent data be combined (e.g. whole fish data, edible portion) and would this be misleading to identify trends in contaminant levels? The group felt that a monitoring council for fish contaminants would be a good idea.

The group proposed to undertake a project to examine the inter-relationships between existing monitoring programs and to work towards developing a suitable indicator. The first step would be to examine archived data on a lake by lake and species-by-species basis. This would represent a large time and cost investment, but would be worthwhile.

4.2 Wildlife Contaminant Monitoring
Chair: Pam Dryer, U.S. Fish and Wildlife Service

Members of the Habitat, Terrestrial Wildlife and Chemical Contaminants groups discussed issues related to wildlife contaminant monitoring. They identified a critical need for better co-ordination between monitoring agencies within the basin.

A number of high feasibility indicators were identified. However, there were problems with consistency of data availability across countries and states. Table 8 below identifies these indicators and problems associated with data availability.

Table 8: Wildlife Contaminant Indicators

Wildlife Contaminant Indicator	*Critical Issues/Gaps*
1. Bald Eagle	Data lacking in Canada; Require better diet composition data (contaminant levels for appropriate size classes of fish);
2. Herring Gull	Data lacking in U.S.; Data available for Apostle Islands, Keewenaw/Huron Islands Keewenaw Peninsula, Taquamon Island;
3. Common Loon	Good data on contaminants in diet (fish); Contaminant data lacking in Canada; Focus has been on mercury, limited organic contaminant data available; Availability of Minnesota population information is declining;
4. Snapping Turtle	Data for south shore of Lake Superior is lacking;

5. Mink	Could consider contaminant levels in larger inland, sensitive species such as mink.

4.3 Biological Non-chemical Issues
Chair: Pat Collins, Minnesota Department of Natural Resources

Members of the Terrestrial Wildlife, Aquatic and Habitat groups identified several areas where monitoring overlap and the potential for co-ordination existed. These are summarized in Table 9 below:

Table 9: Ecological Community Indicators

Indicator	***Committees Involved***	***Critical Issue***
1. Land Use/Cover Change	Habitat, Sustainability, Terrestrial	Forest fragmentation;
2. Accessible Stream Length	Habitat, Aquatic, Sustainability	
3. Monitoring of Exotics	Habitat, Aquatic, Terrestrial, Sustainability	Displacement of native species by exotics;
4. Common Loon	Habitat, Human Health, Sustainability	Inland lake transparency;
5. Wetland	Habitat, Terrestrial, Aquatic, Sustainability, Chemical Contaminants	Loss of wetlands; Contaminant issues;
6. Breeding Bird Monitoring	Habitat, Terrestrial	
7. Benthic Invertebrates	Habitat, Aquatic, Chemical Contaminants	

5.0 Session IV: The Challenge of Identifying Funding Opportunities
Chair: Jake Vander Wal, Ontario Ministry of the Environment

Each group identified several critical monitoring gaps in Sessions II and III. As well, the requirement for increased co-ordination and collaboration was commonly iterated. Session IV was intended to review existing and new funding opportunities with the potential to fund new monitoring and co-ordination efforts on Lake Superior. A list of all the potential funding sources identified in this session is provided in Appendix VII.

5.1 Federal/State Funding in USA
Speaker: Richard Hassinger, Minnesota Department of Natural Resources

Several potential sources of significant funding may be available to fund monitoring in the U.S. These include funds associated with the introduction of two bills in congress, namely, the Conservation and Reinvestment Act of 1999 (S.25, H.R. 701) and the Permanent Protection for America's Resources 2000 (H.R. 798 and S.446). These pieces of legislation would involve a reinvestment of 50 – 60% of $4.6 billion for "wildlife and wild places projects". As well the National Science Foundation (NSF) is waiting approval from Congress to increase environmental research, education and scientific assessment by $1 billion over the next five years. Their report "Environmental Science and Engineering for the 21st Century: The Role of the National Science Foundation" recommends a range of activities including research funding, building laboratories, interdisciplinary research and multi-discipline research. The report can be viewed at the website http://www.nsf.gov/nsb/tfe/nsb99133/start.htm.

5.2 U.S. EPA Funding Opportunities
Speaker: Paul Bertam, U. S. Environmental Protection Agency

The Great Lakes National Programs Office (GLNPO) is responsible for conducting research and monitoring in the Great Lakes. The program priorities are:

- State of the Lake (SOLEC) indicators - base program for 5 lakes, monitored once every two years for water quality, contaminants and plankton;
- Lakewide Management Plans (LaMP);
- Special studies (e.g. Lake Michigan contaminant mass balance study).

GLNPO's approach to requests for assistance is not to fund external long-term monitoring programs, but to assist with data/information needs through:

- Existing monitoring programs;
- Cooperation with other agencies;
- Funding special studies;
- Grants and interagency agreements.

5.3 Ontario Great Lakes Renewal Foundation
Speaker: Gail Krantzberg, Ontario Ministry of the Environment

The Ontario Great Lakes Renewal Foundation (GLRF) is a recently established funding agency, which is private sector driven, but operates in cooperation with local, provincial, and federal governments. This foundation has a unique opportunity to inspire investment in Great Lakes renewal by engaging others, including industry and the corporate sector, as they have an interest in the protection of the Great Lakes.

The mandate of the GLRF is to advance Great Lakes revitalization by increasing available resources needed to help communities move towards a healthy and sustainable Great Lakes Basin Ecosystem. The foundation's objectives focus on five major areas:

- Cleaning up degraded areas;
- Revitalizing, protecting and conserving natural systems in Ontario's Great Lakes;
- Sustaining action-based community initiatives;
- Achieving balanced ecosystem needs, and;
- Demonstrating leadership through partnerships.

Information about the Ontario Great Lakes Renewal Foundation can be found at their website: www.greatlakes.on.ca.

Eleven projects have been funded to date in Thunder Bay, Nipigon Bay, Severn Sound, the St. Clair River and Niagara Rivers, Toronto and the Bay of Quinte. These projects have supported habitat rehabilitation, research, pollution prevention and community capacity building.

The foundation's current priorities are to:

- Acquire private sector contributions;
- Establish a Grant Advisory committee;
- Forge relationships with other foundations;
- Network with Great Lakes private and public sector leaders;
- Demonstrate progress;
- Ensure AOC receive priority funding, and;
- Ensure partnerships.

5.4 Canadian Funding Opportunities
Speaker: Margo Shaw, Upper Lakes Environmental Research Network (ULERN)

Despite widespread declines in funding for government and academic research in recent years, there has been no reduction in research/monitoring mandates. This necessitates a shift in how we fund programs. More agencies are looking to collaborative agreements and alternate funding sources. Several potential funding sources exist, including new federal and new provincial programs, corporations and private foundations.

The Upper Lakes Environmental Research Network (ULERN) was formed in 1997 to facilitate natural resource and environmental research in the Upper Great Lakes basin. This coalition is comprised of more than 140 members from government, academia and the private sector.

ULERN's goal is to tackle research problems that individual agencies cannot for a variety of reasons (i.e. lack of funding, expertise or time).

Soliciting funding from non-traditional sources requires in some cases, a change in approach. In general, funding agencies are interested in:

- The nature of the research or monitoring project -
    - i) A project that captures imagination, vision;
    - ii) A good fit with the funding program mandate;
    - iii) Volunteer/public/student involvement, and;
    - iv) Partners with matching funding.
- Accountability -
    - i) Demonstrated good financial management;
    - ii) Past history of success, and;
    - iii) Low project overhead costs.
- A win for the funding agency -
    - i) A tax receipt;
    - ii) Acknowledgement of monetary contributions (publicity), and;
    - iii) The opportunity to influence research/monitoring direction.

If the Lake Superior Binational Program were to consider establishing a Monitoring Council, or expanding current monitoring activities there are several potential avenues for funding:

- Partnerships represent the opportunity for sharing data, resources, expertise and perhaps funding;
- New foundations such as the Ontario Great Lakes Renewal Foundation, Ontario Research and Development Challenge Fund, the Ontario Innovation Trust and the Canadian Foundation for Innovation may provide capital and operating funding;
- Corporate foundations, (e.g. Canada Trust Friends of the Environment Foundation);
- Private foundations (e.g. the Richard Ivey Foundation);
- Government sources such as Human Resources Development Canada and FedNor, can provide funding for hiring of students and interns;
- Multinational funds such as the North American Fund for Environmental Cooperation.

6.0 Session V: Establishing Monitoring Efforts for Gaps – Next Steps

This session was designed to focus on critical gaps identified in sessions II and III. Groups were to consider ways to address these gaps and identify how/who might be involved. The instructions to the chairs were:

1. For critical monitoring gaps identified in the previous breakout sessions, consider the following:
   i) Can existing information/data be used in novel ways to answer these needs?
   ii) If not, discuss how, and who should collect monitoring data (i.e. identify agency interest);
   iii) How can monitoring efforts be supported (identify potential funding sources)?
   iv) The potential for new monitoring.

2. Prepare a brief presentation for reporting to the Plenary Session.

The suggestions from each of the six break-out groups are summarized in sections 6.1 to 6.6.

6.1 Chemical Contaminants
Chair: Melanie Neilson, Environment Canada

The Chemical Contaminant group considered ways to address critical gaps for several of the committees' indicators. These are summarized in Table 10 below.

Table 10. Chemical Contaminant Indicators

Indicator	***Issue***	***Critical Gap***	***Suggested Fix***	***Who?***
1. Zero Discharge Chemicals *	Sources of chemicals (emission stacks, products, clean sweeps);	Need transport models; Need to educate public;	Piggy back on CGLI's information gathering exercise (under BNS); Promote education about alternatives to these chemicals;	CGLI Environmental Non Governmental Organizations
2. Chemical Indicators 2 – 6 (Concentrations in sediment, water, air & fish)	Not all chemicals are sampled due to lack of analytical methods and high cost;	Lack of knowledge of available information; Need for data compatibility;	Partnering; Website listing who is sampling where; Introduce QA/QC programs (round robin testing);	
3. Prevention Chemicals*		Lack of data for these chemicals;	Co-ordinate an intensive sampling year (multi-media) on Lake Superior; Ask GLNPO to consider adding on to their sampling cruises;	GLNPO

* See Appendix IV for complete list of chemicals.

6.2 Aquatic Communities

Chair: Don Schreiner, Minnesota Department of Natural Resources.

This group considered how to address gaps in monitoring the long-term environmental health of the Lake Superior basin. The key data gaps in Canadian waters were identified as:

- Diversity and sustainability;
- Monitoring of exotic species – good data exist for Duluth Harbour, Thunder Bay harbour and Sault Ste. Marie;,
- No net loss of habitat, and;
- Contaminant monitoring and consolidation of data.

The overriding requirement is the need for better organization and consolidation of data and ensuring its ready availability.

6.3 Terrestrial Wildlife

Chair: Pam Dryer, U.S. Fish and Wildlife Service

The Terrestrial Wildlife Committee spent much of this session examining the list of indicators and outcomes. The group recognized the need to better clarify indicators and outcomes. They identified land use/land cover as a priority for the group and recognized the need to co-ordinate more closely with other committees. The most critical gaps for this committee are:

- Threatened and Endangered species – data is available basinwide, but needs to be pulled together;
- Amphibian monitoring;
- Land use/Land cover – 50 x 50 m resolution data analysis has been done for Wisconsin and Minnesota, but needs to be completed for Michigan and Ontario;
- Data analysis needs to be completed for 1995 and compared with 1985;
- Classifications need to be standardized;
- Exotic Plant monitoring.

6.4 Habitat Group

Chair: Pat Collins, Minnesota Department of Natural Resources

The Habitat group identified five key areas requiring further work. Table 11 below summarizes these gaps, and provides a suggested solution and agency to address these gaps.

Table 11: Habitat Indicator Gap Analysis

Indicator/Critical Gap	***Suggested Fix***	***Who?***
1. Complete Metadata Summary	Collect data information for stream flow and identify gaps;	U.S.Geological Service (WRD)
2. Linking Data to Indicators	Connect process of data collection to product needed and currently being used;	Habitat Committee

3. Data availability	Make data more easily available to other agencies and public;	

Table 11: Habitat Indicator Gap Analysis (continued).

Indicator/Critical Gap	*Suggested Fix*	*Who?*
4. Benthic Invertebrate & Inland Lake Transparency Indicators	Target additional sources of information;	Ontario Ministry of Natural Resoures USGS (BRD)
5. Accessible Stream Length	Work with GLFC Technical committee to collect and summarize information;	Habitat Committee Great Lakes Fishery Commission.

6.5 Human Health
Chair: Joyce Mortimer, Health Canada

Three main areas for further work were identified in the area of Human Health. These are summarized in Table 12 below.

Table 12: Human Health Indicator Gap Analysis

Indicator/Critical Gap	*Suggested Fix*
1. Drinking Water – Private Well Water and Municipal Water Supply	Review chemical list; Survey local data sources in the U.S. and add to database; Complete Canadian data for any new chemicals; Investigate raw water quality as an indicator;
2. Body Burden	Tissue level studies have focused on southern Great Lakes; Enhance data set for Lake Superior basin; Summarize subsistence data on the Canadian side of Lake Superior; Develop database on U.S. side;
3. Fish Contaminants	Requires further discussion, U.S. to screen other contaminants of concern;

6.6 Developing Sustainability
Chair: Jim Cantrill, Northern Michigan University

This group identified the need to conduct a thorough search to identify what data/information is available; in particular what time trend data exist. These data gaps present the potential for capacity building and opportunities for collaboration. Table 13 summaries these issues.

Table 13: Sustainability Indicator Gap Analysis

Indicator/Critical Gap	***Who?***	***Funding Opportunities***
1. Demand for Social Services	Health & Human Services sectors Municipalities State Government Non governmental Organizations (NGO's) Lutheran Social Services	Federal, State & Provincial Government Agencies
2. Recreational Cultural Activities	National Parks Service, U.S.Forestry Service Conservation Authorities Ontario Ministry of Tourism	N/A
3. Citizen Participation in Decision Making	Universities	ULERN Kellogg Foundation
4. Mining Reserves	Ministry of Northern Development and Mines (MNDM) Bureau of Mines Universities	N/A
5. Aquifers (Quality/Quantity)	U.S. Geological Service Natural Resources Canada Environment Canada	N/A
6. Environmental Education Curriculum	North American Association for Environmental Education Dept/Ministry of Education Great Lakes Environmental Education Council of Great Lakes Research Managers Universities	Federal/State Government Agencies ULERN Foundations
7. Popular Support for Environmental Policies	Roger/Gallup/Harris polling Universities	Federal/State Government Agencies ULERN Foundations
8. Media Coverage	Society of Environmental Journalists Universities	Federal/State Government Agencies ULERN Foundations
9. Regional Trade Balance	Dept. Of Commerce Federal Reserve Ontario Ministry of Finance Labour Unions	N/A
10. Transitional Economies	Economic Development Corporations FedNor Departments of Labour Lakehead University	N/A

7.0 Session VI: Co-ordination of Interagency Monitoring Efforts

Two speakers were asked to address their experiences with collaborative monitoring programs, with a view to applying lessons learned to the Lake Superior Program.

7.1 Standardization of Lake Superior Fisheries Monitoring
Speaker: Don Schreiner, Minnesota Department of Natural Resources

Fisheries monitoring in the Great Lakes have had a long history of successful collaboration and standardization. This began in the early 1960's with a focus on lake trout rehabilitation, sea and lamprey control. Later, the focus broadened to include non-indigenous species management and work on the Lake Superior fisheries monitoring. These activities are co-ordinated by the Great Lakes Fishery Commission, a not-for-profit organization formed by Canadian and U.S. governments to oversee Great Lakes fisheries management.

Membership on the Lake Superior Technical Committee consists of state/provincial natural resource agencies from Michigan, Minnesota, Ontario and Wisconsin, federal agencies (U.S. Departments of Geological and Fish and Wildlife Services and the Canadian Department of Fisheries & Oceans). Monitoring in the lake is divided into 4 major habitat zones; offshore (> 80 m), nearshore (0 – 80 m), harbours, estuaries and embayments and tributaries. Program indicators and sampling details are summarized in Appendix II - Aquatic Communities. Funding for fish monitoring is largely provided by the individual agencies involved. Additional funding is provided by the Great Lakes Fishery Commission and outside partners such as universities, Sea Grants and U.S. Environmental Protection Agency.

This example of monitoring co-ordination in Lake Superior has worked well because of several factors, including:

- Central leadership and co-ordination provided by the GLFC;
- Development of clear guidelines and joint strategic planning;
- Agency commitment from both policy and field personnel;
- Focus on relevant projects of shared interest;
- Regular face-to-face meetings, and;
- Emphasis on decision making by consensus.

As with any program, there are always areas that pose challenges, such as:

- Expanding objectives and the need to re-examine priorities;
- Recent agency changes and reorganizations;
- A loss of memory due to personnel changes;
- Funding and time to address emerging issues, and;
- Interaction with other agencies and the public who may have divergent interests.

7.2 Developing Monitoring Co-ordination Councils: Lessons Learned
Speaker: Charlie Peters, United States Geological Survey

Monitoring councils are interagency organizations formed to provide a forum to co-ordinate consistent and scientifically defensible monitoring methods and strategies. Monitoring councils focus on collaboration and comparability. Why? Because every year government agencies, industry, academic researchers and private organizations commit enormous resources to monitor, protect and restore water resources and watersheds.

There are several reasons for forming a monitoring council:

- To Reduce monitoring budgets and sites;
- To Reduce agency duplication and costs;
- To better address legislation;
- To Improve reporting of results;
- To Promote awareness of water quality issues.

Several examples of water quality monitoring councils exist in the U.S. at the national (e.g. National Water Quality Monitoring Council), regional (e.g. Southeastern Monitoring Council) and watershed (e.g. Big Thompson Watershed Forum) scale. These monitoring councils have provided assistance in several key areas, including:

- The design and promotion of goal oriented monitoring strategies for sampling, data analysis, interpretation and reporting;
- Data methods and comparability;
- Fostering institutional collaboration, and;
- Data management and accessibility.

Not all monitoring councils have been successful, and there may be several reasons why such an organizations may fail. These include inadequate senior management support, a lack of funding or differences in agency philosophies. An examination of the key elements in forming a successful council include:

- A commitment to collaboration and a recognition of the time required to develop trust between partners;
- Members are in a position to influence organizational commitment;
- Committed leadership by a few key members;
- Minimal monetary commitment.

8.0 Session VII: Reaching Consensus
Chairs: Melanie Neilson, Environment Canada,
Margo Shaw, Upper Lakes Environmental Research Network

At this plenary session, participants reviewed the workshop progress and made recommendations on the next steps. In the breakout session's groups had ranked indicator feasibility, identified gaps and overlaps in monitoring programs and considered ways to address key requirements/needs. Possible routes to addressing these needs were identified:

- Have existing agencies fill in the gaps;
- Have theme committees fill in the gaps;
- Look to other agencies for assistance (e.g. Council of Great Lakes Resource Managers, International Joint Commission), and;
- Establishing a monitoring council.

The idea of forming a Lake Superior Monitoring Council was discussed at length. Pro's and con's of such a council were identified:

Pro's	**Con's**
- Increased economies of scale	- More meetings (resource drain)
- Increased efficiencies	- Potential for a group to get short shrift
- Potential for increased funding	- Do we want to reinvent the wheel?
- Remove pressure from overworked committees	
- Get things done	

Consensus was reached that no one was in favour of establishing a separate monitoring council, but that the program requires additional assistance with co-ordination and fundraising. The group agreed that one way to achieve this was to enhance the role of the existing Binational Work Group. The proposal was to appoint or hire an individual/ agency to work under the supervision of the Work Group. Funding for this could come from several agencies providing seed money into a central pot, or by agency commitment of staff time to the project. However, there was no consensus on this proposal.

A list of nine recommendations follows. They are ordered beginning with the most critical.

9.0 Workshop Recommendations:

1. Develop a co-ordinated monitoring strategy for the Lake Superior basin. All of the Lake Superior Binational Program agencies will participate and seek resources for implementation. The monitoring strategy will be peer reviewed and presented in the LaMP 2002.

2. Prepare a revised list of 'better bet' indicators for each theme committee.

3. Build a more complete metadata summary. This will involve 3 steps:

   i) Include additional metadata identified at the workshop in the existing summary table (see Appendix VI, of this report);

   ii) Approach the International Joint Commission regarding input of complete Lake Superior metadata list to their Website.

   iii) Search for additional metadata.

4. Form *ad hoc* groups to address sampling protocols, sample analysis and data reporting standardization and comparability identified by theme committees.

5. Identify monitoring gaps and make recommendations on those that are most critical. (For a first cut, see Section 3.0 of this report).

6. Facilitate greater co-ordination among agencies and theme groups to address common issues (for examples, see section 4.0 of the report). Establish a co-ordination committee to address these issues.

7. Identify funding necessary to address monitoring gaps and co-ordination of monitoring activities.

8. Report monitoring results in the LaMP 2002.

9. Adjust the existing Lake Superior Binational Work Group functions to achieve 1-8.

10.0 References

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11.0 Appendices

Appendix I: Workshop Participant List

Appendix II: Workshop Agenda

Appendix III: Summary of Objectives and Sub-objectives for Six Theme Committees

Appendix IV: Summary of 'best bet' Indicators for Six Theme Committees

Appendix V: Metadata Request Form

Appendix VI: Metadata Summary for Six Theme Committees

Appendix VII: List of Funding Sources

Appendix I

Lake Superior Binational Monitoring Workshop
List of Registrants

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Appendix II

Lake Superior Binational Monitoring Workshop

October 26 & 27, 1999
(Opening Reception - Monday, October 25)
Holiday Inn, Sault Ste. Marie, Ontario

AGENDA

Monday, October 25

6:00 - 9:00 PM	Registration	Main Lobby
7:00 - 9:00 PM	Reception/Cash Bar	Thompson Suite

Tuesday, October 26 - Algoma Ballroom West & Centre

8:00 - 8:30 AM	Registration	Main Lobby
8:30 - 8:45 AM	Workshop Welcome *Darrell Piekarz, Environment Canada, Toronto, ON* *Janet Pellegrini, U.S. Environmental Protection Agency, Chicago, IL* *Margo Shaw, ULERN, Sault Ste. Marie, ON*	
8:45 - 10:00 AM	**Session I: Setting the Stage for Lake Superior** 8:45 - 9:00 AM Workshop Overview & Goals *Janet Pellegrini & Darrell Piekarz*	
	9:00 - 9:30 AM Overview of Lake Superior Ecosystem, Principles and Objectives *Bob Kavetsky , U.S. Fish & Wildlife Service, East Lansing, MI*	
	9:30 - 10:00 AM Important Elements in Monitoring and Assessing the Lake Superior Ecosystem Integrity *Stephen Lozano, U.S. Environmental Protection Agency, Duluth MN*	
10:00 - 10:15 AM	Break - Algoma Ballroom East	
10:15 AM - Noon	**Session II: Indicator Feasibility/Metadata Summary**	
	10:15 - 10:25 AM Charge to Breakout Groups *Darrell Piekarz*	
	10:25 - Noon	

Breakout Groups (6)
. Review of Metadata Summary
. Feasibility of EPO Indicators

Lake Superior Work Group Committee Co-chairs

Noon - 1:00 PM Lunch - Algoma Ballroom East

Tuesday, October 26 . . . Continued

1:00 - 2:00 PM **Session II Cont'd.: Indicator Feasibility/Metadata Summary**

1:00 - 1:30 PM
Report From Co-Chairs

Lake Superior Work Group Committee Co-chairs

1:30 - 2:00 PM
Discussion/Analysis of Metadata/Indicator Feasibility

Janet Pellegrini & Darrell Piekarz

2:00 - 3:00 PM **Session III: Exploring Monitoring Gaps and Overlaps**

2:00 - 2:15
Charge to Breakout Groups

Janet Pellegrini

2:15 - 3:00 PM
Breakout Groups (3)

Lake Superior Work Group Committee Co-chairs

3:00 - 3:15 PM Break - Algoma Ballroom East

3:15 - 5:00 PM **Breakout Discussions Resume: Exploring Monitoring Gaps and Overlaps**

4:00 - 5:00 PM
Plenary Session: Presentation and Synthesis of Gap/Overlap Analysis

Chair: Jim Cantrill, Northern MI University

5:00 - 6:30 PM Free Time

6:30 PM **Theme Dinner - French Canadian**

Speaker: Traditional Ecological Knowledge of Lake Superior
Thomas Biron, Michigan State University Extension, Sault Ste. Marie, MI
Native Elder: Willard Pine, Garden River First Nation, Sault Ste. Marie, ON

Wednesday, October 27 - Algoma Ballroom West & Centre

8:30 - 8:35 AM Recap of Day I, Introduction to Day II Goals Darrell Piekarz

8:35 - 10:15 AM **Session IV: The Challenge of Identifying Funding Opportunities**

8:35 - 9:30 AM
Presentations:

Federal/State Funding in the USA *Richard Hassinger, Minnesota DNR, St. Paul*

U.S. EPA Funding Opportunities *Paul Bertram, US E.P.A., Chicago*

Ontario Great Lakes Renewal Foundation *Gail Krantzberg, Ontario MOE, Toronto*

Canadian Funding Opportunities, *Margo Shaw, ULERN, Sault Ste. Marie, ON*

9:50 - 10:15 Am
Panel Discussion *Chair: Jake Vander Wal, MOE, Thunder Bay, ON*

Wednesday, October 27 . . . Continued

10:15 - 10:30 AM Break - Algoma Ballroom East

10:30 - Noon **Session V: Establishing Monitoring Efforts for Gaps: Next Steps**

10:30 - 10:40 AM
Charge to Breakout Groups
Janet Pellegrini

10:40 - 11:30 AM
Breakout Sessions (6) *Lake Superior Work Group Committee Co-chairs*

11:30 AM - Noon
Plenary Session
. Report From Co-Chairs
Discussion and Synthesis *Chair: Elizabeth Laplante, U.S E.P.A., Chicago*

Noon - 1:00 PM Lunch - Algoma Ballroom East

1:00 - 3:00 PM **Session VI: Co-ordination of Interagency Monitoring Efforts**

1:00 - 1:30 PM Developing Monitoring Co-ordination Councils: Lessons Learned
Charlie Peters, Lake Michigan Monitoring Council, Middleton, WI

1:30 - 2:00 PM Standardization of Lake Superior Fisheries Monitoring
Don Schreiner, Minnesota DNR, Duluth

2:00 - 3:00 PM Plenary Session: Applications to the Lake Superior Experience
Melanie Neilson, Environment Canada, Burlington, ON

3:00 - 3:15 PM Break - Algoma Ballroom East

3:15 - 4:30 PM **Session VII: Reaching Consensus**
. What Have We Accomplished?

. Where Do We Go Next?

Co-chairs: Margo Shaw, ULERN
Melanie Neilson, Environment Canada

Appendix III: Summary of Objectives and Sub-Objectives for each of the 6 Work Groups (Lake Superior Binational Program, 1998).

OBJECTIVE	***SUMMARY***	***SUB-OBJECTIVES***
1. Chemical Contaminants	Levels of persistent, bioaccumulative toxic chemicals should not impair beneficial uses of the natural resources of the Lake Superior basin. Levels of chemical contaminants, which are persistent, bioaccumulative and toxic, should ultimately be virtually eliminated in the air, water and sediment in the Lake Superior basin.	<u>Sources:</u> a) Goal of zero discharge and zero emission of 9 designated persistent, bioaccumulative toxic chemicals from sources within the basin (Binational Program to Restore and Protect Lake Superior Basin); b) Atmospheric deposition of persistent, bioaccumulative toxic chemicals of human origin should be virtually eliminated; <u>Environmental Impacts:</u> c) Concentrations of zero discharge/zero emission and lakewide remediation category chemicals should not exceed the most sensitive yardstick of environmental quality (Smith & Smith, 1993); d) Concentrations of chemicals in the local remediation category should meet local sediment and water quality standards and no long cause use impairments; e) Concentrations of chemicals in the prevention/monitor category should not increase in air, water or sediment; f) Sources of prevention/investigation category chemicals should be identified, and presence/absence of sources be confirmed in the basin; Source presence should trigger monitoring of media most likely to concentrate the chemical;
2. Aquatic Communities	Lake Superior should sustain diverse, healthy, reproducing and self-regulating aquatic communities closely representative of historical conditions.	a) Lake trout valuable indicators/integrators of ecosystem health, other aquatic species may be useful as indicators; b) Native aquatic species are key elements of a healthy ecosystem; c) Aquatic biota should be free from contaminants of human origin; d) Management of exotic fish (including rainbow and brown trout, Pacific salmon) should be managed in a manner not detrimental to native fish species; e) New exotic/nuisance species must not be introduced into ecosystem; Accidental introductions should be eliminated through prevention; Bait use must not contribute exotic species or genetic stocks to lake;
3. Terrestrial Wildlife	The mission is ' Support a diverse, healthy, reproducing and sustainable native wildlife community in the Lake Superior basin. Terrestrial wildlife includes plants, animals and associated microorganisms.'	a) There is a diverse, healthy, reproducing and sustainable native wildlife community in the Lake Superior basin. b) There is a wildlife community-based program to monitor the health of ecosystems in the Lake Superior basin. c) Species at risk/concern (T & E) are recovered.

Appendix III: Summary of Objectives and Sub-Objectives for each of the 6 Work Groups (Lake Superior Binational Program, 1998) continued.

OBJECTIVE	*SUMMARY*	*SUB-OBJECTIVES*
4. Habitat	Extensive natural environments such as forests, wetlands, lakes and watercourses are necessary to sustain healthy native animal and plant populations in the Lake Superior ecosystem, and have inherent spiritual, aesthetic and educational value. Land and water uses should be designed and located in harmony with the protective and productive ecosystem functions provided by these natural landscape features. Degraded features should be rehabilitated or restored where this is beneficial to the Lake Superior ecosystem.	a) Ecological health of the Lake determined largely by the health of tributary lakes and rivers; Land use planning/regulation should eliminate/avoid destructive water linkages and foster healthy land-water linkages; b) Long-term consequences of incremental landscape change, habitat destruction and fragmentation should be avoided through research and planning; c) Importance of nearshore, shoreline and wetland habitats should be addressed through identification, protection and restoration of sites for reproduction and rearing of fish, water birds, mammals, other wildlife and plants;
5. Human Health	The health of humans in the Lake Superior ecosystem should not be at risk from contaminants of human origin. The appearance, taste and odour of water and food supplied by the Lake Superior ecosystem should not be degraded by human activity.	a) Fish and wildlife should be safe to eat, and consumption should not be limited by contaminants of human origin; b) Water quality should be protected where currently high, and improved where degraded; communities, industries and regulators outside the basin should be informed of consequences of long-range atmospheric transport of contaminants into the basin; c) Lake Superior should be safe for total body contact activities, including areas adjacent to urban and industrial areas; Air quality should be protected where currently high, and improved where degraded; communities, industries and regulators outside basin should be informed of consequences of long-range atmospheric transport of contaminants into the basin;
6. Developing Sustainability	Human use of the Lake Superior ecosystem should be consistent with the highest ethical and scientific standards for sustainable use. Land, water and air use in the Lake Superior ecosystem should not degrade it, nor any adjacent ecosystems. Use of the basin's natural resources should not impair the natural capability of the basin ecosystem to sustain its natural identity and ecological functions, nor should it deny current and future generations the benefits of a healthy, natural Lake Superior ecosystem. Technologies and development plans that preserve natural ecosystems and their biodiversity should be encouraged.	a) Public, private decisions will be right when they tend to preserve the integrity, stability and beauty of the biotic community (Leopold 1966); b) The ecosystem provides resources (eg. water, fibre, minerals, energy, waste transport and treatment, food, recreation, spiritual sustenance) which should be valued as environmental capital; c) Institutional capacity to integrate technology and sustainable design should be developed within the ecosystem; d) Basis for guiding sustainable development should be the pattern of land, water and air use, as these affect ecological, social and economic processes;

Appendix IV
Summary of Lake Superior Work Group 'best bet' Indicators

A. Chemical Contaminants

Indicator	*Purpose of Indicator*	*Illustration of Indicator*	*Interpretation of Indicator*
1. Progress Towards Zero Discharge & Zero Emission	To measure progress towards zero discharge & zero emission of 9 designated persistent, bioaccumulative toxic chemicals[1];	Trends of chemical concentrations in water, fish, sediment & other ecosystem compartments; Measurements & estimates of release of chemicals from basin sources;	Discharge/emissions (measured as kg/yr, mass or other units for surrogate measures) will be compared to 1990 baseline data to indicate whether progress is being achieved;
2. Atmospheric Deposition Trends for Zero Discharge Chemicals[1]	To indicate progress towards virtual elimination of zero discharge chemicals from the environment;	Rates of change in atmospheric loadings of zero discharge chemicals in the wet, dry & gaseous phases;	Magnitude of trend indicates whether virtual elimination is being achieved;
3. Open Lake Concentrations of Zero Discharge & Lakewide Remediation Chemicals[2]	To indicate whether open lake concentrations of chemicals meet water quality yardsticks (most sensitive available standard);	Measurement of zero discharge & lakewide remediation chemicals every 2 yrs. in open lake (>80 m.);	Concentrations will be considered acceptable only if 95-100% of data indicate levels below yardstick;
4. Sediment Concentrations of Zero Discharge, Lakewide Remediation & Local Remediation[3] Chemicals	Zero discharge & lakewide remediation chemicals: To indicate whether sediment concentrations meet sediment yardsticks; Local remediation chemicals: To indicate restoration of impaired uses at Areas of Concern (AOCs);	Changes in concentrations of chemicals in sediments at different depths; Upper segments of sediment cores compared to local (AOC) yardstick; Maps of extent of chemical contamination at AOCs;	Sediment Concentrations at depths within sediment core expressed in ug/g; Trends over time indicates change in 3 classes of chemicals; Sediment Concentrations in exceedance of yardsticks, or causing use impairments indicate need for further reductions;
5. Ambient Concentration Trends of Prevention/Monitor Pollutants[4] in Water, Sediment, Air/Precipitation	To indicate whether concentrations of Prevention/Monitor pollutants increase in air, water or sediment;	Bar graphs showing changes in concentrations over time in air/precipitation & water; Trends in sediment concentrations from dated sediment core profiles;	Concentrations in air, water & sediment not increasing over time will indicate levels are not negatively impacting lake; Chemicals may be added to lakewide or local remediation categories;
6. Prevention/Investigate Chemicals[5]	To determine presence/absence of chemicals in ambient air, water, sediment; To identify potential sources of chemicals;	Decisions to re-categorize these chemicals to be based on information from literature search, presence/absence in lake, & sources;	Data from ambient & source monitoring used to determine whether continued monitoring is needed; Chemicals may be added to lakewide remediation, local remediation, or prevention/monitor chemicals;

[1] Zero Discharge Chemicals: chlordane, DDT, dieldrin, dioxin, hexachlorobenzene, mercury, octachlorostyrene, PCBs, toxaphene;
[2] Lakewide Remediation Chemicals: PAHs, alpha-BHC, cadmium, heptachlor, heptachlor epoxide;
[3] Local Remediation Chemicals: aluminum, arsenic, chromium, copper, iron, lead, manganese, nickel, zinc;
[4] Prevention/Monitor Pollutants: 1,4-dichlorobenzene, 1,2,3,4-tetrachlorobenzene, mirex/photo-mirex, pentachlorobenzene, pentachlorphenol, gamma-BHC;
[5] 1,2,3,5-tetrachlorobenzene, 3,3-dichlorobenzidine, 2-chloroaniline, tributyl tin, beta & delta BHC, hexachlorobutadiene;

B. Aquatic Communities

Indicator	*Purpose of Indicator*	*Illustration of Indicator*	*Interpretation of Indicator*
1. Off shore Community - Abundance of Key Species - Presence of Exotic Species	To monitor presence & relative abundance of key species (lean & siscowet lake trout, herring) & exotics to evaluate progress toward achieving populations of self-sustaining indigenous species;	Trends in relative abundance of native & non-native fish (benthic, pelagic), plankton & benthic invertebrate species over time; Pie chart to illustrate % of community made up of exotic species;	Data will allow measure of how stressors (harvesting, exotics, nutrient loadings) affect the offshore community & indicate what regulatory solutions are needed;
2. Nearshore Community: - Abundance of Key Species - Presence of Exotic Species - Habitat Loss or Restoration	To monitor presence & abundance of key species (lean & siscowet lake trout, herring, whitefish, longnose & white suckers, walleye, slimy sculpin, *Diporeia* spp. *Mysis relica*), exotics & habitat changes to evaluate diversity & long-term sustainability of nearshore aquatic community;	Trends in abundance of native & exotic fish, plankton & benthic invertebrate species over time for each jurisdiction; Graphs illustrating trends in abundance of exotic species;	Data will allow measure of how stressors (harvesting, exotics, nutrient loadings, changes to habitat) affect the nearshore community & indicate what regulatory solutions are needed;
3. Harbour-Embayments-Estuaries Community: -Abundance of Key Species - Presence of Exotic Species - Habitat Loss or Restoration	To monitor presence & abundance of key species (walleye, yellow perch, pike, small mouth bass) exotic & benthic invertebrates (chironomids, oligochaetes, burrowing mayfly) to measure the impact of remedial action plans in Areas of Concern;	Comparison of trends in abundance of native & exotic fish, species over time at for AOC & non-AOC sites; Comparison of density of benthic invertebrates at AOC & non-AOC sites;	Data will allow measure of how stressors (as above & including water diversions, dredging, thermal loading) affect harbours, bays & estuaries; Solutions will involve educational, administrative & regulatory actions;
4. Tributary Community: - Abundance of Key Species - Presence of Exotic Species - Habitat Loss or Restoration - Self-sustaining Indigenous Species	To monitor presence & abundance of key species (brook trout, white suckers, walleye, sturgeon, burbot, other salmonines, in selected tributaries to the lake; To monitor growth & abundance or larval sea lamprey in tributaries;	Absolute abundance of juvenile salmonine fish species over time; Number of coho salmon, brown trout, rainbow trout, chinook salmon & brook trout migrating up tributaries over time; Larval lamprey growth & survival in different tributaries;	Data will allow measure of how reductions in stressors (logging, road & pipeline crossings, sedimentation, pollution, exotics, dams water diversion) tributary communities; Solutions will involve educational, administrative & regulatory actions;
5. Toxic Contaminants in Aquatic Biota	To monitor contaminants (PCB, DDT, chlordane, mercury, dioxin, DDE, dieldrin, toxaphene) in 1 prey & 1 predator species of fish from each of 4 habitat types;	Table documenting levels of the major contaminants found in each species collected from each habitat type on an annual basis;	Changes in levels of contaminants in offshore fish species provides measure of changes in atmospheric loadings to lakes; Changes in levels of contaminants in nearshore fish species provides measure of changes in point-source loadings to lake;

C. Terrestrial Wildlife

Indicator	*Purpose of Indicator*	*Illustration of Indicator*	*Interpretation of Indicator*
1. Breeding Birds (50+ species)	To monitor diversity, relative abundance & distribution of birds;	No. of taxa, relative abundance & relative distribution of over 50 breeding bird species;	Indicator provides evidence of effects of habitat change on avian communities;
2. Amphibian Populations	To monitor the diversity & relative abundance of selected amphibian species within the lake basin;	Relative abundance of amphibian species through frog/toad call surveys;	Indicator will track declines which may indicate a problem;
3. Rare& Important Plants (G_1,G_2 of TNC list)	To measure the relative abundance of rare & important plants over time;	Relative abundance of rare & important plants;	Indicator will track declines which may indicate a problem;
4. LandUse Change	To measure land use change over time (ie. forest type, edge density, age structure, landscape characteristics & forest structure);	Land use patterns measured at a level not coarser than 200 x 200 m. resolution at 5-yr. intervals;	Indicator provides evidence of habitat change;
5. Micro& Invertebrate Soil Organisms	To measure changes in the relative density & abundance of soil organisms over time;	Relative density & abundance of soil organisms over time;	Indicator will track declines which may indicate a problem;
6. Tree Swallows	To measure contaminant levels in tree swallows;	Trend in body-burdens of contaminants in tree swallows over time;	Indicator will show changes in levels of contaminants in nearby water;
7. Snapping Turtles	To measure contaminant levels in snapping turtles;	Trends in body-burdens of contaminants in snapping turtles over time;	Indicator will show changes in rates of contaminant bioaccumulation in turtles;
8. Colonial Birds	To measure relative abundance, distribution & contaminant levels in colonial birds;	Trends in relative abundance, distribution maps & contaminant levels in colonial bird populations;	Indicator will show changes in population levels which may indicate a problem, & changes in rates of contaminant concentrations over time;
9. Nocturnal Owls	To measure the relative distribution & abundance of nocturnal owl species;	Trends in relative distribution & abundance of nocturnal owl species;	Indicator will show changes in population levels & distributions which may indicate a problem;
10. Federally Listed Threatened& Endangered (T&E) Species	To measure the relative distribution & abundance of T&E species;	Trends in relative distribution & abundance of T&E species;	Indicator will show changes in distribution & abundance which may indicate a problem;
11. Exotic Plants& Terrestrial Animals(i.e. Gypsy Moth)	To measure the relative distribution & abundance of exotic plants & animals;	Trends in relative distribution & abundance of exotic plants & terrestrial animals;	Indicator will show increases which may indicate a worsening situation;
12. Medium-sized Carnivores	To measure the relative distribution & abundance of carnivores;	Trends in relative distribution & abundance of medium-sized carnivores;	Indicator will show declines which may indicate a problem;
13. White-tailed Deer	To measure the relative abundance of deer;	Trends in relative abundance of deer;	Indicator will show population impacts;
14. Ruffed Grouse	To measure the relative distribution & abundance of grouse;	Trends in relative distribution & abundance of grouse;	Indicator will show declines which may indicate a problem;

C. Terrestrial Wildlife

Indicator	*Purpose of Indicator*	*Illustration of Indicator*	*Interpretation of Indicator*
15. Lichens/Mosses / Fungi	To measure the relative distribution, abundance and growth of lichens, mosses & fungi;	Trends in relative distribution, abundance and growth of lichens, mosses, fungi;	Indicator will show declines in population/growth which may indicate a problem;
16. Common Loons	To measure productivity & contaminant levels in common loons;	Trends in population productivity & contaminant levels in common loons;	Indicator will show levels of mercury bioaccumulation, & effects of habitat alteration;

D. Habitat

Indicator	*Purpose of Indicator*	*Illustration of Indicator*	*Interpretation of Indicator*
1. Stream Flow/Sedimentation	To monitor stream flows & sediment transport to track changes in land use patterns;	Line graphs of mean discharge, stream base flow, peak-to-low ration & sediment loading for streams on annual basis;	Changes in these parameters (e.g. increased frequency of peaking; increased sediment transport) indicate watershed degradation;
2. Benthic Invertebrates	To monitor trends in density & species richness of benthic invertebrate communities in streams, estuaries, inland lakes;	Graphical illustration of benthic community measures (density, taxonomic richness, diversity indices) & physical properties (pH, turbidity, nutrients) for comparison between site and temporal patterns;	Water quality & status of benthic invertebrate communities to detect problem sources and indicate need for mitigation measures;
3. Inland Lake Transparencies	To monitor clarity of inland lakes to determine changes in water quality over time;	Maps of secchi depth readings for lakes to indicate changes in water clarity over time;	Changes in water clarity may provide an indication of the overall ecosystem health of inland lakes;
4. Forest Fragmentation	To monitor patterns of landscape composition & pattern to track forest fragmentation;	Bar or line graphs of metrics including class area, mean patch size, patch size variability, total forest edge, nearest-neighbor distance etc. to indicate changes over time;	Decreases in forested area, mean patch size, increases in nearest-neighbor distance & patch edge indicate increased forest fragmentation, and the potential for forest species declines;
5. Accessible Stream Length	To monitor increases in total wetland area & accessible stream length to track habitat rehabilitation and protection efforts.	GIS-based system providing maps & graphs of changes in wetland area and accessible stream length.	Increases in wetland area, accessible stream length will provide indicators in positive change in lake's ability to produce fish & other aquatic life.

E. Human Health

Indicator	*Purpose of Indicator*	*Illustration of Indicator*	*Interpretation of Indicator*
1. Fish Contaminants	To monitor levels of contaminants in fish to provide information on human exposure;	Bar graphs showing fluctuation of contaminants over time & space; Contaminants will be summed to provide overall indicator of fish contamination;	Data will be used to monitor changes in contaminant levels for remedial plans, & for the issuing of contaminant advisories to public re: consumption limits;
2. Drinking Water Quality	To monitor quality of raw, treated and distributed water for comparison to water quality objectives & guidelines;	Bar graphs of geometric averages of contaminant concentrations (lead, trihalomethanes, nitrates, benzo[a]pyrene, mercury, etc.) in raw, treated & distributed levels to show trends over time;	Indicator would reveal trends in contaminant levels in water in various locations throughout the lake;
3. Recreational Water Quality	To monitor beach postings and *E. coli* counts spatially & temporally throughout the lake;	Bar graphs showing trends over time for *E. coli*, beach closures & contaminant levels;	Data will show seasonal and local trends in recreational water quality to aid in beach management & prediction of poor water quality episodes;
4. Air Quality	To monitor concentrations of 9 contaminants at 99 sites throughout the lake to provide an index of air quality;	Bar graphs of geometric means showing trends for each pollutant & air quality index over time;	Data will show overall air quality trends & allow regulatory agencies to monitor the effects of remedial plans;
5. Radionuclides	To monitor concentrations of whole milk for radionuclides;	Bar graphs of cesium & strontium concentrations in milk over time; Bar & line graphs showing total radiation as a % of MAC;	Indicator will provide a measure of the overall exposure of the population to radionuclides from weapons fallout;
6. Body Burdens	To monitor concentration of toxic contaminants in human tissue to determine delivered doses of chemicals;	Methods for illustrating trends in contaminants in human tissue to be determined; May measure contaminant levels in mother's milk;	Body burden information is useful to delineate potential from actually delivered doses of chemicals;
7. Health Effects	To monitor the occurrence or change in rate of adverse health outcomes directly linked to contaminant effects;	Measures such as birth weight, gestational age & malformations of infants will be plotted over time;	Trends in such measures may indicate contaminant effects, or changes in prenatal care;
8. Cohort Indicator of Exposure and Effects	To repeatedly monitor cohort of people within the basin for exposure indicators & expression of health effects;	Epidemiological techniques will be used to illustrate trends in exposure and health effects;	Indicator will help link human health outcomes to levels of contaminant exposure;

F. Developing Sustainability

Indicator	*Purpose of Indicator*	*Illustration of Indicator*	*Interpretation of Indicator*
1. Reinvestment in Natural Capital	To monitor balance between what is extracted from social & natural basis for life, & what is returned to the land & society; To promote projects designed to facilitate an equitable balance in future;	Measures include: amount of sustainable forestry, extent of watershed management & restoration programs, native fisheries & wildlife stocking, exotic species control & native plant repatriation, reclamation of mines and industrial sites, replacement of wetlands & biotic diversity;	
2. Quality of Human Life	To measure a range of social indicators to indicate the quality of life in the basin;	Measures include: incidence of crime, migration demographics, demands for social services, transportation infrastructure status, recreational & cultural opportunities, citizen involvement in decision making, public access to lakeshores, population density;	
3. Resource Consumption Patterns	To monitor types & quantities of resources consumed in basin, such as energy, water use & waste stream loadings;	Measures include: recycling programs, forest & mining resources remaining in basin, types of electric power generation, quality & volume of aquifers, tourism, depletion of wildlife and fisheries, landfill capacity & incineration volume, urban sprawl, loss of native flora;	
4. Awareness of Capacity for Sustainability	To implement a range of educational programs focusing on sustainability & to assess social conduct;	Measures include: environmental & sustainability education in schools, promotion of resource conservation programs, incorporation of ecological design into building codes, zoning regimes, popular support for environmental regulations, community outreach programs by natural resource agencies, media coverage of sustainability-related issues;	
5. Economic Vitality Measures	To understand the threats & opportunities to economic health of watershed, & implement projects to demonstrate sustainable alliance between environmental & economic sectors.	Measures include: per capita income, cost of living, extent of poverty, local employment trends, regional trade balance, diversity of communities economies, facilitation of transitional economics, value-added industry, regional & local tax bases.	

Appendix V
Lake Superior Metadata Requirements

In 1996, the governments of the Lake Superior Binational Program released the *Ecosystem Principles and Objectives, Indicators and Targets for Lake Superior* Discussion Draft. One of the goals of the document is to facilitate progress towards a set of informative ecosystem indicators by which the health of the Lake Superior Basin ecosystem can be assessed. Quantitative targets of these indicators are used to measure its physical, biotic and cultural elements. The first step towards meeting this goal is to identify and compile indicator and monitoring information that is being gathered by researchers and resource managers throughout the Lake Superior Basin. To produce a comprehensive inventory of existing monitoring programs within the Lake Superior Basin, the following metadata are required for each monitoring program.

(NOTE: This form is based on the International Joint Commission Council of Great Lakes Research Managers (IJC-CGLRM) research inventory questionnaire. If you have completed the IJC-CGLRM inventory, complete only questions 1,2, 5, 6 and 7 of this form and we will search for your contribution on the IJC website. Thank you for your cooperation and participation.)

****

1. Title of monitoring / research program:

2. Project Leader or contact person for this program:

Name:

Organization/Agency:

Address:

City:

State/Province:

Zip Code / Postal Code:

Phone/ FAX:

E-mail:

Web page (if any):

3. Briefly describe (1-2 sentences) your monitoring program.

4. Information regarding what is being indicated in your monitoring program:

a) Purpose of the monitoring activities?

b) Scale of phenomena / process (check as many as apply):

physical / chemical	**biochemical**	**cellular**
organism	**community**	**ecosystem**
population	**landscape**	**other:**

c) Type of phenomena / process being monitored (check as many as apply):

i. Impact of Pollutants

ii. Exotic Species

iii. Natural Ecological Processes

iv. Natural Physical/Geological Processes

v. Treatment/ Manufacturing Processes

vi. Land Use and Habitat

vii. Resource Management

viii. **Socio-economic**

ix. **Others**

d) Briefly describe how the information is collected (i.e. surveys, aerial photography, census, cruises).

e) Start date of the program (MM/DD/YY):

f) How long is the monitoring program planned to continue? (If not planned to continue, please include end date.)

g) Frequency of monitoring?

h) Length of time series?

i) Geographic scope of the monitoring program?

j) Ecological feature being monitored (check as many as apply):

nearshore
open water
tributary mouth
watershed
other:

k) What, if any, are the unmet needs of your monitoring efforts?

5. Reporting Methodologies :

a) How are outcomes reported?

b) Is data stored in a database? Yes ð No ð

If "Yes", in what format?

6. Information regarding the Lake Superior Bi-national Program (LSBP):

a) Are you aware of the LSBP? Yes ð No ð

b) Are you familiar with the *Ecosystem Principles and Objectives, Indicators and Targets for Lake Superior* report?
Yes ð No ð

c) Is your data available to the Lake Superior Binational Program Work Group?

Yes ð No ð Please contact me ð

d) In the future, LSBP will be compiling results from monitoring programs to report against their ecosystem indicators. Would you be willing to contribute a brief summary of your results (a graph, table, or paragraph) to this initiative?

Yes ð No ð

7. Comments or suggestions are welcomed.

Appendix VI
Metadata Summaries for Six Theme Committees

Chemical Contaminants

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
2	MISA Program - Municipal Industrial Strategy for Abatement	Tym Garside, garsidety@ene.gov.on.ca, 705-949-4640	Ontario Ministry of the Environment	Program to monitor/limit effluent discharges to regulate industrial discharges and track trends associated with abatement applications	Chem. Contaminants/ 1-2, 5-6
5	Lake Superior Fisheries Monitoring in Minnesota Waters (also used in other US and Ontario waters)	Don Schreiner, don.schreiner@dnr.state.mn.us, 218-723-4785	Minnesota Dep't. of Natural Resources, Fisheries	Assess rehabilitation of stocks and monitor stocking events, assess harvesting and effects of various regulations, monitor fish flesh contaminants and biological parameters in fisheries.	Aquatic Communities/ 1-4 Dev. Sustainability/ 1, 3 Chem. Contaminants/ 1 Human Health/ 1
6	USEPA Environmental Monitoring and Assessment Program (EMAP) - Great Lakes	Stephen Lozano, lozano.stephen@epa.gov, 218-529-5205	US Environmental Protection Agency	Monitoring to estimate current status and trends in selected indicators of ecological health in Great Lakes (pollutants, exotic species, benthos, etc.)	Aquatic Communities/ 1-4 Chem. Contaminants/ 1-6
12	Indicies of Biological Integrity Development	Scott Niemela, 651-296-8878, scott.niemela@pca.state.mn.us	Minnesota Pollution Control Agency	Once IBI's are developed the intention is to sample streams on a five year cycle. The results of the sampling will be used to evaluate over-all condition, effectiveness of previous control actions taken, and to gather discharge information on ten basins in Minnesota including the Lake Superior basin.	Aquatic Communities/ 4 Chem. Contaminants/ 6 Habitat/ 1, 5 Dev. Sustainability/ 3
15	Turkey Lakes Watershed	Dean Jeffries, Dean.Jeffries@cciw.ca, 905-336-4969	Environment Canada	Multi-agency, multi-disciplinary study of air and precipitation, surface, soil and ground waters, terrestrial and aquatic biota in watershed draining into Lake Superior, initiated to evaluate effects of anthropogenic perturbations on ecosystems within Precambrian Shield	Aquatic Communities/ 1-3, 5 Chem. Contaminants/ 1-6

Chemical Contaminants (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
17	Great Lakes Water Quality Survey Studies	Glen Warren, warren.glenn@epa.gov, 312-886-2405	US Environmental Protection Agency	Monitoring surveys of open waters of Lake Superior for biological, chemical and physical water quality data to evaluate long-term trends in ecosystem health	Aquatic Communities/ 1 Chem. Contaminants/ 1, 3, 6
18	Great Lakes Fish Monitoring Program	Sandy Hellman, hellman.sandra@epa.gov, 312-353-5006	US Environmental Protection Agency	Monitoring of fish contaminants for long-term trends and human health implications	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
20	State-wide Lake and Steam Management Planning	Al Stevens, al.stevens@dnr.statemn.us, 651-297-3287	Minnesota Dep't. of Natural Resources, Fisheries	To develop fisheries management plans (lake and streams), evaluate management actions, and monitor long term trends in fish communities and aquatic resources health.	Chem. Contaminants/ 1, 6 Aquatic Communities/ 1-5 Habitat/ 1, 3, 5 Dev. Sustainability/ 1, 3
21	Minnesota Fish Contaminants Program	Pat McCann, patricia.mccann@health.state.mn.us, 651-215-0923	Minnesota Dep't. of Natural Resources	Annual contaminant monitoring of fish in lakes and rivers	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
22	Michigan's Fish Contaminant Monitoring Program	Bob Day, dayrm@state.mi.us, 517-335-3314	Michigan Dep't of Environmental Quality	Annual contaminant monitoring of fish	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
23B	Fish Contaminant Monitoring Program	Mark Ebener, mebener@northernway.net, 906-632-0073	Inter-tribal Fisheries Assessment Program	Contaminant monitoring of lake trout and whitefish on 3 yr. basis	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
23B	Fish Contaminant Monitoring Program	Mark Ebener, mebener@northernway.net, 906-632-0073	Inter-tribal Fisheries Assessment Program	Contaminant monitoring of lake trout and whitefish on 3 yr. basis	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
29	National Contaminant Biomonitoring Program	Anthony Frank, Anthony_Frank@usgs.gov, 304-724-4503	US Geological Survey	Monitoring to document trends in occurrence of persistent toxic chemicals in fisheries	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1

Chemical Contaminants (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
31	Effects of Global Climate Change on Great Lakes Wetlands	Kurt Kowalski, Kurt_Kowalski@usgs.gov	US Geological Survey	Long-term data on responses of wetlands to warming events through paleoecological analyses of sediment cores	Habitat/ 2, 5 Chem. Contaminants/ 5, 6
32	Environmental Effects of Industrial Effluents	Jim Sherry, Jim.Sherry@cciw.ca, 905-336-4813	Environment Canada	Development and use of in vivo and in vitro techniques to assess ability of industrial effluents to cause health effects in aquatic ecosystems	Aquatic Communities/ 5 Human Health/ 1 Chem. Contaminants/ 1
33	Great Lakes Surveillance Program	Serge L'Italien, Serge.L'Italien@cciw.ca, 905-336-4960	Environment Canada	Open lake cruises for sampling of trace organics, nutrients, major ions and physical parameters to ensure compliance with water quality objectives, evaluate trends and identify emerging issues	Chem. Contaminants/ 1
34	Integrated Atmospheric Deposition Network	Ilora Basu, ilora@indiana.edu, 812-855-2926	Indiana University	Monitoring to estimate atmospheric deposition of organochlorine compounds to Great Lakes.	Chem. Contaminants/ 5, 1
35	Integrated Atmospheric Deposition Network	Elisabeth Galarneau, elisabeth.galarneau@ec.gc.ca, 416-739-4431	Environment Canada	Monitoring to estimate the atmospheric deposition of toxic impounds to the Great Lakes	Chem. Contaminants/ 1
37	National Contaminants Information System	Aaron Carswell, carswella@dfo-mpo.gc.ca, 905-336-4490	Fisheries & Oceans Canada	Computerized warehouse of information on toxic chemicals in fish and other aquatic life and their habitats	Aquatic Communities/ 5 Chem. Contaminants/ 1 Habitat/ 2
38	Persistence and Fate of Pesticides and Industrial Chemicals in Water	Jim Maguire, jim.maguire@ec.gc.ca, 905-336-4927	Environment Canada	Assessment of hazards of organics, organometallics and metals to aquatic organisms	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1
39	Quantifying Vertical Motion Along the North Shore of Lake Superior	Marie Zhuikov, eralph@d.umn.edu, 218-726-7677	Minnesota Sea Grant College Program	Monitoring of upwellings along north shore of Lake Superior, and their impacts on food webs and sediment distribution in the lake	Aquatic Communities/ 2, 3 Chem. Contaminants/ 1 Human Health/ 1

Chemical Contaminants (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
40	Remedial Action Plan Update	Gail Krantzberg, krantzga@ene.gov.on.ca, 419-314-7973	Ontario Ministry of the Environment	Annual review of progress towards implementing RAPs and restoring beneficial uses in Areas of Concern	Aquatic Communities/ 1-5 Chem Contaminants/ 6 Habitat/ 1-5
44	Watershed Export and Speciation of Trace Metals in the Lake Superior Basin	Linda Campbell, linda@seagrant.wisc.edu, 608-263-3259	University of Wisconsin Sea Grant Institute	Assessment of factors controlling mobility, flux and speciation of metals in Lake Superior watersheds	Chemical Contaminants/ 3, 4
46	Great Lakes Fish Contaminant Surveillance Program	Mike Whittle, whittlew@dfo-mpo.gc.ca, 905-336-4565	Fisheries & Oceans Canada	Monitoring to determine temporal and spatial trends in contaminant burdens of Great Lakes fish and the forage base	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1
47	Great Lakes Fisheries Specimen Bank	Ronald Russell, russellrw@dfo-mpo.gc.ca, 905-336-4861	Fisheries & Oceans Canada	Maintenance of a specimen bank/tissue archive for retrospective chemical and biological analyses of aquatic biota representative of Great Lakes aquatic ecosystem	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1
63	Toxaphene in the St. Louis River	Patricia King, patricia.king@pca.state.mn.us, 651-296-8727	Minnesota Pollution Control Agency	To analyze toxaphene in bottom sediment in two locations on the St. Louis River to determine if there was historical sources in the area.	Aquatic Communities/ 5, 4 Chem. Contaminants/ 1, 5 Habitat/ 2
64	Loads of Toxic Contaminants in the St. Louis River	Patricia King, patricia.king@pca.state.mn.us, 651-296-8728	Minnesota Pollution Control Agency	To perform source investigations and allocation of loads of eight contaminants of concern identified in the St. Louis River.	Aquatic Communities/ 3, 5 Chem. Contaminants/ 1, 5, 6 Habitat/ 2
65	Contaminants in Lake Superior Fish	Jerry Flom, Gerald.flom@pca.state.mn.us, 651-296-8382	Minnesota Pollution Control Agency	To determine if there was any regional differences in contamination.	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1

Aquatic Communities

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
3	Forage Fish Trawling Survey	Ken Cullis, ken.cullis@mnr.gov.on.ca, 807-475-1269	Ontario Ministry of Natural Resources	Bottom trawl survey to monitor changes in abundance and composition of forage fish, zooplankton (particular emphasis on lake herring, lake trout forage base)	Aquatic Communities/ 1, 2, 3
4	Sport Fish Monitoring	Ken Cullis, ken.cullis@mnr.gov.on.ca, 807-475-1270	Lake Superior Management Unit, Ontario Ministry of Natural Resources	Direct management decisions regarding harvest levels, seasons, catch limits and identifies angler issues for discussion and resolution. Also, provides fish attribute data for stock status determination.	Aquatic Communities/ 1-4 Dev. Sustainability/ 1, 3
5	Lake Superior Fisheries Monitoring in Minnesota Waters (also used in other US and Ontario waters)	Don Schreiner, don.schreiner@dnr.state.mn.us, 218-723-4785	Minnesota Dep't. of Natural Resources, Fisheries	Assess rehabilitation of stocks and monitor stocking events, assess harvesting and effects of various regulations, monitor fish flesh contaminants and biological parameters in fisheries.	Aquatic Communities/ 1-4 Dev. Sustainability/ 1, 3 Chem. Contaminants/ 1 Human Health/ 1
6	USEPA Environmental Monitoring and Assessment Program (EMAP) - Great Lakes	Stephen Lozano, lozano.stephen@epa.gov, 218-529-5205	US Environmental Protection Agency	Monitoring to estimate current status and trends in selected indicators of ecological health in Great Lakes (pollutants, exotic species, benthos, etc.)	Aquatic Communities/ 1-4 Chem. Contaminants/ 1-6

Aquatic Communities (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
12	Indicies of Biological Integrity Development	Scott Niemela, 651-296-8878, scott.niemela@pca.state.mn.us	Minnesota Pollution Control Agency	Once IBI's are developed the intention is to sample streams on a five-year cycle. The results of the sampling will be used to evaluate over-all condition, effectiveness of previous control actions taken, and to gather discharge information on ten basins in Minnesota including the Lake Superior basin.	Aquatic Communities/ 4 Chem. Contaminants/ 6 Habitat/ 1, 5 Dev. Sustainability/ 3
14A	Exotic Species Monitoring Program-Zebra Mussels	Ken Cullis, ken.cullis@mnr,gov.on.ca, 807-475-1231	Ontario Ministry of Natural Resources-Lake Superior Management Unit	Periodic surveys at various locations in Lake Superior determine if reproducing populations are present.	Aquatic Communities/ 1-3 Habitat/ 2 Dev. Sustainability/ 1, 2
14B	Exotic Species Monitoring Program-Ruffe Monitoring	Ken Cullis, ken.cullis@mnr,gov.on.ca, 807-475-1231	Ontario Ministry of Natural Resources-Lake Superior Management Unit	Annual Ruffe monitoring in the Thunder Bay Harbour area will determine distribution and relative abundance.	Aquatic Communities/ 1-3 Habitat/ 2 Dev. Sustainability/ 1, 2
15	Turkey Lakes Watershed	Dean Jeffries, Dean.Jeffries@cciw.ca, 905-336-4969	Environment Canada	Multi-agency, multi-disciplinary study of air and precipitation, surface, soil and ground waters, terrestrial and aquatic biota in watershed draining into Lake Superior, initiated to evaluate effects of anthropogenic perturbations on ecosystems within Precambrian Shield	Aquatic Communities/ 1-3, 5 Chem. Contaminants/ 1-6
17	Great Lakes Water Quality Survey Studies	Glen Warren, warren.glenn@epa.gov, 312-886-2405	US Environmental Protection Agency	Monitoring surveys of open waters of Lake Superior for biological, chemical and physical water quality data to evaluate long-term trends in ecosystem health	Aquatic Communities/ 1 Chem. Contaminants/ 1, 3, 6

Aquatic Communities (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
18	Great Lakes Fish Monitoring Program	Sandy Hellman, hellman.sandra@epa.gov, 312-353-5006	US Environmental Protection Agency	Monitoring of fish contaminants for long-term trends and human health implications	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
20	State-wide Lake and Steam Management Planning	Al Stevens, al.stevens@dnr.statemn.us, 651-297-3287	Minnesota Dep't. of Natural Resources, Fisheries	To develop fisheries management plans (lake and streams), evaluate management actions, and monitor long term trends in fish communities and aquatic resources health.	Chem. Contaminants/ 1, 6 Aquatic Communities/ 1-5 Habitat/ 1, 3, 5 Dev. Sustainability/ 1, 3
21	Minnesota Fish Contaminants Program	Pat McCann, patricia.mccann@health.state.mn.us, 651-215-0923	Minnesota Dep't. of Natural Resources	Annual contaminant monitoring of fish in lakes and rivers	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
22	Michigan's Fish Contaminant Monitoring Program	Bob Day, dayrm@state.mi.us, 517-335-3314	Michigan Dep't of Environmental Quality	Annual contaminant monitoring of fish	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
23A	Tribal Commercial Fish Assessments	Mark Ebener, mebener@northernway.net, 906-632-0072	Inter-tribal Fisheries Assessment Program	Collection of biological data from lake trout and whitefish in Native American commercial fisheries	Aquatic Communities/ 5
23B	Fish Contaminant Monitoring Program	Mike Ripley, mebener@northernway.net, 906-632-0073	Inter-tribal Fisheries Assessment Program	Contaminant monitoring of lake trout and whitefish on 3 yr. basis	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1

Aquatic Communities (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
26	Assessment of Lake Trout Populations in Michigan Waters of Lake Superior	Shawn Sitar, sitars@state.mi.us, 906-249-1611	Michigan Dep't. of Natural Resources	To annually determine; relative abundance, length and age composition, sex and maturity, sea lamprey wounding, growth, and mortality for lean and siscowet lake trout. To periodically determine relative abundance, diet and above listed biological parameters for lake trout varieties, other predators and forage fish at different seasons and depth strata. To determine lake trout total allowable catches.	Aquatic Communities/ 1-5 Dev. Sustainability/ 1, 3
29	National Contaminant Biomonitoring Program	Anthony Frank, Anthony_Frank@usgs.gov, 304-724-4503	US Geological Survey	Monitoring document trends in occurrence of persistent toxic chemicals in fisheries	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
32	Environmental Effects of Industrial Effluents	Jim Sherry, Jim.Sherry@cciw.ca, 905-336-4813	Environment Canada	Development and use of in vivo and in vitro techniques to assess ability of industrial effluents to cause health effects in aquatic ecosystems	Aquatic Communities/ 5 Human Health/ 1 Chem. Contaminants/ 1
37	National Contaminants Information System	Aaron Carswell, carswella@dfo-mpo.gc.ca, 905-336-4490	Fisheries & Oceans Canada	Computerized warehouse of information on toxic chemicals in fish and other aquatic life and their habitats	Aquatic Communities/ 5 Human Health/ 1 Habitat/ 2
38	Persistence and Fate of Pesticides and Industrial Chemicals in Water	Jim Maguire, jim.maguire@ec.gc.ca, 905-336-4927	Environment Canada	Assessment of hazards of organics, organometallics and metals to aquatic organisms	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1

Aquatic Communities (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
39	Quantifying Vertical Motion Along the North Shore of Lake Superior	Marie Zhuikov, eralph@d.umn.edu, 218-726-7677	Minnesota Sea Grant College Program	Monitoring of upwellings along north shore of Lake Superior, and their impacts on food webs and sediment distribution in the lake	Aquatic Communities/ 2, 3 Chem. Contaminants/ 1 Human Health/ 1
40	Remedial Action Plan Update	Gail Krantzberg, krantzga@ene.gov.on.ca, 419-314-7973	Ontario Ministry of the Environment	Annual review of progress towards implementing RAPs and restoring beneficial uses in Areas of Concern	Aquatic Communities/ 1-5 Chem Contaminants/ 6 Habitat/ 1-5
43	US Canada Great Lakes Islands Project	Karen Vigmostad, vigmo@pilot.msu.edu, 517-339-2202	Michigan State University	Binational collaboration to provide central base for activities, data, and information about the islands	Habitat/ 4 Terrestrial Wildlife/ 4 Aquatic Communities/ 2
45	Wildlife Lake Surveys	Ray Norrgard, Ray.Norrgard@dnr.state.mn.us, 651-296-3779	Minnesota Dep't. of Natural Resources	Shallow lakes surveyed to monitor macrophyte abundance ,water quality and clarity for evaluation of wildlife habitat	Habitat/ 3 Aquatic Communities/ 1, 2, 5
46	Great Lakes Fish Contaminant Surveillance Program	Mike Whittle, whittlew@dfo-mpo.gc.ca, 905-336-4565	Fisheries & Oceans Canada	Monitoring to determine temporal and spatial trends in contaminant burdens of Great Lakes fish and the forage base	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1
47	Great Lakes Fisheries Specimen Bank	Ronald Russell, russellrw@dfo-mpo.gc.ca, 905-336-4861	Fisheries & Oceans Canada	Maintenance of a specimen bank/tissue archive for retrospective chemical and biological analyses of aquatic biota representative of Great Lakes aquatic ecosystem	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1
61	USGS-Streamgaging Network	Steve Blumer, spblumer@usgs.gov, 517-887-8922	US Geological Survey, Water Resources Division	To maintain and record continuous data at: streamgaging stations, crest-stage stations, and lake level gauging stations. Miscellaneous measurements of velocity are also recorded at numerous sites.	Aquatic Communities/ 4 Habitat/ 1, 2

Aquatic Communities (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
62	Minnesota Milestone (Routine Stream) Monitoring	Sandra Bissonnette, sandy.bissonnette@pca.state.mn.us, 651-297-3575	Minnesota Pollution Control Agency	To detect water quality changes over time by continuing to record basic chemical measures of stream water quality for locations at which such measures have been collected regularly for a long period of time.	Aquatic Communities/ 5, 4 Habitat/ 2
63	Toxaphene in the St. Louis River	Patricia King, patricia.king@pca.state.mn.us, 651-296-8725	Minnesota Pollution Control Agency	To analyze toxaphene in bottom sediment in two locations on the St. Louis River to determine if there was historical sources in the area.	Aquatic Communities/ 5, 4 Chem. Contaminants/ 1, 5 Habitat/ 2
64	Loads of Toxic Contaminants in the St. Louis River	Patricia King, patricia.king@pca.state.mn.us, 651-296-8726	Minnesota Pollution Control Agency	To perform source investigations and allocation of loads of eight contaminants of concern identified in the St. Louis River.	Aquatic Communities/ 3, 5 Chem. Contaminants/ 1, 5, 6 Habitat/ 2
65	Contaminants in Lake Superior Fish	Jerry Flom, Gerald.flom@pca.state.mn.us, 651-296-8382	Minnesota Pollution Control Agency	To determine if there was any regional differences in contamination.	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1

Terrestrial Wildlife

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
1	Wildlife Assessment Program	Neil Dawson, neil.dawson@mnr.gov.on.ca, 807-939-3120	Ontario Ministry of Natural Resources	Wildlife Assessment Program established to develop long-term population monitoring of selected terrestrial vertebrates impacted by forest management activities, Monitoring includes nocturnal owl monitoring, spring woodpecker survey, avian migration monitoring, amphibian road call counts, backyard frog surveys, small mammal monitoring, salamander monitoring and forest songbird monitoring,	Terrestrial Wildlife/ 1, 2, 8, 9
10A	Bald Eagle Biosentinel Project	William Bowerman, wbowerm@clemson.edu, 864-646-2185	Clemson University	Monitoring to determine annual reproductive outcome, deformities, sex & age, health status of nesting eagles throughout Michigan, contaminants in blood/feathers measured on 5 yr. rotation	Terrestrial Wildlife/ 8, 10 Chem. Contaminants/ 1 Aquatic Communities/ 5
10B	Michigan Common Loon Survey	William Bowerman, wbowerm@clemson.edu, 864-646-2186	Clemson University	Lakes surveyed to determine loon occupancy and nesting success of a state-threatened species	Terrestrial Wildlife/ 16
11	Wisconsin Herpetological Atlas Project	Gary Casper, gsc@mpm.edu, 414-278-2766	Milwaukee Public Museum	Project involves building a distribution data base for all reptiles and amphibians in Wisconsin, to determine species range limits and habitat preferences	Terrestrial Wildlife/ 2
13A	Herring Gull Egg Monitoring Program	Chip Weseloh, chip.weseloh@ec.gc.ca, 416-739-5846 /5845	Canadian Wildlife Service	Annual monitoring of contaminant levels in Herring Gull eggs	Terrestrial Wildlife/ 8

Terrestrial Wildlife (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
13B	Colonial Waterbirds of Great Lakes Population Surveys	Chip Weseloh, chip.weseloh@ec.gc.ca, 416-739-5846 /5846	Canadian Wildlife Service	Census of breeding populations of colonial waterbirds on rotation basis	Terrestrial Wildlife/ 8
13C	Surveillance of Toxic Chemicals in Herptiles in the Great Lakes	Chip Weseloh, chip.weseloh@ec.gc.ca, 416-739-5846 /5847	Canadian Wildlife Service	Monitoring contaminant levels and impacts on herptiles	Terrestrial Wildlife/ 7
16	Status of Wildlife Populations	Margaret Dexter, margaret.dexter@dnr.state.mn.us, 651-297-4962	Minnesota Dep't. of Natural Resources	Annual compilation of hunting and trapping harvest statistics and census and survey data to determine populations estimates, hunter harvest estimates and long-term trends in wildlife populations	Terrestrial Wildlife 13
24	Forest Bird Monitoring in the Great Lakes National Forests, Forest Bird Diversity Initiative	Gerald Niemi, gniemi@d.umn.edu, 218-720-4270	University of Minnesota	Presence and abundance of forest birds collected annually in Minnesota to investigate response of forest birds to regional land use patterns	Terrestrial Wildlife/ 1, 4
27	Tree Swallow Contaminant Monitoring	Gerald Niemi, gniemi@d.umn.edu, 218-720-4270	University of Minnesota	Monitoring of sentinel species to detect areas of sediment chemical contamination	Terrestrial Wildlife/ 6
30	Effects of Organochlorine Contaminants on Avian Endocrine Systems	Angela Lorenzen, Angela.Lorenzen@ec.gc.ca, 819-953-48110	Environment Canada	Examine effects of complex mixtures of environmental organochlorine contaminants on endocrine systems in wild birds	Terrestrial Wildlife/ 1, 8
43	US Canada Great Lakes Islands Project	Karen Vigmostad, vigmo@pilot.msu.edu, 517-339-2202	Michigan State University	Binational collaboration to provide central base for activities, data, and information about the islands	Habitat/ 4 Terrestrial Wildlife/ 4 Aquatic Communities/ 2

Terrestrial Wildlife (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
48	Ruffed Grouse Monitoring	Al Stewart, StewartA@dnr.state.mi.us, 517-373-1263	Michigan Dep't. of Natural Resources	Monitoring to estimate population trends and fall hunting success	Terrestrial Wildlife/ 14
49	White-tailed Deer Monitoring	Robert Johnson, JohnsonR@dnr.state.mi.us	Michigan Dep't. of Natural Resources	Monitoring to assess population trends and yearly recruitment to set harvest limits and predict hunting success	Terrestrial Wildlife/ 13
50	Beech Bark Disease Monitoring Program	Andrew Gillespie, agillesp@hp1.nena.org, 610-975-4021	USDA-FS, Forest Health Monitoring Program	Presence/absence of the disease and or its vectors.	Terrestrial wildlife/ 11, 15
51	Hemlock Wooly Adelgid Monitoring Program	Noel Schneebergern, schneeberger@usda.gov, 610-975-4136	USDA-FS, North-eastern Area, Forest Health Protection	Presence/absence in a county.	Terrestrial Wildlife/ 15
52	Asian Longhorn Beetle Monitoring Program	Terry Goodman, terrill.d.goodman@usda.gov,	USDA-Animal and Plant Health Inspection Service, PPQ	Monitor at Ports of entry and warehouses.	Terrestrial Wildlife/ 11
53	Pine Shoot Beetle Monitoring Program	Terry Goodman, terrill.d.goodman@usda.gov,	USDA-Animal and Plant Health Inspection Service, PPQ	Presence vs. absence of insect, if present determine if the population locally established.	Terrestrial Wildlife/ 11
54	European Gypsy Moth Monitoring Program	Terry Goodman, terrill.d.goodman@usda.gov	USDA - Animal and Plant Health Inspection Service, PPQ	To monitor population outbreaks in MI and identify newly established populations in WI and MN.	Terrestrial Wildlife/ 11

Terrestrial Wildlife continued.

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
55	Federally Threatened and Endangered Species Monitoring Program	?	US Fish and Wildlife Service and Canadian Wildlife Service	To determine whether the goal of "Species of Concern (T/E) are recovered in the Lake Superior Basin" is being reached or has been met.	Terrestrial Wildlife/ 10
56	Owls ?	?	?	To determine the timing and magnitude of spring and fall migrations, develop long-term migration trends.	Terrestrial Wildlife/ 9, 1
57	Common Loon Monitoring	Joe Kaplan, piprapipra@aol.com, (207) 865-3302	BioDiversity Research Institute for contaminants monitoring-individual state.	Collect information toward the understanding and conservation of the Common Loon and to use the Common Loon as an indicator of aquatic integrity.	Terrestrial Wildlife/ 16
58	Breeding Birds Population and Community Monitoring Program	Neil Dawson, neil.dawson@mnr.gov.on.ca, 807-939-3120	Ontario Ministry of Natural Resources	To collect data on number of taxa, relative abundance and distribution. The program also monitors indications of habitat changes in the microhabitat, patch, Lake Superior basin, landscape, and Great Lakes region. Also, neotropical migrants breed in the Lake Superior basin and monitoring of those birds may provide indications of changes in neotropical habitats.	Terrestrial Wildlife/ 1, 4, 11
59	Frog and Toad Population Monitoring	?	US Geological Survey - Biological Resources Division	To determine declines in toad and frog populations with audio surveys.	Terrestrial Wildlife/ 2

Terrestrial Wildlife (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
60	Colonial Birds Population and Contaminant Monitoring	Sumner Mattison, mattes@dnr.state.wi.us, 608-266-1571	US Geological Survey - Biological Resources Division	To determine productivity information, reproductive success and contaminant data.	Terrestrial Wildlife/ 8
66	Minnesota County Biological Survey	Carmen Converse, carmen.converse @dnr.state.mn.us, 651-296-9782	Minnesota Dep't. of Natural Resources	To identify significant natural areas and to collect and interpret data on the distribution and ecology of rare plants, rare animals, and native plant communities.	Terrestrial Wildlife/ 3, 10 Dev. Sustainability/ 1, 3

Habitat

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
7	Forestry Aerial Photography	William Befort, bill.befort@dnr.state.mn.us, 218-327-4450	Minnesota Dep't. of Natural Resources	Aerial photographs taken every 8 yrs. for vegetation interpretation, terrain analysis	Habitat/ 4 Dev. Sustainability/ 3,1
8	Landsat Vegetation Mapping and Change Detection	William Befort, bill.befort@dnr.state.mn.us, 218-327-4452	Minnesota Dep't. of Natural Resources	Landsat images used to create detailed vegetation map of the state; to detect forest change and prioritize filed inventory plots for revisit	Habitat/ 4 Dev. Sustainability/ 3
9	Forest Inventory on State Lands	Gary Cummings, gary.cummings@dnr.state.mn.us, 218-327-4449 ext. 226	Minnesota Dep't. of Natural Resources	Mapped forestry inventory on 5.3 million acres in northern and eastern Minnesota to guide foresters in managing harvesting and other treatments on state forest lands	Habitat/ 4 Dev. Sustainability/ 3
12	Indicies of Biological Integrity Development	Scott Niemela, 651-296-8878, scott.niemela@pca.state.mn.us	Minnesota Pollution Control Agency	Once IBI's are developed the intention is to sample streams on a five year cycle. The results of the sampling will be used to evaluate over-all condition, effectiveness of previous control actions taken, and to gather discharge information on ten basins in Minnesota including the Lake Superior basin.	Aquatic Communities/ 4 Chem. Contaminants/ 6 Habitat/ 1, 5 Dev. Sustainability/ 3
14A	Exotic Species Monitoring Program-Zebra Mussels	Ken Cullis, ken.cullis@mnr,gov.on.ca, 807-475-1231	Ontario Ministry of Natural Resources-Lake Superior Management Unit	Periodic surveys at various locations in Lake Superior determine if reproducing populations are present.	Aquatic Communities/ 1-3 Habitat/ 2 Dev. Sustainability/ 1, 2

Habitat (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
14B	Exotic Species Monitoring Program-Ruffe Monitoring	Ken Cullis, ken.cullis@mnr,gov.on.ca, 807-475-1231	Ontario Ministry of Natural Resources-Lake Superior Management Unit	Annual Ruffe monitoring in the Thunder Bay Harbour area will determine distribution and relative abundance.	Aquatic Communities/ 1-3 Habitat/ 2 Dev. Sustainability/ 1, 2
20	State-wide Lake and Steam Management Planning	Al Stevens, al.stevens@dnr.statemn.us, 651-297-3287	Minnesota Dep't. of Natural Resources, Fisheries	To develop fisheries management plans (lake and streams), evaluate management actions, and monitor long term trends in fish communities and aquatic resources health.	Chem. Contaminants/ 1, 6 Aquatic Communities/ 1-5 Habitat/ 1, 3, 5 Dev. Sustainability/ 1, 3
25	Forest Landscape Monitoring with Remote Sensing	Peter Wolter, pwolter@sage.nrri.umn.edu, 218-720-4275	University of Minnesota	Landsat TM satellite imagery used to detect change in forest cover types, age classes, and landscape characteristics over time	Habitat/ 4 Dev. Sustainability/ 3
31	Effects of Global Climate Change on Great Lakes Wetlands	Kurt Kowalski, Kurt_Kowalski@usgs.gov	US Geological Survey	Long-term data on responses of wetlands to warming events through paleoecological analyses of sediment cores	Habitat/ 2, 5 Chem. Contaminants/ 5, 6
40	Remedial Action Plan Update	Gail Krantzberg, krantzga@ene.gov.on.ca, 419-314-7973	Ontario Ministry of the Environment	Annual review of progress towards implementing RAPs and restoring beneficial uses in Areas of Concern	Aquatic Communities/ 1-5 Chem Contaminants/ 6 Habitat/ 1-5
43	US Canada Great Lakes Islands Project	Karen Vigmostad, vigmo@pilot.msu.edu, 517-339-2202	Michigan State University	Binational collaboration to provide central base for activities, data, and information about the islands	Habitat/ 4 Terrestrial Wildlife/ 4 Aquatic Communities/ 2
45	Wildlife Lake Surveys	Ray Norrgard, Ray.Norrgard@dnr.state.mn.us, 651-296-3779	Minnesota Dep't. of Natural Resources	Shallow lakes surveyed to monitor macrophyte abundance ,water quality and clarity for evaluation of wildlife habitat	Habitat/ 3 Aquatic Communities/ 1, 2, 5

Habitat (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
61	USGS-Streamgaging Network	Steve Blumer, spblumer@usgs.gov, 517-887-8922	US Geological Survey, Water Resources Division	To maintain and record continuous data at: streamgaging stations, crest-stage stations, and lake level gauging stations. Miscellaneous measurements of velocity are also recorded at numerous sites.	Aquatic Communities/ 4 Habitat/ 1, 2
62	Minnesota Milestone (Routine Stream) Monitoring	Sandra Bissonnette, sandy.bissonnette@pca.state.mn.us, 651-297-3575	Minnesota Pollution Control Agency	To detect water quality changes over time by continuing to record basic chemical measures of stream water quality for locations at which such measures have been collected regularly for a long period of time.	Aquatic Communities/ 5, 4 Habitat/ 2
63	Toxaphene in the St. Louis River	Patricia King, patricia.king@pca.state.mn.us, 651-296-8723	Minnesota Pollution Control Agency	To analyze toxaphene in bottom sediment in two locations on the St. Louis River to determine if there was historical sources in the area.	Aquatic Communities/ 5, 4 Chem. Contaminants/ 1, 5 Habitat/ 2
64	Loads of Toxic Contaminants in the St. Louis River	Patricia King, patricia.king@pca.state.mn.us, 651-296-8724	Minnesota Pollution Control Agency	To perform source investigations and allocation of loads of eight contaminants of concern identified in the St. Louis River.	Aquatic Communities/ 3, 5 Chem. Contaminants/ 1, 5, 6 Habitat/ 2

Human Health

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
5	Lake Superior Fisheries Monitoring in Minnesota Waters (also used in other US and Ontario waters)	Don Schreiner, don.schreiner@dnr.state.mn.us, 218-723-4785	Minnesota Dep't. of Natural Resources, Fisheries	Assess rehabilitation of stocks and monitor stocking events, assess harvesting and effects of various regulations, monitor fish flesh contaminants and biological parameters in fisheries.	Aquatic Communities/ 1-4 Dev. Sustainability/ 1, 3 Chem. Contaminants/ 1 Human Health/ 1
18	Great Lakes Fish Monitoring Program	Sandy Hellman, hellman.sandra@epa.gov, 312-353-5006	US Environmental Protection Agency	Monitoring of fish contaminants for long-term trends and human health implications	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
21	Minnesota Fish Contaminants Program	Pat McCann, patricia.mccann@health.state.mn.us, 651-215-0923	Minnesota Dep't. of Natural Resources	Annual contaminant monitoring of fish in lakes and rivers	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
22	Michigan's Fish Contaminant Monitoring Program	Bob Day, dayrm@state.mi.us, 517-335-3314	Michigan Dep't of Environmental Quality	Annual contaminant monitoring of fish	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
23B	Fish Contaminant Monitoring Program	Mark Ebener, mebener@northernway.net, 906-632-0073	Inter-tribal Fisheries Assessment Program	Contaminant monitoring of lake trout and whitefish on 3 yr. basis	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
28	Assessment of Human Tissue Levels in Great Lakes Population	Joyce Mortimer, joyce.mortimer@hc-sc.gc.ca, 613-954-5991	Health Canada	Initiate an assessment of human tissue contaminant levels in the Great Lakes basin population	Human Health/ 6, 8
29	National Contaminant Biomonitoring Program	Anthony Frank, Anthony_Frank@usgs.gov, 304-724-4503	US Geological Survey	Monitoring to document trends in occurrence of persistent toxic chemicals in fisheries	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/1
32	Environmental Effects of Industrial Effluents	Jim Sherry, Jim.Sherry@cciw.ca, 905-336-4813	Environment Canada	Development and use of in vivo and in vitro techniques to assess ability of industrial effluents to cause health effects in aquatic ecosystems	Aquatic Communities/ 5 Human Health/ 1 Chem. Contaminants/ 1

Human Health (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
36	Trends in Disease Incidents and Mortality Rates	Joyce Mortimer, joyce.mortimer@hc-sc.gc.ca, 613-954-5991	Health Canada	Summary of descriptive analyses of incidence of morbidity data (cancer, congenital anomalies) and mortality in Great Lakes Areas of Concern	Human Health/ 1
37	National Contaminants Information System	Aaron Carswell, carswella@dfo-mpo.gc.ca, 905-336-4490	Fisheries & Oceans Canada	Computerized warehouse of information on toxic chemicals in fish and other aquatic life and their habitats	Aquatic Communities/ 5 Human Health/ 1 Habitat/ 2
38	Persistence and Fate of Pesticides and Industrial Chemicals in Water	Jim Maguire, jim.maguire@ec.gc.ca, 905-336-4927	Environment Canada	Assessment of hazards of organics, organometallics and metals to aquatic organisms	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1
39	Quantifying Vertical Motion Along the North Shore of Lake Superior	Marie Zhuikov, eralph@d.umn.edu, 218-726-7677	Minnesota Sea Grant College Program	Monitoring of upwellings along north shore of Lake Superior, and their impacts on food webs and sediment distribution in the lake	Aquatic Communities/ 2, 3 Chem. Contaminants/ 1 Human Health/ 1
41	Remedial Action Plans (RAPs) and Lakewide Management Plans (LaMPs) Co-ordination	Joyce Mortimer, joyce.mortimer@hc-sc.gc.ca, 613-954-5991	Health Canada	Address human health issues in the development and implementation of Remedial Action Plans and Lakewide management plans (LaMPs).	Human Health/ 7, 8 Dev. Sustainability/ 1-5
42	Source Apportionment of Human Exposure to Urban Air Toxins	Gregory Pratt, gregory.pratt@pca.state.mn.us	Minnesota Toxics Indexing System	Measurement of personal exposure to indoor, outdoor, neighbourhood and central site concentrations of selected volatile air toxics	Human Health/ 4
46	Great Lakes Fish Contaminant Surveillance Program	Mike Whittle, whittlew@dfo-mpo.gc.ca, 905-336-4565	Fisheries & Oceans Canada	Monitoring to determine temporal and spatial trends in contaminant burdens of Great Lakes fish and the forage base	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1
47	Great Lakes Fisheries Specimen Bank	Ronald Russell, russellrw@dfo-mpo.gc.ca, 905-336-4861	Fisheries & Oceans Canada	Maintenance of a specimen bank/tissue archive for retrospective chemical and biological analyses of aquatic biota representative of Great Lakes aquatic ecosystem	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1
65	Contaminants in Lake Superior Fish	Jerry Flom, Gerald.flom@pca.state.mn.us, 651-296-8382	Minnesota Pollution Control Agency	To determine if there was any regional differences in contamination.	Aquatic Communities/ 5 Chem. Contaminants/ 1 Human Health/ 1

Developing Sustainability

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
4	Sport Fish Monitoring	Ken Cullis, ken.cullis@mnr.gov.on.ca, 807-475-1268	Lake Superior Management Unit, Ontario Ministry of Natural Resources	Direct management decisions regarding harvest levels, seasons, catch limits and identifies angler issues for discussion and resolution. Also, provides fish attribute data for stock status determination.	Aquatic Communities/ 1-4 Dev. Sustainability/ 1, 3
5	Lake Superior Fisheries Monitoring in Minnesota Waters (also used in other US and Ontario waters)	Don Schreiner, don.schreiner@dnr.state.mn.us, 218-723-4785	Minnesota Dep't. of Natural Resources, Fisheries	Assess rehabilitation of stocks and monitor stocking events, assess harvesting and effects of various regulations, monitor fish flesh contaminants and biological parameters in fisheries.	Aquatic Communities/ 1-4 Dev. Sustainability/ 1, 3 Chem. Contaminants/ 1 Human Health/ 1
7	Forestry Aerial Photography	William Befort, bill.befort@dnr.state.mn.us, 218-327-4449	Minnesota Dep't. of Natural Resources	Aerial photographs taken every 8 yrs. for vegetation interpretation, terrain analysis	Habitat/ 4 Dev. Sustainability/ 3,1
8	Landsat Vegetation Mapping and Change Detection	William Befort, bill.befort@dnr.state.mn.us, 218-327-4451	Minnesota Dep't. of Natural Resources	Landsat images used to create detailed vegetation map of the state; to detect forest change and prioritize filed inventory plots for revisit	Habitat/ 4 Dev. Sustainability/ 3
9	Forest Inventory on State Lands	Gary Cummings, gary.cummings@dnr.state.mn.us, 218-327-4449 ext. 226	Minnesota Dep't. of Natural Resources	Mapped forestry inventory on 5.3 million acres in northern and eastern Minnesota to guide foresters in managing harvesting and other treatments on state forest lands	Habitat/ 4 Dev. Sustainability/ 3
12	Indicies of Biological Integrity Development	Scott Niemela, 651-296-8878, scott.niemela@pca.state.mn.us	Minnesota Pollution Control Agency	Once IBI's are developed the intention is to sample streams on a five year cycle. The results of the sampling will be used to evaluate over-all condition, effectiveness of previous control actions taken, and to gather discharge information on ten basins in Minnesota including the Lake Superior basin.	Aquatic Communities/ 4 Chem. Contaminants/ 6 Habitat/ 1, 5 Dev. Sustainability/ 3
14A	Exotic Species Monitoring Program-Zebra Mussels	Ken Cullis, ken.cullis@mnr,gov.on.ca, 807-475-1231	Ontario Ministry of Natural Resources-Lake Superior Management Unit	Periodic surveys at various locations in Lake Superior determine if reproducing populations are present.	Aquatic Communities/ 1-3 Habitat/ 2 Dev. Sustainability/ 1, 2

Developing Sustainability (continued).

No.	Monitoring Project Title	Contact Person, E-mail, Tel.	Agency	Objective	Relevant Work Group/Indicator
14B	Exotic Species Monitoring Program-Ruffe Monitoring	Ken Cullis, ken.cullis@mnr,gov.on.ca, 807-475-1231	Ontario Ministry of Natural Resources-Lake Superior Management Unit	Annual Ruffe monitoring in the Thunder Bay Harbour area will determine distribution and relative abundance.	Aquatic Communities/ 1-3 Habitat/ 2 Dev. Sustainability/ 1, 2
19	Generating Baseline Sustainability Data for Lake Superior Basin	Kristine Bradof, kbradof@mtu.edu, 906-487-3341	Michigan Technological University	Construction of baseline 'best bet' social and economic sustainability indicators	Dev. Sustainability/ 2, 5
20	State-wide Lake and Steam Management Planning	Al Stevens, al.stevens@dnr.state.mn.us, 651-297-3287	Minnesota Dep't. of Natural Resources, Fisheries	To develop fisheries management plans (lake and streams), evaluate management actions, and monitor long term trends in fish communities and aquatic resources health.	Chem. Contaminants/ 1, 6 Aquatic Communities/ 1-5 Habitat/ 1, 3, 5 Dev. Sustainability/ 1, 3
25	Forest Landscape Monitoring with Remote Sensing	Peter Wolter, pwolter@sage.nrri.umn.edu, 218-720-4275	University of Minnesota	Landsat TM satellite imagery used to detect change in forest cover types, age classes, and landscape characteristics over time	Habitat/ 4 Dev. Sustainability/ 3
26	Assessment of Lake Trout Populations in Michigan Waters of Lake Superior	Shawn Sitar, sitars@state.mi.us, 906-249-1611	Michigan Dep't. of Natural Resources	To annually determine; relative abundance, length and age composition, sex and maturity, sea lamprey wounding, growth, and mortality for lean and siscowet lake trout. To periodically determine relative abundance, diet and above listed biological parameters for lake trout varieties, other predators and forage fish at different seasons and depth strata. To determine lake trout total allowable catches.	Aquatic Communities/ 1-5 Dev. Sustainability/ 1, 3
41	Remedial Action Plans (RAPs) and Lakewide Management Plans (LaMPs) Co-ordination	Joyce Mortimer, joyce.mortimer@hc-sc.gc.ca, 613-954-5991	Health Canada	Address human health issues in the development and implementation of Remedial Action Plans and Lakewide management plans (LaMPs).	Human Health/ 7, 8 Dev. Sustainability/ 1-5
66	Minnesota County Biological Survey	Carmen Converse, carmen.converse@dnr.state.mn.us, 651-296-9782	Minnesota Dep't. of Natural Resources	To identify significant natural areas and to collect and interpret data on the distribution and ecology of rare plants, rare animals, and native plant communities.	Terrestrial Wildlife/ 3, 10 Dev. Sustainability/ 1, 3

Appendix VII

List of Funding Sources

Funding Source	Contact Information
Conservation and Re-investment act of 1999	The Heartland Institute – think@heartland.org
Permanent Protection for America's Resources	www.house.gov/resources/106cong/democrat/endorse.html
Michigan Sea Grant	Www.engin.umich.edu/seagrant/
Great Lakes Fishery Commission	www.glfc.org/
International Joint Commission	www.ijc.org/
FedNor	www.fednor.ic.gc.ca
Human Resource Development Canada	www.hrdc-drhc.gc.ca/
Ontario Innovation Trust	www.oit.on.ca
Friends of the Environment	www.fef.ca
The Richard Ivey Foundation	www.ivey.org/