

6.0 Proposed Lake Huron Indicators

Environmental indicators communicate information about the environment and about the human activities that affect it. When communicated effectively, the indicator highlights problems and draws attention to the effectiveness of current policies. The target audiences are the public and the decision makers. To command their attention, indicators must be relevant, and they must communicate value. Choosing an indicator reflects a set of values that is perceived as being important. Key to an indicator's selection, acceptance and usefulness is consultation with stakeholders throughout the procedure to develop environmental indicators. The development of indicators and evaluation of progress are dynamic, interactive and evolving processes that will require continued cooperation.

The indicators characterize specific desired outcomes that answer questions. Indicators must provide objective information in order to identify the cause of a problem and its relative weight. Indicators must quantify information to make its significance apparent, and must simplify that information to improve communication.

Environmental indicators are a measure of environmental condition such as ecological integrity, aquatic health, human health, or quality of life. Environmental indicators can measure trends over time in changes or non-changes in environmental and ecological conditions. Environmental indicators can function as an early warning signal for identifying environmental concerns, and they are a valuable tool for measuring progress towards achieving of identified environmental goals. When properly developed and utilized, environmental indicators will affect improvements in environmental conditions, with clear linkages showing the effectiveness of programs or other activities to successfully control environmental stressors.

Environmental indicators are a useful tool for identifying pressures on the ecosystem, the state of the environment due to these pressures, and the response or action taken by environmental agencies or other parties to address the environmental conditions and pressures.

Indicators can provide guidance on needs, priorities and policy effectiveness, but only if decision-makers consider them useful and use them. If decision-makers are responsive to comments and insights about programs and policies, then policy evaluation, formulation and effectiveness will be improved, as will the end points or goals of those policies.

When considering an indicator consideration of the following factors is essential:

- Is the indicator necessary, does it address an issue of significant importance?
- Is the indicator sufficient, does it provide information about spatial or temporal changes?
- Is it based on a well-understood and generally accepted conceptual model?
- Is the indicator relevant, does it provide information about major environmental change?
- Is it feasible to collect data (monitor) for interpretation of the indicator and has past experience demonstrated the reliability of the indicator?
- Does the indicator provide a scientifically sound protocol?

Indicators Background

The goal of the Lake Huron Initiative effort is:

to restore and maintain the chemical, physical, and biological integrity of the waters, tributaries, and nearshore terrestrial and aquatic ecosystems of Lake Huron.

In a straightforward, understandable form, indicators must communicate specific information about progress regarding the goal of the Lake Huron Initiative and on the adequacy of programs and policies to achieve the goal.

Indicators should answer such questions as:

- What is the current state of Lake Huron?
- What are trends? Are we making progress toward achieving the goal?
- What and where the causes are (stresses)?
- Are present protection, restoration and pollution prevention programs, policies, processes, and practices working?

The indicators chosen for Lake Huron should accurately reflect the importance of the beneficial use impairments identified for Lake Huron those are:

- Restrictions on fish or wildlife consumption
- Degradation of fish or wildlife populations
- Loss of fish or wildlife habitat

The indicators should also reflect the desired outcome in addressing the use impairments as shown in Table 44:

Table 44. Beneficial Use Impairments with Desired Outcomes.

Beneficial Use Impairment	Desired Outcome
Restrictions on fish or wildlife consumption	There shall be no restrictions on the human consumption of fish in Lake Huron basin ecosystem as a result of anthropogenic (human) inputs of persistent toxic substances.
Degradation of fish or wildlife populations	Maintenance of the ability of fish and wildlife populations to function normally in the absence of severe environmental stress (ecosystem health) and to cope with changes in environmental conditions which impose stress, <i>i.e.</i> to be able to maintain their processes of self-organization on an ongoing basis (ecological integrity). Maintenance of the diversity of biological communities, species and genetic variation within species.
Loss of fish or wildlife habitat	Land development and use compatible with maintaining aquatic habitat of a quantity and quality necessary and sufficient to sustain an endemic assemblage of fish and wildlife populations.

International Joint Commission, 1996.

The Lake Huron Initiative effort has identified proposed indicators for Lake Huron. The Initiative identified potential indicators for Lake Huron and those indicators were the topic of discussion at the State of the Lakes Ecosystem Conference 2000 Lake Huron Initiative breakout session. Comments were received on the proposed indicators including the identification of additional potential indicators. The comments received were used to revise the original indicators and resulted in the following list.

Proposed Lake Huron Indicators

The indicators identified in Table 45 are the indicators identified as potentially important for Lake Huron. The list indicators is provided to help generate discussion and is based on previous work completed in support of the State of the Lakes Ecosystem Conferences (SOLEC), the International Joint Commission, Fish Community Objectives, the Great Lakes Fishery Commission, and others. This list was derived from the report: *Selection of Indicators for Great Lakes Basin Ecosystem Health - Version 4*, Appendix 2 and has been modified based on comments provided through SOLEC 2000 (October 2000) and the Lake Huron State of the Lake Symposium (March 2001). The table includes:

- Indicator number and code (CP = Critical Pollutants, H = Physical Habitat, F = Fisheries, O = Other Issues) (code = SOLEC Indicator code).
- Indicator name,
- What the indicator measures,
- Has indicator been proposed for the SOLEC Indicator List (C.R. = Concept Retained in another indicator).

The table also identifies the indicators that were identified as having high priority for implementation. These indicators were identified at the 2002 Lake Huron Workshop as the indicators most appropriate for implementation.

Table 45 identifies the additional proposed list of Lake Huron Indicators.

Table 45. List of Lake Huron Indicators.

Indicators for Critical Pollutants

Indicator Number	Indicator Name	Measure	Priority H	SOLEC Indicator
CP – 111	Phosphorus Concentrations and Loadings	Total phosphorus levels (ug/L) in the springtime open waters, and annual total phosphorus loads to each lake.	High	Yes
CP – 114	Contaminants In Young-of-the-Year Spottail Shiners	Concentration of PBT chemicals in young-of-the-year spottail shiners (contaminant trends). The use of lake perch should also be considered.	High	Yes
CP – 115	Contaminants in Colonial Nesting Waterbirds	1) Annual concentrations of DDT complex, PCBs, Dioxins and other organic contaminants and Hg and other metals in Herring Gull eggs from sites in Lake Huron (U.S. and Canada). 2) Periodic measurement of biological features of gulls and other colonial waterbirds known to be directly or indirectly impacted by contaminants and other stressors. 3) Reporting of Saginaw Bay data separate from that of other Lake Huron collection sites.	High	Yes, with separate reporting of Saginaw Bay data
CP – 117	Atmospheric Deposition of Toxic Chemicals	Annual average loadings of toxic chemicals from the atmosphere to Lake Huron based on measured atmospheric concentrations of the chemicals, as well as wet and dry deposition rates.	High	Yes
CP - 118	Toxic Chemical Concentrations in Offshore Waters	The concentration of toxic chemicals in the offshore waters of Lake Huron.	High	Yes
CP - 4081	<i>E. coli</i> and Fecal Coliform Levels in Nearshore Recreational Waters	Monitoring <i>E. Coli</i> at all beaches on Lake Huron and focusing on Saginaw Bay and southeast Lake Huron. Should include 1) Counts of <i>E. coli</i> and/or fecal coliforms in recreational waters measured as number of organisms per volume of water and 2) Frequency of beach closings at specific locations.	High	Yes
CP - 4083	Contaminants in Edible Fish Tissue	Concentration of persistent, bioaccumulative toxic chemicals targeted by the Great Lakes Water Quality Agreement in edible fish tissue. Focus on lake trout and whitefish. Also include dissolved organic carbon, particulate organic carbon (in water column) and lipid content in fish tissue.	High	Yes
CP - 4090	Radionuclides	Concentration of H-3 (tritium) in surface water - southeast Lake Huron.	High	Yes

CP - 4516	Sediment Flowing Into Coastal Wetlands	Suspended Sediment Unit Area Yield (tonnes/km ² of upstream watershed) for a representative set of existing monitoring sites just upstream of coastal wetlands.		Yes
CP - 8135	Contaminants Affecting Productivity of Bald Eagles	1) Concentrations of DDT Complex, PCB, PCDD, and other organic contaminants and mercury and other heavy metals in Bald Eagle eggs, blood, and feathers; 2) number of fledged young produced; and 3) number of developmental deformities. Should also include osprey monitoring. Differences between contaminant levels in inland versus coastal bald eagles.	High	Yes, with addition of osprey monitoring
New	Contaminants in Snapping Turtles	Concentrations of persistent, bioaccumulative toxic chemicals in snapping turtles.	High	Yes

Indicators for Physical Habitat

Indicator Number	Indicator Name	Measure	Priority	SOLEC Indicator?
H - 4510	Coastal Wetland Area by Type	Quality and area of coastal wetlands by type (e.g., dry year/low water level area versus wet year/ high water level area).	High	Yes, revised
H - 4511	Gain in Restored Coastal Wetland Area by Type	Gain in restored wetland area by type.	High	Yes
H - 7041	Cottage and Second Home Development	Number of new residences in the nearshore and whether development is under restrictive zoning to protect the nearshore.	High	C.R.(7002, 7027) revised
H - 7055	Habitat Adjacent to Coastal Wetlands	Land use within 1 kilometer (km) of coastal wetlands.	High	Yes, revised
H - 8114	Habitat Fragmentation	The pattern of natural habitat remaining within ecoregions/subsections, as measured by: 1) area to perimeter ratio, 2) size and 3) percent intact cover for habitat patches.	High	Yes, revised
H - 8131	Extent of Hardened Shoreline	Kilometers of artificially hardened shoreline. (Does not include artificial coastal structures such as jetties, groynes, breakwalls, piers, etc.). This should include estimation of area of hardened shoreline that disrupts ecological functions of the shoreline area (e.g., coastal wetlands, dune areas, delta wetlands and eroding bluff areas).	High	Yes, revised
H - 8149	Protected Nearshore Areas	Percentage of main lake shoreline in protective status. Categorized in one of six International Union for the Conservation of Nature (IUCN) classes: 1) strict protection, 2) ecosystem conservation and recreation, 3) conservation of natural features, 4) conservation through active management, 5) protected landscapes, and 6) managed resource protected areas.	High	Yes

Indicators for Fisheries

Indicator Number	Indicator Name	Measure	Priority	SOLEC Indicator?
F - 6	Fish Habitat	Population of sentinel fish species. For example, the measures for tributary quality could include the number of dams, number of miles of river channel that is impounded, number of miles of (formerly) high-gradient stream	High	Yes, partial

		channel that is impounded, miles of river channel connected to Lake Huron and the number of miles between the river mouth and the first dam. The number and location of fish passage facilities (up- and downstream) that could be used successfully by species or communities of concern (for example, lake sturgeon, or other anadromous fishes listed in FCGO).		
F - 9	Walleye	Abundance, biomass, or annual production of walleye populations in historical, warm-coolwater, mesotrophic habitats of Lake Huron. Populations of restoring self-sustaining stocks.	High	Yes - modified
F - 9	<i>Hexagenia</i>	Abundance, biomass, or annual production of burrowing mayfly (<i>Hexagenia</i> spp.) populations in historical, warm-coolwater, mesotrophic habitats of Lake Huron. Presence or absence of a <i>Hexagenia</i> mating flight (emergence) in late June- July in areas of historical abundance.	High	Yes-modified
F - 17	Preyfish Populations	Abundance and diversity, as well as age and size distribution, of preyfish species (i.e., deepwater ciscoes, sculpins, lake herring, rainbow smelt, and alewives) in Lake Huron.	High	Yes
- F				
F - 93	Lake Trout and Scud (<i>Diporeia hoyi</i>)	Abundance, yield, or biomass, and self-sustainability of lake trout and scud (<i>D. hoyi</i>) in coldwater, oligotrophic habitats of Lake Huron.	High	Yes
F - 104	Benthos Diversity and Abundance	Species diversity and abundance in the aquatic oligochaete community.	High	Yes
F - 9002	Non-native Species: Aquatic	Assess the presence, abundance and distribution of invasive non-native aquatic species in the Lake Huron and tributaries and their impacts on ecosystem functioning. <i>This indicator is under development.</i>	High	Yes

Indicators for Other Issues

Indicator Number	Indicator Name	Measure	Priority	SOLEC Indicator?
O - 8	Salmon and Trout	1) Productivity, yield, or harvest of Pacific salmon, rainbow trout and brown trout using abundance (e.g., catch of each species in a given unit of sampling effort), or biomass metrics; 2) populations of stocked and naturally produced fish; and populations of wild or self-sustaining salmonine harvest/yield.		Yes
O - 109	Phytoplankton Populations	Phytoplankton biomass (species and size composition) and size-fractionated primary productivity (Carbon-14 uptake or photosynthesis) as indicator of microbial food-web structure and function.		Under Consideration
O - 116	Zooplankton Populations	Community composition; 2) Mean individual size; and 3) Biomass and production.		Yes
O - 4501	Coastal Wetland Invertebrate Community Health	Relative abundance of sensitive taxa (e.g., mayflies, caddis flies), tolerant taxa (e.g., Chironomina as a proportion of total Chironomidae abundance, Isopoda), richness of specific taxa, and functional feeding groups (e.g., herbivores, detritivores, carnivores), working towards the development of an Index of Biotic Integrity (IBI).		Yes

F - 4502	Coastal Wetland Fish Community Health	An Index of Biotic Integrity (IBI) will be developed based on measures of species richness and abundance, percent exotic species, percent phytophils and other appropriate parameters.		Yes
O - 4504	Amphibian Diversity and Abundance	Relative abundance and diversity of calling frogs and toads.		Yes, revised
O - 4513	Presence, Abundance & Expansion of Invasive Plants	Presence, abundance, & expansion of invasive plants (both native and non-native), such as purple loosestrife and Eurasian water milfoil.		Yes
O - 8161	Threatened Species	Number, extent, and viability of species ranked as G1-G3 or S1-S3 in the Biological Conservation Database.		Yes
New	Non-native Species: Terrestrial	Assess the presence, abundance and distribution of invasive non-native terrestrial species in and their impacts on ecosystem functioning. <i>This indicator is under development.</i>		Yes

Appendix E identifies each proposed indicator and provides a detailed explanation of the indicator.

Additional Potential Indicators

The Lake Huron Initiative identified proposed indicators for Lake Huron prior to the State of the Lakes Ecosystem Conference 2000. A Lake Huron Initiative breakout session discussion and subsequent comments identified additional potential indicators. Additional potential indicators that were identified are as shown below in Table 46.

Table 46. List of Non-SOLEC Lake Huron Indicators.

Recommended Non-SOLEC Indicators for Critical Pollutants

Indicator Number	Indicator Name	Measure
CP - 4142-4158	Organochlorines in human breast milk	Concentrations of organochlorines in breast milk (should include contaminants in blood serum)
New	River Mouth Sediments	Measurement of toxic pollutants in sediment (persistent bioaccumulative substances and organic carbon), possibly at river mouths.
New	Tributary Sediment	Identification of areas where excessive sediment is impairing fish reproduction and the benthic community.
New	Contaminants in Sea Lamprey	Contaminants in sea lamprey as an indicator of ecosystem health.

Recommended Non-SOLEC Indicators for Habitat

Indicator Number	Indicator Name	Measure
H - 21	Habitat	Quality and area of nearshore terrestrial habitat (e.g. colonial waterbird nest sites, forest cover, agricultural land, soil types, beach types, etc.).
New	Fish Health – Dissolved Oxygen	Dissolved oxygen in the nearshore areas as an indicator of fish health.
New	Native Species Biodiversity Index	Biodiversity index of native species as an indicator of ecosystem health.
New	Lake Huron Islands	Island acreage or shoreline protective status.
New	Tributary Connectivity	Number of dams, stream mile connected to Lake Huron
New	Alvars	Area and quality of alvar habitat
New	Inland Wetlands	Area and quality of inland wetland

Recommended Non-SOLEC Indicators for Fisheries

Indicator Number	Indicator Name	Measure
New	Deepwater Ciscoes	Ensure a healthy population of Deepwater Ciscoes. Bloater chubs represent the second largest harvest of the Canadian commercial fishing fleet.
F - 16	Lake sturgeon	Rehabilitate populations; delist as threatened or endangered species. Should include miles of critical spawning habitat available and presence of larvae and young-of-the-year fish.

Recommended Non-SOLEC Indicators for Other Issues

Indicator Number	Indicator Name	Measure
O - 5	Sea Lamprey	Reduce sea lamprey population by 50% by 2000; 90% by 2010
O - 109	Phytoplankton Populations	Phytoplankton biomass (species and size composition) and size-fractionated primary productivity (Carbon-14 uptake or photosynthesis) as indicator of microbial food-web structure and function.
New	Intensive Agricultural Operations	Location, frequency of occurrence, potential for impact on ground and surface waters of Intensive Agricultural Operations.
New	Outdoor Recreation	Outdoor recreation opportunity as an indicator of available recreational resources and an indicator of development pressure.
New	Groundwater Quality	Groundwater quality as an indicator of water quality and potential impact on human health
New	Communication structure	Communication structure as an indicator of the ability to respond critical environmental issues.
New	Population Change Indicator	Watercraft permits; coastal or nearshore campground, hotel and motel units; and population changes.
New	Buffer Strips	Degree to which buffer strips have been installed on Lake Huron tributaries.
New	Well Water Quality	Levels of pollutants in wells in the Lake Huron watershed
New	Combined Sewer Overflows	Degree and frequency of partially treated waste water released within the Lake Huron watershed
New		Legal, investment and institutional indicators.

The above potential indicators have been identified as topics and no additional description of the potential indicator has been developed at this time. Future effort should be committed to development of these indicators if the indicator is identified as import to the Lake Huron effort.

For additional information and detailed descriptions of the indicators listed above and additional indicators, see *Selection of Indicators for Great Lakes Basin Ecosystem Health* (U.S. Environmental Protection Agency/Environment Canada) at (www.epa.gov/grtlakes/solec/98/indicators).

Actions Needed to Develop and Implement Indicators

There are presently a number of frameworks for developing indicators and reporting on the status of the Great Lakes ecosystem. Three major processes for Lake Huron are: 1) lakewide management planning efforts (Lake Huron Initiative Action Plan) 2) Great Lakes Fishery Commission – Lake Huron State of the Lake Report and 3) the State of the Lakes Ecosystem Conference (SOLEC). The Lake Huron Initiative Action Plan and the Great Lakes Fishery Commission – Lake Huron State of the Lake Report focus specifically on Lake Huron, and issues that are of concern within the basin. SOLEC addresses the entire Great Lakes Basin, and concentrates on issues that are common to all the lakes.

For Lake Huron, SOLEC, held every two years, will be the key venue for reporting on progress regarding the development and implementation of Lake Huron indicators. Traditionally, there have been individual lake presentations made at each of SOLEC conferences.

Responsibility for Lake Huron Lakes monitoring is divided among a vast number of agencies throughout the basin. While agency programs meet their individual needs and mandate, the lack of consistency in protocols and methodology severely limits the usefulness of the resultant data for sharing, comparing and possible integration with other agency data. Agencies responsible for monitoring may use different techniques, with the end result being that the status of the monitoring results cannot be compared between jurisdictions.

One example of lake-scale cooperation effort is the Lake Michigan Monitoring Coordination Council (LMMCC). The Lake Michigan LaMP formed the LMMCC to coordinate and promote common protocols and comparability in monitoring. The Council's goals include developing collaborative monitoring strategies, facilitating shared data among agencies and the public, and identifying and promoting volunteer monitoring opportunities.

Table 47 identifies recommended priority actions for implementing Lake Huron Indicators.

Table 47. Recommended priority actions for implementing Lake Huron Indicators.

Issue	Action
<p>Institutionalize a mechanism for delivering coordinated and efficient monitoring programs and timely reporting on environmental change and progress as measured by indicators.</p>	<ul style="list-style-type: none"> • The Great Lakes Water Quality Agreement calls for the establishment of a monitoring strategy for each of the Great Lakes. The Lake Huron Initiative (or other similar effort) should consider establishing a monitoring council to: <ol style="list-style-type: none"> 1) Examine all indicators, including SOLEC, and prioritize indicators; 2) Develop a coordinated monitoring strategy to measure and report on indicators; 3) Identify monitoring gaps; 4) Promote adoption of indicators by appropriate agencies who agree to monitor and report; 5) Promote compatibility of protocols and resultant data; 6) Facilitate data access among participating agencies and the public; 7) Coordinate regular science reporting against LaMP indicators at the biennial SOLEC conferences. • Develop terms of reference for a Lake Huron monitoring council. • Develop and maintain a current and functional metadata inventory of Lake Huron agency monitoring programs, and appropriate data holdings. • Establish a rotational cycle of intensive monitoring on Lake Huron, so that a comprehensive picture can be achieved for over time. Assist in the coordination and enhancement of the efficiency of binational, basinwide monitoring programs (such as the open lake water quality and fish contaminants monitoring programs). • Explore options for developing an information management system that would integrate Lake Huron data and allow for geospatial presentation and analysis of environmental change and progress. Ensure compatibility with other existing/developing information management systems. • Consider the Saginaw River watershed as a pilot site to initiate an indicator monitoring program throughout the watershed.

Indicator Monitoring

If the indicators outlined in the preceding section are to provide information to support future management decision-making, they must be adopted by Lake Huron monitoring programs and guide the selection of parameters and media to be sampled and assessed. Numerous monitoring programs and activities are underway in the Lake Michigan basin. These programs monitor water quality, sediments, fish, air quality, and habitat. They involve collecting chemical, microbiological, fish and wildlife, physical characteristics, land use, and other environmental data. These programs exist at the federal, state, provincial and local levels.

One of the main actions needed to be undertaken is to determine whether the current monitoring coverage is sufficient to support indicators proposed. To initiate the use of indicators, a comprehensive review of monitoring programs at the federal, state, and local levels is needed. This should include an analysis of gaps, inconsistencies, and unmet needs; an assessment of the adequacy of existing efforts to support critical ecosystem indicators; and a plan for addressing major monitoring needs, particularly those considered most important for lakewide management decision-making.

Monitoring should be viewed in the broadest sense, including not only traditional water quality parameters, but also habitat, wildlife, land use, nonpoint source pollution and other measures of ecosystem health. Future project outcomes in relationship to the implementation of the indicators are expected to provide stakeholders with important information to enable them to engage their community in a valuable dialogue regarding the status of knowledge on their local area. Stakeholders will benefit from the exchange of information and the opportunity to enhance monitoring programs.