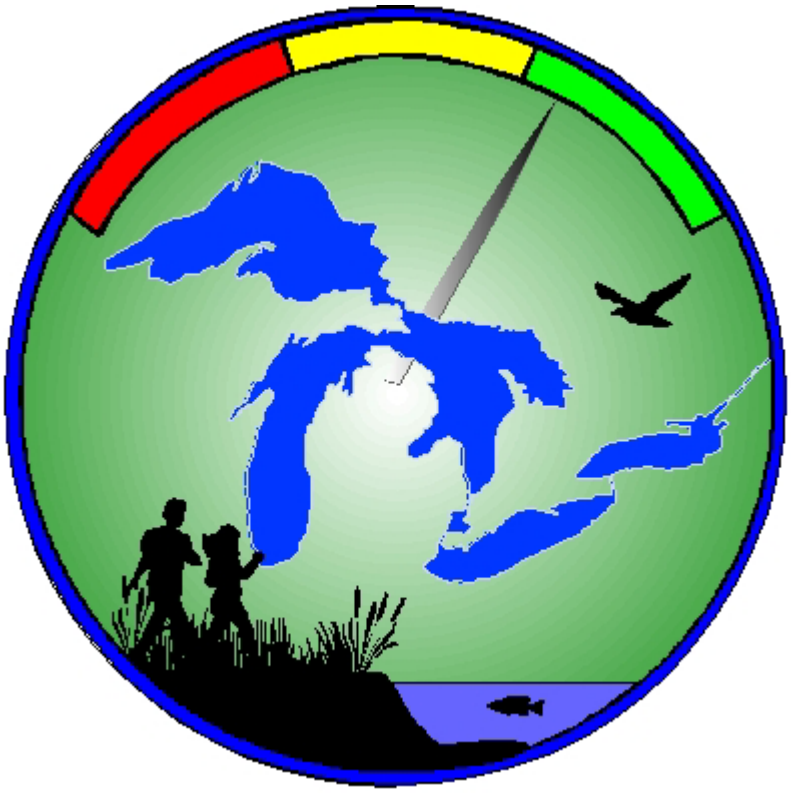
State of the Lakes Ecosystem Conference 2004



Conference Proceedings

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1. Introduction

What is SOLEC?

The State of the Lakes Ecosystem Conferences (SOLEC) are hosted by the U.S. Environmental Protection Agency and Environment Canada on behalf of the two countries. These conferences are held every two years in response to a reporting requirement of the binational Great Lakes Water Quality Agreement (GLWQA). The goal of SOLEC is to achieve the overall purpose of the GLWQA "*to restore and maintain the physical, chemical and biological integrity of the Great Lakes Basin*". The conferences are intended to report on the state of the Great Lakes ecosystem and the major factors impacting it, and to provide a forum for exchange of this information amongst Great Lakes decision-makers. These conferences are not intended to discuss the status of programs needed for protection and restoration of the Great Lakes basin, but to evaluate the effectiveness of these programs through analysis of the state of the ecosystem. Another goal of the conference is to provide information to people in all levels of government, corporate, and not-for-profit sectors that make decisions that affect the Great Lakes.

These conferences are a culmination of information gathered from a wide variety of sources and engage a variety of organizations. In the year following each conference, the Governments prepare a report on the state of the Great Lakes based in large part upon the conference process.

The first conference, held in 1994, addressed the entire system with particular emphasis on aquatic community health, human health, aquatic habitat, toxic contaminants and nutrients in the water, and the changing Great Lakes economy. This conference and SOLEC 1996 were based on a series of ad hoc indicators that were suggested by scientific experts. The 1996 conference focused on the nearshore lands and waters of the system where biological productivity is greatest and where humans have had maximum impact. Emphasis was placed on nearshore waters, coastal wetlands, land by the Lakes, impacts of changing land use, and information availability and management. Following SOLEC 96, those involved identified a need to develop a comprehensive, basin wide set of indicators that would allow the Parties to report on the progress under the Agreement in a consistent and standard format.

For SOLEC 98, the indicator development process became more regimented with the development of a comprehensive suite of easily understood indicators that objectively represented the condition of the Great Lakes ecosystem components (as called for in Annex 11 of the GLWQA). The goal is to use these indicators every two years to inform the public and report progress in achieving the purpose of the GLWQA, thus initiating a regular and comprehensive reporting system. This indicator suite would draw upon and compliment indicators used for more specific purposes such as Lakewide Management Plans (LaMPs) or Remedial Action Plans (RAPs) for Areas of Concern (AOCs). During SOLEC 98 and afterward, the suite was thoroughly reviewed and a general consensus was obtained that the suite of 80 indicators was necessary and sufficient.

Following the general acceptance of the Great Lakes suite of indicators, was the movement to begin implementing them. At SOLEC 2000, the challenge was to see how many of the 80 indicators could be reported on. In some cases this was a fairly "easy" task – data were already available for use in reporting on an indicator (by various agencies). In other cases, this task became more difficult as new data were required before they could be reported, or further research and development was required before implementing data collection efforts and then reporting on an indicator. Post SOLEC 2000 and through the winter of 2001, there was an opportunity for further review of the indicator list and for revisions to be made to the indicator suite. SOLEC 2000 was the first conference to begin the actual assessment of the

state of the Great Lakes using these science-based indicators. SOLEC 2000 featured 33 indicator assessments.

The focus of SOLEC 2002 was to continue to update and assess the state of the Great Lakes using the current suite of indicators with an emphasis on biological integrity, the theme for SOLEC 2002. "Integrity" is not specifically defined in the GLWQA; therefore the following definition was used for SOLEC 2002 and any corresponding documents.

> *"Biological integrity is the capacity to support and maintain a balanced integrated and adaptive biological system, having the full range of elements (the form) and process (the function) expected in a regions natural habitat."*
> By James R. Karr, modified by Douglas P. Dodge

SOLEC 2002, presented a candidate set of Biological Integrity indicators that would assist with reporting on Biological Integrity at SOLEC 2004. In addition, groundbreaking work had been completed on land-based indicators: forestry and agriculture. Also, a new suite of indicators was proposed for consideration to assess groundwater health. A new grouping of societal response indicators was also proposed to help in the assessment of community contribution to improving the health of the basin. SOLEC 2002 also provided revisions to current indicators in the Great Lakes suite and identified management challenges and actions. SOLEC 2002 featured 43 indicator assessments.

Since SOLEC 2002, organizers have held two reviews on the Great Lakes indicator processes and products. The first review included indicator experts from outside the Great Lakes basin. They were asked to evaluate the overall effectiveness and efficiency of the SOLEC process. In other words, how does the Great Lakes system of developing and reporting on indicators measure up with indicator systems in other parts of the world? A report by this group of reviewers concluded that, "SOLEC is not *the* world leader in indicator development, but it is *a* world leader. In particular it is a leader in the consultation process, which is one of SOLEC's greatest strengths."

The second review by stakeholders and indicator users evaluated the entire suite of current Great Lakes indicators with suggestions provided to add, remove or modify existing indicators in the suite to assist with the reporting on the state of the Great Lakes ecosystem and factors impacting it. Changes to the process for developing and reporting on Great Lakes indicators were made as a result of input from both reviews.

The modifications to existing indicators and new proposed indicators are documented in the report, *Great Lakes Indicators Suite: Changes and Progress 2004 document*.

The focus of SOLEC 2004 was to continue to update and assess the state of the Great Lakes using the current suite of indicators with an emphasis on physical integrity, the theme for SOLEC 2004. Although a physical integrity paper was not finalized in time for the conference, it will be completed during 2005 so that an assessment on the state of physical integrity in the Great Lakes basin can be reported at SOLEC 2006.

The *State of the Great Lakes 2005: Draft for Discussion* was the first attempt by SOLEC organizers to prepare a draft status report prior to the conference itself. In the past, this report was not completed until after the conference. SOLEC 2004 also marks the introduction of nine bundles of indicators which incorporate the 81 Great Lakes indicators in the suite. The bundles include: Contamination, Biotic Communities, Invasive Species, Coastal Zones, Aquatic Habitats, Human Health, Land Use – Land Cover, Resource Utilization and Climate Change. Some of these categories are under development and will require additional indicators and sub categories before being considered complete. Five of the nine indicator bundles were assessed for SOLEC 2004.

Biological Integrity of the Great Lakes basin, as reported in the biotic communities indicator bundle, was reported to be IMPROVING for Terrestrial (forestry) components and the Aquatic Open Waters assessment was MIXED, with no obvious trajectory. For more information on the bundle assessments

refer to the *State of the Great Lakes 2005: Draft for Discussion* and the Day 1 Plenary Summaries beginning on page 10 of this document.

Next Steps and Challenges

- Finalization of the physical integrity paper which will include an agreed upon definition of physical integrity. This paper will facilitate the reporting on the state of physical integrity of the Great Lakes basin at SOLEC 2006.
- Sampling of tributaries and inland surface water bodies should be used in assessing the state of the Great Lakes basin through a "watershed approach".
- The MIXED indicator assessment needs to be better explained within the indicator reports.
- Need to further develop the land use – land cover indicator bundle including the forestry and agriculture components.
- Need to report on more land-based indicators.
- Need to re-evaluate and re-organize the societal response/resource utilization sub set of indicators. There is a need to incorporate social scientists into the indicator process, especially in terms of human or societal response indicators.
- A continuing challenge is to increase ownership and commitments to indicator reporting – some agencies have accepted lead roles for the responsibility of preparing biennial indicator reports, however, many indicators are still awaiting "adoption". More agencies assuming ownership of indicators will aid in populating and reporting on the state of these indicators.
- Endpoints, targets or reference values are required for most indicators.
- Need to provide information to various levels of government, including municipalities, in a useful format (summary information as well as specific details) in order to direct policy and assist with decision-making.
- Need to make State of the Great Lakes information more accessible and available.
- Review of the Ecological Footprint analysis and the relevance to reporting an Ecological Footprint score for the Great Lakes basin.
- The theme for SOLEC 2006 is Chemical Integrity. A workshop is proposed for the fall of 2005. This workshop will further develop the ideas discussed in the Chemical Integrity workshop held on Day 3 of SOLEC 2004. This work will include the development of an agreed upon definition of chemical integrity and a subset of indicators required to report out on the state of Chemical Integrity in the Great Lakes basin. SOLEC organizers will be coordinating this workshop in conjunction with the Great Lakes Binational Toxics Strategy organizers.

2. SOLEC 2004 Highlights

- SOLEC 2004 presented the most comprehensive assessment yet of the state of the Great Lakes basin ecosystem. SOLEC 2000 featured 33 indicator assessments, SOLEC 2002 featured 43 reports and this year, 56 indicator assessments were presented. This increase in indicator assessments reflects the increased effort of SOLEC to encourage the reporting process, and thus increase active participation.
- The concept of Indicator Bundles was proposed and reported in the State of the Great Lakes 2005 draft report. The indicator bundles include: Contamination, Biotic Communities, Invasive Species, Coastal Zones, Aquatic Habitats, Human Health, Land Use – Land Cover, Resource Utilization and Climate Change. Five of the nine indicator bundles were assessed at SOLEC 2004.
- This was the second SOLEC to host a special session attended by managers within the Great Lakes basin. This managers' session was designed to discuss Great Lakes research and monitoring needs to assist in future decision-making and management challenges.
- The Ecological Footprint for the Great Lakes basin was calculated to be over 4 times that of the world average and SOLEC attendees were left with an important question to answer, "What intelligent species would risk destroying its only habitat for more 'stuff"?

3. Opening Thanksgiving Address

TΛTWANAWELATU SHUKWAYATISΛ¸
Opening - Thanksgiving Address [i]

Shukwayatis∧ wahat∧'nikuhlisane' tsi né tyotkut t∧twanuwelatu
It was decided by Our Creator that we should always give thanks

nu' k∧ke ∧twatyataloluk' ahti ohnikalihotu.
whenever we gather for any reason.

Ka'l:ku wahnislate ne kaíku kantyohkwa t^yetinuwelatu akweku aktehsu
This day we greet and thank this group who come from different

Nitho né nu. Kuh nu Tyolutakel wahyakwatyataloloke
Places. To this place, Toronto, we all gather

Ne lati kahle kuti -sonowanos tsi nu latinuhkwatslunihe
Both male and female leading scientists, for making medicine (research)

A:ú s^takalítate nen kanyutalakesu wisk nikanekowanus.
To heal the five great lakes to a healthier state,

Nen tesskyatyelu nu Skanenkolatunihe wasakolihutu latisonowanuse
Similar to when Peacemaker came and lifted up the Fifty Chiefs to preserve

Kayenlakowa t^hatihsni. Ne t^twanuhelatu tsi niyolihowan^ swayohtusel
The Great Law of Peace. so we give thanks for you delegates and for the
Great work you are doing for State of the Lakes Ecosystem Conference.

Nuwa' kwi aosahutatna:t^s tsi nikanuhkwatsliyo lotí su.
SOLEC will share findings and the good medicine made to date.

Ta, ne kati wi tho nu yo tu ha ke ukwanikulha. Skaliwat utwaste.
So we bring our good minds together and work as one mind.

Né kwi onah y∧ he' twatl∧na:yuha.
We turn our voices toward him (Creator).

Né ∧twatloli ohutsyáke tyotsyel∧htu, ukwa:nulha tsi
We speak first of the Earth, Our Mother that

teyukí'sniheh. Ne e:s∧ tyukiyahwihé
supports us. From her we obtain many things:

Ne tekyattíhu onéklasuha kale kaska:wáyutu tsi kayu
The different grasses and bushes that

tyukiyawi onuhkwat
give us medicine,

Ne s∧ tsi kayu wayunthé'he, kwah ok thiku:ne:se'
The many kinds of hanging fruit we use among which are

awΛhihte' kale tsyohtahkwaka:yu,
the Strawberry and the Raspberry,

Ne s∧ tsi kalháyutu, né wahta nikalu:tohtu'
The standing forests, and especially the Maple

tyukiyawihe né óshes,
that gives us its' sweet juice,

Akweku kutilyo'shu tsi nén o:wáhlu ∧twatekuni, kale s∧
All of the animals that provide our food and

atslunyáhkwa', ne oskanu:tu: tho latiyatale,
clothing, and among them the Deer,

Ne s∧ otsi't∧ha'shu tsi kayu henek latityé'hse kale tsi'
The birds that fly over us and whose

tehatiliwahkwa ne sk∧n∧ko k∧s u:tu ukwanikula
voices delight us (our minds),

Ne kanyatala:kes, kahyuhatatis, kale tsi' kaná:tsli'su
The lakes, the rivers and the streams

tsi tyukiyawi'he ohne:kánus u:tu sk∧n∧ko ukwayahta
that provide (water) for our well-being,

Ne s∧ ahs∧ tekutanutele, tsi' yuki'kwahel - o:n∧ste,
The Three Sisters, Our Sustenance: Corn,

ohsaheta, kale yonu'slake:tote', nen yukw∧he'khw∧.
Beans and Squash, upon whom (food) we live.

Ska:li'wat ∧twatste nuh t∧hetwatn∧helatu kontu
We draw our minds together into one and give thanks for that which

Ohutsyaké'ka. Né tho nuh yaw∧ ukwanik∧la.
is on earth. And so it will be in our minds.

On∧ ∧twatloli lu'wayatakenháhs Shukwayatis∧ kalúyake nu'kwa.
We speak now of the Creator's Helpers, those above the earth.

Yukwanuté tsi ne s∧k∧ lotiyote tsi nahté sako∧hau
We know that each is carrying out his responsibility:

Yu'kisotne'ha, latisakayuntise, tsi' tetwatsh∧thos nithanes
Our Grandfathers, the Thunderers, who come from the west

latihawi: yukonoles aosakan∧hu' kanyatalá:kes, kahna'slihsu
carrying rain to replenish the lakes and streams

kale tsi sakotiw∧hú oh∧tysoku kutnayelho'kowats,
and who keep the monstrous animals he did not make underground

Shukwak∧, kwu'teke wéhní:tale', nen yowéla talíhatu
Our Elder brother, the Sun, who warms the wind

tsi sahawi kukwi:te ne,
that brings growth to the land,

Yukisotha, kwa'shuté:ke wéhní:tale', tyakon∧tau kahwistáeks
Our Grandmother, the Moon, who regulates time and the

nuh ∧hunaklate latiksasu,
coming of children,

Yu'kisótneha ne otsistóhkwa' ha ne lohnanute'kwe
Our Grandparents, the Stars whose meaning our

náhte k∧tuhe' yo'tlastuné,
ancestors once knew,

Ne owéla tyoyak∧: tsi nu tyo'setu okuha,
The Wind, that comes from the place hidden by a veil,

Ne tyowe'luto uskanu tyotkut. n∧ i: ukwaliwa
(and) that blows always moderately for us.

N∧kati wi ∧tsi'yéhyatalohloke Shukwayatis∧ Laolhaslisuha,
Now we roll together all His Helpers, and

Skali'wat ∧twaste ne on∧ t∧yéhi yakwat∧nawélatu.
combine our minds into one to give our thanks for them.

Ne tonayawΛ tyotkut ukwanikule.
And so it will be in our minds.

N∧kati wi on∧ ∧tsitwatlohli ne Skanyadali:o, tsi nahi kutho
And now we speak of Sganyadaiyo', Handsome Lake, during whose

ohutsya:ke tehotawuli ne Shukwayatis∧ laowana wahoyatolu'ne.
sojourn on earth the Creator's word again alighted.

Ne ne nu uh ∧twatloli n∧ Kayé Niyukwetuk, Yukiniku:lale,
And we mention also the Four Beings, Our Guardians,

Shukwayehnawase, Né kwi theyetinewelatu tsi s∧k∧ Lotiyote tsi nahté
who protect us, We thank them that they continue to carry out

lonatlihute. Ne tonayawane tyotkut ukwanikule.
their duties. And so it will be in our minds.

Tá n∧katiwi ∧twatli wayu t∧hetwanahelatu' Shukwayatis∧, ne
And now we carry our thanks all the way up to the Creator, he who

kaluyake tethotuskwahele. Ne Shukwatahu'satate kale teshukwakonle'
dwells in the Sky World. He is listening to us and watching us

tsi niwahnislaténi kale tsi niwa'shuténi. Ne tahetwanuwelatu tsi
day and night. We thank him for

niyot ahkweku lohsoh. Ne to nu yawu'.
everything. So be it.[1]

[i] For the alphabet used by Oneida - ^ or Λ has the nasal sound of 'en', u has the nasal sound of 'on'.

[1] Enos Williams, a ceremonial leader of the Six Nations spoke the main part in Cayuga translated in to English by M.K. Foster, and translated to Oneida by Grafton Antone, and adapted for this presentation.

4. SOLEC 2004 Conference Opening Summary

Pradeep Kharé – Regional Director General, Environment Canada – Ontario Region
Gary Gulezian – Director, U.S. Environmental Protection Agency – Great Lakes National Program Office

Welcome to the sixth State of the Lakes Ecosystem Conference. This conference has been held every other year since 1994 and is co-sponsored by Environment Canada and the U.S. Environmental Protection Agency.

It is a welcomed opportunity to participate in this international gathering of decision makers from government, industry, Tribes, First Nations, academia and environmental groups. SOLEC is a forum where research and monitoring efforts from throughout the Great Lakes basin are used to build an overall picture of Great Lakes ecosystem health. This information is critical for good public policy and environmental policy makeup.

SOLEC is held, and the subsequent State of the Great Lakes reports, are issued, in partial response to the Great Lakes Water Quality Agreement. Canada and the United States have a continued commitment to this Agreement. This year, the two countries will also begin a review of the Great Lakes Water Quality Agreement. The assessment of the status of the Great Lakes ecosystem based on indicators—the work leading to today's conference—will contribute immensely to this review.

Our work on the Great Lakes is an excellent example of effective binational co-operation and co-ordination in reducing pollution, improving air and water quality and reducing sources of land pollution. This work, to protect the health of our citizens and enhance the competitiveness of our economies, will continue to be an important part of Canada-U.S. relations.

However, assessing the health of something as large and complex as the ecosystem of the Great Lakes basin is a challenge. Protecting the integrity of the Great Lakes basin ecosystem continues to be a top priority at every level of government in Canada and the U.S. The Great Lakes indicators help us do this.

A consistent system of reporting based on indicators provides science-based information on the state of the Great Lakes basin ecosystem. Although substantial progress has been made, new and ongoing threats to the health of the Great Lakes such as invasive alien species, new chemicals and pollution from out-of-basin pollution sources, need to be addressed.

Knowledge, incentives and partnerships are the keys to our environmental future. And as SOLEC demonstrates it is important to remember that with the Great Lakes, we not only share problems, but we also share in the solutions.

The work that you are doing here at SOLEC is at the forefront of such work worldwide. The Great Lakes region leads the way once again, as it did in the 1970s in developing a strategy to manage phosphorus; as it did in the 1980s in developing the concept of virtual elimination and zero discharge of persistent toxic chemicals; as it did with its pioneering concept of the ecosystem approach to management.

This conference has brought to our doorstep an impressive roster of speakers and conference delegates from both sides of the border with exciting scientific information that will no doubt help us to build an overall picture of Great Lakes ecosystem health.

Over the next two days you are going to hear and discuss a lot of information about the state of the Great Lakes basin and the stresses on the ecosystem. Consider the information well and help provide us with the advice we need to formulate the policies that will lead us towards an ecologically and economically sustainable Great Lakes basin.

5. SOLEC 2004 Plenary Presentation Summaries

Plenary Presentations Summary

The 13 plenary presentations at SOLEC 2004 covered many topics with the first day focusing on the concept of indicator bundling and assessments. The state of the Great Lakes, St. Clair River – Detroit River Ecosystem and the St. Lawrence River were the focus of the presentations on Day 2 of SOLEC. Presentations from SOLEC 2004 can be found at
http://www.epa.gov/greatlakes/solec/solec_2004/presentations/index.html

Indicator Bundling and Assessment – SOLEC 2004 – Day 1

Ecological Footprint and Human Drivers

The opening presentation on Day One was given by Dr. William Rees, University of British Columbia. The Ecological Footprint was created as a means of assessing the sustainability of any population. For SOLEC 2004, the concept of the Ecological Footprint was applied to the Great Lakes basin. Stressing that a sustainable society lives within the means of nature, Dr. Rees explained that improved 'livability' does not equate to greater sustainability. The Ecological Footprint of the basin is equivalent to the area of land and water ecosystems required to produce the resources that the basin population consumes, and to assimilate the wastes that the population produces, wherever on Earth the relevant land/water may be located.

The Ecological Footprint for the Great Lakes basin is just over 4 times that of the world average. The per capita Ecological Footprint of the Great Lakes basin residents is 9.6 hectares, compared to the world average of 2.3 hectares. At nearly 397 million hectares, the Ecological Footprint of the basin "occupies" an area equivalent to 43% of the area of North America. However, the basin is home to the equivalent of only 9% of the North American population. Dr. Rees concluded with the implications of this consumption for the basin and the technological challenges faced by bringing the Great Lakes basin's eco-footprint close to regional carrying capacity. Government intervention in the form of "ecological fiscal reform" is required, as well as the realization that it is time to reconsider our lifestyles. SOLEC participants were left to answer the question, "What intelligent species would risk destroying its only habitat for more 'stuff'?"

Human Oriented Issues

Lori Boughton, Office of the Great Lakes, Pennsylvania Department of Environmental Quality, presented Human Impact on the Great Lakes as reported on by 40 indicators that have been "bundled" into three groups: contamination, human health and land use – land cover.

Contaminants Bundle
This bundle looks at contaminants in Great Lakes fish and wildlife as well as concentrations in non-living media such as air, water, and sediment, and is currently assessed as mixed and improving. This presentation looked at various indicator reports within this bundle including: phosphorus to represent nutrient loadings, Spottail Shiner, Lake Trout and Bald Eagle to outline the bioaccumulation of contaminants in the aquatic food web, and atmospheric deposition as a representation of sources and loadings. While a number of signs of recovery are evident in the indicator reporting, many ecosystem objectives are not achieved and there is still much work to b done especially regarding emerging chemicals in the Great Lakes basin.

Human Health Bundle
This bundle addresses the fundamental questions: Should I drink the water? Should I swim in the water? Should I eat the fish? And should I breathe the air? This bundle has been assessed as mixed and improving. Information from indicator reports on beaches, air quality, ozone and fish consumption, answered these questions with a qualified "yes". Improvement is still needed for consistent monitoring

and data collection, informing the public, and addressing pressures from climate change, population growth and land use.

Land Use – Land Cover Bundle
Containing many 'new' indicator reports that reflect the ecosystem's physical appearance, there was no overall assessment for this bundle as the data to link physical factors to specific impacts is not available. Indicator reports for this bundle include land cover and conversion, urban density, forest lands and brownfield redevelopment. Urbanization and sprawl and its negative effect on groundwater quality and quantity were presented. There was also good news as successful brownfield redevelopment efforts are in place. Finally, emphasis was placed on the importance of protecting two vulnerable areas within the Great Lakes basin that are currently being threatened and lost by development: islands and cobble beaches.

Natural Resources and Biological Integrity

Doug Dodge, Stream Benders, spoke of Natural Resources Utilization and Biological Integrity. Six biotic communities were reviewed based on different trophic levels and represented in the list of Great Lake indicators, followed by a look at invasive species, coastal zones and aquatic habitats.
The *Biotic Community Bundle* assessment includes:

- *Forests* – The forest community of the Great Lakes basin was assessed as mixed and improving. Forests cover 27.8 million hectares, or about half (51%) of the land in the Great Lakes basin. Total forest area has expanded by 3-11% across the Great Lakes basin in the last quarter century. The increase in forested areas in recent decades has lead to this assessment and will help to improve water quality and quantity, as well as increase riparian vegetation providing improved land/water interfaces for species recovery.

- *Invertebrates and Fish* – Looking at *Hexagenia* and *Diporeia* as native benthic indicator species, native invertebrates are in trouble, with the biggest threats coming form zebra and quagga mussels. Physical changes in wetland habitats also continue to threaten invertebrates by providing conditions that are more suitable for the success of non-native species. Indicator reports for salmon and trout are mixed and improving across the basin. Walleye populations are threatened by habitat loss and non-native species. The status of other fish populations, including yellow perch, American eels, lake sturgeon, and prey fish, were also reviewed.

- *Amphibians, Reptiles and Birds* – Indicator reports for all three species indicate a status of mixed and deteriorating. There has been a general decline in amphibian populations, likely because of the loss of suitable habitat. Contamination in turtle eggs is still above guidelines with the high levels slowing the development of turtle embryos. Decreases in wetland birds, and increases in the number of tolerant species, along with the downward trends in amphibian communities suggest that the quality and quantity of wetlands continues to decrease.

Invasive Species Bundle
Looking at non-native species, sea lamprey controls are assessed as fair to good and improving, with the numbers of sea lamprey being considerably lower than levels measured before control programs began in the 1960s. With regard to other non-native species in the Great Lakes, nearly 10% of all species that have been introduced into the Great Lakes basin have detrimentally affected ecosystem integrity. Human activities associated with shipping are responsible for more than half of all introductions. The assessment for the non-native species indicator is poor and deteriorating. The overall assessment for the Invasive Species bundle is mixed and the trend is identified as unchanging.

Coastal Zone Bundle
Coastal zones are currently assessed as mixed and deteriorating. The three habitat types, nearshore aquatic, coastal wetlands (see assessment below) and nearshore terrestrial, are all being detrimentally affected by the continuing hardening of shoreline, elevated phosphorus levels and land conversion. The status of toxic chemicals in open water aquatic habitats is mixed and improving, but due to spatial and

temporal differences, their status in offshore waters is difficult to summarize. The concentrations of toxic chemicals in sediments are declining for several heavy medals and their status is mixed and improving. When looking at aquatic habitats, the value of groundwater and its ecological role in the state of the Great Lakes ecosystem has been generally ignored, or at best, incompletely assessed. The assessment made at SOLEC was mixed and deteriorating.

Coastal Wetlands

The coastal wetlands assessment, presented by Joel Ingram, Environment Canada, and Thomas Burton, Department of Zoology and Fisheries and Wildlife, Michigan State University, is a sub bundle of the coastal zones bundle. The status of Great Lakes Coastal Wetlands was presented based on work done by the agencies involved with the Great Lakes Coastal Wetlands Consortium. Looking at coastal wetlands, biological indicators are assessed using an Index of Biotic Integrity (IBI). IBIs rely on attributes of biological systems to measure its condition. Based on several metrics which are attributes of the biota that show a predictable response to human disturbance, IBIs are used across a range of disturbance types for lacustrine wetlands across all 5 Great Lakes.

Eight indicators were individually considered to provide an overall assessment of coastal wetlands as mixed and deteriorating. Area by type, birds, amphibians, contaminants, water levels, plants, invertebrates and fish were assessed as follows:

Area by Type – The hydrology and/or geomorphology of all Great Lakes coastal wetlands have been impacted to some degree by human activity. Breakdowns of wetland area by type showed that barrier protected wetlands are a dominant coastal feature and support the largest area of wetland within most of the Great Lakes.

Birds and Amphibians – Wetland bird and amphibian species in the Great Lakes were assessed as mixed and deteriorating. There have been significant declines in seven sensitive bird species, and in four amphibian species. Population indices have been developed for wetland bird and amphibian species and examples of the decline of various species were presented. Further work needs to be done to develop basinwide IBI for amphibians.

Contaminants – Contamination in snapping turtle eggs is assessed as mixed and unchanging. Basinwide estimates or trends of contaminants in snapping turtle eggs are not available. However, monitoring near several Areas of Concern has established environmental guidelines. Total PCB levels remain above consumption guidelines.

Water Levels – Periods of water level fluctuation represent a natural disturbance that favours diversity and native plant species. In lakes such as Ontario and Superior, the controlling of water levels has resulted in narrowed wetland zones, lower diversity, and increasing dominance of invasive species.

Aquatic invertebrates, fish, and vegetation – Across the 61 lacustrine wetlands investigated basinwide, invertebrate community health is assessed as mixed, with the trend being undetermined. Similar to invertebrate communities, fish community health is also assessed as mixed and undetermined. Various observations were presented with regard to fish species, community composition, and invasives. With the changes in water levels dramatically affecting the plant communities of the Great Lakes coastal wetlands, they have been assessed as mixed and deteriorating. Indices have been developed and will soon be published for these wetlands based on fish, invertebrates and plants.

Future developments including: finalizing work on methods and indicator development (including IBIs), developing an implementation plan, collecting data broadly across the basin, and reporting regularly to SOLEC concluded this presentation on the state of coastal wetlands.

Ecosystem Status Reports – SOLEC 2004 – Day 2

The plenary presentations on Day Two of SOLEC 2004 provided the state of the five Great Lakes, St. Clair River – Detroit River Ecosystem and the St. Lawrence River. Presentations on the state of Lake Ontario and Lake Erie fisheries were also presented.

Lake Superior

Steve Schlobohm, U.S. Forest Service, presented the state of Lake Superior. Assessed as mixed, Lake Superior is seeing various species recover and some contaminants trends decline, while other issues are emerging, such as new contaminants and the threat of non-native species.

The issues currently affecting Lake Superior's physical integrity are as follows:

1. Chemical Contaminants
- Zero Discharge Demonstration (ZDD) program is unique in scheduling load reductions to achieve zero discharge of the 9 critical pollutants by the year 2020.
- There has been a decline in mercury emissions and the reduction of contaminants such as dieldrin in herring gull eggs.
- There are elevated mercury levels in lamprey from the Lake Superior system compared to the other Great Lakes.

2. Habitat Alteration
- Current threats to wetlands are: draining and filling, water level regulation and site-specific stresses such as shoreline development.
- The majority of impairments to aquatic habitat and water quality are found in embayments and tributaries.

3. Non-Native Species
- Lake Superior has the highest ratio of non-native species to native species in the Great Lakes as the lake represents a dead-end for shipping.

4. Future Threats
- Global warming, climate change, increasing water temperatures, large scale water export and proposed new mines are other critical issues that need to be explored in Lake Superior.

Lake Michigan

Norm Grannemann, U.S. Geological Survey, presented the state of Lake Michigan as mixed. A number of issues affecting the physical integrity of the lake were outlined by the presentation. These include:

- Development occurring in some of the most ecologically sensitive areas of the watershed including coastal wetlands.
- Low water levels, causing problems for shipping industries and negatively impacting wetlands.
- Resurgences of the macroalgae *Cladophora* resulting in poor water quality and reduced beach use.
- Decline of *Diporeia*, a keystone species in the food web. Due to this decline and other issues, the Lake Michigan food web is considered threatened.
- Threats from an engineered connection between the Mississippi River and Lake Michigan drainage basins; the most serious threat being the bighead carp.
- Pumping from wells for water supply and various forms of drainage, such as tile drains which affect groundwater flows.
- Utilizing shallow glacial-deposit aquifers as sources of water which lead to more potential conflicts related to wells and depleted streamflow.

Lake Huron

Janette Anderson, Environment Canada, presented a report on the physical integrity of Lake Huron. Major threats to physical integrity include habitat loss, degradation and fragmentation.

1. Habitat Loss
- Habitat loss has occurred due to the loss of coastal wetland areas and shoreline alteration via development.
- Land use has changed dramatically from 2 types of wetlands and forests to urban and agricultural land with most of the remaining wetlands being coastal.
- Water levels are currently the lowest in Lake Huron that they have been in over 30 years, resulting in a number of problems including the colonization by wetland plants on beaches and mudflats, navigational difficulties and a lack of water exchange.

2. Habitat Degradation
- Primarily through sedimentation of coastal wetlands and bays, habitats have been degraded.
- Impermeable surfaces and agricultural practices divert water quickly to drains and streams during a rainfall resulting in high flows that carry sediment and can erode unstable banks.

3. Habitat Fragmentation
- This fragmentation has resulted from dam construction in tributaries.
- Dams threaten the Lake by blocking fish migration, impairing high gradient habitat, modifying stream channels, and creating reservoirs that serve as sediment and nutrient sinks.
- Lake sturgeon, now listed as endangered or threatened by 5 Great Lakes states, has been greatly affected by dams.
- To provide spawning habitat there is a need to identify potential spawning sites, restore high gradient habitats and provide fish passage around any dams that lie between the lake and restored habitats.

St. Clair River – Detroit River Ecosystem

Ted Briggs, Ontario Ministry of the Environment, presented SOLEC participants with a report on the status of the St. Clair River – Detroit River ecosystem. The region, which serves as a shipping link, has developed into one of the most highly industrialized and environmentally altered areas in the Great Lakes basin, and is assessed as mixed. Major stressors outlined were:

1. Chemical Contaminants
- Long term monitoring programs are in place for contaminants in the corridor.
- Results indicate declining or static trends over time for most contaminants sampled.
- Progress is being made in the remediation of contaminated sediments in the St. Clair River.

2. Population Pressure
- Land use practices associated with increases in population are the largest stressors to this ecosystem.
- On the Canadian side, land use is primarily agricultural with some major industrial centres.
- On the U.S. side, where population increase and related effects are much greater, land use is more variable ranging from heavy industry to high and low density development, agriculture land, grasslands and deciduous forests.

3. Non-Native Species
- Continued introduction of non-native species is one of the greatest threats to the area's biodiversity.

A number of ongoing and future projects are being actively pursued by various government agencies and stakeholders to address the current stresses to the St. Clair River – Detroit River Ecosystem.

Lake Erie

Sandra George, Environment Canada, presented the state of physical integrity of Lake Erie by looking at the various impacts on tributaries, nearshore habitats and offshore waters.

Tributaries
- These waters transport nutrients and sediments to Lake Erie's nearshore habitats and provide spawning and nursery habitats for migratory fish species.
- Nutrient and sediment inputs have been reduced but many of Lake Erie's tributaries are still overwhelmed with sediment and nutrients by the time they reach Lake Erie.
- Dams and other barriers exacerbate this problem by altering river characteristics and preventing fish and other organisms from accessing upstream spawning and nursery habitats.

Nearshore Habitats
- The natural processes that maintain these habitats have been altered by physical changes including: shoreline hardening and alteration, harbour development, infilling and diking of wetlands, and the introduction of invasive species.
- Invasive species, primarily the colonization of zebra and quagga mussels, have irreversibly impacted nearshore habitats.
- Currently, there are efforts on protecting and rehabilitating nearshore habitats.

Offshore Waters
- Regulations of discharges have resulted in improved sediment conditions, which have allowed for the return of *Hexagenia*, a key component in the food chain, to the western basin.
- Currently, oxygen levels are low in the central basin, which are not suitable for many organisms, especially fish.
- Dreissenid mussels have altered substrates invading soft and hard substrates changing their character and structure.
- Currently, lake-wide loadings are at or below target, while concentrations are increasing, particularly in the spring and summer. The reasons for this apparent contradiction are unclear.

Lake Erie Fishery

Phil Ryan, Ontario Ministry of Natural Resources, presented the state of Lake Erie fisheries. The goals established for Lake Erie's various fish communities and a review of the current status of each fish community was also presented.

The Cool-Water Community
- This community has lost significant biodiversity through the extinction of various species and the major decline in abundance and distribution of lake sturgeon.
- As an example, sauger is regionally extinct in Lake Erie and a well organized attempt to re-introduce it has failed.
- Other species discussed were yellow perch and walleye, believed to be more abundant than historical records, and burrowing mayflies which are assessed as mixed.

The Coldwater Community
- This community has experienced a catastrophic loss of native biodiversity.
- On the positive side, a lake trout stocking program was initiated, and their survival improved with the establishment of sea lamprey control in the 1980s.

The Prey Fish Community
- This community is considered poor and unstable.
- Winter conditions limit the survival of prey fish such as alewife and shad, causing instability, and this in turn affects the viability of salmonid eggs.

Lake Ontario

Rimi Kalinauskas, Environment Canada, provided a presentation on the state of Lake Ontario. Lake Ontario was reported as an "ecosystem in transition" with the key factors affecting the physical integrity of the lake being lake level regulations, zebra and quagga mussels, and urbanization.

1. Lake Level Regulations
- Water levels have been regulated by a series of dams on the St. Lawrence River since 1960.
- This regulation seeks to balance a number of interests including hydropower, commercial navigation, and shoreline property owners downstream, and it has worked to reduce the range in fluctuations.
- Many scientists believe that this regulation has had serious and lasting impacts on fish and wildlife, shoreline habitat and dune barrier systems, and the numerous wetland complexes that line the shoreline.

2. Zebra and Quagga Mussels
- Filtering activities have reduced the amounts of material in the water column, thereby increasing light penetration and allowing re-growth of extensive macrophyte beds in many littoral areas.
- Colonization has affected the physical, chemical and biological integrity of the lake including the decline of native benthic organisms and the emerging issue of Type E Botulism.
- Since the impact of non-native species is irreversible, prevention is the key.

3. Urbanization
- On the Canadian side, land use and population growth are stresses on the system and this stress is growing, mostly at the western end of the basin. This pressure is not being felt as strongly on the U.S. side.
- Increased impervious cover in urbanized areas leads to increases in stormwater runoff, more and higher peak flows and lower base flows, resulting in a drastically altered hydrological regime.

Lake Ontario Fishery

Bruce Morrison, Ontario Ministry of Natural Resources, continued the focus on Lake Ontario with a presentation on its fishery. A "bottom up" approach provided a complete picture of the ecosystem.

Benthos and Prey Fish
- *Diporeia,* an important food item for many fish species, have not done well since the colonization by Dreissena.
- Recent surveys on Mysids, another important food item for various species, suggested a declining trend was occurring, but sampling in 2003 suggested that this decline did not continue.
- The main prey fish are young freshwater drum, white perch, suckers and cyprinids and more recently the round goby which has become well established.
- Currently, abundance and biomass indices of alewife and rainbow smelt lead to a mixed status.

Walleye, Salmon and Trout
- Current work suggests that the walleye population is stable.
- With respect to recreational fishing, both catch per unit effort and harvest per unit effort have recently increased, although overall effort for walleye fishing has not increased to the catch and harvest numbers of the 1980s.
- The status of the whole salmon and trout fishery is stable; however, there is an undetermined prognosis on this fishery as many of the fish species are dependant on stocking.
- The status of lake trout is uncertain as the main objective of a self sustaining population has not yet been achieved.

Other species that were not included in the Great Lakes indicator suite but are important to commercial fisheries and the Lake Ontario ecosystem are the American eel and the lake sturgeon. The American eel is currently under consideration for listing as a species at risk. The lake sturgeon is caught every year, although there are no programs directed at assessing the health of this population.

Overall Assessment and Consumption Guidelines

- The Lake Ontario commercial fishery has been declining for the past 5 years and is assessed as poor, with an undetermined prognosis.
- The recreational fishery has remained relatively stable for several years following a decline in effort in the early to mid-90s and is assessed as fair, with a stable-improving prognosis.
- Many of the large bodied commercial and sport fish species have consumption guidelines associated with them.
- As new contaminants are listed by U.S. Food and Drug Administration and/or Health Canada, such as those found in fire retardants, guidelines will become more complex.

St. Lawrence River

Serge Villeneuve, Environment Canada, presented an assessment of the St. Lawrence River. Major structural changes in the St. Lawrence have caused alterations to the hydrodynamics, shoreline and biological resources.

Structural Changes

- The most important structural changes to the St. Lawrence have been the construction of dams for hydroelectric power, the Seaway and the Shipping Channel.
- Over hundreds of years, the Shipping Channel was deepened and widened requiring extensive dredging of larger segments of the river; most of the dredged sediment was deposited close to the Channel or shores of the River.
- Construction of dams for hydroelectric power generation and the Seaway, with extensive excavation and dredging, flooded a series of rapids, and displaced thousands of inhabitants.

Shoreline

- Shoreline hardening offers only local protection and amplifies the erosion process downstream.
- It has resulted in major losses of wetlands and accompanying wildlife populations.
- Severe coastal erosion will require social and economical decisions in the near future, since very costly shore protection structures do not resist winter storms and inhabitants.

Hydrodynamics and Biological Resources

- Using Lake St. Pierre as an example, extensive dredging has changed water flow through the lake, and these changing water levels affect wetlands.
- Aquatic plants influence the physics, current, waves and sedimentation of the system. Their absence causes water to move faster so that slow waters are limited to the shores.
- The deepening of the shipping channel has contributed to the amplification of this process.

Trends show that despite the major structural changes to its ecosystem, the St. Lawrence River has shown a strong resilience and still shelters very productive habitats and diversified fauna and flora.

6. SOLEC 2004 Breakout Session Summaries – Day 1

Ecological Footprint Question and Answer Session

Facilitator: Dr. William Rees, Professor and Director, School of Community and Regional Planning, University of British Columbia
Recorder: Susan Arndt, Environment Canada

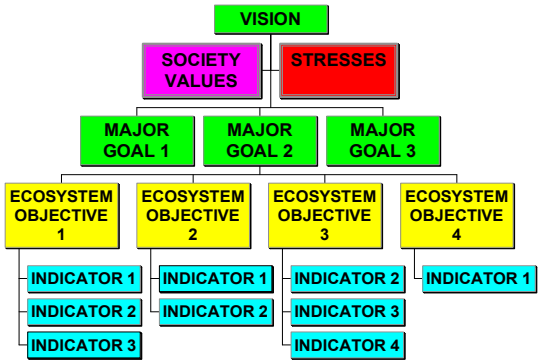
With approximately 50 people in attendance, Dr. Rees hosted a lively question and answer period during the lunch break on Day 1 of SOLEC 2004. Overall, the audience seemed to be in agreement with the concepts of the Ecological Footprint (EF), but was unsure of its applications and solutions. Some of the questions raised were related to the impacts of urban versus suburban dwellers, the application of the EF to various sectors, and the users of this type of information. In response to these questions, Dr. Rees explained that generally urban dwellers have a smaller footprint. With an influx of people moving out of cities and into the country or suburbs, they are increasing their footprint with increased land and energy use. The EF can be used to look at various sectors and is now being used around the world in this way. For example, the concept has been adopted by Australia to promote policy and targets by finding a way to personalize the environmental crisis that is occurring so that Australia's ecological footprint can be reduced.

Further discussion focused on the concepts of peak oil, energy alternatives, and how society can begin to penetrate these myths and develop reasonable solutions to the problem. In response to this discussion, Dr. Rees stressed that society needs to become conscious of our own actions and that as globalization continues; the myths that that society lives by must evolve to become more comparable to that of other cultural organizations. It is important to realize that energy alternatives are not always clear cut alternatives, but by using new and existing technology, and coming up with solutions now, as opposed to when it may be too late to make the adjustment.

Introduction to Indicators Information Session

Facilitator: Paul Bertram, U.S. Environmental Protection Agency
Recorder: Elizabeth Hinchey Malloy, U.S. Environmental Protection Agency

- This presentation was originally prepared for SOLEC 2002 to provide a brief overview of the Great Lakes indicators, and how the suite of indicators was derived. It is important to understand the relationship between VISION, GOALS, ECOSYSTEM OBJECTIVES and INDICATORS:



- A VISION is the "big picture" or the overall goal for the Great Lakes. For example, the overall vision for the Great Lakes taken directly from the Great Lakes Water Quality Agreement (GLWQA) is "…to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin ecosystem".

- Once the overall VISION has been developed, major, discreet GOALS for various parts of the VISION can be set. GOALS are influenced by both societal values and by the stresses that are currently being imposed on the ecosystem, and are entities that might be measurable and achievable.
    - Societal values tend to dictate the uses to which the Great Lakes are restored (i.e. manage them for maximum sustained harvest of fish for food, or manage them for human health implications). Often times these uses are not mutually compatible.
    - In addition, there are many stresses currently imposed on the ecosystem: like too many nutrients, toxic contaminants, habitat alteration, and invasions of non-native species.
    - An example of a GOAL or general objective from the GLWQA is that "These waters should be: Free from nutrients…in amounts that create growths of aquatic life that interfere with beneficial uses".
- Once major GOALS are identified, then the specific measurable ecosystem OBJECTIVES can be established. The concept is that if all the specific OBJECTIVES are achieved for any given goal, then the major GOAL can be reached.
    - An example from a specific, quantified OBJECTIVE from the GLWQA is an established recommended maximum annual phosphorous loadings for each of the Great Lakes; for Lake Erie the annual loading objective is not more than 11,000 metric tonnes.
- Then once the quantified objectives are established, measure progress towards these objectives can be measured. INDICATORS are measurable parts of the ecosystem from which information can be inferred in relation to the objectives. There can be several INDICATORS related to the same objective.
    - For example, if the GLWQA sets phosphorus loading OBJECTIVES for the Great Lakes, specifically 11,000 metric tonnes for Lake Erie, then phosphorus concentrations in the water can be measured as an indicator of achievement of the objective. And the relationship between phosphorus in the water and plankton growth allows phosphorus concentrations to be used as an indicator of trophic status of the water.
- There is also another aspect to indicators that needs to be highlighted: A MEASURED value and an expected TARGET or ENDPOINT are both required. The observed measurement can then be compared against the desired state to allow for an assessment based on the indicator. Identifying the end points is the challenging part.
    - The MEASUREMENT – what is the *observed* state of the ecosystem component being measured?
    - The REFERENCE value – what is the *desired* state of the ecosystem component being measured?
- It is important to note that not all indicators are created alike; some are more effective than others. Thus, for SOLEC a set of criteria is used to apply to candidate indicators; the overall criteria are those of NECESSARY, SUFFICIENT and FEASIBLE. Is each indicator needed, or is there some redundancy in the set? Are all the indicators, taken as a whole, SUFFICIENT to characterize the Great Lakes ecosystem components, or are some elements missing? And is the indicator FEASIBLE to measure and report?

The selection of indicators for SOLEC has been an ongoing process. It began with over 850 proposed indicators that have since been reduced to approximately 80. The indicator suite was revised and reviewed at SOLEC in 1998 and 2000 and it continues to evolve with SOLEC 2004 considering such indicators as: groundwater, forests, and resource utilization. For SOLEC 2004, the indicators have been arranged into nine bundles.

Questions raised during this session were focused on the frequent use of the term "MIXED" when assessing the bundles. The feeling was that the bundles are too broad a category for this term to be useful. Each indicator still needs to be examined separately and it is important to look at each indicator within the bundles for a more satisfying assessment. Currently, there is only one index, the Index of Biotic Integrity (IBI), within coastal wetlands sub bundle. The forest lands indicator currently looks at four elements, but is not a true index.

Other discussion items included the idea of developing a relational database/matrix to allow indicators to be examined many different ways, the ability to set baselines, and how SOLEC reduces 850 indicators to 80. For Great Lakes basin reporting, the whole basin picture of good, fair, or mixed is reported, but some indicators need to be applied to each lake, harbour, and /or local Areas of Concern including Remedial Action Plans. Since indicators are not static, some will be removed from the suite if external reviews warrant it. Indicators are filtered through criteria of NECESSARY, SUFFICIENT and FEASIBLE, and the process of reducing the numbers is an incredible challenge since it is very difficult to create a vision that covers such a large area. For more information on the indicator process see Selection of Indicators, Version 4 at www.binational.net.

Contaminants Bundle of Indicators
Discussion Session Summary

Facilitator: Marcia Damato, U.S. Environmental Protection Agency
Recorder: Veronica Lo, Environment Canada
Participants: 25

Focus Question 1: Are the indicators and assessments correct and useful?

General Comments
- Should be able to cross-reference indicators in more than one bundle/sub-bundle (however, might be more accessible to public if related indicators are placed in only one category; e.g. sport-fishers will only look at sections on sport fishing and not other bundles).
- Need discussion/acknowledgement of uncertainties included in each indicator report.
- Some conclusions in indicator reports are not supported (e.g. indicator #117) and are contrary to government reports.
- Breakdown information by lake within indicator report i.e. Indicator #114.

Comments on Specific Indicators
Phosphorus Concentrations and Loadings (Indicator #111)
- How are the conclusions drawn when basic loading information is generally not collected? Are they based on “expert” opinion rather than comprehensive data?
- No indication of role of agriculture in phosphorus loadings (Are concentrations higher in Lake Erie because of agricultural productivity/runoff near the western shore?).

Contaminants in Colonial Nesting Waterbirds (Indicator #115)
- Not a good indicator because trends are different for each colony.

Atmospheric Deposition of Toxic Chemicals (Indicator #117)
- Figure 5 shows a net loss of PCB from Lake Michigan that is consistent for 1992, 93, and 94. However, starting in 1995 there is a drastic reduction in this ness loss! Can this be explained? Suggest comparing Blanchard estimates to Lake Michigan Mass Balance Study modelling estimates.

Contaminants in Whole Fish (Indicator #121)
- Need to describe why and which contaminants cause which disorders in fish, in piscivorous animals and in humans too. Combine sport fish with whole fish with regards to edibility.
- Get Lake Ontario mercury levels for walleye into your whole fish and sport fish indicators.

External Anomaly Prevalence Index for Nearshore Fish (Indicator #124)
- Should be moved to nearshore bundle.
- Science not developed enough to use this as a reliable indicator.

Drinking Water Quality (Indicator #4175)

- Should belong in human health indicator bundle exclusively (human health should be the main perspective).
- This indicator report gives no indication of microbial contaminants in ambient waters. Current drinking water treatment approaches do not address majority of human pathogens. With declining water levels, microbial contaminants in water become increasingly important. Absence of spatial /temporal qualifiers limits the use and reliability of such indicators.
- Tendency to treat *E.coli* as a uniform population; suggests homogeneity in *E.coli*. Some text should be rewritten to give a clear assessment of identifying different strains – can trace origin of strain.

Contaminants in Sport Fish (Indicator #4201)

- Should be exclusively in human health bundle.
- Some of the chemical measurements for sport fish program, if brought into proper temporal/spatial perspective, could be used for the contamination bundle.
- Needs to be clear whether or not the purpose of fish indicator reports is to protect them as a species or to assess contaminants in them.
- Need to include more Canadian data in sport fish indicator; could be separate report for human health as consumption advisories.
- Get Lake Ontario mercury levels for walleye into your whole fish and sport fish indicators.

Air Quality (Indicator #4202)

- Missing current studies being undertaken which would alter status in future.
- Improbable to eradicate reactions to ozone; indicators not keeping up with science.
- Reference for Canada – U.S. Air Quality Agreement 2002 Program Report is wrong. It was written by U.S. and Canadian governments, Air Quality Committee.

Acid Rain (Indicator #9000)

- NOx and SOx should be separate indicators as opposed to acid rain as a whole.
- Reference for Canada – U.S. Air Quality Agreement 2002 Program Report is wrong. It was written by U.S. and Canadian governments, Air Quality Committee.

Assessment of Indicators

- Indicator reports sanitize conditions by assigning “mixed, improving” status. From a management perspective there is a false sense of success of programs when you see the “mixed and improving” status.
- For “mixed” status, need expert to identify specific top management priorities – What is improving? What isn’t improving?

Focus Question 2: What refinements, simplifications, or enhancements to the assessments and/or bundles would you propose?

- Measurements: the basic concept of observed and reference measurements needs to be reiterated. There is a lack of integration of spatial and temporal relationships of indicators to get a picture of whether or not ecosystem is improving (i.e. status of PCBs through different media is needed).
- Buffering from sediments and historic loadings make some changes seem small – need to look at all the media together for an accurate assessment of contaminants. The indicators are “patchy” – there is little integration among the indicators. Follow a series of contaminants in different media: sediments, water and biota (at different trophic levels). This kind of dataset will be conducive to modelling.
- Definitions are too loosely used – i.e. pharmaceuticals vs. by-products of pharmaceutical manufacturing, or pharmaceuticals vs. antibiotics.
- Need mechanism to identify where to obtain data – too many “islands of data”.
- Would be helpful to keep index of acronyms and chemical terms.
- Can not make generalizations of status of toxic chemicals – need to distinguish between specific chemicals – status is different for each chemical.

- Deposition and loading – current studies should be cited. Alternatively, some studies are cited but are not present in the text.
- Each indicator should be peer-reviewed. Response by facilitator: In order to ensure accessibility to the public, each indicator should not necessarily be peer-reviewed, but a working group can be used to gather all data.
- Broad consensus of group that contaminants bundle is not up-to-date, lacks temporal and spatial integration.
- A 'mixed' status is not useful or interpretable by managers. The bundling approach results in vague designations.
- An eclectic mix of topics selected in this bundle. Is it a case of selecting the best thing to measure or a case of utilizing what is already measured (so as not to start new programs)?
- There is no simple solution to assessment. In Ontario we have routine Ontario Ministry of the Environment sport fish sampling and are struggling with commercial fish sampling. Inter-jurisdictional guidelines need to be highlighted. Do not bundle indicators based on contaminants but maybe focus on habitat or simply aquatic.
- There is a big overlap in "Toxics in Media" and "Sources and Loadings" sub-bundles. Could eliminate the "Sources" sub-bundle as all of its indicators are covered in the "Toxics in Media" sub-bundle. Or make a better distinction between sub-bundles.
- Call the bundle "pollutants" to include nutrients, persistent toxic substances (PTS) and pharmaceuticals. To most, contaminants are only PTS. Separate out data on presence and trends of pollutants. A separate category could be "effects" - perhaps in an Ecosystem Health bundle which would also include ecological community health.
- Maybe group the indicators by longevity of their database (0-5 years, 5-10, 10-15 etc.) and/or by how many lakes or sites are included. Disagreement among breakout participants on presence or absence of trends. The indicators could also be organized by whether they contain legacy or new compounds.

Emerging Indicators

- A large number of indicators are assessed as "mixed and improving," but 95% of them look at legacy contaminants (PCBs, DDT, etc) that were regulated decades ago – we need to look at contaminants that are new (e.g. pharmaceuticals). Either add new indicators or expand current indicators.
- Where is monitoring for emerging problems like PBDEs? Governments are not in a position to make effective management decisions if new contaminants are not being monitored
- When phosphorous was banned from detergents, some substitutes were discovered to be endocrine disruptors (nonophenols) – in this case the solution was worse than the problem – onus is on industry and government to research solutions before implementing them.
- One indicator missing from bundle is pharmaceutical and personal care products (PPCP). This is an increasingly important and wide variety of contaminants.
- Need to also clarify what pharmaceuticals are being measured (i.e. discharge of original product from manufacturing or residuals in sewage).

Focus Question 3: What are the key management implications?

- Are agencies committing the necessary resources to collecting baseline data for new toxins? I.e. archive fish samples and design fish consumption advisories to include new contaminants.
- All indicators should have a Management Section.
- There is no clearing house of available data and reports do not capture everything.
- Account for time period in assessments i.e. "mixed and improving" over last 30 years.
- Decline in emissions, but no change in assessment of mercury level.
- Need to pool data (could identify what may seem to be a large change but it may only be a small change relative to other data).
- Is SOLEC establishing linkages with other organizations?
- Should a stronger tie be made to RAP and LaMP programs? However, on the flip side, are some monitoring programs used, too biased on samples from AOCs which might skew the "lake wide" trend?

- Governments should be more transparent in these reports and acknowledge that they are only reporting on a few of many toxic substances, perhaps to support their own monitoring programs.
- Must have long term trends of contaminants in the various media.
- Need to know how the contaminants found in fish effect their life history and the condition/quality of fish food so that we can understand their role in restoration effort, fish reproduction, food web structure, etc.
- Future stressors/unaccounted for stressors will need to be considered on order to have a clearer picture of the state of the lakes (i.e. climate change, population growth, emerging chemicals of concern, urban sprawl, etc).
- Are we forcing ourselves to use the date that is available to make assessments? Or are there indicators missing that should be developed in order to answer the questions posed?
- Since focusing on legacy chemicals the effectiveness of decisions that were made 20 years ago are being evaluated.
- Based on a limited number of indicator chemicals (PCB/DDT/Hg) the assessments provide a "sanitized" view of chemical/pollutant conditions in the Great Lakes basin. This may lead to a false conclusion if trends in emerging chemicals are not included (and would lead to a lack of management response).
- As management tools alone, the indicators are not helpful. It requires a tremendous explanation/discussion to understand their meaning, limits, or usefulness. While site specific chemical emissions/loadings across the basin(s) may have been reduced, the total loadings of chemicals are far greater than is being revealed. Loadings are less, but not without impact to human and ecosystem health.
- The lack of an integrated approach across the various media gives a "stove pipe" perspective of the ecosystem's condition.
- Declining chemical loadings may also be related to loss of industries (steel, coal mining, and metal processing) both offshore and defunct. The contributions of other socio-economic factors are not addressed, nor can they adequately be done with available data. Government regulations alone are not drivers.
- Indicators point up, down, and sideways, they simply give an "indications" not a statement of condition in dynamic systems. Far too many "mixed, improving" to be believable.

Biotic Communities and Non-Native Species Bundles of Indicators
Discussion Session Summary

Facilitator: John Perrecone, U.S. Environmental Protection Agency
Recorder: Jackie Adams, U.S. Environmental Protection Agency
Number of Participants: 24

Focus Question 1: Are the indicators and assessments correct and useful?

Non-native species indicators (Indicator #18 and Indicator #9002)
- Invasive species other than lamprey are not adequately addressed.
- Current non-native species indicators are a measure of discovery rather than introduction. Vector control measures and risk assessment of species posing a higher risk of invasion need to be addressed.
- If a large impact of non-native species is trophic level/foodweb disruption, then energy transfer measures would be helpful to monitor the degree to which ecosystem function has changed from some "baseline" which supports desired fish communities and/or species biomass.
- Need indicators (of non-native species) which will illuminate functional changes which should be of concern to fisheries managers – what management action is appropriate? Can we manipulate the foodweb disruption to meet fish management objectives or is it time to amend our management expectations.
- Need to expand the non-native species indicator – perhaps with "potential" invasives not currently in the Great Lakes. McIsaac/Ricciards postulate a number of species "likely" to invade the Great Lakes.

- Need to do a better job on the terrestrial component of non-native species.
- The missing piece is tracking populations (status and trends) of other non-natives besides sea lamprey. In the current suite, there are indicators related to a coarse level of risk (i.e. incoming species which are discovered) and ecosystem response (i.e. biotic indicators like plankton, benthos etc.), but no indicators related to a more finite level of risk from those species which get a toe hold (Gobies, ruffe, mussels etc.).
- Sea Lamprey description is a good model for how to interpret abundance trends in a way that is useful for managers (i.e. is the abundance of sea lamprey within a target range? Will the abundance support meeting lake trout Fish Community Objectives on each lake?).
- Without continued funding, seemingly past issues will once again become present and future issues i.e. sea lamprey. Prevention is the best cure. However, it is easier to look at the impacts of non-native species. A measure could be the number of research projects targeted at prevention vs. impacts.

Salmon and Trout Indicator (Indicator #8)
- Is the use of non-native species that require extensive human intervention (stocking) appropriate as an indicator i.e. non-native salmons?

Walleye Indicator (Indicator #9)
- Trends in yields vs. diversity of stocks?

General comments
- Need a way to determine the level of interest for a particular issue otherwise the assessment is an incomplete picture.
- Need to determine baselines, benchmarks and endpoints for the indicators. This will help to improve the assessments.
- There is no sense of what is or is not a stable community (i.e. zooplankton).
- Not sure if the indicator information is useful at a regional scale. Are there assessments/indicators relevant at RAP/AOC levels such as Toronto?
- Hard to ignore the subjectivity of the assessments. Are there less subjective assessment methods?
- Forage bases are changing – what are the long term consequences?
- Contaminants are declining – how far is far enough?
- Coastal wetlands are refugia, yet sensitive bird and amphibian species are declining – why?
- Indicators are almost universally assessed as “mixed” where known. Trends seem more commonly “deteriorating”. Indicator for non-native aquatic seems “lumped” compared to other indicators.
- Individual indicators (i.e. sturgeon) are very helpful for building momentum and resources (i.e. Congress); however, there are complex relationships with things like sea lamprey – i.e. sturgeon protocol for lampricide treatment.
- Indicators are useful, assessments may be disputed but this is healthy and will lead to the evolution of more standardized/vigorous assessments.
- Benthos Diversity and Abundance (Indicator #104) was discussed at length at SOLEC 2002 and concluded to be unsuitable in its present form. Participant was surprised to see it still on the list without qualification. Same for Phytoplankton Populations (Indicator #109).

Additional information sources
- Council of Great Lakes Governors for information on non-natives/ballast water exchange. The exchange of ballast water is done to maintain the security of the people on board, the goods and the ship.

Focus Question 2: What refinements, simplifications, or enhancements to the assessments and/or bundles would you propose?

Non-native species indicators (Indicator #18 and Indicator #9002)
- Include a level of effort and effectiveness of research (projects targeted at Aquatic Invasive Species impacts/prevention). Include discussion of potential invaders so public is educated about what to be

on the lookout for, possibly facilitating rapid response (i.e. spread of gobies towards salt water; species is a threat to both fresh and salt water).
- Ratio of non-native invasive species biomass to native species biomass.
- Should provide status reports on major non-native species.
- An indicator of the ecosystem is not only the status and spread of already established non-native invasive species, but also the risk of new non-native species via vectors (i.e. non-native mussels, some are established, need a risk assessment of potential invasions). Put money into new invasions and may get money for prevention.
- Use GIS and land cover analyses to look for likely areas of invasion. Use food web to integrate the bundle.
- Need a list of critical non-native species present and an evaluation of status/spread/change.
- Should have the 10 'big' aquatic invasive species listed (beside sea lamprey) i.e. ruffe, round goby, quagga, etc.
- Need indicators that identify the spread of existing non-natives (i.e. percent potential habitat already invaded) and the number of new invaders over time.
- Include potential non-native invasive species in this bundle.

General comments
- Although indicator suites evolve, it might be worth trying to integrate them (at least the more longstanding ones). It would help in summarizing and simplifying use by the reader.
- Genetic diversity and divergence (stock structure/population structure) measure added for key species.
- There is repetition of indicators in multiple bundles: need better rationale for how the groupings were made and how they are to work together as a bundle – integration.
- Indicators seem wildly disparate in scope ranging from specific fish species to all benthos.
- Assessment of fish species should include comments regarding "stocks" as appropriate e.g. walleye.
- All indicators need refining, definition of endpoints, etc.
- Include algae as stressors to Great Lakes ecosystem/human health (including the release of toxins from cyanobacteria and the importance of physical structures in nearshore areas (impoundments, breakwaters) in affecting phytoplankton community structure – not just nutrients).

Focus Question 3: What are the key management implications?

Non-native species (#18 and #9002)
- Target more funding towards prevention using quantitative targets (model after sea lamprey control efforts).
- Sea lamprey, fish populations and Fish Community Objectives – current trends vs. management objectives clearly helps managers know where increased control is necessary: Lake Superior, Michigan, Huron.
- Translate what the sea lamprey indicator means to human values and/or uses (i.e. production of commercially harvested species) and therefore what managers need to do to ensure harvest levels are sustainable.
- "We won't know when we get there." Fish Community Objectives do not provide measurable benchmarks – this needs investment dollars.

General Comments
- Use successful indicators efforts to provide justification for more resources for developing other indicators (build on success/publicize and generate grass roots support).
- Describe a desirable end state that recognizes change/adaptation to change in a productive way.
- What ecological function, form needs to be addressed, and can it be addressed? If not, is there a need to manage user expectations (with new management objectives)?
- In order to evaluate an indicator there must be an endpoint.

- How do we provide information to management that will make them think in terms of management actions? Scientists do not know how to convey ideas very well to managers to get the importance through. What senior managers want is not always known.
- Some management questions are: What is "restored"? How much equals protection? These are area specific management decisions. What will this mean to the ecosystem as a whole?
- Where should the money be spent? How much effort has to be applied to have some effect? Is monitoring a particular indicator ever going to lead to any significant political will to change the underlying problem?
- There is a bit of a conundrum that many of the management decisions with regard to land use operates at a smaller scale (i.e. municipalities) whereas, the indicators show unclear linkages to that level of spatial organization. For example, how does 20% of land area in the Toronto region lost to development in 10 years impact lake trout?
- Resources are better spent on preventing rather than controlling non-native species. Ability to "manage" biological systems on a Great Lakes basis seems very limited.
- Management implications should be related to existing plans/objectives.
- Maybe indicators can be bundled according to pressing issues at the time of SOLEC, along with reporting them in the established bundles, like a management "vignette".
- Resource managers are the best folks to decide how to tackle issues. SOLEC should focus on assigning priority to issues along with providing associated supporting data.
- Long term management – develop an indicator on sustainable development.
- Short term management – find a way to tell/indicate the emergencies to the decision makers.
- Provide decision makers with advice on what are the most urgent needs – allows for the allocation of limited resources to get best result for the least spending.
- Land use decisions to sustain ecosystem include:
  - Control/treat urban runoff and agricultural runoff.
  - Conserve/recharge water tables.
- Key management implications include:
  - Halt invasions by non-native species.
  - Restore/protect shore wetlands.

Habitats Bundle of Indicators
Discussion Session Summary
(Note: This session did not discuss the climate change bundle as originally planned)

Facilitator: David Nagler, Toronto and Region Conservation Authority
Recorder: Ewa Downarowicz

Focus Question 1: Are the indicators and assessments correct and useful?
Focus Question 2: What refinements, simplifications, or enhancements to the assessments and/or bundles would you propose?
(Questions 1& 2 were grouped together in this discussion)

- The general consensus was that this bundle was not well done.
- The open water aquatic habitat indicators are incomplete – there is no mention of biological or physical habitat indicators – only the chemical. We can not assess habitat without talking about biology. Three indicators in current bundle are useful - #111, #118 and #119. None of the other indicators are particularly good habitat indicators. Need to consider zebra mussel colonization, macrophyte beds, anoxia and primary production. Between "coastal zones" and open lake habitat we are missing the nearshore zone (spawning beds etc.).
- Water mass characteristics, thermal alterations/changes, and seasonal changes need to be considered.
- Groundwater is important but not relevant to aquatic habitat – needs to be its own bundle. The groundwater indicators need to be expanded to greater breadth and representative of other areas.

- Currently, there is nothing on surface flows (water quantity, natural flow regime), energy and estuarine/nearshore processes.
- The habitat bundle should include indicators on physical habitat loss and degradation in the Great Lakes and adjoining watersheds (i.e. aquatic habitats – migration, spawning, nursery habitats, species at risk habitats, and impact of invasive species).
- Propose chemical, physical, biotic bundles for Aquatic Habitats.
- Need more physical indicators, need more function and form (process) focus. Examples: temperature, pH, dissolved oxygen (DO), contamination, thermal changes, heavy-metal deposition, substrate, water quantity, flow variation/alteration, sedimentation rates, climate information, energy processes. Also need measure of energy input into the system, i.e. storm effects, ice effects. Need indicators that measure pathways/barriers, hydrologic conditions, shoreline alterations, absence/presence of non-native species that alter physical conditions.
- Open water habitat is irrelevant. Focus on coastal, wetland, tributaries, estuaries, near-shore, and connecting waters are more important for assessment and restoration. These areas are more productive, have unique biodiversity and therefore are more indicative of the degradation of the physical condition. The coastal zones should be included with this bundle.
- Hypoxia is a critical measure of measure of open lake habitat.
- Primary productivity (or chlorophyll) needs to be measured again. It can be monitored by satellite.
- Suggest using satellite images of suspended solids on lake surfaces to track history of change in water quality and use historic conditions as a baseline.
- Connection between Index of Biotic Integrity (IBI) function and physical habitat:
    - Need sensitivity analysis of IBI for each lake rather than averaging for all lakes, making it more relevant. Different habitats need different IBIs (habitats in Lake Superior are much different than Lake Erie).
    - IBI may not be useful but shows linkage between certain patterns between disturbance and species presence/success. Potential habitat vs. suitable habitat - is the IBI really telling us how the species are doing because of human disturbance or is there variability in natural habitat patterns? Maybe a better approach would be: habitat utilization for fish and separate for invertebrate communities. Link to stress, not habitat - disturbance/pressure.
- Hard to pinpoint where alteration is coming from - what is causing and in which part of the watershed? Geographical scale and temporal scale are important.
- Scaleable hierarchy for each indicator, to bring it back to the local level.
- Environmental signals – disaggregating information is important.
- Change approach from political boundaries to ecological boundaries.
- Stitch projects together. Ecosystem health and community health are interactive.
- Adjacent land use and its impacts, buffer zone – affects thermal state of the water. Degree of vegetative cover indicator of degree of alteration.
- Nutrient management issues.
- Physical destruction and flow rate need to be considered.
- Nursery habitat for fish important indicator of general health.
- Tributaries, wetlands and lakes need separate assessment.
- Separation of physical, biotic and chemical or aquatic and terrestrial.
- Possible data sources: Conservation authorities have flow data dating back to 1950s; Environment Canada has data that may be more systematic; Ocean observing systems hydrological and meteorological parameters. Can build on the network and put into Great Lakes GLEOS, GOOS. Need metric readings.
- Indicators are telling us approximate status but not future trends and what is driving them.
- Not predictive enough; not aimed at identifying sources and causes.
- Should be measuring levels, sources, and impacts of chemicals that may have impacts at extremely low concentrations such as endocrine system disruptors.
- Should be measuring systems used to control water, levels for those controls and means to predict future trends and possible social actions (including shoreline management and water body connectivity).
- Should be including barriers (dams, weirs) to fish/biota migration in tributaries.

- If this is the “short list”, it falls short. Need an indicator that captures the impact of dreissenids on open water habitats.

Focus Question 3: What are the key management implications?

- Inter-governmental cooperation is very important.
  - Water legislation is mostly at municipal level – it needs to be coordinated with provincial and federal government.
  - SOLEC is seen to be at the federal and provincial level: how do you take it to the municipal and NGO (non-government organization) level?
  - Institutional gaps exist. Policy framework needs to allow integration between three levels of government. Policy framework - everybody knows their role and overall vision.
  - Improve linkages to planners and the planning process – different political scales. Link federal, provincial and state to local, public and private.
  - Need dialogue between three levels of governments. Need overall guidance and vision. Need mandate for municipalities so their actions are well guided. Local communities are restoring local habitat but lack greater vision. NGOs have taken over government’s responsibility for greater vision. At the municipal level people make changes, no provision of resources, community up rather than top down from provincial and federal governments.
  - Inter-municipal coordination needed. Need to coordinate communities and have them on the same system, onboard to same ecosystem approach.

- Scale issues; need a whole systems approach, hierarchy of indicators. Scale-ecological and political. Indicators need to be scaleable to municipality, otherwise do not have much application to local management initiatives. Natural heritage strategy also needs to be taken into account.
- Tie indicators to levels of government and actions.
- Ecological footprint needs to be considered.
- Regulatory side is strong, but what about the improvement side – what agencies are working on improvement? There is a difference between restoration and preventative action. Need a change in approach.
- Need indicators of stewardship.
- A lot of overlap and therefore, should work together instead and have one system, one approach.
- There is extensive overlap between bundles which creates confusion from a program and management viewpoint. How are the bundles being used? What is the link between the indicators and management action? This should drive the choice of indicators.
- How do we cross over from the science inherent in the indicators to the sociology/social context driving them? We do the science to influence people; we need socially meaningful indicators that are functional at the local, public level.

Focus Question 4: Habitat degradation: How can essential habitats be protected and restored to preserve the species and unique and globally significant character of the Great Lakes ecosystem?

- Local standpoint – educating the public. People do not like the top down approach. Environmental curriculum is needed in schools. Environmental options cost more money.
- Need local policy to prevent non-native species from coming in. Home depot, garden stores, landscaping bring in invasive species. The public should not have the option to buy these non-native species.
- Need consistent legislation and consistent enforcement. No loopholes for developers.
- Economic perspective is taking over. Need to consider eco-footprint and fundamental change. Wellness rating needs to be added to real estate values and overall cost benefit analyses. Indicators of happiness and well-being, not Gross Domestic Product (GDP), need to be considered. Disconnect from economic values.
- What is being done currently is not working –losing the environmental battle as a society and do not realize the gravity of the problem. Best management practices are not making a difference.
- Need to award environmental champions.

- Funding issues – there is a general lack of funding.
- Need to look at the bigger environmental issues and make environmentally correct options more available to the general public.
- Protect habitat through land acquisition. Mainly NGOs do it but it is expensive and slow. Need to recognize property potential for restoration and enhance ecosystem value. Manage lands to maximize ecological potential. Surrounding land use and buffers are also important. Future development and design planning are needed.
- A "department of habitat" is needed.
- Linkages between agencies and planning departments are needed. Need linkage between regulators and land acquisition to further environmental objectives. Need communication between small community groups and government and regulatory agencies.
    - Identify overall strategy.
- Limited resources available; need synergy for funding. Connection with money not individual grant but more creative funding options.
- Data-sharing needed between agencies: research organizations and policy makers.

Human Health Bundle of Indicators
Discussion Session Summary

Facilitator: Melissa Hulting, U.S. Environmental Protection Agency
Recorder: Meg Boyar
Number of Participants: 25

The session began with a presentation by Donald Cole of the University of Toronto on *Blood Mercury Levels: methyl mercury and persistent organics*.
Summary: The information presented was from the Health Canada studies "Great Lakes fish-eater studies." The Great Lakes anglers study went through fish license database to identify people who consume lots of fish – thought these people would potentially have higher levels of contaminants. Developed questionnaires and did statistical analysis. Used ethnic groupings to help segregate the data – south Asians eat more fish in general and showed higher rates of contaminants. There were higher levels of mercury with more Great Lakes fish meals and this survey probably only captures part of the exposure. There is a correlation of blood mercury with amount of fish consumed. The study did not include First Nations communities.

Human health indicators are quite diverse and the group chose to look at each indicator separately following 3 basic focus questions:

1. **Are the indicators and assessments correct and useful?**
2. **What refinements, simplifications, or enhancements to the assessments and/or bundles would you propose?**
3. **What are the key management implications?**

Drinking water quality (Indicator #4175)

- This indicator has a focus on finished/treated water, but needs to encompass the full range of water consumption in the whole basin region, i.e. bottled water, water from other sources.
- This is based on an analysis of treated drinking water; source water quality also needs to be considered to make this a better indicator. However, the U.S. does not gather information on source water.
- Why is TREATED drinking water being measured? This is an indicator of treatment technologies.
- Do not see how this indicator analysis relates to the analysis of the past 2 years…how do you track trends over time if the methodologies change? Also, the description of this indicator has changed dramatically in the past year. An explanation of the changes (over time) and how it impacts the analysis is needed.

- Need to review the indicator periodically, replace some parameters with more relevant ones, and review the endpoints. When a certain chemical has declined and become less of an issue, replace with current concern.
- Total organic carbon and dissolved carbon are not very useful from the human perspective…more relevant to include/focus on trihalomethanes, pharmaceuticals, personal care products, groundwater, source water, bladder cancer.
- The assessment of "good" is misleading because the indicator does not assess the ecosystem objective of protecting the water at its source.
- This indicator has been evaluated as "good/unchanging" however; it needs to include something on the gaps (i.e. in local settings). How can an assessment of "okay" be given basin wide?
- There is a huge communication gap between the SOLEC process and the amount of data and research available to tap into. For example, there is plenty of research on endocrine disruptors, raw water data, Giardia and Cryptosporidium. Different sources of information need to be obtained to get a better package on drinking water quality.
- This indicator should be linked to land use indicators.
- Need to include information of drinking water supplies from First Nations/Tribal communities – a number have boil water advisories.

Biological Markers of Human Exposure to Persistent Chemicals (Indicator #4177)

- Need to include Canadian information, discuss with Doug Haines of Health Canada. Need a Canadian equivalent to the U.S. National Health and Nutrition Examination Survey (NHANES), also need a regional NHANE.
- Need greater clarity on how to use the indicator, who will use the indicator and who will benefit from the information? How do we present the information and better develop the indicator to help the managers to make decisions?
- Studies are nice to read, but directly comparable data is needed, need the same thing to be measured in the same way on a regular basis. Indicator information needs to be broken down by region, averages or non-regional data presentations do not work.
- Need an ongoing monitoring program that supports this indicator, random studies are not enough.
- Markers of exposure don't tell you about the potential health consequences.
- Need to more generally track what is getting into humans.

Management implications

- Are the human health indicators changing the management actions around the Great Lakes?
- Fish consumption management implications: how effectively are people influences? Improvement of fish advisories.
- Teach/educate in elementary schools, kids will become the teachers of the parents.
- Need more collaboration on these issues between managers.
- Need to consider PBDE chemicals, and other new chemicals, similar to PCBs, disruptions normal functioning of the thyroid in the human being. Which bioaccumulate in humans? In ecosystems?
- Need some kind of criteria regarding what chemicals to look at (i.e. PFO's, Perchlorates, etc) - narrow it down to chemical of concern.
- Make the documentation of indicators part of teaching the sciences in a school curriculum – a practical application of the scientific method.

Beach Postings, Advisories and Closures (Indicator #4200)

- What are the impacts of constant exposure over time?
- The parameters of this indicator are very difficult to compare because so much depends on weather conditions and water currents. Weather is taken into account in sampling but not in overall reporting. These are important things to know if you want to fix the problem.
- Criteria of this indicator are black and white; however different jurisdictions measure things differently. What protocols are used? This is an inconsistent way finding out about the health effects, no human surveillance component, need to survey groups like windsurfers or other regular water activity groups.

- There is much new information about the ecology of *E.coli*, including persistence in sand. This is important in terms of management decisions. Need to know where exactly the *E.coli* are coming from. Can other bacterial indicators be used? Can we measure *E.coli* faster?
- The diagram for this indicator is quite useful – commend the authors, it is the best trend diagram in the entire set of indicators.
- Improved microbial source tracking will lead to additional information on where *E.coli* area coming from – this needs to be added to "Future Actions."
- Seems to be much easier to get data from the U.S. side of the lakes.
- Monitor 20 beaches (high profile beaches) consistently over a couple of swimming seasons, to help define real trends and be able to compare data.
- It would be useful to distinguish between beaches in urban areas and non-urban areas (do not lump together). Additionally, monitor the number of people using the beaches.

Contaminants in Sport Fish (Indicator #4201)
- Need Canadian data – from Environment Canada, Health Canada or Ontario Ministry of Environment. Also need individual state data.
- Data presented ends at 2000, need more recent data.
- Should PBDE's be a concern?
- Need to include other fish species such as walleye and perch (or change title of indicator). We should be looking at the fish that are the most often caught/sought after and consumed.
- Should include consumption of waterfowl and game, either in this indicator or in a separate indicator. Are the hunters in the Great Lakes basin getting the information that they need? Create a similar guide to the guide to eating sport fish. Canadian geese, ducks, mallards, black ducks, 'dabbling ducks', eat the sediments and ingest PCBs, mercury, etc. In Canada, some of this data may be available from Bridget Braun of Canadian Wildlife Service and Ducks Unlimited.

General Comment
- The above 3 bullets illustrate the lack of thinking about integration of the indicators – is the focus on what is important for sport hunting, market niche or about the true integrity of all species interconnected on the lakes. These indicators must be brought back to the Great Lakes ecosystem; should not divert as much and keep the whole picture in mind. Need systems analysis, flow charts of entire ecosystem sets of indicators, from source, to human encounters, to other forms of contamination, to ecosystem self-cleansing.

Air Quality (Indicator #4202)
- This is the best indicator in the human health suite because it uses the best dataset (includes long term trends as well as recent short term trends – last 5 years).

General Human Health Indicator Comments
- How do we focus on awareness of all these indicators as a public health issue?
- SOLEC has focused on developing the indicators and getting the indicators right, however, in **the** future should shift the focus to pubic action, recommendations, etc.
- Human health indicator bundle does not include an indicator about emotional and/or spiritual health associated with simple access to the lakes and related issues.
- Correlations between indicators and health effects support hypothesis and show trends. However, can not use the indicators for direct cause and effect when there are other risk factors for the health outcomes that have not been included or considered.
- Many of these indicators need more contemporary endpoints (remove obsolete endpoints for problems already solved).

Land Use – Land Cover Bundle of Indicators
Discussion Session Summary

Facilitator: Susan Howard
Recorder: Julie Sims

Number of Participants: 38

Focus Question 1: Are the indicators and assessments correct and useful?

General Discussion

- The indicators need clear endpoints to be meaningful.
- Information from these indicators can be easily misinterpreted when the information is removed from specific context. For example, none of the indicators capture when the land use remains the same but the character of its use changes (i.e. there are many regions where shoreline residences used to be predominantly seasonal but are now being converted into functional year-round residences). How is this change measured for use and the effect that it may have?
- Need consistency in the measuring unit and weighting of the indicators. Suggestion to use a ratio such as an urban versus agriculture versus natural ratio in order to avoid this issue and this could also help circumvent the scale issue within different jurisdictions.
- Another approach – keep the basin-wide perspective, but look at sub-basins/watersheds so that it may be possible to see a change occur. In the case of urban density, the Ontario CMA's (Consensus Metropolitan Area) do not show urbanized areas the same as in the United States. One suggestion was to use population data and an accurate delineation of the area to give an indication of growth rates. Could even look at the number of building permits. Regardless, the parameters must be clearly identified.
- There are indicators that are relevant to land use-land cover but are missing from this bundle. For example, wetlands – the only inclusion in this bundle is Indicator #4863 Land Use Adjacent to Wetlands (Coastal Wetlands) and it is inadequate because it alludes to only coastal wetlands.
- The indicators in this bundle are more like an inventory.
- The indicators in the bundle are all risk indicators.
- Is the appropriate data being collected for this bundle? Are all available resources being tapped including experts in particular fields? For example, property tax assessments in Ontario may give information on how the land is currently being used.
- Could develop layers of data/information and overlay them, then determine what the effect that that land use has on the basin. Another interpretation would be to look at the layers and determine what risk is associated with a particular land use.
- Indicator #7062 Integrated Pest Management does not address many forest/wetland invasive species. These need to be included here or put in a separate indicator.
- Ground surface hardening is a very important indicator, but needs further development. An alternative could be "Length of Journey to Work."
- Need to capture rural residential estates – could look at rural non-farm population within 50 km of a city centre.
- Need a measure of urban dispersion – could look at the difference in density/growth across the CMA (Census Metropolitan Area)/SMSA.
- The urban density indicator has used the CMAs incorrectly.
- The urban density indicator is too ambiguous. While an increase in density can be an indicator of better utilization, it can also indicate sprawl.
- Authors of land use indicators should consult with Association of Municipalities of Ontario (AMO), Federation of Canadian Municipalities and U.S. counterparts.
- Contact the Brownfield Institute for information on the Brownfield indicator (#7006).

Land Cover-Land Conversion Indicator (Indicator #7002)

- Data have to be standardized in order for the indicator to be meaningful. Also, trend data are missing.
- There is a gap in data collection in Canada – further work needed. Cost is an issue but cost sharing may be possible with advances in the use of satellite imagery.
- A simple classification system needs to be established – urban developer, agriculture and forest specialists must agree on common "large" land classes in order to integrate information coming from all these practitioners.

- A standard classification system of land use (see how it compares to the U.S. NLCD protocol at 30 metre grids for the entire basin). This data can then be summarized by watersheds or sub-watersheds and combined with slope classes and ecoregions.
- Could develop an indicator for land use that draws on property assessment databases.
- This is possibly the most important (pressure) indicator. Land cover ratio is one of the most influential factors on condition at the watershed scale. It is more important to monitor the cover ratio than the conversion rate.

Agriculture indicators

- These indicators seem to be segregated from context. It is hard to interpret an indicator about sustainable agriculture practices without considering simultaneously the other issues (pesticides, nutrients, etc).
- There was a similar discussion regarding misinterpretation of the indicators and difficulties measuring the change in character of agriculture land (i.e. rural non-farm area data).
- These indicators lack an assessment and need endpoints.
- These indicators simply present current status of a condition but are not related to a desired state or condition. These indicators are not useful.
- Nutrient Management (#7061) should measure the number of acres rather than the number of plans or percent of total farm area.

Forest Land Indicator (Indicator # 8500) and Bundle

- Need to measure trends in forest land protection (i.e. sustainable forest management programs such as Sustainable Forestry Initiative (SFI), National Forests, Canadian Standards Forest Certification and Forest Stewardship Council). Although these lands do not fit within the IUCN "protected" categories, they do and will continue to provide significant contributions to the conservation of biological diversity. The aggregate number of acres of land in each program adds to the knowledge of the state of the forests. Data source for SFI: Brad Williams of the American Forest and Paper Association.

Focus Question 2: What refinements, simplifications, or enhancements to the assessments and/or bundles would you propose?

- The concept of a bundle is an improvement to looking at 83 indicators. However, there are redundancies in this bundle and there should be ways to find commonalities (i.e. a measure of imperviousness would include rooftops, roads, car habitat, etc.). Enlist land use planning expertise.
- A coherent story or framework is needed to describe what this information means and how it may be used. Could focus on land use-land cover and its relationship to water quality.
- Another suggested framework for the bundle is: water quality; biodiversity; energy use.
- Although grouping indicators into a bundle may be a better way to manage the indicators, SOLEC is missing the mark with this bundle. Few of the indicators in this bundle are currently reported and they do not reflect known information.
- Need to make it clearer (more obvious) how the indicators within the bundle are combined and how the overall assessment is determined.
- An index may work better than a bundle as it would give a simple message and would need scientific data to support it. One way to achieve an index would be to make a watershed assessment. Characteristics would have to be selected for the overall assessment once an objective was determined with a desired future. Then, the index would be providing a value against a threshold.
- A concern with bundling the indicators is the possibility of missing or covering up specific basin issues. Bundling may be good to prevent information overload but each basin has unique issues. It was recommended that each basin be considered separately.
- Need to include nutrient concentration; soil loss (sediment concentration); toxic seepage from contaminated sites; pesticide concentration in water and sediment.

Focus Question 3: What are the key management implications?

- It is unclear how local decision-makers would use this information and whether the suggested indicators would provide any relevant information at the local level. Need to clarify the targeted stakeholders. SOLEC information is best used at the senior policy level and may not, in its current form, be usable at the local or municipal level where different jurisdictions and methodologies are an issue.
- Develop a scaled approach to indicator identification based on the decisions to be made. Have fewer indicators for broad scale analyses and decisions, need more indicators close to the action. How do you translate basin-wide data into action on a state or local basis?
- The key challenge is to identify desired future conditions (DFCs) for each bundle or indicator and develop incentives to encourage programs towards the DFCs.
- Need to develop clear endpoints. Managers may find it hard to use SOLEC analysis of "mixed, deteriorating" without any recommendations on what to improve. Managers may need more clear information regarding what the stress is and how to improve conditions in order to move towards a "good" state.
- The scope of SOLEC should be Great Lakes basin-wide and among basins – what is the same and what is different amongst the basins? Each basin is different with varying populations and community/city needs.
- Management challenges include:
    - Identifying shifts in the location and viability of biodiversity across the landscape as the forest landscape changes.
    - Identification/realization and decision – how do we know when there is enough biodiversity present on a unit of land?
    - Need greater buy-in from all land-owners to provide a complete picture of the current state of biodiversity, use this info to determine the management needs and work with the stakeholders to implement the needs.
- Management indicators may include: sediment, riparian health (% streams and shoreline that is forested), hydrologic modification (dam density, road density and number of stream crossings), point sources and introduced species.
- Hard to manage land uses that are driven by market pressures – difficult to monitor these pressures.
- Great Lakes managers have been rooted in resource management and water quality disciplines. Need to draw in urban experts – especially those involved in urban indicator development.
- Need to keep the separation between the “land cover-land conversion” indicator and the “area, quality and protection” indicator. The latter is focused on specific areas that require individual assessments while land cover focuses on a larger scale.
- Needs of different levels:
    - Senior managers need a clear framework/vision that they will quickly understand and use.
    - Program managers need to be able to disaggregate data/drill down to use information for a particular area whether it’s basin-wide, ecosystem or lake-basin.
    - Decision makers need rate of change information able to be applied at a local level.

Suggested Indicator for Land Use-Land Cover Bundle

Change in Urbanization

- Rate of urban population change divided by rate of rural/urban land use-land cover change over 5 years for Canada’s CMAs and the U.S.’s SMSAs.
- Greater sensitivity to change.

There were discussions about SOLEC not tapping into all resources. There were a few suggestions of organizations to contact The Council of Great Lakes Mayors, Great Lakes City Initiatives, Smart Growth, etc.

Resource Utilization Bundle of Indicators
Discussion Session Summary

Facilitator: Carolyn O'Neill, Environment Canada
Recorder: Chrissy McConaghy, U.S. Environmental Protection Agency
Number of Participants: 10

Focus Question 1: Are the indicators and assessments correct and useful?

General discussion
- Need a highly integrated indicator of Great Lakes basin sustainability, such as an ecological footprint analysis.
- The assessment of mixed is difficult to interpret from the management standpoint.
- Disaggregating some of the indicators would be very helpful.
- These indicators are a great start but need to focus on what exactly they will be used for – economic efficiency or environmental conservation.

Commercial / Industrial Eco-Efficiency (Indicator #3514)
- Tracking the 25 largest employers is a good start, but a greater number and variety of businesses need to be included (i.e. small and medium enterprises).
- Explore ways to capture large employers that are not yet reporting eco-efficiency.
- An assessment of eco-efficiency across different economic sectors could also be illustrative. Efficiency is important, but also need to consider overall production/productivity.
- Efficiency may lead to greater consumption. Measure total resources used per capita.

Economic Prosperity (Indicator #7043)
- This indicator as currently defined was seen as valuable by some participants, but many felt that it needed broadening and further refinement.
- This indicator needs to be reworked, with a more robust definition and data for the entire basin. The group debated the relevance of unemployment data to economic prosperity. If the economy is prosperous and at full employment, does that create greater impacts on the environment? Economic prosperity is a false objective unless full employment leads to sustainability.
- Should this indicator address sustainability, i.e. go beyond prosperity (hence, the need for a high-level, integrated indicator, such as ecological footprint analysis).
- Measuring economic health is an endpoint in itself, so the key for this indicator is the ecosystem context.
- Make indicator meaningful to all stakeholders: employment, per capita income, and job satisfaction. Each of these is easy to understand, meaningful to the whole community and can be quantified.
- The economic prosperity indicator doesn't fit very well in this bundle. Either make it a bundle and give it a set of meaningful indicators or place it within a different bundle (and it would still need to be more than merely "unemployment").

Water Withdrawal (Indicator #7056)
- Withdrawal is not the issue, consumptive use and diversion are.
- Change the indicator title to Water Consumption (to reflect exports of water out of the basin by baby food manufacturers, breweries, bottled water companies, etc.).
- Split the indicator up, and include water consumption as a metric.

Energy Consumption (Indicator #7057)
- Revise the purpose statement.
- Consider using several indicators within an energy consumption category (to address consumption, renewable vs. non-renewable sources, and conservation).
- Focus on the heavy cost of depletion of non-renewable energy sources.

- Create an indicator of total carbon release.
- Reduction per capita is a good indicator unless efficiency leads to great consumption elsewhere; measure reduction in carbon releases.

Solid Waste Generation (Indicator #7060)
- This indicator lacks data on the amount of material recycled, reused, and regenerated.
- It might be relevant to mention hazardous waste with this indicator, and refer to other pertinent Great Lakes indicators (possibly the contaminants bundle).

Focus Question 2: What refinements, simplifications, or enhancements to the assessments and/or bundles would you propose?

- Use the metabolism model for this analysis.
- It is vital to make the concept of 'ethics' explicit in this suite of indicators. It is implicit in most of the process but it needs to be/must be articulated.
- All of these indicators need to add resource use and waste production. Per capita employment per hectare would indicate employment as a proportion of the footprint.

Focus Question 3: What are the key management implications?

- Need to consult those with economic expertise, such as statistics professionals, industry representatives from the full range (small to international), sociologists, etc.
- Need to continue working on capturing energy issues: i.e. the need to reduce dependence on fossil fuels, increase reliance on renewables, etc.
- Given the possibilities for reducing our ecosystem stresses by focusing on these types of indicators, this bundle of indicators merits more attention.
- It is a major effort to reduce energy consumption and increase the proportion of energy produced by solar and wind – this would create a reduction of the footprint. The Great Lakes region should strive to be a leader in energy research and development. Use reduction of footprint as a measure of ecosystem ethics or ethical management.

Great Lakes Coastal Wetlands Bundle of Indicators
Discussion Session

Facilitator: Ric Lawson, Great Lakes Commission
Recorder: Susan Arndt, Environment Canada

Seven presentations were given during this session each followed by a short question and answer period. A general discussion was held during the last part of the session.

1. Great Lakes Coastal Wetlands Inventory
Presented by: Krista Holmes, Environment Canada
- The Inventory provides the first ever seamless database of classified coastal wetlands.
- Baseline information — 216,000 hectares of coastal wetlands, most found in Lakes Huron and Michigan.
- Uses of the database include a baseline for long term monitoring and comparative analyses.
- Limitations include completeness, limited air photo coverage, missed submergent vegetation, and data from the 1980s.
- Conclusions: the database is complete for Great Lakes and can be built upon.

2. Evaluation of Remote Techniques for Landscape Indicators
Presented by: Laura Bourgeau-Chavaz, General Dynamics
- Use radar data to detect changes in wetlands. Use Landsat data to monitor change.
- Explored techniques to map with in situ data.

- Monitor extent of inundation.
- Pilot sites include: northern Lake Michigan (Upper Peninsula, Mackinac, Leelanau), Lake St. Clair, eastern Lake Ontario.
- Ric Lopez, of the U.S. Environmental Protection Agency – Las Vegas Lab, is conducting preliminary assessments of coastal wetland metrics and indicators.
- Currently analyzed U.S. data only—still working on the Canadian data.
- Conclusions: the two methods complement each other. Results from SAR-Landsat may be used as validation of the landscape metrics/indicators on a larger area than when using fine scale data and field analysis.

3. Contaminants in Snapping Turtle Eggs

Presented by: Kim Fernie, Environment Canada

- The snapping turtle is not migratory so it will reflect what is in that wetland. Turtle eggs are an excellent indicator of contaminants in coastal wetlands and can be used to differentiate different sources of contaminants.
- Contaminants measured: organohalogens (because they stay in environment for a long time, they magnify and bioaccumulate), flame retardants such as PBDEs and PCBs.
- Sites from St. Clair to Cornwall, especially in AOCs.
- Need multi-agency cooperation.
- Goal is to determine spatial and temporal trends of contaminant concentrations.

4. Assessment of Coastal Wetlands Indicators – An Introduction

Presented by: Marci Meixler, Cornell University

- The project goals were to evaluate methods, define Standard Operating Procedures, compile results, and make recommendations. Draft final report updated fall 2004.
- Assessing
    - Cost: median expenses, effort (per person hours), labor (number of people) score.
    - Measurability: level of technical expertise.
    - Basinwide applicability of sampling by wetland type.
    - Availability of complementary data: how many identified data sources, in U.S. and Canada.
    - Indicator sensitivity of wetland condition changes: indicator response to degradation, use in various wetland types.
    - Ability to set endpoints or attainment levels: Do endpoints exist? What is the length of the sampling period?
- Overall indicators that worked well (preliminary recommendations) include:
    - Water chemistry
    - Fish
    - Macroinvertebrates
    - Landscape attributes.
- Optimization schemes include: Decreased cost, time, best indicator sensitivity.
- Indicators optimized for cost are: amphibians, vegetation, landscape attributes.
- Conclusions: Monitoring programs should include water chemistry, fish, landscape attributes, and macroinvertebrates.

5. Plant Community Health

Presented by: Dennis Albert, Michigan Natural Features Inventory, Michigan State University Extension

- Objective was to identify plant indicators of biotic integrity that reflect land use and water chemistry.
    - Lake Superior – acid, barrier protected, bog vegetation.
    - Northern Lake Huron – basic, open bay, calciphiles.
    - Lake Michigan – basic, drowned river mouth.
- May have to develop different indicators for each vegetative type of wetland.
- Land use variables taken from aerial photography. Surrounding land uses: upland forest, farming, urban.
- Vegetation variables

    - Mean cover by taxonomic group.
    - Number mean cover of species (native or non-native).
    - Number cover of species by plant zone.
    - Floristic quality index (FQI).
    - Conservatism coefficient.
    - Wetland coefficient for site or plant zone.
- Water quality variables
    - Many variables but specific conductivity, chloride and sulfate are best. However, not much data on them.
    - Potential plant indicators.
    - Coverage and number of exotic species.
    - Nutrient loadings—some plants are tolerant of high nutrient loadings. During sampling none of the sites had submergents. No good data because of low water levels.
    - Site based indices are strongest indicators (FQI).
    - Taxonomic based metrics and ecological species groups were weak indicators.

- Land use variables identified six factors that accounted for 70% of the variability.
    - Test plant indicators against water chemistry differences. For example, northern Lake Huron chloride levels low but high numbers of conservative plants. Disturbed sites have more chloride, low number of conservative plants.
    - Regional chemical differences are significant.
    - Regional relationships between site-based indicators and water chemistry.
    - No strong relationships between species-based metrics and chemistry.
    - Floristic quality indices or conservatism index most effective for rapid inventory of sites or zones.
    - Exotics species identification of extremely disturbed sites.
    - Many plant metrics only effective within specific regions.
    - Water level changes reduce effectiveness of plant metrics.

6. Invertebrate and Fish Community Health

Presented by: Don Uzarski, Grand Valley State University

- Want to determine the importance of variables in structuring fish and invertebrate communities. What's more important: lake, ecoregion, or wetland type? Or is it based on vegetation type? How should the IBIs (Index of Biotic Integrity) be stratified?
- In 2002 data was collected on numerous parameters:
    - Fish—61 sites. Found 15,000 fish in 51 taxa.
    - 104 plant zones from all the sites.
    - 62 invertebrate sites. Found 56,000 invertebrates in 237 taxa.
- Sampled all major inundated plant zones.
- 3 invertebrate replicate samples taken from each inundated vegetation zone. 150 organisms per replicate.
- Timed the picking, tallied, set goals. Identified to genus, species. Ran principle components analysis.
- Chemistry and land use analysis
    - Scirpus and bulrush, high dissolved oxygen (low respiration), adjacent forests.
    - High runoff and urbanization group.
    - High nutrients and agriculture group.
- Biology analysis
    - Fish data and vegetation type—similar to chemistry and land use analysis.
    - Does the biology correlate with the chemistry and the land use? There is a good linear correlation.
    - Fish community composition shifts with anthropogenic disturbance to bullrush. As disturbance increases, it affects every community.
    - Correlation of fish with invertebrate data. Most variability in scirpus community.
- Specific metrics developed to indicate certain things.

- Adjacent to agriculture the chances are good that measuring wetland chemistry/physical parameters will indicate disturbance.

7. Amphibian and Wetland Bird Diversity and Abundance
Presented by: Steve Timmermans and Tara Crewe, Bird Studies Canada
- Developing IBIs (Index of Biotic Integrity) for birds.
- Goals: to quantify stress, identify biotic attributes, analyze data.
- Wetlands selected around the basin where there are Marsh Monitoring Program (MMP) volunteers.
  Birds—88 wetlands.
  Amphibians—87 sites.
  Stressors include: land and road cover, percent of agriculture, urban, etc.
- Richness relative percent, total richness, abundance, analyzed by year.
- Water levels need to be taken into account—data divided into high and low water level years.
- Bird wetland IBIs tested with wetland disturbance. IBIs decreased with an increase in disturbance.
- Wetlands will be ranked and categorized into quality (excellent to poor).

General Discussion
Opening questions: Broad-scale application across the basin—what will work based on the information presented today? What should we focus more attention on? How should the Great Lakes Coastal Wetlands Consortium (GLCWC) proceed?

Comment: Please clarify the wetland vegetation analysis. Are substrate soil types considered and, if not, why not?
Response: It was collected and analyzed but not a major focus of the analysis. Just the biota is not adequate. This is a good point. The fact that data was collected in a low water period was significant.

Comment: Two extremes—mapping broad-scale and individual indicators. If wetlands are not conserved there is not anything to consider. Land use is easy to measure and people can understand it. Restoration can cost 10 times more than protection.
Response: Consortium has developed a baseline and will get a start on developing techniques to allow the improvement of the inventory and to get an idea of the change. Rates of change are not easily measured right now. Land use is used strongly as an indicator of disturbance. Individual biotic measures are used to correlate against those land use characteristics. Consortium has been looking into this but it has not been put together yet. Also, there is not enough information to give long term trends.

Comment: There is a strong climatic, land form and land use gradient between northern parts and southern parts of the basin. GLEI (Great Lakes Environmental Indicators – another group working on coastal wetland indicators) separates the north and south. Recommend assessing the performance of IBI between these eco-provinces because scaling and reference conditions may be very different and will end up with different scales.
Response: GLCWC addressed that last year—there are differences that exist but ecoregional taxa were removed. What was left did show a response to disturbance.

Comment: If you can not set a bar that is attainable then how can managers respond? Disturbance has been going on for so long that the goals may be unattainable in southern sections.
Response: When you look at land cover attributes there are differences between Lake Superior and the southern lakes. There is merit in stratification between north and south. With biology there is an attempt to account for species variance. This was corrected for at each site. The richness was divided by species. This does not take into account everything. Marsh Monitoring Program data is sparse in the northern regions. What the Consortium is aiming to do is to develop cost effective, rapid monitoring so that sites can be quickly monitored. Those sites that score lower on monitoring, need to receive greater help and will require policy changes.

Comment: The impression is that these indicators are developed to document habitat changes. It is difficult to document wetlands that have undergone restoration. What are the differences between a

natural or restored wetland? The goals are the same. Can you show improvement over time, will an IBI do that? There is a high correlation between rare species and quality over time. There may be a need to have different end points over time.
Response: The goal is to achieve a long term monitoring program. Lake based IBIs are needed but the charge was to develop a basinwide IBI. Trying to get basinwide indicators but they may be useful in lake basins as well. Ultimately to be more effective, scales changes may be needed. More intensive work on the monitoring and analytical end is needed.

Other General Comments
- Initiative to do wetland mapping in Canada. On Earth Day 2005 there is a U.S. Fish and Wildlife Service wetland program/initiative to re-measure plots nationwide. U.S. has never had synoptic coastline mapping. Need a picture of the coastline so we are not stitching together maps. This costs dollars.
- Data layer needed to record where the wetlands are and prioritize them for restoration.
- Need to see the large scale edge effects.
- Is there a way to combine across taxa and come up with a scoring scheme? Not sure if this is feasible.

Groundwater Bundle of Indicators
Discussion Session Summary

Facilitator/Moderator: Doug Alley, International Joint Commission and Nancy Gaffney, Toronto and Region Conservation Authority
Recorder: Glen Warren, U.S. Environmental Protection Agency
Participants: 20

Introduction
Description of the history of groundwater concerns in the Great Lakes basin and the addition of Annex 16 (the Groundwater Annex) to the Great Lakes Water Quality Agreement in 1987 under which the two Federal governments (the "Parties") agreed to map hydrogeological conditions and determine contamination of surface water from groundwater in the Great Lakes basin. Not much work was done on Annex 16 until 1994 when the IJC created an Indicators for Evaluation Task Force – groundwater indicators where included in the deliberations. A SOLEC Groundwater Subcommittee, composed of binational groundwater experts and policy makers, was established and a workshop was held at SOLEC 2002. The subcommittee continued its activities, submitted proposed indicators to the SOLEC peer review process and developed four indicators of groundwater quality and quantity (#7100-7103). Expert speakers will outline issues related to groundwater monitoring in their jurisdiction, describe the results of the groundwater indicator pilot study, and an interesting case study being undertaken in the Lake Erie basin.

1. Ontario Provincial Groundwater Monitoring Network (PGMN)
Presented by: Dr. Vasily Rogojin, Ontario Ministry of the Environment (MOE)
- PGMN - implemented in partnership with Conservation Authorities (CA) and municipalities.
- PGMN is designed to provide information on ambient groundwater levels and quality and is implemented on a watershed basis (coverage mainly in southern Ontario).
- 380 monitoring wells currently in place. First round of water quality sampling and analyses completed.
- Physical parameters measured are pressure and temperature.
- Water quality parameters measured are major ions, nutrients, physical parameters, metals, volatile organics and pesticides.
- QA/QC – wells constructed in accordance to guideline, water quality sampling collection and handling protocol, accredited labs, data review. On-site data collection field guidelines are followed.
- Products of the program include: access by program partners to continuous groundwater level data, water quality data, and understanding of variability-access via website.

- Linkages with other MOE programs include – water budgets, drought response plans, permits to take water, understanding of cumulative impacts, interference complaints, environmental assessment processes, source protection plans, potential land uses, etc.
- Only water budgets for parts of the Grand River have been completed so far.
- Next steps for the program include: network refinement/rain gauge network, information system enhancement, water quality – phase 2, selection of wells for on-going water quality sampling, special studies, analyses and reporting (annual report).

2. Groundwater Issues and Monitoring in Wisconsin and Michigan
Presented by: Dr. Norm Grannemann, U.S. Geologic Survey
- There are two driving forces for Wisconsin work: 1) the interaction of groundwater and surface water, and how withdrawals are impacting surface water quality and quantity, and 2) drawdown in sandstone aquifer – draw down of 336 and 458 feet reported in Milwaukee and Green Bay areas respectively. Groundwater flow toward Lake Michigan has been reversed.
- Groundwater management areas – Waukesha and Brown County – significant drawdowns have led to arsenic, radium and salinity problems.
- One goal for groundwater monitoring is to provide enough data to determine how much water is being used.
- Michigan – legislation is not in place, evaluating existing resources, has a database of well drilling activity.
- Legislators want info on the impact of withdrawing groundwater on neighboring land owners.

Moderator note - Recent U.S. Geological Survey report shows that Michigan, Ohio and New York have "1 or fewer" long-term groundwater observation wells per 100 square miles, Pennsylvania and Wisconsin have "2-5 wells" and Illinois and Indiana have "6 to 10" wells for the same unit area.

3. Base Flow Due to Groundwater Discharge in the Great Lakes Basin (Indicator #7102)
Presented by: Dr. Andrew Piggott, National Water Resource Institute
- Overall assessment of indicator is "mixed and deteriorating." Additional analyses and interpretation are required to validate this tentative assessment but data currently available support this assessment.
- Base flow may be of major importance for ecology. Base flow contribution is determined by analysis of flow separation using hydrographs. The base flow index is a simple physical metric of the contribution of base flow to the stream. Values of the base flow index calculated for stream gauges can be reported on a watershed basis.
- Base flow info can be used to detect changes in stream flow regimes and to assess the impacts of human and climatic factors.
- Pressures: human activities impact groundwater discharge by modifying process of groundwater recharge, flow and discharge.

4. Reporting on Groundwater Indicators in the Grand River Watershed
Presented by: Sandra Cooke, Grand River Conservation Authority
- Grand River watershed – almost 7000 km^2. Part of the greater Toronto 'Golden Horseshoe' which is designated as part of future urban development zone in Ontario.
- Grand River Conservation Authority mission - watershed management, reducing flood damage, improving water quality, etc.
- Geology is sandy and silty tills, sand plain, moraines and sand and gravel deposits, some clay plain. Bedrock geology-60% of wells in bedrock aquifer.
- 70% of municipal (includes major cities) water supply from groundwater, private wells provide 100% of rural supply.

Natural Groundwater Quality and Human Induced Changes (Indicator #7100)
- Purpose - report on ambient and natural groundwater quality-qualitative assessment.
- <1% of wells in the watershed have water quality issues, generally good water quality.

- Human induced groundwater quality changes include increasing chloride concentrations due to increased urban development and denser road networks. Municipalities are working at reducing road salt use.
- Some volatile organic compounds are threatening the water supply (i.e. dioxane).
- Agricultural impacts: Whitemans Creek (a coldwater stream) shows nitrate impact of agricultural nutrient use.
- Pressures in watershed include urbanization, population growth, agricultural impacts, rural impacts (septic systems).
- Management implications include land use planning, beneficial management practices, water resources management, education and awareness.

Groundwater and Land: Use and Intensity (Indictor #7101)
- Land use in the Grand River watershed is largely agriculture and some forest. Maps of land use types in significant recharge areas show less agriculture but more urban development – recommend smart growth.
- Groundwater use and intensity-look at primary uses of existing wells - 79% are for domestic uses.
- Groundwater use and intensity can be influenced by climatic factors-when stream flow is below average then there is a corresponding increase in well use.
- Management implications -need better monitoring.

Groundwater Dependent Plant and Animal Communities (Indicator #7103)
- Tried using stream habitat classification (i.e. coldwater, warm water, sportfish, etc.) – but data coverage in watershed is sparse. Used brook trout spawning locations instead.
- Groundwater dependent ecosystems - sampled in 1989 and revisited in 2003 – generally brook trout are spawning in similar locations, but need to consider the chemical, physical attributes of groundwater.
- Pressures include urbanization, aggregate mining, population growth (salt, septics, stormwater, pesticides, etc.) and climatic factors.
- Management implications include land use planning (smart growth), beneficial management practices, and water resources management (i.e. water budgets).

State of ecosystem reporting – need further work including more targeted and improved monitoring, consistent monitoring, quality control/quality assurance, evaluating issues at different scales, and integrated watershed resource assessments.

5. Case Study: The Influence of Groundwater on Great Lakes Nearshore Habitat and Water Quality
Presented by: Dr. Norm Grannemann, U.S. Geological Survey (for Dr. Sheridan Haack, U.S. Geologic Survey)
- Total amount of groundwater discharging directly to the Great Lakes is probably not significant, but what there is may be important in an ecosystem context. Huge volumes are discharged via tributary base flow especially to Lakes Erie and Michigan.
- Focus of this case study is the western shoreline of Lake Erie. Issues with groundwater withdrawals in Michigan and Ohio. Regional decline in groundwater levels - historically had flowing (artesian) wells, now there is evidence of reverse flow from the lake.

General Discussion
Are these 4 groundwater indicators enough?
- Is the volume of road salt being used in the Great Lakes basin a good indicator? The impact on groundwater quality is the indicator.
- Should groundwater data be applied to the watershed or to the ground-watershed? Surface watersheds but not ground-watersheds – these need to be mapped.
- Are water budgets or amounts withdrawn from groundwater known? What is the effect of the cumulative withdrawals? Is it sustainable? Monitoring withdrawals will become be important as more development due to growth changes water levels. Need a “baseline” now.

- At SOLEC 2002 the indicator “Managing Groundwater Resources” was suggested but has since been removed from the suite. The management aspect has been put aside. Great Lakes indicators have been, largely biological, chemical, and physical. This is a policy indicator which may be difficult to report.
- Suggest a flow regime indicator – natural flow regimes - use stream gauge data.
- Suggest an indicator that looks at percent of urban area in the significant recharge areas as it relates to total watershed. This would capture the fact that we are paving over areas that we should not be paving.
- Should groundwater be added to ‘Water Withdrawal’ (Indicator #7056) ? This is an existing indicator but currently only includes surface water withdrawals. It is already reported on in Groundwater and Land: Use and Intensity indicator. Proposed legislation in Ontario will require actual reporting of takings of water from the Great Lakes basin (anything over 50,000L/day) so data will be available.

Specific comments on Base Flow due to Groundwater Discharge (Indicator #7102)

- Biggest changes in base flow may have been when forests were lost.
- Base flow changes may be slow – function of flow system and hydrology of system.
- Long residence time makes determination of change difficult – i.e. contaminants may take many years (centuries) to cycle through vs. simple level changes due to precipitation.

7. SOLEC 2004 Breakout Session Summaries – Day 2

Lake Superior

Organizer: Elizabeth LaPlante, U.S. Environmental Protection Agency
Recorders: Christina Forst, U.S. Environmental Protection Agency and Ann McCammon Soltis, Great Lakes Indian Fishery and Wildlife Commission

Presentations
- Future Monitoring Challenges – Land Use Metrics For the Next 50 Years – Mark Hudy, U.S. Department of Agriculture Forest Service
- Spatial Data Compilation: Great Lakes Databases – Lucinda Johnson, Natural Resources Research Institute
- Pinnacles and Pitfalls of Watershed Assessments – Alan Clingenpeel, U.S. Forest Service
- Wall Street, Forest Land Loss and Large-Scale Forest Conservation in the Upper Great Lakes – Tom Duffus, The Nature Conservancy
- CCRS Activities in Land-Cover/Land-Use Mapping of the Great Lakes Watershed – Bert Guindon, Canada Centre for Remote Sensing

Session Overview
The breakout session was organized by the Binational Program to Restore and Protect Lake Superior, specifically the Binational Workgroup's Terrestrial Wildlife and Habitat Committees. The committees decided to use the opportunity that SOLEC provided to bring together experts on land use monitoring to discuss their work and to begin the process of developing of set of parameters and a method to monitor land use change. The breakout session was intended to help the committees take the first step in developing that monitoring program. The participants heard from five speakers about not only what they monitor, where they get their data and how they track changes, but also why they chose to monitor the parameters that do.

Future Monitoring Challenges – Land Use Metrics For the Next 50 Years
Mark Hudy has been instrumental in the development of a comprehensive set of land use indicators for large-scale areas using remote sensing. In his presentation, he described the Forest Service's Watershed Integrity Rating, a watershed index of biotic integrity intended to characterize the water corridor.

In terms of recommendations for monitoring, the following metrics were emphasized as ideal:
- Measurable.
- Have no data gaps.
- Repeatable.
- Responsive to management action.
- Cost effective.
- Have low variance in a large range.

Spatial Data Compilation: Great Lakes Databases
Lucinda Johnson presented information on the GLEI (Great Lakes Environmental Indicators) project, whose objectives are to identify environmental indicators of the coastal ecosystems of the Great Lakes basin, to link stressors with environmental responses and recommend and deliver a suite of indicators.

Pinnacles and Pitfalls of Watershed Assessments
Alan Clingenpeel discussed the Eastwide Watershed Assessment Protocol (EWAP) that was applied to the Lake Superior portion of Minnesota and across 25 states between 1999 and 2002. This protocol used land use and other metrics to give a snapshot of watershed conditions using both condition and stressor parameters.

Wall Street, Forest Land Loss and Large-Scale Forest Conservation in the Upper Great Lakes
Tom Duffus spoke about the need to understand the socioeconomic system that is driving land use change. He is studying recent shifts in forest ownership from single owners in the forest products industry to Timber Investment Management Organizations. These organizations are now subdividing and selling these lands, with significant consequences to patterns of land use.

Canada Centre for Remote Sensing (CCRS) Activities in Land-Cover/Land-Use Mapping of the Great Lakes Watershed
Bert Guindon spoke about his work on several projects related to land use, including production of a base land cover map, and a recent project related to sustainability in urban areas. He emphasized that landscape analyses must be specifically geared toward the question that needs to be answered.

After the presentations, panelists and participants in the discussion portion of the breakout session were asked to address two questions:

1. **What are the questions that are required when monitoring land use?**
One point that was emphasized throughout this discussion was that the answer to this question will drive the data used and the level of detail in the analysis.

Suggested questions include:
- What are the trends in population and land ownership in the basin?
- What areas of the basin are most vulnerable to negative changes that may be brought about by various land uses?
- How is critical habitat being affected by land uses?
- What are the risk factors that can lead to negative environmental consequences? Can the vulnerable locations be identified in the basin where negative changes in water quality or some other parameter due to certain land uses would be seen?
- What socioeconomic pressures drive land use change? It was noted that information is needed on what is happening with land conversion as well as the mechanisms that may prevent conversion in places where it is not wanted.
- To what extent is fragmentation by road building and residential development occurring?
- Where and how fast are land uses changing? The argument has been made that plans should only be for 2-4 years in advance because "ten year plans are worthless." If true, a position such as this for 10-year plans has major implications for monitoring.

2. **What parameters might be useful in answering those questions?**
Discussion followed about setting land use thresholds beyond which a particular parameter would be affected. Unfortunately, setting these thresholds can be very costly and difficult. A representative from the Canadian Wildlife Service informed the group that they have done some work in this area.

Issues of scale were also discussed; very detailed mapping is expensive but may be important for local land use decisions. On the other hand, tracking trends at a basin-wide scale may not require such specificity.

On the scale of Lake Superior it will also be important to evaluate the compatibility of the various data so that a basin-wide picture can be generated. It was noted that for a level of consistency, one can use topographic information layers. However, a question was raised regarding whether a wetland is defined the same way in the U.S. and Canada.

Lake Michigan

Organizer and Facilitator: Judy Beck, U.S. Environmental Protection Agency
Recorder: Ewa Downarowicz

Session Overview
Lake Michigan differs from the coastal areas to the open water. Of the 33 watersheds that feed the lake, all but 3 are listed for some beneficial use impairment. While the open water quality is good, the aquatic food web shows signs of the impairments found in the coastal areas and tributaries. This session explored these complex interactions and origins of stress, planned for the upcoming 2005 intensive monitoring and discussed the results of the Great Lakes Coastal Wetlands Consortium work on Lake Michigan's coastal wetlands.

Great Lakes Coastal Wetland Consortium Discussion Summary
- Estimates show that half of the coastal wetlands in the Great Lakes basin are located in Lake Huron and Lake Michigan; the majority are barrier protected and river-mouth type wetlands.
- Barrier wetlands are predominantly located along the northern shore of the lake, Upper and Southern Green Bay.
- Potential plant metrics – Floristic Quality Index (FQI) or Conservatism Index are most effective; percent cover of exotic species provides a good picture of disturbed wetlands; many metrics are only effective in specific regions; water level changes reduce effectiveness of many plant metrics.
- Index of Biological Integrity (IBI) scores for Drowned River plant communities show that the degree of disturbance of plant communities is not grouped according to size but show patterns of disturbance and land use.
- Invertebrate and fish based IBIs for coastal wetlands: disturbance gradient shows that the southern part of Lake Michigan is more disturbed and the north is being less disturbed.
- What metrics match up with the observed gradient? Manistee shows good results. Kalamazoo shows certain types of invertebrates illustrating its relative disturbance and relative abundance of certain types of invertebrates and habitat preferences. Potential indicator fish species include: spottail shiner, black bullhead, green sunfish. Bird and amphibian indicator species include: foraging, nesting, species, etc.
- Possible stressors on these systems include: hydrological alteration, sedimentation, chemical inputs, shoreline alteration, diking, dams, and invasive species. In healthier systems, not many invasive species exist.
- Residential stressor shows that a high percent of coastal wetland area is affected. Roads affect 96% of all wetlands. Dredging is also impacting wetlands. Even northern wetlands are being affected by these stressors.
- Agricultural urban systems drive the biology in wetlands. Chemical inputs have significant negative relationship with the biological state of the wetlands.
- Monitoring is the next step after preliminary results.

Great Lakes Coastal Program Discussion Summary
- Emphasizing partnerships
- Different ecotypes
- Provide Grant money for projects
- Examples of projects:
  - St. Louis river habitat plan – focuses on restoration, invasive species and education (locally led leveraging project).
  - Kakogon Slough Rail survey – recapture and mark.
  - Graveyard Creek Restoration – fish passage restored and stream rehabilitated.
  - Belle Isle Restorations – coastal wetland restoration, native plant census, soft shoreline engineering demo.
  - Grand Sable Dune exotic plant management – mapping and removal of exotic plants.
  - Lakeplain Prairie restoration – fringed orchid reestablishment and 10 year monitoring plan.
- Summary:
  - Developed non-regulatory partnership approach.
  - Great benefit to coastal communities and nearshore, shoreline, riparian and in-stream and removed fish barriers.

- Many project successes.
- Granting issues – compilation of granting opportunities needed.
- Track/monitoring success of projects on long-term changes over time.
- Database of projects is available.

Lake Michigan Mass Balance Modelling Project Discussion Summary

- Monitoring for atrazine, mercury, and PCBs.
- Low to high resolution models.
- Atrazine shows little degradation and the model predicts that levels will increase.
- The model predicts that PCBs will increase in water; while PCBs in sediment will decline.
- Mercury – low screen model shows little methylation occurring in Lake Michigan; the methyl mercury is coming from the tributaries.
- 1994, 1995 and 2005: Plan on revisiting sampling sites and gathering more data. 2005 sampling will provide an opportunity to check the reality of the model forecast and fine tune the models.

Vision for Lake Michigan

- NOAA Coastal Zone Management Program in Indiana offers $1 million per year in grants for research projects.
  - Coastal Estuarine Land Conservation Program (CELCP) should be preserved in each state as a planning document.
  - Each state will develop a plan for areas that are unique to that state.
  - U.S. Fish and Wildlife Service will identify critical habitat types to create a model for Indiana and a transportation plan.
  - Public access component – public property for land acquisition.
  - Rare for federal government to acquire land but can be acquired through this program.
  - Proposition: Conservation Fund should acquire more Great Lakes islands.
  - Need more money from federal government for Lake Michigan and land acquisition – Proposal has been submitted to the federal government for funding for the Great Lakes similar to the funding for the everglades.
  - Need to pull together the Great Lakes Coastal Wetlands Consortium data, CELCP plans and other information to create a better overarching vision and strategy.
  - Tribes have outlined and prioritized coastal wetland areas.

Current Situation and Research and Development

- Significant groundwater and recharge areas exist in Lake Michigan. Groundwater basins and aquifer explanation requires more work. Some significant recharge areas have been delineated by U.S. Geologic Survey in Great Lakes area: estimate of recharge vary from 0-23 inches; presently working on extrapolating this data to the entire basin.
  - Is the recharge being impacted? There is not enough trend data but in the near future, recharge trend information will be available.
  - Land use is not yet being considered.
  - Withdrawal rate data is needed and is very important.
  - Recharge does not equal sustainability. Need social consensus on sustainability. Scientific data can only provide information for decision-making. Quality and quantity need to be discussed.
  - Water use data needs to be summarized by state and completed for Lake Michigan basin.
- Need to focus on preventative measures; not remedial actions. More information exists on damaged systems than natural systems.
- Need for recent and consistent collection of aerial imagery of the Great Lakes basin.
  - Agencies capable of providing data: NASA, NOAA, Great Lakes Observation System (GLOS).
  - Coast Watch can provide remote sensing data.
  - Michigan Sea Grant water temperature data can be used to make contour maps for lake.
  - Landsat satellite project can provide land characterization of the Earth's surface, but is not really useful for coastal areas.
  - Orthophotographs are needed for the entire coastline.

    - Need to create specific grant program for project.
    - Lidar laser technology provides a high resolution for elevation information. The information can be difficult to analyse but could be very useful.
    - NOAA is suggesting Great Lakes survey services- technical assistance for local projects.
- Data exchange:
    - Need to be synchronized for all existing data.
    - Need to optimize existing data.
    - Bring data together from different states and then relate it to watershed and local levels.
    - Information needs to be reformatted and user-friendly.
    - Be available as metadata.
    - Local groups do not have funds for data collection/exchange.
    - Need appropriate funding mechanism.

What needs to be preserved and restored? What needs to be prioritized?
- Numbers may be misleading about the actual ecological state and health of Lake Michigan.
- Accuracy of data – systems are dynamic and change and this change needs to be monitored.
- Time for monitoring is very relevant.
- Need to distinguish between native and invasive (non-native) species.
- Establish baselines of quality and quantity and relate it to stress and degradation. Over time check on restoration areas to see how the system has changed.

Lake Huron

Organizers and Facilitators: Janette Anderson, Environment Canada and Jamie Schardt, U.S. Environmental Protection Agency
Recorder: Christine McConaghy, U.S. Environmental Protection Agency

Session Overview
Participants engaged in a discussion on the value and uniqueness of Lake Huron, pressures in its watershed, and priorities for managers and stakeholders in light of the upcoming 2007 intensified monitoring effort for Lake Huron. The comments provided in this session will ultimately help to shape the Partnership's monitoring effort.

Discussion Summary
1. Recent data was presented that indicate changes in the forage fish community and impacts on Chinook salmon. Despite a huge alewife year class in 2003, two cold winters in a row led to the lowest alewife abundance on record. Tagging data indicates that some Chinook salmon are moving from Lake Huron to Lake Michigan perhaps as a consequence of limited prey availability. Also in 2003, a strong year class of yellow perch was observed, and high numbers of walleye were seen in Saginaw Bay. A final draft report, "Fish Community Objectives for Lake Huron," may be found on the Great Lakes Fishery Commission website www.glfc.org/pubs/SpecialPubs/Sp95_1.pdf

2. The future of Lake Huron: "What will Lake Huron look like in 25 years?" and "What do you want Lake Huron to look like in 25 years?"

- Concerns that were discussed included:
    - Development pressures – more intensive use of cottages, second homes, population increase, impact on Lake Huron and its 30,000 islands.
    - Water quantity and outflows.
    - Climate change – lake level changes, terrestrial vegetative responses.
    - Need for integrated, coordinated management and planned development.
    - Stormwater runoff.
    - Air pollution, acid rain, ozone.

- Human health in First Nations/Tribal communities living within Areas of Concern (AOCs).
- Health effects of contaminants in fish tissue.
- Continued monitoring to determine endpoints and fill data gaps.
- Recognition of Georgian Bay, the "forgotten lake".

3. Data gaps and information needs

The group reached a consensus that there is a need to not only collect new data and fill data gaps, but also to look at and integrate existing data. The following data needs were identified:

- Land use indicators – forest canopy, riparian buffer, wetlands, and rate of urbanization.
- Variability within and between watersheds (use for setting targets).
- Climate change (including rate – gradual versus sudden).
- Water levels and outflows/water quantity.
- Demographic information – develop indicators and plan for impacts.
- Monitoring – air quality (pristine and urbanized areas), tributaries and nutrients, contaminant, and pathogens.
- Work with agriculture sector— land use, tile drainage impacts.

Highlights and Management Implications
- Integration and coordination are needed among management, including watershed planning, cooperation across traditional agency/sector divides, and technology transfer.
- Land use planning and strategies to address development pressures in Lake Huron and Georgian Bay are critical needs.
- More integration and sharing of existing data are needed.
- Political support is necessary to fund cleanups and recognize scientific findings.
- Communication of environmental information to Tribes/First Nations, as well as attention to human health and fisheries impacts on these communities.

General Comments
The Great Lakes are spectacular. How has this society polluted some of these areas to the point where fish cannot be eaten? In 25-50 years, the lake may still be enjoyed aesthetically, but what will the water quality be like? There is a need to work together with all involved sectors (i.e. industry, government, etc). How can the Great Lakes be improved currently and in the future?

For over 500 years, native herbal medicine has been practiced. The medicines (herbs) provided are affected by acid rain, air pollution, ozone depletion and other environmental stressors. There is a need for more/better communication from professionals to educate people on environmental issues.

Monitoring and treaties are excellent things to do, but at end of the day what has really changed in Lake Huron? As a society, there is no umbrella group to share technology and facilitate reducing the impacts on the lake.

Lake Erie

Organizers: Sandra George, Environment Canada and Dan O'riordan, U.S. Environmental Protection Agency
Facilitator: Scudder Mackey, S.D. Mackey and Associates
Recorder: Lillian Hopkins

Presentation:
- Physical Integrity of Lake Erie Landscapes, Watersheds and Hydrology – Scudder Mackey, S.D. Mackey and Associates

Overview of Session
Stressors to Lake Erie's natural ecosystem include the impacts of changing land use, shoreline alteration, nutrient loading, chemical contamination and exotic invasive species. These factors have direct impacts on habitat quality and food web dynamics. This session addressed these issues and other stressors with particular emphasis on land use and the potentially detrimental effects of land use change.

Definition
Physical Integrity - Physical structure, connectivity, and processes that "…maintain a balanced, integrated, and adaptive system capable of sustaining all components and interactions (structure and function) in an organized manner."

The paths (connections) taken by water through the landscapes are important:
- Watershed to Tributary (effects of interruptions between the two is a stressor).
- Watershed to Lake (connectivity).
- Tributary to Lake (dams and shoreline alterations are stressors).
- Ecological benefits provided as water moves through the system.

How has the physical integrity of Lake Erie been impaired?
- Watersheds – reduced forest cover, restructuring of subsurface flows, altered flows, ground and surface water withdrawals, altered pathways.
- Tributaries – sedimentation, accelerated erosion, increased flows, temperature change/thermal effect, habitat alteration, channel morphology (instability, width/depth ratios), loss of connectivity (absolute and temporary), altered base flows, alter thermal regime, and alter chemical regime.
- Estuaries/River Mouths – altered substrate, raised temperatures, increased stratification (thermal), increased turbidity (from channel dredging), changes in light regiment (transparency: from turbidity), altered physical structure (substrate), altered lateral flow/connectivity, littoral sediment transport, deposition and erosion, and altered substrates.
- Coastal Wetlands – filtering, sediment trapping, inability to migrate landward (during higher water levels).
- Nearshore (<10 m water depth, <5 m in Western Basin) – littoral sediment transport, deposition and erosion, altered substrates, changes in water depth and changes in energy (wave energy), shoreline hardening (parallel), change in light regiment (increased transparency), loss of barrier systems (beaches, nearshore substrates and wetland implications), loss of sediment supply (coarser grain sediment).
- Open Lake – plumes, change in substrate, delivery of water (time and flow rate) from tributaries/flow characteristics (which changes nutrient and contaminants loadings), physical dispersion, re-suspension, hypoxia, thermal stratification effects.

What are the stressors causing these impairments?
1. Landscape/Watersheds
2. Hydrology
3. Other

- **Watershed –** urban sprawl, land use change, agricultural activities, impervious surfaces, ground and surface water, withdrawals/water use.
- **Tributaries** – dams and barriers, hydro-geomorphic alterations (e.g. channel straightening), levies and dikes, filling of flood plain, altered connectivity between groundwater and surface water (interactions), mining (sand extraction).
- **Estuaries/river mouths** – dredging of navigation channels (contaminant issues for dredging), faster and warmer water, invasive exotic plant species (and other organisms e.g. zebra mussels), dredging, shoreline hardening and alteration, navigation structures.
- **Coastal wetlands** – exotics (especially macrophytes), land use (especially hardening, roads etc.)
- **Nearshore** – zebra mussels, re-suspended sediment, dams, shoreline altering, mining (sand extraction).

- **Open lake** – zebra mussels, sediment deposition (increased sediment loads), atmospheric deposition, respiration (zebra mussels), increased transparency in the open lake.

Over what spatial and temporal scales do these stressors act?
- Agriculture (decade) – urban.
- Climate change (decade or longer) – global.
- Navigation (seasonal or annual) – tributary.
- Algal bloom (seasonal/annual) – tributary.
- Storm events (broad or isolated) – basin.

Focus on local/watershed scales for effective management and the need for better integration across all scales. Need to look at all scales and evaluate the situation. For example, local stressors may be very significant but at a watershed scale, they are not as important, i.e. irrigation withdrawals.

What key indicators describe the physical integrity of Lake Erie and its condition?
- Shoreline hardening (sediment transport, habitat loss, extent of development, coastal processes, connectivity). Watershed level, including river banks, tributary, river mouth, shoreline.
- Altered flow regime (capturing channel stability).
- Kilometres of regulated river (and where located).
- Availability of spawning substrate and for rearing (nursery habitat).
- Fragmentation index (wetland and forest habitats-terrestrial; pathway corridor).
- Community infrastructure assessment (indicative of biological condition).
- Percentage of type of cover (degree of hardness and softness).
- Water consumption, withdrawals, diversions, agriculture, industrial evaporation (expressed as for example: tiles/km (or as a percentage), number of pipes, drainage ditches, open water: dry land).
- Channel alteration.
- Soil type – filtration capacity to determine infiltration rate (time scale).
- Secchi disk readings/water transparency.
- Habitat supply – product of quantity and quality (for a range of indicator species).
- Aquatic substrate size.
- Mixing offshore of a river mouth.
- Beach erosion (measurement of sediment availability).
- Social indicators (users).
- Surface temperature.
- Sedimentation rates (coring).

How can physical integrity be integrated into landscape/watershed assessments (tool availability/development)?
Satellite imagery is becoming less expensive with time/orthophotograpy/remote sensing/assessments of land cover. Part of the "state" reporting processes is available.

What are the data/information needs that are necessary to develop and implement these indicators?
- Need long-term comprehensive monitoring programs.
- Real commitment of government funds; long-term input compared to one-time funding inputs.
- Better database integration across disciplines and agencies.
- Database quality control and the development of better remote sensing technologies are needed.

Lake Ontario

Organizer and Facilitator: Fred Luckey, U.S. Environmental Protection Agency
Recorder: Veronica Lo, Environment Canada

Session Overview
This break out session focused on the issue of non-native species, which have severely disrupted Lake Ontario's aquatic foodweb since the LaMP made its initial beneficial use impairment determination a decade ago. Lake Ontario fishery managers discussed the stressors impacting Lake Ontario's fisheries and proposed changes to the LaMP's list of beneficial use impairments. This session also focused on minimizing impacts of lake level controls on nearshore habitats, including coastal wetlands. The International Lake Ontario – St. Lawrence River Water Level Study is currently in year 4 of a major 5 year study evaluating the possibility of changing the current water level control plan in order to consider a broader range of factors including environment and recreation. Members of the International Joint Commission Reference Study and LaMP staff discussed the work underway to evaluate a variety of potential changes to the current lake level control plan and how to best monitor the ecosystem's response to any future changes.

The 2002 reassessment of the 1998 Problem Definition
- Benthic and nearshore phytoplankton populations were determined to be degraded.
- Conservative approach.
- *Diporeia hoyi*: decline has negatively impacted fisheries.
- Zebra mussels negatively impact phytoplankton populations.

Lake Ontario Lower Aquatic Foodweb Assessment (LOLA)
- Focus sampling to compare survey information to pre-zebra mussel conditions.
- Evaluating changes in the lake's lower food web and its ability to support fish populations.

2004-2005
- LaMP is reassessing fisheries

Overview of Lake Ontario with a focus on open water area
Lake Ontario Food Web pre-1850
- Only lake trout, ciscoe, burbot, and other native species existed.

Post Dreissena, phosphorous abatement
- Presence of alewife, smelt.
- Most native fish species in offshore are stocked fish.
- Decline of *Diporeia*.

Currently
- *Diporeia* found only in deepest waters; mysis future uncertain.
- Presence of the three-spined stickleback (non-native preyfish) in offshore waters.
- Round goby (non-native) distribution is expanding.

LaMP Indicators
1. Prey Fish
- Offshore – diverse array of preyfish populations should be sufficient to support healthy productive predator fishes.
- No target has yet been set due to dynamics of prey fish.

2. Lake Trout
- Population should be sustained through natural reproduction.

Great Lakes Indicators and Fisheries
Organized by habitat:
- Mesotrophic shallow nearshore areas.
- Oligotrophic and very deep offshore areas.

Bottom up drivers and linkages: lake whitefish – concurrent declines of *Diporeia* and lake whitefish; reproductive failure or low young-of-the-year survival; and Dreissena colonization.

Degraded Fish and Wildlife Populations in Areas of Concern
Evidence of impairment includes:

- Benthos and habitat is impaired (due to non-native species).
- Predators have high levels of contaminants warranting consumption advisories.
- Contaminants linked to lake trout reproductive failure.
- All native open-water species (lake trout, Atlantic salmon, blue walleye, deep water ciscoes, deep water sculpin, American eel and lake sturgeon) are in decline except those that are stocked or that have diverse diets.
- Non-native prey fish are sources of thiaminase.
- Round goby still colonizing, displacing benthic fish, and eating lake trout, eggs, or dreissena.
- Most salmonids showed low natural reproduction, attributed to tributary health.
- Non-native species new diet items do not provide levels of the types of essential fatty acids that are contained in native foods.

- **How can the degradation of open water fish populations be addressed?**
- **How should the Lake Ontario LaMP define goals and objectives to address the degradation of fish populations and provide a broad array of ecological, social and economic benefits?**

Fish populations

- Reduction in stocking because forage fish populations are in decline and/or because the population is not balanced.
- The reduction in fish populations in the early 1990s was due to increasing biomass of top predators such as salmon and trout but with no change in prey fish biomass. A decline in prey fish is evident now.
- Evidence of global climate change, e.g. lake whitefish, therefore, not entirely attributed to non-native species.
- Native fish populations are degraded because the system still relies on stocking.
- Will not reach equilibrium because this balance depends on sea lamprey control and re-stocking; but can still improve populations of native species.
- The greatest biomass of fish was from 1988 – 1992. Large-bodied fish declines are not surprising because they were already in decline in 1998, despite the claim that the status was improving. LaMP Stage 1 document published in 1998 was prepared with the latest data available (date from 1995). In the 1995 data, this decline was not evident.
- Should consider geographic distribution of fish population when discussing health of fisheries. There have been major geographic shifts i.e. dead zones in lakes due to a decline in *Diporeia*, uncertainty about mysis. There are no large benthic invertebrates remaining.
- Many species are forced into environments that are not thermally appropriate.

Climate Change

- Climate change: global warming will cause a warmer-water fishery management strategy to be considered. Cold-water species will still be considered in the Great Lakes because of the depth of waters in the lakes.
- What is natural reproduction of lake trout? Lake trout still spawning on shoals and new substrates, but not many are surviving.
- A change in temperature and phosphorous loading affects fisheries.

Invasive Species

- Prediction is that carnivorous amphipod populations will increase. A focus on prevention will be required.
- Australia and New Zealand have a green list of allowed species – precautionary principle.

- Zebra mussels are efficient filter-feeders. What analysis has been done on their biomass material? Zebra Mussels are recycled into sediments and contaminants tend not to bioaccumulate in mussels. What has been the net effect of ecosystem balance shift after introduction of zebra mussels?

Management Perspective
- Major focus of LaMPs has been drinking water quality. Need to know what targets are realistically achievable.
- Who are the investigators for the LaMP data? Ontario Ministry of Natural Resources, U.S. Geological Survey, Department of Fisheries and Oceans, Ontario Ministry of the Environment and Canadian Food and Inspection Agency.
- How can Fish Community Goals and Objectives (FCOs) be created to address safe development? The best thing is prevention. Consultations with waste water treatment plants, nuclear plants and the public are also very important as well as changes in legislation and good public relations. It takes a long time to collect data as well as to strengthen lake monitoring cooperation.
- Presence of nearshore sewage plants, water collection plants, nuclear power plants impact fish populations, but their exact role is unclear. Sewage effluents, cooling waters, cleaning contaminants and that create plumes all affect fish populations. Nuclear power plants monitor populations on a local scale, but not at a larger scale.
- What analyses of phytoplankton and zooplankton have been done? This analysis is needed as new data is required.

Minimizing Impacts of Lake Level Controls on Nearshore Habitats
- Study team comprised of agencies, academia, and interest groups.
- Eight technical groups addressing environmental issues.
- Final report due October 2005.

Shared Vision Model – Bill Werick, International Joint Commission
- Plan Formulation: simulate regulation of Lake Ontario with potential water supplies with the ability to evaluate based on these different parameters.
- Provides greater accessibility.
- Four strategies to developing a regulation plan.
- Once plan formulated, can run through model to measure different aspects, e.g. water levels.
- Post-processor interprets data and creates a plan evaluation, e.g. economic analysis/ranks plans according to economic benefit.
- Overall judgement performed.
- Model goes through data, selects a specific focus, and analyzes data based on that focus.
- Shared vision process demands an early decision.
- This approach only looks at water level.

Coastal Wetlands
- Focus on developing evaluation criteria for study.
- Wetlands one of the most sensitive to changing water levels.
- Large shrub and tree areas moving up from shore.
- Hydrologic linkage: habitat compressed as water level increases – dynamic response.
- Reduce potential elevation level of plants as water level decreases.
- Cattails moving upslope into meadow communities.
- How can a plant community response be quantified? Predict using water level cycles.
- Four geomorphic types of coastal wetlands.

Quantification
- Plants sampled on different elevation levels.
- Site-specific digital elevation models created – combined to create generalized geometric model
- Plants categorized according to structure – e.g. broad-leaf, thin-stem, etc.
- Binational coastal database created.

- Wetland bird communities – oriented along a hydrological gradient, e.g. shrub community versus shallow water bird communities.
- Variabilities tested: water level fluctuations, plant community and water depth.
- Bird and Habitat surveys conducted using 475 survey plots to estimate species density.
- Environmental Performance Indicators narrowed down to approximately 15 essential indicators that are different for the upper and lower St. Lawrence River.

Questions
- Do climate change models exist? Yes, they are a part of a mandate where 4 different projections are used. A sensitivity test will determine the most suitable approach.
- Are bird species used as indicators? Certain species benefit from degraded habitat, but wetland-nesting birds are very sensitive to disturbance. Reproductive parameters to measure health of wetlands are required.
- Principle component analysis – is this appropriate for habitat indicators?
- Great Lakes indicators provide a current status perspective on wetlands.
- Have seasonal variations been taken into account? Water depth variations inclusive of breeding parameters have been included.
- IJC model provides a prediction perspective. Can both perspectives together be brought together?

Adaptive Management as a Component of a New Regulation Plan
IJC Lake Ontario – St. Lawrence Study Guiding Principles
- Environmental sustainability – what is it and how do is it achieved?
- Ability to respond to unusual conditions.
- Adaptability to changes in water supply.
- Flexibility to adapt to advances in knowledge.
- Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs.

Adaptive Management Process
1. Assess problem.
2. Design a plan.
3. Implementation of this plan.
4. Monitoring outcomes.
5. Evaluating outcomes.
6. Adjusting implementation of plan over time.

Necessary Elements
1. Sound Science.
- Predictive models of ecosystem function.
- Recognition of uncertainty.
- Monitoring – test hypotheses in models.
- Data management.

2. Management Commitment and Flexibility
- Management objectives.
- Feedback to system managers.
- Clear responsibilities.

3. Public participation
4. Long-term funding

Successful Applications of Adaptive Management
- B.C. Forest Service, Glen Canyon Dam/Colorado River, San Pedro River, Everglades.
- Need consensus of management goals.

Priority targets for modelling – Lake Ontario and Upper River
- Great Lakes Marshes – meadow marsh, open water, area not dominated by cattails.
- Temperature regimes – northern pike, largemouth bass.
- Wetland diversity and condition – swamp sparrow.
- Species at risk – blandings turtle, bridle shiner, pugnose shiner, American eel.
- Habitat shaper – muskrat.

Present Operating Structure
- International Joint Commission – Board of Control.
- Adaptive Management Working Group.
- Regulation Representatives.
- Operations Advisory.
- Operators of dams.

What monitoring programs exist?
How could the feedback function to the board of control be organized to be most effective?

Building on the International Joint Commission Water Level Study
- No plans to continue work after study concludes.
- Information and data transfer.
- Assessment of coastal habitat impairments.
- Coastal habitat indicators.
- Indicator monitoring.
- Use of IJC models to assist future decision-making.
- Who will maintain model when group disbands?
- LaMPs play a role by addressing monitoring needs.

Next Steps
- Move study forward.
- Habitat workshop in November 2004. A report on habitat issues will be produced from this workshop.

Discussion
- Quality aspect of lake water and source waters needed for certain regulation parameters e.g. effluent level limits.
- U.S. does assessments of parameters, e.g. water quality standards based on health and ecological parameters. Numbers based on science.
- Coastal wetland quality indicators. Working with the conservation authorities, getting stakeholders to define what is acceptable and addressing issues at a community level.
- Once regulation regime is established, what flexibility is there to deal with catastrophic events or items that do not fit within model?
- Habitat protection versus personal property protection. The challenge is to develop these guidelines.
- Levels vary widely, in terms of data collection, and how proximate it is to the wetlands under study. Focus is on long-term and weekly studies.

8. SOLEC 2004 Workshop Summaries – Day 3

Chemical Integrity

Organizers: Dale Phenicie, Council of Great Lakes Industries, Jim Smith, Environment Canada and Ted Smith, U.S. Environmental Protection Agency
Facilitator: Dale Phenicie, Council of Great Lakes Industries
Recorder: Veronica Lo, Environment Canada

Presentations
Chemical Integrity Summary – Dale Phenicie, Council of Great Lakes Industries
What Elements Define the 'Chemical Integrity' of the Great Lakes? – Gerald Matisoff, Case Western Reserve University
Research on the Chemical Integrity of the Great Lakes – Brian Eadie, National Oceanic and Atmospheric Administration
Chemical Integrity: Moving into the Future – Miriam Diamond, University of Toronto

Session overview
The purpose of this session was to facilitate planning for SOLEC 2006, which will focus on the chemical integrity of the Great Lakes. This session considered the state of science on chemical integrity, the relationship between chemical, physical and biological integrity, and the research that is currently being performed or planned for the future.

What Elements Define the Chemical Integrity of the Great Lakes?
- Maintaining chemical integrity is one of the mandates of the Great Lakes Water Quality Agreement (GLWQA).
- The GLWQA sets Specific Objectives for several chemicals, but others may be of concern as well that are not included in Annex 1.
- Chemicals are important because of their interactions with biological functions.
- All factors and interactions between biology and physical habitats must be considered, not just chemical properties.
- The SOLEC 2002 definition of biological integrity may also serve as a definition of chemical integrity, especially if one includes links to physical integrity and human uses, i.e. "Chemical Integrity is the capacity to support and maintain a balanced, integrated and adaptive biological system having the full range of elements and processed expected in a region's natural habitat." James R. Karr, 1991 (modified).
- Examples of stressors on the system include non-native species (and the resultant changes in trophic dynamics, nutrient availability, habitats, flow, and sequestering of contaminants) and climate change.
- What is a chemical? Not just "toxics." All chemicals can be toxic. The relationship with exposure is important.
- Other physical and biological factors are important such as the sources and loadings of the chemicals and habitat issues and the combined effects on the biological integrity. Other important factors are: temperatures, water levels and flows, wind, ice cover, solar radiation, contaminant and nutrient cycling, and the relationships between all of these factors.
- To make judgments regarding integrity, they must ultimately be accounted for through modeling, forecasting, and risk assessment.
- When defining Chemical Integrity, the following must be considered:
    - Rates of change.
    - Natural conditions or concentrations.
    - Biological conditions and freedom from manmade chemicals.
    - Ecosystem form and function in light of human uses and presence.
    - Sustainability of human uses.

- Great Lakes indicators missing from the list regarding chemical integrity are:
    - Oxygen – What is the state of oxygenation of the ecosystem? Depletion rates? Sediment oxygen demand (SOD)? Presence of a hypoxic area?
    - Legacy contamination – Perhaps rate of progress at Areas of Concern (AOCs) is a chemical integrity indicator.
    - Pathogens – presence can be confused with chemical toxicity.
    - New technology monitoring system deployment – need to track chemical integrity and identify problems at the source.
    - Better use of models, risk assessment, and ecosystem forecasting.
- The current chemicals that are monitored such as PCBs, dioxins and DDT, may not be the correct chemicals to be screening. The concentrations of these substances are decreasing and will continue to do so. "How clean is clean?" How will the decomposition of all chemicals be handled? Will monitoring continue for these chemicals once it is confirmed that they are decomposing?
- Modeling, risk assessment, and ecosystem forecasting to predict the effects of biological, chemical, physical and human-induced changes on ecosystems and their components may help. If such models do not exist, should they be developed?
- To track chemical integrity the following need to be addressed:
    - Identify what is to be assessed. What is the real goal of maintaining "chemical integrity?"
    - Remember that the goal is assessment, not monitoring.
- Once on this track, the selection of indicators of chemical integrity will readily follow.

Comments on Defining Chemical Integrity

- Chemical detectability has increased dramatically such that very smaller amounts of chemicals can be detected in the environment. "What is the threshold of concern for these compounds?" It is important to understand the significance, not just be concerned about the presence of these chemicals in the environment.
- The awareness of false negatives from modeling needs to be addressed. Validation and the testing of these models are needed, so there is a response to changing inputs.
- Mixtures of chemicals are a reality, but the toxicity of each chemical does not always have additive effects. However, the additive effects need to be considered as well as how the chemistry of the system is impacted. Calcium and magnesium ratios are an example.
- All interested parties need to be involved with this work in order to solve this situation.
- It is difficult to deal with chemicals that appear benign, such as chlorides. They are not highly toxic, but levels are elevated. Maybe there is a need for some guiding principles. Should monitoring continue for fish contaminate levels that are decreasing? Monitoring in watersheds, where changes can be detected, is required. The presence of a chemical may be a threat but by the time it is seen in a fish, it is too late.
- For SOLEC 2006, an assessment of the chemicals in each Lake and the source of the chemical are needed.
- The GLWQA identifies an ecosystem approach to defining integrity. Chemical integrity cannot be reviewed in isolation from biological or physical factors.
- The Great Lakes are a system of habitats. The chemical and biological integrity of the system defines these habitats. Chemicals can affect habitats.
- Models are needed that include all of these factors.
- Chemical Integrity is not just an ecosystem problem but a multimedia problem. Water issues and the status of the air and land must also be coupled in the assessment.
- New analytical techniques can be applied to old (archived) samples to provide data for running various models.
- Chemical integrity affects biological integrity and biological integrity affects chemical integrity.
- Some key materials need to be added to the common monitoring lists in order to provide the broader chemistry information that is needed. Carbon dioxide and organic carbon are two examples.
- Natural substances are always present and enter the "how clean is clean" debate.
- Synergistic effects should be considered. An ecosystem toxic burden indicator is needed.
- Toxicology information is needed to make assessments on chemical integrity.

- Management efforts and the tracking of results need to be considered.
- Monitoring for substances other than PCBs, DDT, and mercury is needed.

Monitoring Systems for Chemical Integrity

- Many elements must be integrated into an ecosystem forecast to predict effects of biological, chemical, physical and human induced changes on ecosystems and their components.
    - Climate change.
    - Aging infrastructure.
    - Areas of Concern (AOCs).
    - Fundamental process rates.
    - Persistent Bioaccumulative Toxics (PBTs) and Nutrients.
    - Pharmaceuticals.
- PBTs have declined in the Great Lakes, but restrictions still exist, internal reservoirs and recycling may be dominant factors, and some controls are needed beyond the Great Lakes basin.
- Nutrients have declined but phosphorus is increasing in the Lake Erie Central Basin, likely caused by the activities of dreissenids, which may be altering the size structure and dynamics of particles in Lake Erie. Nitrogen is increasing elsewhere.
- In order to apply models for forecasting purposes, monitoring and the understanding of Lake dynamics and conditions are needed.
- Better measures of concentrations, loads, rates and modeling are needed.
- Understanding factors like sedimentation rates and temperature stratification are critical.
- Wireless environmental observatories are examples of the technology needed to collect this information. Three dimensional models are ready to make use of this information.
- Studies like the Lake Michigan Mass Balance have provided critical process rates unavailable at the same fine-scale for the other Great Lakes.
- Surveys are needed that identify “new” chemicals such as pharmaceuticals and risk assessments for these substances are necessary.

Comments on Monitoring Systems for Chemical Integrity

- A blend of research, modeling, and monitoring is needed.
- Annex 1 in the GLWQA is out dated. It may not make sense to include new numbers in revisions to the agreement. More information on chemical impacts is available since the original specific objectives were set. It may be better to go to a narrative statement about chemical integrity.
- In situ testing has slowly matured and should become part of the future monitoring landscape.
- Monitoring of storm water loads is needed, especially those that result in wastewater treatment plant by-passes.
- Monitoring for the presence and loadings of chemicals is needed, but so is monitoring for ecosystem effects.
- Management actions need to be driven by risk assessments.
- Ecosystem responses need to be considered on the basis of communities not just single organism responses.

Chemical Integrity: Moving into the Future

- Recruitment of young people into the field of Great Lakes Science is imperative.
- When seeking the “wholeness” of integrity, societal and political complexities need to be included. A strong political will is required to maintain scientific resources and make use of the information that these resources produce.
- Currently, all resources are being put into maintaining existing programs and institutions and not funding or planning for future needs.
- As the research culture ages there is less of an ability to meet multifaceted challenges. The trend indicates the need to respond to increasingly complex issues. Single mediums issues like eutrophication and the need for phosphorus controls, or even multi-media issues like PBTs and the need for both national and international controls are not the only issues at hand. Multi-media AND multi-issue situations, where several things are happening at once, are now more common. Climate

change, exotic species, nutrient issues, PBTs and pharmaceuticals are all current issues that need to be addressed.
- The issues are not only complex, but the political restraints are not always allowing the information generated, to be used. Data does not get included in regulations and the 'best' data does not always get used. The public is not interested in data produced by scientists. There is a need to produce information that cannot be ignored politically.
- Much of the environmental progress in the Great Lakes has come by shifting resource extraction and manufacturing offshore. Resource use, no mater where it occurs, is a driver of the degradation of the Great Lakes. Population growth is a serious issue for the basin. Increases in transportation related energy have been tremendous, especially those related to truck transportation. While nitrogen oxides have decreased, ozone and particulate trends are increasing which is a dangerous trend.
- Risk assessment, while a helpful tool, does not deal with these realities. It does not connect subtitle toxicological impacts with exposure. The precautionary principle must be relied on for guidance.

Comments on Chemical Integrity in the Future
- Data availability, including raw data, is essential. This data needs to be made freely available by government agencies. Recent trends to charge for the data, means that the best information may not be used.
- Political realities are a problem. Regulatory agencies need to be more proactive.
- A new paradigm for how science interacts with politics is required. Currently, policy makers ask for research, researchers act in a policy vacuum and report final results. Policy makers then act, often without a full understanding of the science and its relationship to the decision making process. Researchers and politicians need to work together throughout the entire process.
- The municipal aspect of chemical issues needs to be incorporated.
- Policy may need to be directed at the municipal level to deal with urban use issues.
- There is a need for a revised Water Quality Agreement Annex 1 list that does not become dated. Any new/revised Annex 1 standard will be instantly out of date. The Great Lakes Initiative (GLI) process should be used to update the GLWQA.
- An item to consider is whether the tributaries meet the GLI lake standards?
- Scientists are policy makers. It is the transmission of this information that is important. The media only report out on interesting stories.
- Education and having the public involved is important. Why was the education indicator removed from the suite?
- The "mixed" assessment for Great Lakes indicators is not useful.
- Great Lakes indicators need to report on nearshore and tributary data.
- Scientists must build consensus with the public.

Climate Change

Organizers: Marg Dochoda, Great Lakes Fishery Commission, Bill Meades, Natural Resources Canada, Rochelle Sturtevant, Great Lakes Sea Grant

Presentations
- Great Lakes Climate Change Forecasting: A Preliminary Needs Assessment – Rochelle Sturtevant, Great Lakes Sea Grant
- Confronting Climate Change in the Great Lakes Region – Brian Shuter, University of Toronto
- Indicators of Climate Change Impacts on Terrestrial – Aquatic Interactions – Fred Beall, Natural Resources Canada and Jim Buttle, Trent University
- Discrepancies in Greenhouse Lake Level Predictions: Reasons for Uncertainty – Brent M. Lofgren, Great Lakes Environmental Research Laboratory

Session Overview
This workshop consisted of a participatory discussion on potential roles for SOLEC relating to regional climate change scenarios and identifying key physical indicators to assess regional impacts of climate

change. Topics discussed included potential impacts of climate change on the open lake and on terrestrial aquatic interactions.

Findings and Predictions

- Human-produced, heat-trapping gas emissions cause climate change.
- Early signs of climate change are being recorded in the Great Lakes, i.e. warmer temperatures, extreme rainfall events, shorter winters, and reduced periods of ice cover.
- By 2100, winters will warm by 3-7 degrees Celsius and summers by 3-11 degrees Celsius. There will be:
  - More heat waves.
  - Growing seasons will be several weeks longer.
  - More precipitation in spring and winter, and less in summer and fall (10-20% increase overall)
  - Drier soils and more droughts.
  - Storms and floods will be 50-100% more frequent with a 12% chance of 100-year floods each year.
  - Excessive low-level clouds.
  - Reduced ice cover.
- Lake levels may or may not decrease depending on the balance of precipitation, runoff and evaporation, with the latter being impacted by temperature, humidity and ice cover. A 10% increase in rainfall is needed for each 1 degree Celsius of warming in order to maintain existing water levels.
- Productivity of coldwater fish populations such as salmonids may decline dramatically as coldwater species will be replaced by cool water species (e.g. walleye) and cool water species will be replaced by warm water species (e.g. smallmouth bass). There are limits in ability of fishes to shift their ranges northward, i.e., the most northerly coastline.
- Non-native species may find conditions conducive for invasion.
- Lake stratification will be longer, with more dead zones and fish kills are possible.
- Mercury and other contaminants in sediments may be mobilized by warmer, low-oxygen conditions.
- Wetlands, amphibians, shorebirds, and waterfowl may be stressed by total runoff, base flows timing and magnitude of peak flow such as earlier spring runoff, more intense flooding, and lower water levels in summer. The number of ephemeral streams may increase along with erosion and sedimentation. Export rates for chemicals may change (e.g., nutrients, acidification, and mercury).
- Sixty eight percent (68%) of the Great Lakes' drainage basin is terrestrial. The ratio of land to lake will increase with climate change. By 2100, prairies may move eastward; hardwood forests may move north, and boreal forests may retreat out of the basin. In the near-term, productivity will increase due to increases in carbon dioxide (CO_2) and nitrogen. Forest health could be damaged by elevated ozone levels, more frequent droughts and forest fires, and insect pests surviving milder winters.
- Birds migrating in the spring (governed by length of day) may arrive after insect hatches which are governed by temperature. Resident birds, raccoons, skunks, and white-tailed deer may benefit. With the boreal forest, moose may be forced out of the Great Lakes region.
- Forces interacting with climate change include growing population, increasing urbanization and sprawl, fragmentation of the landscape, industrial pollution of air and water, social challenges, invasive species, and geographic variability and limits (e.g. Great Lakes, Canadian Shield).
- There will be more demand for scarcer water resources in streams, lakes, and groundwater.
- Farmers will need to contend with higher ozone levels, less soil moisture in summer, storms and flooding in spring, extreme summer heat, abundant pests and pathogens, and farmers will not be able to simply shift operations northward (due to Canadian Shield).
- Heat-related health problems will likely increase in vulnerable populations, more ground-level ozone will be produced, and pathogens, parasites, and vectors (mosquitoes) may survive and reproduce more readily under warmer conditions.

Minimizing Climate Change and its Impacts on the Great Lakes Region

To deal with climate change, a three-pronged approach can be used:

- Reduce emissions – energy solutions, transportation, agricultural, forestry and integrated strategies.
- Minimize pressure on the environment – air quality improvements, water resource protection, habitat protection, urban and land use planning.
- Plan and prepare to manage the impacts of a changing environment – emergency preparedness, agricultural and forestry adaptations, public health improvements, infrastructure adjustments and education.

To manage the impacts of a changing environment, climate change will need to be considered in long – term planning and construction, especially investments in infrastructure such as:

- Land and water use planning.
- Water intake and well construction.
- Sewage treatment system construction.
- Coastal development.
- Shipbuilding and Seaway development.
- Reducing/redirecting pressure on natural resources.

Flexible management is required to accommodate extremes; unpredictability and uncertainties such as anticipating ski seasons, fish year classes, ship loading conditions and flood plain construction will exist.

Indicator Needs

Soundness of today's decisions will likely be tested by climate change. Indicators are needed that are:

- Predictive.
- Accurate.
- Dynamic (incorporate new information and a range of scenarios).
- Focused on vulnerable or representative sites.
- Rooted in long historical databases.
- Relative to a target or end-point.
- Rooted in global models, and in particular.
- Local (regional and sub-basin scale).
- Reflective of new extremes (e.g., temperature extremes, storms, waves, water levels).

Specifically, the following Great Lakes indicators may be useful for purposes of tracking and predicting climate change:

- #6 Fish Habitat
- #120 Contaminant exchanges between media (air to water to sediment)
- #4202 Air quality
- #4510 Coastal wetland area by type
- #4519 Number of extreme storms
- #4858 Climate change (Ice Duration on the Great Lakes)
- #4860 Phosphorus and nitrate levels
- #7055 Habitat adjacent to coastal wetlands
- #8137 Nearshore species diversity and stability
- #8150 Breeding bird diversity and abundance
- #8161 Threatened species
- #9002 Non-native species
- New Indicator: #9003 Climate change (effect on crop heat units)
- New Indicator: #7102 Base flow due to groundwater discharge
- New Indicator: #7061 Nutrient management
- New Indicator: Sediment flow and availability (plus transport, deposition, re-suspension),
- New Indicator: Water levels
- Proposed Indicator: #8164 Landscape ecosystem health

Some new indicators may need to be developed that involve reporting on:

- Precipitation patterns and storms.
- Runoff.
- Waves.
- Water levels.
- Timing and magnitude of river and stream flows.
- Amount and timing of sediment and chemical loadings.
- Erosion.
- Key species or habitats, especially ranges.
- Global temperature trends.
- Wind.

Consultation for agencies proposing to cease data collection is needed. Historical databases can be extremely important for predicting impacts of climate change in the Great Lakes region; likewise, existing datasets, such as the extensive network of stream gauges, should be analyzed for utility in tracking and predicting impacts of climate change. New strategies may be needed to reconstruct historical conditions, i.e. analysis of materials in sediment cores, bubbles in ice, etc.

The Impacts of Climate Change on Other Great Lakes Indicators
Many Great Lakes indicators may be influenced by changing climate. Careful consideration will be needed to determine the extent to which indicators may be disrupted or biased by changing climate. For example, increased hypoxia or duration of anoxia may increase due to climate change, even though progress continues to be made with phosphorus reductions. Species invasions due to range expansions may increase even though progress towards closing the door on trade-related vectors is evident.

Great Lakes Beaches

Organizers: Doug Alley, International Joint Commission and Michael D'Andrea, City of Toronto

Presentations

- Microbial Source Tracking of Fecal Pollution – Tom Edge, National Water Research Institute
- Advances in Rapid Biodetection and Review of Beach Water Quality Standards – Cassandra Lofranco, Ontario Ministry of the Environment
- U.S. Great Lakes Beach Regulatory Management and Research Activities – Norman Grannemann for Sheridan Haack, U.S. Geological Survey
- Frequency of Sampling Effects on Beach Postings – Ted Bowering, City of Toronto

Workshop Overview
The Great Lakes shoreline provides some of the most beautiful beaches in the world, yet many continue to be posted as unsafe for swimming for significant periods during the bathing season. These postings represent a diminished quality of life, as well as disincentive to tourism and are a detriment to local economies. This session addressed the multi-faceted "Swimability" issue, discussed the new Great Lakes Beach Advisory indicator, updated participants on the U.S. Canadian programs to mitigate recreational water quality impairments as noted in the Great Lakes Water Quality Agreement and provided information on rapid detection methods under development in both countries.

The participants in this session considered the following subset from the existing Great Lakes indicators suite, which relate to tracking progress made on improving beach water quality conditions within the basin:

- #111 Phosphorus Concentrations and Loadings
- #4200 Beach Advisories, Postings and Closings

General conclusions were reached and the recommendations provided are summarized under the following questions which were related to how the Beach Advisories, Postings and Closings indicator is being used throughout the Great Lakes basin.

1. Is a common beach water quality assessment protocol needed?

- Given the disparity in existing beach posting criteria (Canada versus U.S.), sampling frequencies and protocols (among locations even within a given jurisdiction), there is a genuine need for a standardized basin-wide, beach water quality assessment protocol including the development of criteria respecting epidemiological risk and sampling regime.
- This protocol would allow for a more objective assessment of beach water quality conditions at a given beach area and provide for a more direct comparison of conditions across the basin.
- This standardization should lead to a regulatory requirement (basin-wide) rather than a guideline which is subject to interpretation by local officials, which could bias the interpretation of beach water quality conditions at a given location.
- A public education component should be included with the protocol development including education on health risks.

2. Is the existing "Beach Advisories, Postings and Closings" indicator acceptable for reporting?

- If this indicator's purpose is to compare and track conditions across the basin, the indicator should reflect this need and therefore a standardized approach is required.
- Beach postings in some jurisdictions is not reflective of actual water quality monitoring data, but may be biased by "rainfall" rules established at the local level (e.g. beach considered unsafe for swimming for a set period of time after a rainfall event, irrespective of water quality data).
- Need to recognize that the need for an indicator to assess basin-wide comparisons is different than the needs of local health units assessing local health risks.
- The present system does not allow for the appropriate compilation of trend statistics i.e. cannot adequately assess whether conditions are improving.
- Should consider focussing assessment on those beach areas with good data (quality of data and historical records) and track changes at these locations over time, as indicators of general conditions across the basin.

3. Is there another indicator better suited for assessing beach water quality conditions?

- Rapid biodetection techniques should be pursued i.e. day of sampling/analysis is preferred rather than relying on antecedent conditions (typically for samples collected days earlier) to determine whether beach water quality conditions are acceptable for swimming, especially for those beach areas impacted by local pollution sources. Pilot testing of this approach should be actively pursued and compared to conventional/existing approaches.
- *E.coli* appears to be the internationally recognized standard and therefore should be used until a new protocol or standard is developed but there is a need to establish a common sampling and standardized assessment protocol across the basin.
- Should pursue the development of a more integrated "ecosystem" health indicator for ecological assessment, in addition to "recreational" or microbiological assessment.
- Recognize the need for a standardized reporting protocol.
- Recognize the linkage between beach water quality and progress made on the implementation of stormwater management controls (urban and rural).

Great Lakes Water Quality Agreement Review

Organizers and Facilitators: Harvey Shear, Environment Canada and Vicki Thomas, U.S. Environmental Protection Agency
Recorder: Christina Forst, U.S. Environmental Protection Agency

Workshop Overview
The Great Lakes Water Quality Agreement (GLWQA) between Canada and the United States is reviewed by the two governments every 6 years. The next comprehensive review of the operations and effectiveness of the Agreement was scheduled to start in the fall of 2004. As part of the review of the Agreement, the monitoring components and the development and implementation of ecosystem health indicators will be examined. This workshop discussed the adequacy of present monitoring and indicator development, and sought advice on improvements that can be made to both aspects of the Agreement. The output from this workshop will be used as input to the broader review by the governments.

Opportunities
- There is an opportunity to use data from SOLEC to assess the "operation and effectiveness" of the Agreement.
- Science based information in the Agreement is 17-28 years old and outdated.
- Opportunities to include or update management actions or processes for indicators, monitoring, or other science based provisions in the Agreement.

Actions to Date
- The Binational Executive Committee (BEC) has formed an Agreement Review Scoping Committee, comprised of staff from U.S. Environmental Protection Agency – Great Lakes National Program Office and Environment Canada's Great Lakes and Corporate Affairs Branch, tasked with developing an open, transparent and inclusive review process.
- The Committee has developed a draft recommended review process. This will be going out for public comment soon.
- Features of the process to include:
  - Focus on operation and effectiveness.
  - Create review groups.
  - Set of detailed and overarching questions developed.
  - Emphasis on public involvement.
  - Review will not rewrite or suggest changes to Agreement, the decision on whether and how to update Agreement will come later.

Draft GLWQA Review Timeline
- Stage 1: Design and Scope of the Review Process: March – September 2004
- Stage 2: Stage Two: Review and Analysis: Late 2004 through – August 2005
- Stage 3: Development of new Agreement: 2006 – 2007

Key Questions for Discussion:
- How can the information for SOLEC be used in the Agreement review?
- How can the need for an ongoing set of indicators and appropriate surveillance and monitoring be included in the Agreement?

What the Current Agreement States?
- Annex 1 – Specific Chemical Objectives.
- Supplement to Annex 1 – Lake Ecosystem Objectives.
- Annex 11 – Surveillance and Monitoring including the call for the development of ecosystem health indicators.

Annex 11: Some Thoughts on Surveillance and Monitoring
- Relevance – some parts no longer relevant (e.g. GLISP); narrow focus on water quality.
- Clarity of Purpose – clear, but inclusion of surveillance and monitoring from other annexes will make it clearer; narrow focus on water quality.
- Science – does not reflect current science; ecosystem approach not reflected.
- Consistency – not all applicable laws and policies are reflected (e.g. habitat protection and non-indigenous species).

Possible Approach

- Add a preamble on general principles for surveillance and monitoring.
- Change water quality to environmental quality.
- Combine monitoring and surveillance requirements from Annexes 2, 3, 12, 13, 14, 15 and 16.
- Include a commitment to joint planning/co-ordination.
- Commitment to an assessment of the state of, and trends in, health of biological communities including people, and an assessment of state and trends in habitat.
- Commitment to establish and maintain a list of indicators (including lake trout and *Diporeia* for Lake Superior) for use in reporting on the state of the Lakes.
- Commitment to meet biennially starting in 2008 to report on the state of the Lakes, and to update the indicator list.
- Establishment under the Parties of a binational surveillance and monitoring work group to coordinate surveillance and monitoring.

Comments

- Repetition and outdated science in the current Agreement.
- Need a rationale for monitoring and surveillance in the scope of what SOLEC is producing.
- Agreement needs to focus on habitat, non-native species, and not just water quality issues.
- Ecosystem approach is not reflected in the Agreement. The GLWQA is based on a physical watershed and then it is divided into political entities. The watershed concept needs to be engrained in the Agreement so that indicators do not get compromised by political divisions.
- Need a call for ecosystem objectives versus lake by lake objectives.
- Temperature and impacts on fish populations needs to be included.
- Need a way for the states to be held accountable for actions. States have different priorities which are not always environmental.
- SOLEC is not embedded in the Agreement. SOLEC has scientific information that needs to be considered when the Parties review the Agreement. SOLEC was established to assess how well the Parties were doing in reaching the goals of the GLWQA.
- Does the Agreement need to be revised? Some argue that revisions are not required.
- The Agreement needs to have an explicit recognition of a declaration of principles similar to those expressed in the Ecological Footprint presentation. Need to include ethics in the Agreement.
- Need to exclude numeric values in the revised Agreement so that it is not dated.
- Agreement requires numbers which serve as guidelines.
- Agreement needs to be flexible and less specific.
- A definition of 'sustainability' needs to be agreed upon and then defined in the Agreement.
- Monitoring needs to be better defined.
- Need to tie information together better in the revised Agreement, i.e. surface water and groundwater need to be discussed together.
- Provincial/State and municipal governments need to be included in this review.
- Need to tie scientific data with budgeting information.
- The Executive Order may engage higher level officials in the GLWQA review.
- There is much monitoring around the Great Lakes that support the Agreement however, there is so much data that it needs to be simplified and better defined so that everything is reported under one agreement, that being the GLWQA. This process will assist in engaging provinces, states, etc.
- Agreement needs to include economic indicators (Resource Utilization indicators).
- Some of the reductions listed in the Agreement are being achieved, however other threats need to be included, i.e. biodiversity, land use, habitat protection, etc.
- Endpoints are needed.
- Issues around the science, policy and emotion and how they are connected.
- Science tells us the information, policy determines what to do with the information, and/or decision making but the emotion comes from the public. Messages need to be better communicated to the public as policy makers listen to the reaction/emotion of the public.
- Role is to provide the best scientific information available.

- Communicating this information to assist with policy and decision making requires some work. For example, indicators/indicator bundle assessments are “MIXED”.
- Need to review the formal documents from the 1980 review of the GLWQA.
- Results from the Science Advisory Board meeting in February 2004 regarding the GLWQA need to be considered.
- The current Agreement is treaty-like in nature. The Agreement needs to be changed in order to include local level understanding, including Traditional Ecological Knowledge.
- Water quantity should be included as a habitat/ecosystem issue which can be regulated through the Annex. The Fishery Objectives can be referenced within the Agreement as everything does not need to be included in one document.
- The information included in the Agreement cannot conflict with the Boundary Waters Treaty.

Human Health in the Great Lakes

Organizers: Adele Iannantuono, Health Canada and Heraline Hicks, Agency for Toxic Substances and Disease Registry
Recorder: Elizabeth Murphy, U.S. Environmental Protection Agency

Presentations
- Overview of ATSDR’s Great Lakes Human Health Effects Research **–** Heraline Hicks, Agency for Toxic Substances and Disease Registry
- Public Health Implications of Hazardous Substances in the 26 U.S. Great Lakes Areas of Concern - Annette E. Ashizawa, Agency for Toxic Substances and Disease Registry
- Population Health Implications of Climate Change in the Great Lakes – St. Lawrence Region – Dieter Riedel, Health Canada
- Polybrominated Diphenyl Ethers Flame Retardants: An Emerging Persistent Organic Pollutant – John Jake Ryan, Health Canada
- Great Lakes Public Health Network: An Overview **–** Adele Iannantuono, Health Canada
- Overview of Great Lakes Human Health Network – Elizabeth Murphy, U.S. Environmental Protection Agency

Workshop Overview
Current research and networking efforts were presented and discussed by representatives of the Agency for Toxic Substances and Disease Registry (ATSDR), Great Lakes Human Health Effects Research Program and Health Canada. ATSDR is characterizing exposure to persistent toxic substances and investigating the potential for adverse health outcomes from that exposure via fish consumption in vulnerable populations. Health Canada presented information on the development of its public health network. The Great Lakes Human Health Network discussed the future directions of calls and actions, membership expansion and recent efforts in the organization of members.

Current Human Health Research Findings
- A Great Lakes Health Effects Program (GLHEP) no longer exists in Canada.
- There are several outreach programs in existence to educate the public regarding contaminants of concern, i.e. cooking classes, public health fairs, etc.
- Even with lower pollution levels, ATSDR is still seeing many of the same health outcomes that were observed in the epidemiological studies from the early 1980s.
- Associations between Areas of Concern (AOCs) were difficult to attain because the specifics of each AOC were not teased out in the report, but rather a general overview was provided.

Emerging Issues in the Great Lakes Basin
- Direct or indirect effects of global warming and climate variability, e.g. extreme weather and ecosystem shifts.
- A warmer, more variable and more extreme climate would change regional and local environments and resources, on which community health and well-being depend.

- Location will determine the types of environmental and health risks in different regions and communities.
- Effects will depend on extent and speed of changes, and on the extent of community coping capacity.
- Need to look at population demographics, mobility, obesity, disabilities, social capital, etc and then look at how climate change affects people, especially those that are vulnerable.
- Need to look at the predictability of weather and mitigation actions to determine the health implications for those who are vulnerable, i.e. in severe heat/cold conditions, older and/or less fortunate individuals.
- Other environmental issues to consider are: an increase in lightening (increase in droughts/fires), increase in UV radiation (cancer rates, plant and fungal composition changes), and increases in insect, tick and rodent borne diseases (climate changes forests and woodlands; diseases and vectors shift northwards).
- Climate change vulnerability assessments, and adaptation and mitigation planning are necessary.
- Side effect of mitigation planning include: biofuels and byproducts, tight buildings, carbon storage.
- Health implications exist for some of the greenhouse gas mitigation technologies.
- Poly brominated diphenyl ethers (PBDEs) are a global occurring issue.
- Different classes of PBDEs exist however; the focus is on the "penta" class of PBDEs since they are the most diffused and significant to environmental issues.
- PBDE flame retardants make increase safety with respect to fire, however, the bioaccumulation of these substances cause endocrine disruption through thyroid and estrogenic effects, neurodevelopmental effects in rodents, etc.
- Concentrations of PBDEs appear to be increasing contrary to most other Persistent Organic Pollutants (POPs).
- PBDE levels in Lake trout and herring gull eggs have increased since the 1980s.
- Traditionally for POPs/PBDEs, the major vector for human exposure is food consumption; however other unidentified sources are probable.
- From the analyses of more than 100 commercial foods, PBDEs are present in most animal based foods.
- PBDE levels in individual Canadian human milk show increases in median values for 1992 from about 3 µg/kg (ppb) milk fat to more than 25 µg/kg (ppb) in 2002, i.e. a factor of 10.
- Present human exposure world – wide to PBDEs ("penta" class) is highest in North America with lesser amounts in Europe and Asia.

Translating Science into Service – The Great Lakes Human Health Network (GLHHN)

- The Binational Executive Committee (BEC) in 2001 recognized that a mechanism to improve environmental health communication tied to Great Lake waters was needed. It was recommended that a Binational Great Lakes Human Health Network be formed.
- U.S. Environmental Protection Agency, Health Canada, ATSDR and several States and Tribes developed a charter for the Network which was approved by the BEC in 2002.
- U.S. and Canada each developed domestic Networks, to be merged at a later date.
- The GLHHN will address health issues related to the ecosystem of the Great Lakes basin, which include: drinking water, recreational water quality, fish consumption, or other health issues identified by the Lakewide Management Plans (LaMPs) and Remedial Action Plans (RAPs). While air and water are issues of concern, many of these problems can not be limited to the basin.
- Currently, First Nations are not involved in the planning of Health Canada's Great Lakes Public Health Network. Health Canada is coordinating the formation of the Public Health Network and membership issues are being addressed by the network's steering committee. There is Tribal representation on the U.S. Great Lakes Human Health Network.
- Neither of the networks can currently offer funding. However, there is hope that after the two networks are combined to form a binational network, funding needs could be identified and elevated to respective management.
- The Canadian Great Lakes Public Health Network was not involved in the drafting and review of the Great Lakes indicators because it is still in the preliminary stages of planning. Both the Public Health Network and the Human Health Network will be relied upon for future SOLEC work and reports.

Monitoring Coordination and Information Management

Organizers: Mark Burrows, International Joint Commission and Melanie Neilson, Environment Canada
Recorder: Elizabeth Hinchey Malloy, U.S. Environmental Protection Agency

Presentations
- BEC Cooperative Monitoring and Inventory – Melanie Neilson, Environment Canada
- Great Lakes Observing System (GLOS) – Roger Gauthier, Great Lakes Commission
- Canada – Ontario Agreement (COA) Annex 4 – Ian Parrish, Ontario Ministry of Natural Resources and Brad Hill, Environment Canada
- Addressing Compatibility Issues with Existing Provincial Systems Such as Land Information Ontario (LIO) Under the COA – Mike Robertson, Ontario Ministry of Natural Resources
- GLENDA, Great Lakes Environmental Database System – Ken Klewin, U.S. Environmental Protection Agency
- How Do We Put It All Together? Integrating Information Management Systems – Ian Gillespie, Environment Canada

Workshop Overview
Monitoring and reporting on the integrity of the Great Lakes ecosystem requires the involvement of multiple agencies and other organizations on both sides of the border. This involvement necessitates binational coordination of monitoring activities and integration of the resultant information. The Binational Executive Committee (BEC) has launched the Great Lakes Monitoring Inventory on www.binational.net, and has adopted a basin-wide rotational cycle for cooperative monitoring to address key information needs identified by the Lakewide Management Plans (LaMPs) and SOLEC. As well, various information management initiatives (e.g., GLOS, COA Annex 4, GLENDA) are underway in Canada and the United States to facilitate access and sharing of Great Lakes data.

Goals of the workshop included discussing the status and possible means of integrating the array of current information management initiatives, highlighting progress that has been made in coordinating monitoring and reporting, as well as new information management initiatives currently underway in Canada and the United States. It also provided an excellent forum to discuss the challenges of integrating information systems to create a "system of systems" to satisfy key information needs identified by the LaMPs and SOLEC.

BEC Cooperative Monitoring and Inventory
- Needed to coordinate monitoring on Great Lakes.
- Developed basin-wide inventory (www. binational.net).
- Cooperative monitoring approach.
- Basin-wide rotational cycle for focusing monitoring efforts.

Inventory
- Is not a data repository.
- Metadata = only who is doing what and where.
- Searchable.

Cooperative Monitoring
- LaMPs identify key information needs.
- Then steering committee coordinates a proposal and looks for funding or tries to 'piggy back' additional collection needs on top of current activities.
- Establishes data sharing/equipment sharing protocols.
- Schedule exists through 2009 (one lake each year).
- Benefits.

2003 Lake Ontario
- LOADS study (atmospheric deposition.

- Trace organics for mass balance modellers.
- LOLA (lower aquatic food web study) – changes post zebra mussel invasion.

2004 Lake Erie
- Inter-basin transport and lake physics.
- Zebra mussel density and spatial distribution.

2005-2006 Lake Superior
- Toxics in air, precipitation, open lakes (also sediment and fish).
- Lower food web monitoring.
- Fish contaminants.
- Land use change in basin.
- Herp/reptile monitoring pilot study.
- Tributary screening for toxics.

Questions and Comments
Q: What is the Steering Committee?
A: Cooperative monitoring steering committee (not the same as a LaMP steering committee).

Q: Cross-lake comparisons are ok for some metrics, but what about cross-basins?
A: LOLA is a good example. The same experts are on all panels, but of course the design (number of stations, etc) will be different due to differences in each lake.

C: All 5 lakes can not be focussed upon at once. LaMP needs are all different, so design needs to change. Academics are relied upon to help with the design.

Great Lakes Observing System (GLOS)
Monitoring versus observing:
- These are confusing terms and are not interchangeable!
- They have different client bases.

Monitoring Inventory Database
- Target programs for monitoring include ecological monitoring (water, air, biota, sediments and land) which is not the same as the GLOS.
- Database elements = metadata (contact information, program description, parameters, methods, funding, etc).
- Also, links to on-line data references.
- Target audiences = resource managers, general public.
- Uses Great Lakes indicators to define monitoring needs.
- Looking for gaps or overlaps in monitoring.

GLOS is a U.S. initiative with 7 Societal Goals
1. Facilitate safe and effective marine operations.
2. Mitigate effects of natural hazards.
3. Improve prediction of climate variability.
4. Reduce public health risk.
5. Improve national security.
6. Sustain and restore living resources.
7. Preserve and restore healthy ecosystems.

Two Major Components:
1. National system (i.e. National Weather Service, U.S. Geological Survey gauging system, etc)
    - Technology in existence already.
    - Federal agency programs.
    - Satellites, etc

2. Regional systems (Caribbean, Great Lakes, Atlantic, Pacific, Hawaii, etc)
    - Land based inputs.
    - Regional priorities.
    - Greater resolution.
    - More variables.

2004-2005 Major Tasks
- Develop business plan.
- Develop regional association.

Goals
- Meteorologic, hydrologic, hydraulic, chemical and biologic data.
- Education is another important component.
- Modeling, ecological forecasting, and governance.
- Focus on automating and upgrading buoys, more instrumentation, more gauging systems.

Canada – Ontario Agreement (COA) Annex 4
Monitoring and Information Management

Goals
- Identify key contracts.
- Ensure federal and provincial information management systems are compatible.
- Public access to information.
- Provide a decision support system for activities impacting the Great Lakes.

Optimize existing information management. Identify gaps in monitoring activities as well as emerging needs.

Data already exists on the web (GIS) – geospatial and tabular.

Addressing Compatibility Issues with Existing Provincial Systems Such as Land Information Ontario (LIO) Under the COA

Data
- Ontario Road Network
- Ontario Parcel Network
- Residential Boundaries
- Township Improvements
- LANDSAT 7

Themes (thematic data)
- Nesting sites (deer, etc).
- Climate/weather monitoring stations.
- Abandoned mines and hazards.
- Forest cover.

WRIP – Water Resource Information Project

SOLRIS – Southern Ontario Land Resource Information System
- Mapping project of southern Ontario's natural resource.

Ontario Geospatial Data Exchange
- Approximately 130 members (agencies) currently.

Land Information Ontario (LIO) web site: www.lio.mnr.gov.on.ca

Questions and Comments:
Q: Is there a security threat to have all of this information available to the public?
A: Security is definitely something that is considered. Access will be controlled for certain data layers.

GLENDA – Great Lakes Environmental Database System
- Normalized, relational database of over 300 tables.
- Purpose and scope: to be a data warehouse for multi-media, cross program data of documented quality.
- Water and atmospheric chemicals, biota, sediment.
- Data input. There is a remote database on the U.S. Environmental Protection Agency's research vessel, the Lake Guardian.

Current Status
- Lake Michigan mass balance data.
- Water Quality monitoring data (1996-2004).
- Fish monitoring data (1970-current) (in progress).

Availability
- By request to Ken Klewin.
- Mass balance data is on the web now.
- Next: live database access (in preparation).
- No GIS data yet, maybe in future.

Questions and Comments:
Q: What data is on GLENDA?
A: Only Great Lakes National Program Office data.

Q: When will data be on-line?
A: Hopefully within a year.

Q: Is there going to be a link to the scientific Environmental Information Management System (EIMS) web site at the U.S. Environmental Protection Agency's Office of Research and Development? Will this data be on GLENDA?
A: Yes, this information will be on this site.

How Do We Put It All Together? Integrating Information Management Systems
- Need to get the right information to the right people at the right time.
- The goal should be to get the information management people working with the information technology people to deliver usable data to the non-technical user (goal audience).
- The data must meet standards and compliance criteria in order to be put on the Geobase server.
- Web map services are going to change how decisions are made.

Discussion
1. What are the most challenging barriers to effective data exchange?
2. How can these challenges be overcome, so that the most from government investments can be achieved?
3. What should be the priorities?

- It is important to capture responses from the users as well.
- Within Environment Canada, more than 50% of research community will retire soon, loss of 'corporate knowledge', 'legacy data' and un-entered data. This work must be accessible to next generation of employees.

- Metadata must be consistent, compliant and complete. Perhaps some researchers do not want to provide it without incentives. There is too much institutional and jurisdictional close-mindedness.
- There is a misperception that metadata tools are well developed. People want them to be automated. Expectations are not in line with reality.
- The metadata plan must be an essential part of the grant process. Strong incentive for cooperation. No metadata = no funding.
- There must be some better dialogue between information technology and information management people. This will help make their tasks easier. They must make metadata collection less painful. Agreed that metadata should be part of the grant award process.
- What steps do you take to get data products on-line? A 'how-to' manual may be needed. A 'how-to' document/manual for project managers is being developed by Ian Gillespie, Environment Canada.
- Project managers need education. Data collectors need education to know why metadata is important.
- The differences in legal and political context across the two countries (Canada & U.S.) are perhaps the reason why Canada is taking the lead on this issue in the Great Lakes, not the U.S.
- Legal and policy issues are the big hindrance to this technical sharing, and they are expensive to overcome.
- The governments need to invest in the Binational Executive Committee, the Great Lakes Interagency Task Force, and the Great Lakes Water Quality Agreement.
- What should be done with data that does not meet Quality Assurance standards? Check spatial integrity. Need senior level support for International Organization for Standardization (ISO standards).
- Is operating system/software or data collection compatibility still an issue?
- Some say 'yes' (spatial scale, etc. still unresolved), some say 'no'.
- Quality Assurance (QA) and Quality Control (QC) of data is not good - especially Legacy Act data. Maybe this is why data is not being exchanged! Government cutbacks are diverting time that used to be spent on QA/QC.
- Need for a clearinghouse for the data; "ask once, used by many" concept would be much appreciated. Multiple requests for the same data are not appreciated.
- Data rescue is needed!
- The priority should be to meet more regularly to discuss data exchange issues – more than once every 2 years. Regional data exchange conferences are important!
- Ended session by providing information on the Great Lakes Regional Data Exchange Conference held at the Detroit Marriot Renaissance Center on October 26-28, 2004. (www.rdx.glc.org).

Recent Advances in Monitoring Science and Index Development

Organizers: Wayne Bond, Environment Canada, Janet Keough, U.S. Environmental Protection Agency and Risa Smith, Environment Canada
Recorders: Wayne Bond, Environment Canada and Karen Rodriguez, U.S. Environmental Protection Agency

Presentations
- Current Results from the Great Lakes Coastal Wetlands Consortium – Ric Lawson, Great Lakes Commission Wetland Consortium
- Great Lakes Environmental Indicators: Development of Indicators for the U.S. Great Lakes Coastal Zone – Gerald Niemi, Center for Water and the Environment, University of Minnesota
- CCME Water Quality Index – Scott Painter, Environment Canada
- Canadian Biodiversity Index – Wayne Bond on behalf of Risa Smith, Environment Canada

Workshop Overview
This workshop provided an opportunity for managers and practitioners to discuss emerging research results that will substantially forward ecosystem assessment and state of the environment reporting. The speakers presented new sampling designs and indicators for coastal ecosystems from the Great Lakes Wetland Consortium, the Great Lakes Environmental Indicators Program, the Water Quality Index of the

Canadian Council of Ministers of the Environment (CCME), and the Canadian Biodiversity Index, Framework and Proof of Concept Testing.

Current Results from the Great Lakes Coastal Wetlands Consortium (GLCWC)
The Consortium has been funded by the U.S. Environmental Protection Agency's Great Lakes National Program Office for a multi-phase effort to develop tools for long term monitoring of wetlands. The inventory of Canadian and U.S. coastal wetlands has classified sites into 10 hydrogeomorphic classes. Indicators under evaluation include: snapping turtle as a contaminants indicator, plant Index of Biotic Integrity and Floristic Quality Index, fish and invertebrate indicators, and the Marsh Monitoring Program for bird and amphibian indicators. A gradient approach is being taken by sampling wetlands across a range of disturbance.

Great Lakes Environmental Indicators (GLEI): Development of Indicators for the U.S. Great Lakes Coastal Zone
Ten academic institutions formed this consortium which was funded by U.S. Environmental Protection Agency's Science to Affect Results (STAR) program. Research is aimed at developing indicators that point to causes of impairment. The project classified 762 shoreline segments around tributaries across the U.S. shoreline, based on watershed stressor data, including data on agriculture, atmospheric deposition, land cover, human population, point and non-point sources, and soils. Indicators for contaminants, nearshore diatoms, birds, amphibians, wetland vegetation, fish and invertebrates are being evaluated. Associated projects include a NASA-funded project on land cover change detection, shoreline morphology, and submerged aquatic vegetation detection.

Audience questions associated with these presentations included:
- How the gradients were developed (from field data or watershed data)?
- Will variability/uncertainty be addressed?
- How human-induced effects will be separated from natural variation?
- How reference conditions will be addressed?

CCME Canadian Water Quality Index (WQI)
This tool was developed and tested over a ten-year period by various provinces and regions across Canada. It translates the number, frequency and magnitude of exceedances of water quality objectives by a range of complex water quality parameters into an overall integrated score of water quality for a monitoring site. The WQI is one of six natural capital indicators for Canada recommended by the national Round Table on the Environment and the Economy. As a pilot study, the index has been implemented at the national level for over 300 sites across the country. For stability in the presentation of this index, it is recommended that a three-year rolling average be used, with a monitoring frequency of 4 to 6 times per year. A sensitivity analysis of index results for Ontario suggests that approximately 10 parameters be used in the calculation of the Index in order to enhance the validity of the results. The Sediment Quality Index is constructed in a similar way, and has been applied to the sediments of Lake Erie and Ontario. This Index can be computed for an area or for a number of clustered sites.

Outline of the Framework and Proof of Concept Testing: Summary of the Canadian Biodiversity Index
This unique index is based on the structure of the Water Quality Index and is designed as a communication tool for senior managers and policy-makers, to help them understand the status of biodiversity. The goal is to capture complexity in a non-technical communication tool. The National Roundtable on Environment and Economy recommended this tool for further development. The index would rate sites as healthy, moderately impaired, impaired, and critically impaired based on a summation of 3-6 indicators over each of the four theme areas. The framework for the index has been developed, and proof-of-concept testing of aggregation methods and scoring is underway. A database structure and a manual for proof of concept testing have been developed.

Workshop Discussion
The four presentations were followed by a facilitated plenary discussion involving the presenters and the workshop participants. Questions suggested for the plenary discussion in this workshop included:

- What are the strengths of these programs and which areas need further development?
- What are the prospects for implementation in the Great Lakes Region?
- How are targets or objectives determined, since both the Water Quality Index (WQI) and the Canadian Biodiversity Index (CBI), are to be calculated based on the number, frequency and magnitude by which parameters or individual indicators exceed a target value or guideline?
- Who determines the targets, scientists, policy-makers, or politicians?
- How long are the targets set for and can they be easily changed in a political context?
- Targets/guidelines for water quality parameters (on which the WQI is based) have been set by scientists through a federal-provincial guidelines development process and protocol under the CCME. The overall set of water quality guidelines are approved by senior federal-provincial environment officials. The national guidelines can be studied and modified to reflect site specific conditions.
- Targets or guidelines can be set by reference to (1) a baseline such as pre-settlement wetland conditions; (2) a reference site or reference condition such as a natural or pristine state, or a feasible modified state reflecting best management practices for conservation.
- Guidelines could be set through a political process which takes scientific advice into account as one input – the art of the feasible.
- Targets should be reasonably stable to provide for long-term trends in measurement and reporting. The framework for the CBI suggests that targets/objectives established for an indicator should be for at least 10 years.
- Water quality guidelines and targets vary by use, being most stringent for drinking water, the protection of aquatic life, and recreation, and somewhat less stringent for irrigation and livestock watering. Therefore, the WQI has to be calculated by individual water use.
- The WQI is first and foremost a communications tool, designed to enhance awareness and cause change where needed. Therefore in a local area, site specific guidelines or targets are more likely to be needed to take the local context into account and identify problem areas most in need of remedial action. For example, in the Grand River watershed in Ontario, which is intensely agricultural throughout, the nitrogen guideline was modified by the local Conservation Authority to allow the WQI to distinguish streams most subject to pollution from municipal sewage, and thus flag the opportunity for municipal action.
- One of the biggest challenges facing Canadian Biodiversity Index (CBI) during proof of concept testing is the development of targets/guidelines for each of the indicators under the four themes that comprise the index.

How does one deal with uncertainty and the risk of error or significant variability in the development and calculation of indicators and indices?

- Built in redundancy is one approach to use at the beginning of an investigation. Study the correlation between the wide range of variables collected and then determine the key patterns and identify the select, relatively few variables or measures required to explain most of the variation, and use these for long-term monitoring.
- “Lump” observations together to deal with natural fluctuations and identify real long-term trends. For example, through sensitivity analysis, it has been determined that a three-year running average provides the most stable, long-term trends for the WQI.
- Be conservative. For example, the Framework for the CBI suggests that the indicator with the “lowest/worst” value should be selected in each case to represent the four themes in the index.
- The significant water level fluctuations in the Great Lakes, which have occurred naturally over time, were identified as major confounding factor or uncertainty in some of the Great Lakes indicator work.
- There is a need to distinguish between natural fluctuations or background levels and human induced disturbance (which can be influenced by policy). The availability of long-term data sets can greatly assist with providing this information. For the WQI, as an example, the development of site specific guidelines or reference points (versus using national level guidelines) can assist in removing natural background levels from the calculation, and pinpointing water quality problems caused by human activity.

How can basin wide reporting take into account the large scale differences in geography across the Great Lakes basin?

- There is a need to use comparable methodologies across the entire basin (e.g., the WQI methodology), but adapt it to local circumstances by using site specific guidelines and calculating the index for the water uses relevant to the local area.
- There are vastly different geomorphological conditions across the basin; therefore, one needs to sample on the basis of the different geomorphological strata.
- Biogeographical patterns need to be considered. The herring gull, for example, is a useful indicator species in the Great Lakes, since its range is basin-wide.
- The scalability of indices and indicator methodologies must be considered. For example, the WQI methodology (and the CBI when fully developed) can be applied at the local watershed scale (e.g., one monitoring station), but can also be reported in valid way at the basin-wide or national scale.

Reporting Indicators at a Watershed Level

Organizer: Wendy Leger, Environment Canada

Presentations

- Another Approach to Indicators – Wendy Leger, Environment Canada
- Pathways of Influence from Tributaries to the Great Lakes – Les Stanfied, Ontario Ministry of Natural Resources
- Existing Great Lakes Indicators that Link to Pathways and Watershed Contribution – Wendy Leger, Environment Canada and Victoria Pebbles, Great Lakes Commission

Workshops Overview

Watershed-based resource management has been identified by the International Joint Commission and by federal and provincial levels of governments as a means of ensuring the protection of water resources for both human and ecological health. This workshop examined the potential for using watersheds as a basis for understanding the relationship between tributaries and their contribution to the chemical, physical and biological conditions of the lakes. The initial focus will be to develop Great Lakes indicators that can be measured at the outlet of the tributaries to determine the contribution of their pathways to the overall state of the Great Lakes.

The specific charge to the groups was as follows:

- Identify the best bet suites of indicators that reflect on the State of the Lakes (e.g. nutrients, pathogens, heavy metals, etc.)
- Discuss the best indicator or composite measure for this suite.
    - Can the indicator be monitored at the tributary mouth?
    - Does it reflect an activity or condition happening in the entire watershed?
    - Does it monitor a physical, biological or chemical pathway?
    - What does it tell us about the physical, biological or chemical integrity of the Great Lakes?
    - Does it meet SOLEC criteria of being necessary, sufficient and feasible?
    - Can it be extrapolated around the Great Lakes, and what is the minimum monitoring requirement to support that extrapolation?
- Identify a measurement unit for the indicator (e.g. parts per million).
- Suggest the sampling frequency required (e.g. annual).
- Suggest the spatial extent required to adequately monitor the indicator (e.g. all 4th order tributary outlets).
- Provide a reference for any existing collection protocol.
- If the indicator is currently being collected, identify the collection agency.
- If not, suggest what it would take to collect it.

Physical Indicators

- Group discussion focused on tributary water flow as an important physical indicator of watershed characteristics.
- It was agreed that a watershed approach is appropriate and measurements of water flow conditions at tributary outlets can provide a good indication of inland conditions and potential impacts on the state of the lakes.
- Watersheds are a good way of quantifying contributions (logical unit).
- Water flow conditions indicate the state of a particular watershed but are also critical for proper quantification of nutrient, chemical, and sediment loading to the Great Lakes.
- In general, the group members thought that existing Great Lakes indicators were limited in regards to the physical contributions of tributaries to the lake.

Possible Flow Indicators

- As a means of measuring the conditions and contributions of individual watersheds, it is felt that the water flow regime is the most useful way of describing and evaluating hydrological conditions in a broad sense.
- One particular measure of the flow regime is the deviation of flow from the mean.
- It may also be possible to evaluate the deviation of the flow regime from a natural flow regime; however, questions remain regarding how to quantify/identify a "natural" flow regime. Some work is ongoing with Ontario Ministry of Natural Resources to assess this question.
- Of particular interest for general measurement of a flow regime are minimal flow requirements over a specific period of time.
- Low flow conditions can be assessed by comparing **7Q10** to a reference state (the reference would need to be determined) *Note: 7Q10 is the lowest 7 days of measured flow you have over a 10 year period.*
- **Base Flow Index (BFI)** is another measure of the watershed baseflow conditions. This indicator is new to the Great Lakes indicator suite, (Indicator # 7102) and attempts to measure deviations from normal conditions.
- The flashiness of flow response to precipitation events can be an indication of changes in a watershed conditions (i.e. increased imperviousness); however, watersheds will naturally vary in their response based purely on geologic factors so an appropriate reference state is required.

Related Indicators

- Certain features of a watershed will provide useful information on the condition of the tributary itself.
- The degree of regulation is a useful characteristic of a watershed that affects flow response. It may be helpful to have a Great Lakes indicator for this condition.
- Consumptive water use vs. return flow for individual watersheds.
- Land uses (urban, agricultural, etc.) and their related densities.

Challenges

- Most of the flow indicators discussed above need to be assessed relative to a reference state as further work is required to define such a condition for each watershed.
- The baseline condition of a watershed is a function of its physical characteristics (e.g. geology, topography, etc.). Therefore not all watersheds should be expected to respond in a similar fashion.
- It is complicated to take flow measurements directly at the river/lake interface due to mixing effects and therefore, you need to measure somewhere just upstream of this interface.
- While tributary flow conditions are well monitored on both the Canadian and U.S. sides of the Great Lakes under existing programs, the main challenge to effective application would be due to staffing limitations with regards to data synthesis and analysis.
- While tributary flow contributions to the Great Lakes are generally well monitored, there are small, unmonitored tributaries that drain directly into the lakes that are not monitored. Individually, these tributaries are not important but the cumulative contribution needs to be evaluated.
- Even if these small contributing watersheds cannot be monitored, it may be possible to extrapolate their contributions from adjacent larger tributaries where monitoring does take place.

Brainstorming of Biological Indicators

- Benthic communities – include mussels
  - Stationary/summary of upstream impacts.
  - Absence of benthic organisms would indicate high/low chemical, relationship between chemical to biota already established.
- Migrating Fish – type and numbers.
- Rainbow trout.
- Migratory birds – riparian breeders/those that utilize corridors.
  - Reproductive success.
- Algae.
- Food web structure/complexity or integrity – energy flow/connectivity.
  - Some measure of strength of structure.
- Primary production structure – i.e. ratio of phytoplankton to emergent, emergent to submergent, algae to plants, etc.
- Fish Health – D(eformities) E(roded fins) L(esions) T(umours).
- Exotics – presence/absence of exotics established.
  - Distance of upstream distribution of exotics.
- Terrestrial predators, example: Muskrats.
- Amphibians.

Group Identification of the Best Indicators from the List (in order)

Benthic communities
Migrating Fish
Amphibians

Discussion of Benthic Indicator

A benthic indicator may not measure the direct contribution to the lakes per se, but it is an integrator of many other indicators, such as water quality, sediments, contaminants, and potentially physical impacts. For example, you can use clams as an indicator for contaminants, worms as an indicator for nutrients. As well, the biomass of benthics provides a food source for fish and could be an indicator of site suitability for fish.

This indicator can be monitored at tributary mouths, reflects activities/conditions in the watershed, and responds to components of all three pathways (hydrologic, sediment and chemical) and a measure of the biological pathways. Components of the benthic community provide opportunities to evaluate the pathways individually, that is, a coarse or flagging process that could be used to identify where more rigorous sampling for disruptions in the chemical, physical and biological pathways should occur. For example, an absence of mayflies might indicate nutrient loading. Finally, they provide an opportunity to link to more rigorous sampling; bivalves provide a good source for assessing contaminants.

According to SOLEC criteria, this indicator is not necessary on a lake scale (e.g. Lake Ontario) but it is necessary on a geospatial scale because of local distribution. It is not sufficient as it is an integrator but it is feasible as there is a lot of work going on at federal, provincial/state, and Conservation Authority levels. This feasibility gives the opportunity to build on existing work and to help guide site selection for monitoring. This indicator could also be extrapolated based on ecozone and habitat type (e.g. marsh, stream).

Measurement unit for this indicator could be one of several methods such as IBI (Index of Biological Integrity), Hilsenhoff and % EPT (Ephemeroptera, Plecoptera, and Trichoptera) for richness or abundance. Hilsenhoff or % EPT would be preferred over IBI as there is consensus needed on the method of IBI which could become problematic. Whatever metrics are selected for reporting it is recommended that they be evaluated relative to the expected condition for that ecozone. This method could be done initially at the order level, due to its ease of monitoring; however, more detailed information could be gained by eventually monitoring at the family or species level, which is more time/cost intensive.

It is suggested that this indicator be sampled on a yearly basis (minimum) with the spatial extent to include populated and unpopulated areas in close proximity to tributary mouths.

Data that is currently being collected by U.S. Environmental Protection Agency and OSAP are comparable for 1st level assessment. Also, sampling by Environment Canada, Ontario Ministry of Natural Resources and Ontario Ministry of the Environment are also comparable at more detailed sampling. Conservation Authorities are also collecting data.

Discussion of Fish Indicator
During the initial discussion of the fish indicator, it was suggested that the indicator be measured as the number and types of spawning fish going into tributaries and the number and types of young fish coming out of the tributaries and into the lakes. The group then agreed that this was probably unrealistic and not feasible. As such, the group decided that it would be best to measure one or more keystone species that were:

- Ubiquitous for various habitat types.
- Were sensitive to disturbances.
- Provided a measure of overall contribution of fish from one system.

The group suggested that rainbow trout could represent the groundwater based catchments and that lake sturgeon could provide the surface water catchments. The group acknowledged that other classifications based on thermal, ecozone and habitat types (e.g. large vs. small rivers, cold vs. warm waters) could also be used. From this, a hierarchy of fish indicators was created in which the easiest to measure would be the sentinel species, followed by spawners and juveniles. For the sentinel species, absence/presence would be used as the form of measurement at a frequency of twice a year (once in and once out). Measurement would be made over the entire basin at the tributary outlets which are 3rd order or larger. Data is of good coverage around the basin and there are existing protocols for sentinel species for both Ontario (OMNR) and the U.S. (State agencies), however these protocols differ. The information from these agencies is compiled by the Great Lakes Commission for sentinel species.

Measurement of spawning fish/juveniles is based on the numbers going in and out of the tributary. For spawning fish, this would be twice per year, once in and once out, but is species specific and seasonally driven. Juveniles would only need to be sampled once per year. Data is available for salmonid spawning fish entering tributaries at some locations where there are fishways, however this data is sporadic. Electrofishing surveys of wadable streams could be conducted for long resident juveniles but may be limited due to fiscal constraints. However, biomass data around the Great Lakes could be used as a surrogate for spawning fish/juvenile numbers.

Spawning fish currently can only be monitored at a very small spatial extent, i.e. only where there are fishways present. As such, this indicator would not be adequately monitored. Conversely, monitoring of juveniles needs to be spatially extensive in order to capture all of the juveniles. Ongoing programs could be used (at least in Canada) to provide a statistical description of the abundance and distribution of production from tributaries. Effort would be required to compile datasets for both sides of the lakes. Development of a spawning program would be very time and volunteer intensive, and thus difficult to implement.

Currently, there are no protocols in place for measuring numbers of spawning fish while protocols for juveniles exist only for wadable streams and is not necessarily the same between the U.S. and Canada. Agencies that are currently responsible for this information are State agencies and Ontario Lake units for spawning fish and provincial and state agencies, along with Conservation Authorities for juveniles.

Discussion of Amphibian Indicator
There was insufficient time in this workshop to complete the review of this indicator.

Structure and Complexity

1. Ecosystem Structure and Complexity Issues:

The following were identified as issues that might be taking place up in the watershed that would influence the structure and complexity of the ecosystem:

- Channelized Streams.
- Artificial structures (dams, regulation).
- Drained wetlands.
- No riparian zones.
- Natural heritage features (some measure of these, i.e. % of area still covered by wetlands).
- Imperviousness (landuse).
- Development upstream.
- Tile drainage.

2. How can these be addressed?

- Channelized stream – look at increase in flow velocity.
- Artificial structures – Flow (hydrograph) and temperature.
- No riparian zones – temperature, fish species and benthic invertebrate diversity, contaminants, nutrients, steep banks.
- Imperviousness – contaminants in fish, fish species & benthic invertebrate diversity, road salt (conductivity, chloride).
- Sewage – *E-coli*, pathogens, beach closings.
- Quality of stormwater – dissolved solids, quantify quantity of treated water (number of Combined Sewer Overflows), measuring improvements to water quality (need to standardize according to the type of storm).
- Area of plume at tributaries – remote sensing techniques.
- Percentage of area without stormwater treatment plants – What are the effects? How can these be improved? Look at retrofit measures.
- Condition at mouth i.e. vegetation type, land surface type, sediment build up.

3. Need to look at Cause and Effect as part of the "Next Steps"

Causes:

- Need to characterize these and identify the cause of problems.
- Need to measure them against some type of standard.
- Natural Heritage Features (current & historical) – hydrograph that shows how flashy the system is – use 2 hydrographs, one where heritage features were lost and one where they still exist (system will be less responsive to a rain event).
- Drained wetlands – look at historical records, nitrogen & phosphorus sinks.
- Development upstream (Agricultural, Forestry, Urban, Mining) – forestry management, agricultural practices, areas of forest sustainability.
- Percentage tile drainage (subset of Agriculture) – flashiness (hydrograph), water quality measures (nutrients/contaminants). Step 2: Look at the area where water is tile drained
- Barriers – what impact are barriers having on the natural flow?
- Stream channelization.

Solutions and Implementation:

- Enforcement.
- Best Management Practices.
- Regulations.
- Education.
- Stewardship initiatives.
- Pollution prevention.
- Voluntary participation.

Evaluation

4. General Comments:

- Flow reversal – hydro dam causing flow reversal in Welland River (not the natural flow). Is there a clear understanding of what this is doing? How often does this happen (frequency)?
- Unmitigated hard surface runoff has higher correlation with tributary indicator to lake.
- Hard to say what is causing these issues without knowing the parameters.
- If the collection agencies are missing important programs, look at funding, potential volunteer work
- Need to select monitoring stations away from any lake effects.
- Look at water budgets.
- What is the reference condition? Historical perspective.
- Are there existing U.S. collection protocols?
- Once you have measured indicators at the mouths of tributaries, one method to get at the cause would be to move the monitoring up the stream to isolate the disturbance.

Status of Great Lakes Islands Conservation and Development of Indicators

Organizer and Facilitator: Karen Vigmostad, Northeast Midwest Institute
Recorder: Christine McConaghy, U.S. Environmental Protection Agency

Presentations

- Islands Collaborative – Daniel Kraus, The Nature Conservancy
- Key Islands for Biodiversity Investment – Dave Ewert, The Nature Conservancy
- Review of Three Suites of Islands Indicators – Linda Wires, University of Minnesota

Workshop Overview

The 30,000 Great Lakes islands form the world's largest collection of fresh water islands and their biological diversity is globally significant. In this workshop, efforts to identify priority island areas were presented including the island assessment and ranking system, conservation targets, and freshwater island classification system. Participants were asked to assess draft island indicators that will be used to determine the state of island biodiversity. This workshop was an opportunity to provide feedback and input into this important conservation effort.

Workshop Highlights

- Work achieved by the Islands Collaborative includes:
  - Building the Great Lakes Islands Database; and
  - Developing the Freshwater Island Classification System.
- The system provides a flexible decision tool to managers that can be used to look at islands at multiple scales, from individually to collectively.
- In year two, the project team will identify threats to island biodiversity on a basin-wide scale, and specific threats to the priority island areas. Another goal is the publication of an atlas or summary of Great Lakes island biodiversity. The group will also continue to refine and share the project database and maps.
- Year three will focus on policy communication and outreach, building upon the efforts of years one and two.
- The paper "Key Islands for Biodiversity Investment" was presented. Peer review of the paper is nearing completion. Further refinements are expected based on the results of field testing in several of the Great Lakes.
- Rankings were based a number of criteria:
  - Species richness of colonial nesting waterbirds.
  - Shorebirds, based on the Important Bird Areas program.
  - Land bird migratory stopover sites.
  - Native fish species in near shore waters, fish habitat.

    - Threatened and endangered species.
    - Species and communities of significance, i.e. alvars, dune and swale systems.
    - High quality island characteristics, i.e. size, condition, global importance.
- Aquatic resources associated with islands were considered in the classification in order to capture the importance of corridors, water quality and water quantity.
- In year two, the biodiversity approach and threat analyses will be integrated while considering opportunities and feasibility.

The island indicator development process was reviewed. This was the first unveiling of these three suites of island indicators.

1. Extent, Condition, and Conservation Management of Great Lakes Islands
2. Focal Species and Communities Dependent on Great Lakes Islands
3. Near-Island Landscape Composition and Condition

The indicator suites were selected based on a literature review and an examination of other existing indicator frameworks. The proposed island indicators were then compared to existing Great Lakes indicators. Three suites were selected and developed without respect to data status or availability. Each suite incorporates pressure-state-response indicators.

Workshop participants considered the question: "Are the indicators sufficient for conservation of island biodiversity into perpetuity?" Comments included:

- Consider pressure indicators reflecting socioeconomic change (i.e. number of boat slips, new roads, new airstrips, and other measures of development pressure).
- Consult municipalities and smaller organizations to explore opportunities and needs for using the indicators.
- Other areas (i.e. groundwater; usage of septic systems; and local policies; such as conservation easements, stewardship agreements, privately held islands managed by forest clubs, etc).

Highlights of Management Implications

Classifying thousands of islands in geographic proximity presents a challenge, especially in the Georgian Bay area. Data show that some snakes disperse on these islands in similar patterns to their dispersal on land, indicating that groups of islands are of higher conservation value. There could be various ways to define groups or complexes of islands based on these data.

Another major theme was the need to monitor the changing residential and recreational uses of islands, and to find indicators of development pressure.

Areas requiring more investment and more data need to be identified. To address these challenges, the Islands Collaborative is using remote sensing data, working with other programs (i.e. Great Lakes Coastal Wetland Consortium), and looking to coordinate new data collection where it is most needed. An advantage of the ranking system is that it can provide a more standardized approach to collecting inventory data.

Participants suggested that a website and a newsletter would be useful for communicating best practices and building networks. Contents could include:

- An ongoing list of island projects/clearing house of current events.
- Laws, policies, and examples of island ordinances.
- Researcher websites.
- Effective, proven mechanisms to manage islands and abate threats.

At the local level, funding is needed to develop strategies that fit community issues. Some specific needs mentioned were funding for participation in meetings and round tables, data collection, property purchases for conservation, support for conservation easement negotiation processes, and connecting to other initiatives (i.e. LaMPs, Fishery Commissions, and SOLEC).

The island collaborative solidified its year-two work plan following this workshop. Also, they are working to fund a conference of island experts to create science-based guidelines for island managers.

Stormwater Management: New and Emerging Approaches

Organizer: Michael D'Andrea, City of Toronto
Facilitator: Vicky Barron, Waterfront Regeneration Trust

Presentations
- Low Impact Development – Anne Guillette, Low Impact Development Center
- Optimization of Stormwater/Wastewater Treatment Systems for Wet Weather Flow Control and Experiences with Low Impact Development – Renante Marante, City of Chicago
- Evolution of Natural Channel Design in Ontario – Jack Imhof, Trout Unlimited/Ontario Ministry of Natural Resources
- Developing and Applying Report Card Indicators for Watersheds – Gary Wilkins, Toronto and Region Conservation Authority
- Development of a Master Plan for Stormwater and Combined Sewer Overflow Discharges – William Snodgrass, City of Toronto

These presentations were followed with a round table discussion on existing and proposed Great Lakes indicators related to Stormwater Management. The participants considered the following suite of existing Great Lakes indicators, which relate to tracking progress made on the implementation of stormwater management measures and controls to address the impacts of non-point source pollution within the basin:

Contamination
- #111 Phosphorus Concentrations and Loadings
- #7061 Nutrient Management Plans

Biotic Communities
- #104 Benthos Diversity and Abundance
- #8500 Forest Lands – Conservation of Biological Diversity

Aquatic Habitats
- #118 Toxic Chemical Concentration in Offshore Waters
- #119 Concentrations in Contaminants in Sediment Cores
- #7100 Natural Groundwater Quality and Human-Induced Changes
- #7101 Groundwater and Land: Use and Intensity
- #7102 Base Flow Due to Groundwater Discharge

Land Use – Land Cover
- #7002 Land Cover – Land Conversion
- #7101 Groundwater and Land: Use and Intensity
- #7000 Urban Density
- #7006 Brownfield Redevelopment

General conclusions and recommendations captured in the workshop discussions are summarized under the indicator bundle headings below:

Contamination
- General focus should be on contaminant loadings from watersheds.
- Chlorides and nitrates should be added to the list of indicators for contaminants.
- With respect to Indicator #111 Phosphorus Concentration and Loading:
  - Indicator should be modified to ensure that both total phosphorus mass loading and concentration are included as separate indicators.

- Ensure that this data is being tracked and available e.g. not many municipalities are collecting this type of data.
- Phosphorus Concentration and Loadings is an important indicator.

- With respect to Indicator #7061 Nutrient Management Plans:
  - This indicator should be modified to include Chemical Oxygen Demand (COD) or Biological Oxygen Demand (BOD) information.
  - Number of Management Plans implemented and total basin area addressed by these plans should also be tracked.

Biotic Communities
- An Index of Biological Integrity (IBI) or similar indicator should be added to the indicator suite.

Aquatic Habitats
- An indicator of structure of channels within each watershed should be added e.g. percentage of natural channels.

Land Use – Land Cover
- The following indicators should be added to suite:
  - Area covered by stormwater controls: separated to identify the area for which stormwater quantity (flow) controls are provided and the area for which stormwater quality controls are provided as well as the resulting change in flow.
  - Area covered by Low Impact Development methods, "green" infrastructure, or other innovative approaches.

Other
- The following indicator should be added as a "Stormwater Management Indicator": Volume of Combined Sewer Overflows and Sanitary Sewer Overflows.

Urbanization Effects on Great Lakes Water Quality

Organizer: Doug Alley, International Joint Commission
Facilitator: Jay Unwin, National Council for Air and Stream Improvement, Inc.
Recorder: Kelly Montgomery, International Joint Commission

Presentations
- Review of Past International Joint Commission Activities (IJC) – Isobel Heathcote, University of Guelph
- IJC Science Advisory Board (SAB): Current Work – David Stonehouse, Evergreen Foundation
- Urban Development in the Great Lakes Basin: Land Use and Sustainable Development Planning in the United States – Peter Boyer, International Joint Commission for Elizabeth Brabec, Utah State University
- Policies, Laws and Institutions to Address Impacts of Urbanization in Ontario – Marcia Valiante, University of Guelph

Workshop Overview
Extensive urbanization in the Great Lakes basin is degrading surface and ground water quality and requires the application of new principles, practices and technologies to address the challenges of urban land and water management. The challenges include such obstacles as inadequate and/or improperly sited infrastructure, institutional limitations, and behavioural barriers. Workshop participants discussed the Great Lakes land use indicators and others, as well as binational policy and program implications of water quality impacts of urbanization in the basin. An overview of the IJC 2003-05 Priority on the impact

of urbanization on Great Lakes water quality as well as recent IJC SAB findings, recommendations, innovative ideas and new opportunities were presented.

General Discussion and Presentations

- It was noted that SOLEC has put societal indicators (i.e. crime rate) on the backburner. These indicators have indirect implications to urbanization and thus to water quality.
- Could use releases from Combined Sewer Overflows (CSOs) as an indicator of urbanization and develop a state of the infrastructure indicator.
- There is a need to develop indicators which tell us something about the human health aspect of urbanization.
- An IJC workshop in 1998 revealed that the limited amount of data being collected that would be relevant to measuring urbanization, is being held at the local level and not being shared. In the U.S., this is often due to 'Home Rule'.
- Research still needs to determine if smart growth is really "smart"?
    - Need to figure out how to measure and quantify the impacts of urbanization.
    - Need to better evaluate the economics of best management practices, for example, stormwater ponds and how well they are working.
    - Need to quantify loadings into the stormwater systems and their overall impact on the lakes.
    - Need to determine the "best urban form".

A 2003 IJC study, completed by GHK Ltd. in cooperation with Miriam Diamond and Rodney White involved six cities in Canada and the U.S. The study found that:

- During 1990s, population growth in the communities was profound, and they continue to grow.
- Not just residential growth, but also industrial and commercial growth. For example, Chicago urbanized by 25.2% from 1982 to 1997.
- Projected and mapped growth to 2031.
- Sewage treatment plants and stormwater are two of the major concerns resulting from increasing urbanization.
- Sewage Treatment Plants (STPs) – Despite improvements, STPs are still significant contributors of Total Suspended Solids (TSS), Phosphorus, Nitrogen, metals, and pharmaceuticals to receiving waters and the Great Lakes.
- New facilities are needed to accommodate growing populations.
- Maintenance and operation of existing STPs and related infrastructure is an on-going and growing concern, especially as the maintenance of such infrastructure has been deferred for many years.
- Stormwater is becoming increasingly problematic. There are two culprits which significantly contribute to this problem:
    1. Increasing impervious cover, i.e. larger buildings and auto habitat. Water quality is significantly degraded at great than 25% impervious cover.
    2. Increasing auto emissions, for example, in Chicago where vehicle distance traveled is up 70% from 1990 to 1996.

Currently, the IJC's Working Group on Parties Implementation has two projects regarding land use in development:

- Scientific modeling to measure water quality and impacts of different growth scenarios. This project will work under the notion that the rate of growth cannot be restricted, but where the growth occurs can be controlled i.e. avoid groundwater recharge areas. Therefore, modeling the impacts and results of applied Best Manufacturing Practices (BMP) will guide where and what type of development should be permitted to occur.
- An ongoing survey of laws, institutions, policies, programs, etc., that pertain to land use is to be completed on both the U.S. and Canadian side of the Great Lakes.
- The Working Group evaluation of existing land use studies found that many studies are being undertaken, but few are completed on a binational level. Marcia Valiante, of the University of Windsor, and Elizabeth Brabec, of Utah State University have been contacted to complete evaluations of the polices, laws and institutions that influence urbanization.
- Preliminary thoughts include:

- All levels of government have an impact on urbanization and are currently interested in the issue. (A planning act is currently being reformed at a provincial level).
- Governments are not consistent (i.e. planning versus economic incentives).
- Federal government has a very important leadership role as it owns a large amount of land.
- The role of lending institutions i.e. developers often run into road blocks as lending institutions want to be sure that their money is in a safe investment. They do not encourage alternative/innovative types of development, but prefer the "tried and true" formula especially in the U.S.
- Many consider urbanization a local issue, but there are benefits to be gained by having additional levels of government involved with the issue, particularly in regards to the research and funding which can be provided. There is recognition that the planning and land use policies of the federal, provincial/state governments need to be strengthened, but also that each level of government has a different tool kit to deal with land use. For example, when dealing with transportation issues, depending on what type of transportation and the type of road (i.e. highways, streets, etc.), federal, state or municipal government (s) may have the responsibility of dealing with this issue.
- Need to identify the "human drivers" of urbanization and recognize that people have a desire for low-density housing.

General Discussion

- Has research been undertaken to link Great Lakes indictors to other organizations conducting indicator research work?
- When looking at the Great Lakes indicators, is the need to capture broad thinking or specific details about water quality?

Urban Density – Indicator #7000

- Easy to measure and get population data (population/km^2) for this indicator. The urban density indicator is actually difficult to measure accurately, as it is based on Census Metropolitan Area (CMA). The land within the CMA is often larger than the urban area.
- How will this indicator capture situations such as Detroit, which is heavily urbanized but is losing population?
- This indicator does not capture industrialized lands which often lie on the fringes of cities.
- Need to define an urban area and this definition needs to be consistent. For example, is an airport considered urban land?
- As the boundaries of urban centres change over time, i.e. cities become amalgamated, the suite of Great Lakes indicators will need to address these changing boundaries. There may be a need to set arbitrary boundaries around certain areas and evaluate the density and fluctuation in those specific area(s).
- Difficult to predict in the future.
- Consideration of whether or not the "sprawl" word should be taken out of the definition for this indicator. The word "sprawl" has negative connotations, implies that any development outside of the urban centre has a negative impact on the environment. Such development, if done appropriately can have less of an impact on the environment than intensifying the population in an urban centre on aging infrastructure. Need to include design elements of development. For example, the "sprawl' can be developed using low impact design elements. It would be helpful to be able to incorporate or account for the use of these favourable design elements when evaluating this indicator.
- Need to consider how "green" development can be factored into the indicator. For example, when new greenfield development occurs, state of the art infrastructure and best management practices will be adopted, as compared to the intensification of existing urban areas which relies on aging infrastructure and no stormwater management practices.
- Is there an indicator for patterns of distribution? Is it known which type of development has less of a negative impact on environmental quality, specifically water quality? Is more intensification, i.e. a megalopolis, been developed according to best management practices?
- This indicator includes commercial and industrial areas which are not zoned to permit residential areas which could skew the results.

- Need to specify what scale to assess this indicator? For example, 85% of Ontario is Crown Land, but this is not obvious in the Greater Toronto Area.

Brownfield Redevelopment – Indicator #7006

- Ownership of Brownfields needs to be changed in terms of liability. Previously in Ontario, if a developer purchased a Brownfield, the developer became responsible for cleanup of any contamination on site. The province and municipalities are recognizing their roles in this process.
- Redevelopment within Toronto's boundaries is occurring; while brownfield redevelopment outside of Toronto is still difficult.

Ground Surface Hardening – Indicator #7054

- A revised description is needed.
- Studies and research has shown that more than 25% of ground surface hardening is a result of the degradation of the environment. Therefore, this is a good indicator as there is a clear linkage to water quality.
- This indicator does capture residential and industrial use.
- It is a difficult indicator to measure. It was noted that air photo and satellite technology is making this measurement easier. Some information could be provided by satellite sampling at high resolutions and then extrapolating this information.
- Indicator does not capture whether or not best management practices have been utilized (i.e. if grease and oil traps or porous pavements have been installed in parking lots or whether storm water management ponds have been constructed). It makes an assumption that nothing is being done.
- People can relate well to this indicator as it is easy to visualize what this indicator represents.
- Must provide the scale at which one is measuring the ground hardening percentage i.e. watershed, sub-watershed level, etc.

Vehicle Use – Indicator #7064

- This indicator measures how much time (distance) people are traveling in their car and/or the amount of fuel consumed.
- Amount of vehicle miles traveled, i.e. data on distance commuted to work. The measurement of this distance can be difficult to determine as the stop and start boundaries are hard to set. As many people are commuting greater distances and people are commuting between suburb to suburb for work purposes, it is no longer a set route from the suburbs into the city for work.
- It was suggested that travel data may be available though the Ontario Ministry of Transportation (MTO) and some municipalities. The MTO collects information on road uses, time of day usage, etc, but the data needs to be analyzed.
- This indicator has no way to incorporate whether or not vehicles are being used by one, two, or more passengers.
- Suggested monitoring the volume of road salt used (corrected for climate variability) as an additional indicator.

9. Conference Keynote Address

Mayor David Miller, City of Toronto

Good evening.
I am delighted to be your keynote speaker here, at the 6th biennial SOLEC conference.

I recognize some friendly and familiar faces in the audience – it's wonderful to see you all here in the same room.

Let me say what a wonderful opportunity I think it is to attend a conference of engineers and scientists, policy makers and decision makers, all three orders of government – municipal, state, provincial and federal and non-governmental agencies – and know that everyone here is concerned with the health and future of the largest freshwater system in the world.

As I read your agenda, I was truly impressed by the depth of science and expertise attending over the next two days.

As the people in this room know better than anyone else, cleaning up the Great Lakes is not a small job. Decades of neglect and environmental abuse have taken a toll on the Great Lakes. The environmental strain can't be reversed quickly. Or easily. Or cheaply.

Our task - to restore and improve the Great Lakes - is a collective challenge. But those successes we have had over the past 30 years have resulted, and will continue to result, in cleaner Great Lakes for future generations.

It is clear that it is only by working together and combining resources and expertise that we will continue to make progress.

I understand that this is the first year that municipalities have played a key role in the State of the Lakes Ecosystem Conference. That is a most important breakthrough, and one that I take a very personal interest in.

Since becoming Mayor of Toronto, I have been working with other municipalities on a New Deal for cities with the governments of Ontario and Canada. A cornerstone of the New Deal is "a seat at the table" on issues important to Toronto.

By that I mean that the City government must be at the same table with the governments of Ontario and Canada to provide the City's perspective, experience, and to articulate our needs. It is only through a seat at the table for municipalities that we can ensure that the policies and programs developed by the other orders of government can attain the desired results at the municipal level.

I see the "seat at the table" campaign as completely linked to the Great Lakes Cities Initiative.

This innovative initiative was started by Mayor Richard Daley of Chicago to provide a forum for municipal leaders in the Great Lakes basin to learn from each other and to speak with a collective voice to the U.S. and Canadian Federal, State and Provincial governments.

The Initiative has been in existence for less than two years but it has achieved a tremendous amount. It has focused the municipal interests and role in the Great Lakes and ensured that the municipal voice is heard in the right forums. It has also successfully lobbied the U.S. government for significant new funding dedicated to Great Lakes clean-up.

The Great Lakes Cities Initiative has captured the attention of the other orders of government and clearly sent the message that municipalities need to be at the table, identifying problems, collecting the evidence and data, and determining solutions.

It is also a means for mayors to talk to each other, learn from each other and share best practices.

I value this opportunity to develop relationships with the other Great Lakes mayors in Canada and in the U.S.

As result of this collaboration the mayors in the Great Lakes Cities Initiative have identified six key priorities for municipalities:

Storm Water Run-off and Sewer Overflows
Invasive Species
Waterfront Revitalization
Beaches
Contaminated Sediment and
Water Management

I have only recently had the honour of becoming the Canadian Co-chair of the Great Lakes Cities Initiative and look forward to continuing the work that Mayor Daley and a dedicated group of mayors started on these key issues.

And let me take this opportunity to thank the many mayors who have been involved in the Great Lakes Cities Initiative from its inception.

In particular, Mayor Tim Rigby of St. Catherine's has been instrumental in providing leadership for the Canadian cities and I look forward to working with Tim on the Steering Committee. Mayor Terry Geddes of Collingwood has been a very active participant bringing his energy and enthusiasm to the Initiative. Thank you to you, and to all the other mayors that have been involved.

When I speak of partnerships in the Great Lakes, the Government of Canada is key. The Canadian Federal Great Lakes Program is itself a partnership of eight federal departments and agencies led by Environment Canada.

I was pleased, as I am sure you were, to hear in the Throne Speech yesterday that the Government of Canada is committing to bring forward the next generation of programs to protect and preserve the Great Lakes and St. Lawrence. This is the opportunity for the Canadian government to involve municipalities in the design of these programs from their inception. And I will be working with other mayors to ensure the federal government knows we want to be involved.

Through the Canada – U.S. Great Lakes Water Quality Agreement, the Government of Canada leads restoration efforts through the provision of technical expertise, policy and operational guidelines.

Funding provided through the Great Lakes Sustainability fund for projects in the Toronto area such as fish barrier mitigation, stream naturalization, installation of habitat structures, involvement in municipal stormwater management and wastewater treatment projects and the Remedial Action Plans are demonstrations of municipal federal collaboration and are just a few of the initiatives of the Canadian government.

Now I would like to demonstrate why it is so important that municipalities are involved in the Great Lakes.

Municipalities are on the front lines of the Great Lakes. It is critical that provincial and state governments not only recognize that cities are key to the implementation and success of restoration efforts but that the public's major interaction with the Great Lakes is through municipal services such as drinking water, wastewater collection and treatment, beaches for swimming, and waterfront amenities.

When there are problems with the Great Lakes, those problems are identified first at the municipal level. It is city leaders who are called when the algae blooms appear, when the beaches are closed and when the drinking water smells off.

Restoration, improvement of water quality and shoreline conditions are essential for the vitality of municipalities. Waterfront activity can drive local economies by supporting recreational, commercial, tourism, and cultural activities for residents and visitors and enhance the natural environment by supporting animal and fish habitat.

And most importantly the Great Lakes provide drinking water. In Ontario, 75% of Ontario residents get their drinking water from the Great Lakes.

It is also the municipal involvement and commitment that can ensure a positive result for all involved.

To illustrate a few examples:

St. Catharines' Henley Rowing Course and Martindale Pond is a tremendous waterfront development resulting from municipal initiative and partnerships with the federal and provincial governments and recreation and sporting interests. St. Catharines continues to improve its waterfront and the Great Lakes through its stormwater management program and Pollution Control Plan.

Collingwood Harbour and Severn Sound are great successes with beautiful waterfronts that tell the story. The de-listing of these municipalities as areas of concern is not only encouraging for other municipalities that have waterfronts listed as areas of concern, including Toronto, but are also testament to the results that can be achieved with concerted action through the federal remedial action plans, focused resources, and a commitment to action by all levels of government.

On the other side of the border Erie, Pennsylvania has been a huge success story. Erie has evolved from a hard working industrial port to clean, green and beautiful waterfront attracting recreation amenities and increasing season population.

These are a few examples of the restoration of the Great Lakes from the municipal perspective. When you look into any one of these they are the result of strong relationships.

I would now like to share with you the Toronto perspective. Our City Council and I have made the environment one of our top priorities. I want Toronto to be a champion of the environment, and I am going to illustrate how Toronto is setting and achieving environmental goals.

Last year, through a series of budget consultations we held, called "Listening to Toronto", residents clearly indicated that the environment is a top priority.

To respond, Toronto Council has established the Environmental Roundtable with 18 members of the public to advise the Mayor and City Council on current and emerging environmental sustainability issues affecting the City of Toronto and its goals of a clean, green and healthy City. The chair of the Environmental Roundtable, Deputy Mayor Joe Pantalone, has a deep commitment to the environment and the City.

Toronto is pursuing several environmental initiatives that have a direct and indirect influence on improving Great Lakes water quality.

Natural Heritage System
Starting at the policy level - In Ontario, cities are required to pass an Official Plan, a policy document guiding the physical development of the City. It is a powerful policy instrument, not only because of its legislative basis, and the fact that it is binding on Council, but also because of the extensive public process involved to help formulate it.

The City also adopts other policies and plans such as the Environmental Plan and the Wet Weather Flow Management Master Plan to achieve the Official plan's vision. A foundation of the Official Plan is the Natural Heritage System developed through an ecosystem approach.

The Waterfront
A related priority is the revitalization of the Toronto waterfront. Through a partnership of Toronto, Ontario and Canada we are working with the Toronto Waterfront Revitalization Corporation to create waterfront parks, public spaces, cultural institutions and diverse and sustainable commercial and residential communities.

If Toronto's waterfront is to achieve the vision, it will take renewed energy and commitment from all the partners involved.

Making Connections
The Wet Weather Flow Management Master Plan addresses the problems of stormwater picking up contaminants and polluting watercourses and shorelines and it addresses overflows from the City's combined sewer system during severe weather.

The watershed based plan uses a hierarchical approach to manage wet weather flows: beginning with "at source controls" where the rainwater falls – followed by "conveyance system measures" as the flow moves through the sewer network – and finally "end of pipe facilities" before the flow enters our rivers or lake.

The plan takes a system approach to managing wet weather flow. The goal is to achieve, in a timely and sustainable manner, measurable improvement in ecosystem health of the watersheds, and to reduce and ultimately eliminate the adverse effects of wet weather flow on the built and natural environments.

The approach taken by our Plan is a significant cultural shift in engineering philosophy and practice. We haven't abandoned "engineering", but we have learned the value of harnessing nature's own engineering systems.

Toronto has also adopted a number of new by-laws that are important steps to making our environmental goals a reality.

Posters for the Sewer Use Bylaw and Pesticide Bylaw
The new Sewer Use By-law passed in 2000 makes Toronto the first Canadian municipality to have passed a by-law with pollution prevention requirements. It has stringent concentration limits for pollutants and requires any industry discharging such pollutants in any amount to prepare pollution prevention plans which have to be updated every two years. It also prohibits the discharge of swimming pool water into our ravines. This by-law has won a number of awards including the 2000 MOE Toronto and Region Remedial Action Plan Award of Excellence.

Trees
We all know how important trees are to the urban environment, and how trees mitigate airborne pollution of the Great Lakes. Last week Toronto Council approved the Private Tree By-law to protect trees over 30 centimeters to complement the City Street Tree By-law. These are important steps to reversing the decline of the City's tree canopy.

The new Pesticide By-law restricts the use of pesticides for cosmetic purposes to reduce contamination of storm water.

Water Efficiency Plan
We are also looking at doing things differently. Our Water Efficiency Plan is aimed a deferring the cost of infrastructure expansion to support growth by targeting reductions in wastewater and water treatment flows. The plan implementation is $74 million about 1/3 of the equivalent infrastructure cost.

Salt Truck and Stream
Our Road Salt Management Plan to reduce salt in storm and snow-melt run-off will change salt storage and minimize use of road salt through innovative spreading and controlled applications.

While municipalities are doing what they can, we do look to the Federal and Provincial governments to also take a leadership role in the Great Lakes basin on source water protection, nutrient enrichment and ecosystem imbalance and mitigating the impact of urbanization.

In order to make progress we need to make sure that implementation by municipalities is provided the necessary funding to meet the commitments and as implementers, municipalities must be engaged in negotiation of agreements – again a seat at the table.

In addition I would ask that at this SOLEC you ask yourself and your colleagues the question - is the science meeting the policy? Is the monitoring data being used to the fullest advantage and value to inform the public, policy and decision making, to assess the effectiveness of existing policies and to determine if new policies and legislation is necessary so the public understands they are our ally?

We know how many demands there are on scarce dollars in every government. That is why it is imperative that we work together and work wisely to ensure that those dollars are well spent on implementable solutions directed at achieving the greatest benefit to the Great Lakes.

Thank you for the opportunity to speak to you this evening. I look forward to our work on the Great Lakes and I wish you a good conference.

10. SOLEC Success Story Recipients

SOLEC 2004 Success Story recipients are examples of work that exemplify a strong commitment to improving the environment within the Great Lakes basin. The recipients have demonstrated all or most of the following criteria:

- Showed improvement in the "integrity" of the Great Lakes or local ecosystem
- Forged linkages among economy, environment, and community
- Created a "win-win" situation
- Formed strong partnerships
- Established sustainability as a goal
- Fostered broad stakeholder involvement
- Demonstrated adequate monitoring of effectiveness

Each recipient received a SOLEC Success Story recognition plaque signed by the U.S. and Canadian Consuls General. A special thank you is extended to Phil Chadwick, a talented artist, whose painting adorned the plaque. To see more of Phil's paintings, visit www.philipchadwick.homestead.com.

The SOLEC 2004 Success Story recipients are:

DTE Energy Monroe Power Plant Lake Sturgeon Habitat and Education Project

Lake sturgeon are an important yet threatened Great Lakes fish species whose declining population numbers are a significant cause of concern. Over the past several years, DTE Energy has demonstrated considerable commitment to the rehabilitation of lake sturgeon in the waterways connecting lakes Huron and Erie. From 1997-2000, DTE Energy provided funding for several graduate students to research lake sturgeon movement, patterns and spawning habitat in the Detroit and St. Clair rivers. These studies provided the basis for the design and location of a multi-partner initiative, called the "Sturgeon Habitat and Education Project," implemented earlier this year. The project entailed depositing three artificial spawning "reefs" into the Detroit River. Hopefully, sturgeon will utilize these reefs in their upcoming mating season, spring 2005. As one of the key partners, DTE Energy committed money, materials and logistical support to this effort. Moreover, the Monroe Power Plant provided one of the materials used as a reef: coal cinders (or bottom ash), a byproduct of the coal combustion process used in electrical generation. DTE Energy has also supported governmental and non-governmental stakeholders in monitoring the reefs, and in outreach programs including the distribution of lake sturgeon brochures and the development of educational exhibits. DTE Energy remains a committed partner in this effort, and the Monroe Power Plant stands ready to contribute future "reef" material for this important Great Lakes species.

The Junction Creek Stewardship Committee

Junction Creek is part of the Spanish River watershed in Sudbury, Ontario. In response to detrimental environmental effects that were degrading the watershed, including urban discharge and the effects of over 100 years of mining in the Sudbury area, the Junction Creek Stewardship Committee was formed in 1999. It is an independent body comprised of concerned citizens, individuals from local, regional and provincial government agencies, academia, businesses, industries and community groups. The committee meets monthly to coordinate citizen participation in Junction Creek restoration activities related to reducing soil erosion, re-engineering creek beds and banks, and improving water quality. For example, between 1999 and 2004, approximately 35,000 kilograms of garbage were removed from the creek and thousands of trees were planted, resulting in a tremendous improvement in water quality. With the assistance of the Ontario Ministry of Natural Resources, six thousand brook trout were reintroduced into the upper areas of Junction Creek in 2000 and 2001. Research and monitoring are ongoing to determine the success of this release but current indications show that brook trout are surviving there once again. The Junction Creek Stewardship Committee continues to work on initiatives for further revegetation of the watershed as well as including even more members of the community in its endeavours.

The Lake Huron Centre for Coastal Conservation of Ontario

The Lake Huron Centre for Coastal Conservation, a non-profit environmental organization, provides technical expertise and coastal management for beaches, dunes and other ecosystems. Areas of focus include water quality, coastal processes, climate change and biodiversity. Improvements to the Lake Huron coastal ecosystem were achieved by the completion of a number of coastal stewardship projects focused on an improved understanding of sand dune coastal processes, the important role of vegetation and the fragile nature of the dune systems. The Centre has developed several stewardship manuals, which have provided the needed direction and information to foster behavioral change such as signage changes, pedestrian re-routing, beach cleaning procedures and vehicular parking adjustments. Specific examples include a Dune Guidance Manual for Saugeen Shores and a Beach Management Plan for Friends of Sauble Beach. In all cases, stakeholder involvement and substantial grass roots support from cottage associations, municipal staff and politicians have been the keys to the success of these initiatives. Continued monitoring of dune management by community groups and municipal staff will ensure continued future success and improved dune ecosystems.

Mercury Pollution Prevention Initiative, a joint project by: International Steel Group Burns Harbor, LLC, Ispat Inland Inc., Indiana Harbor Works, and United States Steel, Gary Works

Since 1998, these three Gary, Indiana steel mills have worked through the Lake Michigan Forum and cooperated with the Indiana Department of Environmental Management (IDEM) to inventory mercury uses/sources within these mills and develop a clean sweep/pollution prevention initiative to inventory, recycle, and substitute mercury at their facilities to the greatest extent practical. The initial plan was designed to obtain a 33 percent reduction in mercury usage within two years, a further 33 percent reduction over the next five years, followed by putting a program in place for continued reductions setting a goal of 90 percent-plus reductions within ten years of the project initialization. To date, of the 4,660 pounds of mercury inventoried at the three mills, 3,751 pounds, (approximately 80%), have been removed, recycled, or substituted, removing their potential for release into the local and Great Lakes ecosystem. Just five years into the program, the three companies have jointly surpassed the originally stated goals and additional opportunities to remove even more mercury are actively being sought. The initiative is being managed by the individual participating companies, but supports the sustainability goals of the Lakewide Management Plan for Lake Michigan, the Great Lakes Binational Toxic Strategy, and Indiana's Mercury Program launched by IDEM.

The Michigan Dunes Alliance

The Michigan Dunes Alliance was formed in 1999 with the overall objective of protecting dune and aquatic ecosystems on the east shore of Lake Michigan. Over the past three years, the Alliance has focused on protecting aquatic sites, coastal marshes, dunes and forests along eastern Lake Michigan by increasing the organizational capacity of nine land trust partners, producing twelve site conservation plans and expanding the partners' knowledge of these important coastal systems. Land trust networking has become a valuable part of the Michigan Dunes Alliance. In addition, the Michigan Dune Alliance has developed *The Eastern Lake Michigan Shoreline Plan,* which identifies and ranks 42 sites based on total biodiversity, landscape context, scenic, recreational and value, and conservation value. This allows land trusts to prioritize land protection and stewardship activities. The current full partners of the Michigan Dunes Alliance include: Chickaming Open Lands, Grand Traverse Regional Land Conservancy, Land Conservancy of West Michigan, Leelanau Conservancy, Southwest Michigan Land Conservancy, and The Nature Conservancy. Advisory partners include: Land Trust Association - Midwest Office, Little Traverse Conservancy, Michigan Department of Environmental Quality and Tip of the Mitt Watershed Council.

Appendix A – Conference Program

6th Biennial

State of the Lakes Ecosystem Conference

October 6th - 8th, 2004
Toronto, Ontario

CONFERENCE PROGRAM

Greetings from the SOLEC 2004 Conference Co-Chairs

Paul Horvatin and Harvey Shear

Welcome to the 6th Biennial State of the Great Lakes Ecosystem Conference (SOLEC), sponsored by the Governments of Canada and the United States. Our conferences are designed to be interactive, to maximize delegate discussion and scientific feedback, and to provide insight into emerging trends.

This year, SOLEC will present a comprehensive assessment on the state of health of the Great Lakes basin ecosystem based on the assessments provided from 56 indicators. The assessments are now based on "bundles" of indicators. This new approach is the result of two Peer Reviews held over the past two years and should help to further refine our reporting format and content.

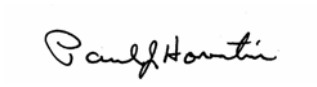
Based on recommendations from SOLEC attendees in 2002, we are presenting you with the DRAFT ***State of the Great Lakes 2005*** report, some 10 months ahead of when we have usually released it. This has meant a lot of extra work for authors and for the SOLEC team, but we hope that this draft aids you in your deliberations. After listening to all the presentations, we invite you to review this work, and enhance the findings with your insight and knowledge. We welcome your input to the draft after SOLEC, and expect to have a final ***State of the Great Lakes 2005*** report available in early 2005.

Following the work presented at SOLEC 2002 on Biological Integrity, we are providing an assessment of the indicator bundles related to Biological Integrity. The theme of SOLEC 2004 is Physical Integrity, and most of the Lake and River presentations on the second day of SOLEC will focus on the physical component of the ecosystem.

An intriguing and though-provoking presentation on the Ecological Footprint of the Great Lakes basin will kick start the conference and we are looking forward to your response to this way of presenting the Great Lakes information. You will also find indicator reports on forestry and groundwater, something that was proposed at the last SOLEC.

Your participation in SOLEC 2004 represents an important contribution to our efforts to meet the goals of the Great Lakes Water Quality Agreement. We look forward to working with you over the next two and a half days.

Sincerely,



Harvey Shear
Co-Chair
Environment Canada

Paul Horvatin
Co-Chair
U.S. Environmental Protection Agency

Definition of Physical Integrity:
Physical Integrity is the ability to maintain a balanced, integrated, and adaptive system capable of sustaining all components and interactions (structure and function) in an organized manner.

EXTRA! EXTRA!

TORONTO HARBOUR BOAT TOUR

On Tuesday, October 5th, 2004, we were pleased to offer SOLEC 2004 delegates a boat tour of Toronto Harbour including visits to restoration sites and spectacular views of Toronto. We thank the City of Toronto and the Toronto and Region Conservation Authority for their assistance in organizing this tour.

JOINT GREAT LAKES COMMISSION~SOLEC RECEPTION

As has become a SOLEC tradition, on Tuesday evening, October 5th, we held a joint reception with the Great Lakes Commission, as they concluded their annual general meeting. Thanks to GLC for providing the liquid refreshments.

DISPLAYS

Be sure to visit Mountbatten Lane and the Baker Room to see the selection of displays related to Great Lakes issues and programs. Displays can be viewed any time between 7:30 am and 5:30 pm October 6th and 7th, and from 7:30 am to 12:00 pm October 8th.

THANK YOU TO THE CITY OF TORONTO AND TORONTO AND REGION CONSERVATION AUTHORITY (TRCA)

A special thank you is extended to the staff from the City of Toronto and the TRCA who have been so very helpful in planning and delivering SOLEC 2004. Please be sure to have a look at their displays and materials available for you in our display area.

TORONTO

TORONTO AND REGION Conservation for The Living City

WE WANT TO HEAR FROM YOU!!

Please complete your evaluation form and return it to the registration desk. Your input is valuable to us – it allows the SOLEC organizers to continually improve the conference and the products.

DAY 1: WEDNESDAY OCTOBER 6, 2004

7:30 am	**CONTINENTAL BREAKFAST – Mountbatten Salon**
9 am - 12 pm	**MORNING PLENARY – Churchill Ballroom**
9:00 am	**Native Greetings** Grafton Antone, *Elder, Oneida Nation of the Thames*
9:10 am	**Welcome and Introductions** MC: John Andersen, *Great Lakes Program Director, The Nature Conservancy* Pradeep Kharé, *Regional Director General, Environment Canada – Ontario Region* Joe Pantalone, *Deputy Mayor, City of Toronto*
	Overview of SOLEC 2004 Gary Gulezian, *Director, Great Lakes National Program Office, U.S. Environmental Protection Agency*
9:30 am	**Ecological Footprint and Human Drivers** William E. Rees, *Professor and Director, School of Community and Regional Planning, University of British Columbia*
9:50 am	**Human Oriented Issues** Lori Boughton, *Chief, Office of the Great Lakes, Pennsylvania Department of Environmental Quality*
10:20 am	**BREAK**
10:50 am	**Natural Resources and Biological Integrity** Douglas Dodge, *CEO, Stream Benders*
11:20 am	**Coastal Wetlands** Joel Ingram, *Wetland Biologist, Environment Canada* Tom Burton, *Professor, Departments of Zoology and Fisheries and Wildlife, Michigan State University*
11:50 am	**Summary and Charge to Participants** – John Andersen
12 pm	**LUNCH – Mountbatten Salon**
INFORMATIONAL SESSIONS (optional) – both sessions end at 1:50 pm	
12:45 pm	**Q & A Session on the *Ecological Footprint*** with William Rees – Churchill Ballroom
1:00 pm	**Introduction to Indicators –** *a primer on indicators* – Rosetti B Room Paul Bertram, *U.S. Environmental Protection Agency*
2 - 5 pm	**AFTERNOON DISCUSSION SESSIONS – Rooms to be Announced**
	Contaminants
	Biotic Communities (including Invasive Species)
	Habitats (including Climate Change)
	Coastal Wetlands
	Groundwater
	Land Use – Land Cover
	Human Health
	Resource Utilization
5:00 pm	**Adjourn**
RECEPTION & DINNER – Churchill Ballroom	
6:00 pm	**Cash Bar Opens** – Churchill Court
7:00 pm	**Dinner** MC: Dale Phenicie, *representing the Council of Great Lakes Industries* **Success Stories Awarded by:** Roger Marsham, *Consul General, Canadian Consulate General in Buffalo* Janice Weiner, *representative from the Consul General of the United States of America* **Keynote Speaker –** Mayor David Miller, *City of Toronto*

DAY 2: THURSDAY OCTOBER 7, 2004

7:30 am	**CONTINENTAL BREAKFAST – Mountbatten Salon**	
9 am – 12 pm	**MORNING PLENARY – Churchill Ballroom**	
9:00 am	**Welcome and Introductions plus Highlights from Day 1** MC: Chris Goddard, *Executive Secretary, Great Lakes Fishery Commission*	
	Ecosystem Status Reports: Lakes and Connecting Channels Presentations	
9:10 am	**Lake Superior**	Stephen Schlobohm, *U.S. Forest Service*
9:25 am	**Lake Michigan**	Norman Grannemann, *U.S. Geological Survey*
9:40 am	**Lake Huron**	Janette Anderson, *Environment Canada*
9:55 am	**St. Clair River–Lake St. Clair–Detroit River Ecosystem**	Ted Briggs, *Ontario Ministry of the Environment*
10:10 am	**BREAK**	
10:40 am	**Lake Erie**	Sandra George, *Environment Canada*
10:55 am	**Lake Erie Fishery**	Phil Ryan, *Ontario Ministry of Natural Resources*
11:10 am	**Lake Ontario**	Rimi Kalinauskas, *Environment Canada*
11:25 am	**Lake Ontario Fishery**	Bruce Morrison, *Ontario Ministry of Natural Resources*
11:40 am	**St. Lawrence River**	Serge Villeneuve, *Environment Canada*
11:55 am	**Native Ceremony**	Grafton Antone, *Oneida Nation of the Thames*
12 pm	**LUNCH – Mountbatten Salon**	
2 – 5 pm	**AFTERNOON WORKSHOPS – Rooms to be announced**	
	Lake Superior **Lake Michigan** **Lake Huron** **Lake Erie** **Lake Ontario**	
5:00 pm	**Adjourn**	

DAY 3: FRIDAY OCTOBER 8, 2004

7:30 am	**CONTINENTAL BREAKFAST – Mountbatten Salon**
9 am – 12 pm	**MORNING WORKSHOPS – Rooms to be announced**
	Concurrent Workshops
	1. The Chemical Integrity of the Great Lakes
	2. Recent Advances in Monitoring Science and Index Development
	3. Monitoring Coordination and Information Management
	4. Impact of Urbanization on Great Lakes Water Quality
	5. Review of the Great Lakes Water Quality Agreement (GLWQA)
	6. Stormwater Management – New and Emerging Approaches
	7. Great Lakes Beaches
	8. Reporting Indicators at a Watershed Level
	9. Status of Great Lakes Islands Conservation and Development of Indicators
	10. Human Health in the Great Lakes
	11. Climate Change
12 pm	**Adjourn**

Day 1 Highlights

Day 1 of SOLEC 2004 begins with a presentation by Prof. William Rees of the University of British Columbia. He is one of the originators of the Ecological Footprint analysis. This tool allows us to calculate the impact that we are having on the planet.

Then we will present assessments of the 56 indicators for which we were able to prepare reports. These indicators have been arranged into 9 "bundles" and the assessments are based on those bundles. This is a major component of the draft State of the Great Lakes 2005 report.

Following lunch, there will be an opportunity for attendees to discuss the Ecological Footprint with Prof. Rees before the afternoon discussion sessions begin. Also, at the same time, Dr. Paul Bertram will discuss indicators and the process that lead to the development of the Great Lakes suite of indicators.

Come and participate in the **Discussion Sessions** that begin at 2 pm. The **Contaminants**, **Biotic Communities** (with Invasive Species), **Habitats** (with Climate Change), **Land Use-Land Cover** and **Resource Utilization** sessions will look at the indicator assessments, the overall bundle assessments (where applicable) and management implications arising from the indicator information. The following three sessions will focus more specifically on indicators:
Groundwater – there are four indicators of groundwater quantity and quality. During this session, hydrogeological issues related to these indicators will be addressed by binational experts and will be illustrated by recent case studies and monitoring programs from throughout the basin.
Coastal Wetlands – the Great Lakes Coastal Wetlands Consortium will take the opportunity to present and discuss the progress being made on reporting on the wetlands indicators.
Human Health – in addition to the facilitated discussion topics listed above, this session will include a presentation by Dr. Donald Cole, Dept. of Public Health Sciences, Faculty of Medicine, University of Toronto, on a sport-fish eaters mercury study.

SOLEC Success Story Awards Dinner With Guest Speaker

Join us Wednesday evening October 6 for a celebration of the SOLEC 2004 Success Story Awards in the Churchill Room. A cash bar will be available at 6:00 pm. Dinner will be served at 7:00 pm followed by the Awards presentations.

Congratulations to this year's recipients:
Junction Creek Stewardship Committee – for their citizen participation work in environmental restoration activities
DTE Energy, Monroe Power Plant – for their work on Lake Sturgeon habitat and education project
Michigan Dune Alliance – for their work on protection of dune and aquatic ecosystems on the east shore of Lake Michigan
The Lake Huron Centre for Coastal Conservation – for their work on Dune Ecosystem Stewardship / Management along the Lake Huron shoreline
ISG-Burns Harbor; Ispat Inland Inc. Indiana Harbor Works; and U.S. Steel Gary Works – for their work on the Mercury Pollution Prevention Initiative

Don't miss the Success Story displays in Mountbatten Court

Our special guest speaker following the Awards presentations will be the Honourable David Miller, Mayor of Toronto

Day 2 Workshops: Focus on Individual Lakes

- **Lake Superior: Land Use Change**
  Changes in land use can precede deleterious changes in water quality, air quality, and the status of fish and wildlife populations and their habitats. This breakout session will discuss the need for the tracking and monitoring of land use change, appropriate land use indicators for the Lake Superior basin, discussion of methods, and available data. It will include a panel discussion led by a group of land use experts including representatives from the U.S. Forest Service, the Canadian Centre for Remote Sensing, The Nature Conservancy and the Natural Resources Research Institute.

- **Lake Michigan: Stresses to the Ecosystem**
  Lake Michigan differs from the coastal areas to the open water. Of the 33 watersheds that feed the lake, all but 3 are listed for some impairment. While the open water quality is good, the aquatic food web shows signs of the impairments found in the coastal areas and tributaries. This session will explore these complex interactions and origins of the stress, plans for year 2005 intensive monitoring and the results of recent Wetland Consortium work on the lake's coastal wetlands

- **Lake Huron: Intensive Monitoring in 2007**
  The Lake Huron Binational Partnership will host this breakout session on "Intensive Monitoring in 2007". The session will begin with an overview of the unique resources and places in the Lake Huron watershed. A kick-off discussion on monitoring and research priorities to pursue in 2007 will follow. This discussion will ultimately help to shape the Partnership's monitoring effort. Agency professionals, researchers, Lake Huron enthusiasts and others interested in the protection and management of Lake Huron are encouraged to participate.

- **Lake Erie: Linking Land and Lake**
  Stressors to Lake Erie's natural ecosystem include the impacts of changing land use, shoreline alteration, nutrient loading, chemical contamination and exotic invasive species. These factors have direct impacts on habitat quality and food web dynamics. This breakout session will address these and other stressors, with a particular emphasis on land use and the potentially detrimental effects of land use change.

- **Lake Ontario**
  Part 1: Re-evaluating the impairment status of Fisheries (2:00-3:00)
  In the first part of this breakout session, discussion will focus on non-native species, which have severely disrupted Lake Ontario's aquatic foodweb since the LaMP made its initial beneficial use impairment determination a decade ago. Lake Ontario fishery managers and LaMP staff will lead the discussion about this and other stressors impacting Lake Ontario's fisheries and proposed changes to the LaMP's list of beneficial use impairments.
  Part 2: Minimizing Impacts of Lake Level Controls on Nearshore Habitats (3:15 - 4:45)
  In the second part of this breakout session, discussion will focus on minimizing impacts of lake level controls on nearshore habitats, including coastal wetlands. The International Lake Ontario-St. Lawrence River Water Level Study is currently in year 4 of a major 5 year study evaluating the possibility of changing the current water level control plan in order to consider a broader range of factors including environmental and recreational factors. Members of the IJC Reference Study and LaMP staff will lead a discussion on the work underway to evaluate a variety of potential changes to the current lake level control plan and how to best monitor the ecosystem's response to any future changes.

Day 3 Workshops: Cross-Cutting Issues

1. Planning For SOLEC 2006 – The Chemical Integrity of the Great Lakes (An Interactive Panel Discussion)

The purpose of this session is to facilitate planning for SOLEC 2006, which will focus on the chemical integrity of the Great Lakes. This will consider the state of the science on chemical integrity, the relationship between chemical, biological and physical integrity, and what research is being done or is planned.

2. Recent Advances in Monitoring Science and Index Development (Four 20-min presentations, followed by a one-hour facilitated plenary discussion)

This workshop is for managers and practitioners to discuss emerging research results that will substantially forward ecosystem assessment and environmental reporting. Experts will present new sampling designs and indicators for coastal ecosystems from the Great Lakes Wetland Consortium, the Great Lakes Environmental Indicators Program, the CCME Water Quality Index, and the Canadian Biodiversity Index.

3. Monitoring Coordination and Information Management

Monitoring and reporting on the integrity of the Great Lakes ecosystem require the involvement of multiple agencies/organizations on both sides of the border. This, in turn, necessitates binational coordination of monitoring activities and integration of the resultant information. To this end, the Binational Executive Committee has launched the Great Lakes Monitoring Inventory on www.binational.net,, and has adopted a basinwide rotational cycle for cooperative monitoring to address key information needs identified by the Lakewide Management Plans and SOLEC. As well, various information management initiatives (e.g., GLOS, COA Annex 4, GLENDA) are underway in Canada and the United States to facilitate access and sharing of Great Lakes data. This workshop will discuss the status and possible means of integrating these initiatives.

4. Impact of Urbanization on Great Lakes Water Quality

Extensive urbanization in the Great Lakes basin is degrading surface and ground water quality, and requires the application of new principles, practices and technologies to address the challenges of urban land and water management. The challenges include such obstacles as inadequate and/or improperly sited infrastructure, institutional limitations, and behavioral barriers. The workshop participants will discuss SOLEC land use indicators as well as, binational policy and program implications of water quality impacts of urbanization in the basin. An overview of the IJC 2003-05 Priority on the impact of urbanization on Great Lakes water quality as well as recent IJC SAB findings, recommendations, innovative ideas and new opportunities will be provided.

5. Review of the Great Lakes Water Quality Agreement (GLWQA)

The GLWQA between Canada and the United States is reviewed by the two governments every 6 years. The next review is scheduled for this fall (2004). As part of a review of the Agreement, the monitoring components and the development and implementation of ecosystem health indicators will be examined. This workshop will discuss the adequacy of present monitoring and indicator development, and will seek advice on improvements that can be made to both aspects of the Agreement. The output of this workshop will be used as input to the broader review by the governments.

6. Stormwater Management – New and Emerging Approaches

Urban development within the Great Lakes basin and the corresponding changes to the hydrologic cycle has resulted in intense pressures on the ecosystem. Increases in impervious area coupled with land-use practices have contributed to degraded water quality conditions in area surface waters and

the Great Lakes nearshore from increased stormwater runoff and discharges from combined sewer overflows. Binational municipal representatives will present “state of the practice” approaches for planning and mitigating the impacts of these discharges including watershed based computer simulation modelling, “Low Impact Development” and ecologically friendly approaches for stormwater management for new and in-fill developments; and new and emerging technologies for stormwater management retrofits and combined sewer overflow control and treatment The workshop participants will discuss and propose Great Lakes indicators for the mitigation of non-point sources

7. Great Lakes Beaches

The Great Lakes shoreline provides some of the most beautiful beaches in the world, yet many continue to be posted as unsafe for swimming for significant periods during the bathing season. These postings represent a diminished quality of life, as well as a disincentive to tourism and are a detriment to local economies. During this session binational experts will address the multi-faceted “Swimmability” issue, discuss the new SOLEC Beach Advisory indicator, update participants on U.S. and Canadian programs to mitigate recreational water quality impairments as noted in the Great Lakes Water Quality Agreement and provide information on rapid detection methods under development in both countries.

8. Reporting Indicators at a Watershed Level

Watershed-based resource management has been identified by the International Joint Commission and by federal and provincial levels as a means of ensuring protection of water resources for both human and ecological health. In keeping with this theme, this workshop will examine the potential for using watersheds as a basis for understanding the relationship between tributaries and their contribution to the chemical, physical and biological condition of the lakes. The initial focus will be to develop Great Lakes indicators that can be measured at the outlet of the tributaries to determine the contribution of their pathways to the overall state of the Great Lakes.

9. Status of Great Lakes Islands Conservation and Development of Indicators

The 30,000 Great Lakes islands form the world’s largest collection of fresh water islands and their biological diversity is globally significant. In this workshop, efforts to identify priority island areas will be presented including the island assessment and ranking system, conservation targets, and freshwater island classification system. Participants will be asked to assess draft island indicators that will be used to ascertain the state of island biodiversity. This will be an opportunity to provide feedback and input in this important conservation effort.

10. Human Health in the Great Lakes

Current research and networking efforts will be presented and discussed by representatives of the Agency for Toxic Substances and Disease Registry (ATSDR), Great Lakes Human Health Effects Research Program and Health Canada. ATSDR is characterizing exposure to persistent toxic substances and investigating the potential for adverse health outcomes from that exposure via fish consumption in vulnerable populations. Health Canada will be presenting information on the development of its public health network. The Great Lakes Human Health Network will also be present to discuss future directions of calls and actions, membership expansion, and to outline recent efforts in member organizations.

11. Climate Change

This workshop will consist of a participatory discussion on potential roles for SOLEC relating to regional climate change scenarios and identifying key physical indicators to assess regional impacts of climate change. Topics to discuss will include potential impacts of climate change on the open lake and on terrestrial-aquatic interactions. A facilitated discussion will follow.

SOLEC 2004 Background/Conference Reports

All of the following reports can be found on the CD provided to each conference registrant:

State of the Great Lakes 2005: Draft for Discussion
Forestry Paper
Ecological Footprint Paper
The Great Lakes Indicator Suite: Changes and Progress 2004

Please visit the SOLEC display (near the registration desk) to pick up copies of reports from previous SOLECs. After October 8th they will only be available electronically.

SOLEC 2004 Steering Committee

SOLEC Steering Committee members represent a wide variety of agencies and organization from around the Great Lakes:

Agency for Toxic Substances and Disease Registry
Council of Great Lakes Industries
Environment Canada
Great Lakes Commission
Great Lakes Fishery Commission
Illinois Environmental Protection Agency
International Joint Commission
Michigan Department of Environmental Quality
Minnesota Pollution Control Agency
Natural Resources Canada
NY State Department of Environmental Conservation
Northeast Midwest Institute
Ontario Ministry of Agriculture and Food
Ontario Ministry of Environment
Ontario Ministry of Natural Resources
Pennsylvania Department of Environmental Protection
Quebec Ministry of the Environment
The Nature Conservancy
Tribes/First Nations
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Forest Service
U.S. Geological Survey
U.S. National Park Service
University of Windsor

There are many other individuals and representatives from environmental groups, academia and all levels of government who have participated in the work necessary to develop this conference.

Appendix B – Participant Feedback Summary

The following information is based on the 75 participant responses to the SOLEC 2004 Evaluation Form with the information being broken down into four main categories.

Key Conference Feedback
Participants were asked the question, "Did the information you received at SOLEC 2004 enhance your ability to preserve, protect and restore the Great Lakes?" Only **33%** percent of the respondents felt that SOLEC 2004 "much to very much" provided information to enhance their ability to preserve, protect and restore the Great Lakes. **Sixteen percent** of respondents felt that the conference had not enhanced their ability to improve the ecosystem. The remaining respondents felt the information would "somewhat" enhance their ability to improve the ecosystem. Some comments received from participants regarding the information presented at SOLEC include "the overall knowledge presented at SOLEC is tremendous, but without extensive background in many of the areas covered and with too many indicators, politicians and some managers may feel excluded from the discussions and yet are a significant factor in the implementation of policy that will improve the health of the Great Lakes for future generations", "the conferences need to broaden their scope to cover more emerging issues", "SOLEC has a lot of excellent data but to whom and where is this data and information going?"; and "future conferences should focus on using SOLEC information and taking action".

Plenary
For both days, over **70%** of the respondents felt that the plenary sessions covered the topics "well or very well", and provided new information. In addition, **77%** of respondents felt that the plenary sessions were "useful or very useful", with respondents commenting that the plenary sessions were informative, data rich, well presented as well as very interesting, especially the information presented on the status of each Great Lake on Day 2. In contrast, some comments received regarding SOLEC 2004 plenary sessions were constructive in that they suggest improvements for future conferences. Comments received included: "too much repetition in some plenary sessions", "need speakers with stronger public speaking skills" and "given that SOLEC is every two years, the presentations should focus on changes, challenges and achievements over the past two years".

Sixty eight percent of respondents also found the Ecological Footprint presentation by William Rees to be a useful way to present Great Lakes information. Comments received included, "it provided a whole new perspective of thinking about the impact of the Great Lakes basin on the rest of North America or globally" but some also felt that the information presented was not useful or practical for SOLEC-related work.

Breakout Sessions
Over **65%** of the respondents felt that the breakout sessions covered their topics "well or very well" and were useful. Comments included, "great opportunity for discussion in the breakout sessions, technically and logistically, the sessions were really well planned and executed, great slides and graphics". However, some of the respondents still felt that the breakout sessions were useful but often too technical and lacked direction and purpose. Some felt that the breakout sessions provided the adequate amount of time for discussion but there was too much time spent on presentations within the session.

Some areas for improvement as identified by respondents to this survey include:
- Facilitators with more knowledge on discussion topics.
- Session separation to accommodate the different audiences and their information needs.
- Shortening of Day 3 Workshops so that participants could attend more sessions.
- More structured exercises for conference participants.

General
Over **70%** of the respondents "agree or strongly agree" that SOLEC provides valuable information and continues to serve a vital function. **Eighty seven percent** of respondents "agreed or strongly agreed" that

the conference was well organized and well done. Many respondents requested that the detailed agenda be posted on the registration website in advance of the conference.

With regards to the printed materials being provided to conference participants, **76%** of respondents "agreed or strongly agreed" that this material was useful and informative and it was especially useful to have the draft indicator reports in advance of the conference. Although, some felt that more time to review these draft materials is still needed prior to the conference. The draft materials also need to be more easily accessible from the conference website.

Overall, the display/poster session was "useful" with **64%** of respondents agreeing or strongly agreeing that displays are a good opportunity to share in-depth knowledge, ask questions and make new contacts. Some areas of improvement for future SOLEC display sessions include: having the display area in a more central location and having more signage to advertise the display and poster session.

Appendix C – Participant Profile

Country	Number of Delegates Attending	Percent
Canada	294	66.2
United States of America	149	33.6
Mexico	1	0.2
Total	444	100

Sector	Number of Delegates Attending	Percent
Federal Government	162	36.50
Provincial/State Government	57	12.84
Municipal Government	55	12.39
Academia/Research	36	8.11
Commissions	26	5.85
Environmental Groups	23	5.18
Industry	20	4.50
Conservation Authorities	19	4.28
Tribal/First Nations	16	3.60
Consulting	10	2.25
Media	3	0.67
Other (Support/Foundation/Professional Association/Societies)	17	3.83
Total	444	100

Appendix D - Participant List

First Name	Last Name	Affiliation	Email Address
Robin	Abshire	City of South Haven	rabshire@south-haven.com
Robert	Adair	U.S. Fish and Wildlife Service	bob_adair@fws.gov
Jacqueline	Adams	U.S. Environmental Protection Agency	adams.jacqueline@epa.gov
Dennis	Albert	Michigan Natural Features Inventory	albertd@michigan.gov
Jon	Allan	Consumers Energy Company	jwallan@cmsenergy.com
Stephanie	Allen	Saulteaux Enterprises (Sagamok First Nation)	anowara@sympatico.ca
Doug	Alley	International Joint Commission	alleyd@windsor.ijc.org
John	Andersen	The Nature Conservancy	jandersen@tnc.org
Ellen	Anderson	Town of The Blue Mountains	mayor@town.thebluemountains.on.ca
Janette	Anderson	Environment Canada	janette.anderson@ec.gc.ca
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