# State of the Great Lakes 2009

# Highlights

EPA

Canada

This Highlights report is based on environmental indicator reports and information on the nearshore that was prepared for the State of the Lakes Ecosystem Conference (SOLEC) in Niagara Falls, Ontario, October 22-23, 2008. Many experts on various components of the Great Lakes basin ecosystem contributed to the process. Data sources and contact information for each indicator are included in the technical report, *State of the Great Lakes 2009*. For the nearshore components, similar information can be found in the report *Nearshore Areas of the Great Lakes 2009*.

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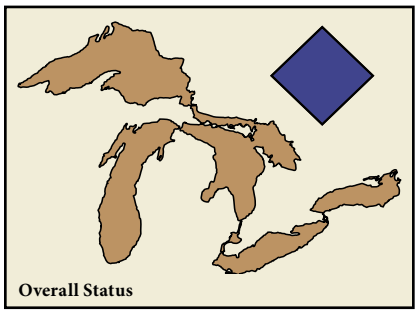
## Assessing Status and Trends of the Great Lakes Ecosystem




*In 2008, the overall status of the Great Lakes ecosystem was assessed as **mixed** because some conditions or areas were **good** while others were **poor**. The trends of Great Lakes ecosystem conditions varied: some conditions were **improving** and some were **deteriorating**.*

Since 1998, the United States Environmental Protection Agency and Environment Canada have coordinated a biennial assessment of the ecological health of the Great Lakes ecosystem using a consistent set of environmental and human health indicators. This assessment is in accordance with the Great Lakes Water Quality Agreement. Indicator reports are supported by scientific information and, to the extent feasible, assessed by Great Lakes experts from Canada and the United States, along with a review of scientific papers and use of best professional judgement.

Indicators are organized into nine categories: Coastal Zones and Aquatic Habitats (combined in this report), Invasive Species, Contamination, Human Health, Biotic Communities, Resource Utilization, Land Use-Land Cover, and Climate Change. Overall assessments and management challenges were prepared for each category to the extent that indicator information was available. This *State of the Great Lakes 2009 Highlights* report is derived from a more detailed *State of the Great Lakes 2009* report. The *2009 Highlights* report also includes information on "Nearshore Areas of the Great Lakes," which was the theme of SOLEC 2008.

Credit: U.S. Environmental Protection Agency Great Lakes National Program Office.

Authors of the indicator reports assessed the status of ecosystem components in relation to desired conditions or ecosystem objectives, if available. Five status categories were used (coded by colour in this Highlights report):

**GOOD.** The ecosystem component is presently meeting ecosystem objectives or otherwise is in acceptable condition.

**FAIR.** The ecosystem component is currently exhibiting minimally acceptable conditions, but it is not meeting established ecosystem objectives, criteria, or other characteristics of fully acceptable conditions.

**POOR.** The ecosystem component is severely negatively impacted and it does not display even minimally acceptable conditions.

**MIXED.** The ecosystem component displays both good and degraded features.

**UNDETERMINED.** Data are not available or are insufficient to assess the status of the ecosystem component.

Four categories were also used to denote current trends of the ecosystem component (coded by shape in this Highlights report):

**IMPROVING.** Information provided shows the ecosystem component to be changing toward more acceptable conditions.

**UNCHANGING.** Information provided shows the ecosystem component to be neither getting better nor worse.

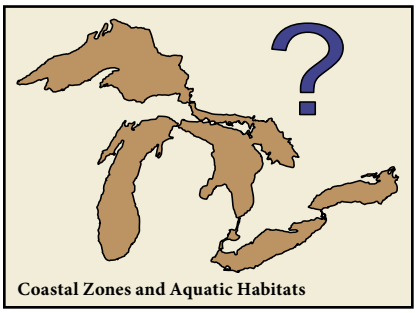
**DETERIORATING.** Information provided shows the ecosystem component to be departing from acceptable conditions.

**UNDETERMINED.** Data are not available to assess the ecosystem component over time, so no trend can be identified.

For many indicators, ecosystem objectives, endpoints, or benchmarks have not been established. For these indicators, complete assessments are difficult to determine.

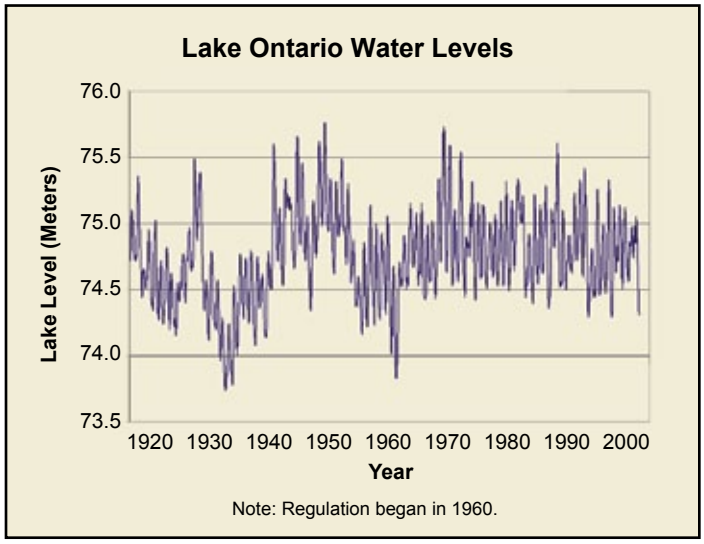
## Indicator Category Assessments and Management Challenges

### COASTAL ZONES AND AQUATIC HABITATS


Coastal Zones and Aquatic Habitats

*Great Lakes coastal zones are unique and rare in the world of freshwater ecosystems. Special lakeshore communities such as coastal wetlands, islands, alvars, cobble beaches, sand dunes as well as aquatic habitats, however, are being adversely impacted by the artificial alteration of natural water level fluctuations, shoreline hardening, development, and elevated phosphorus concentrations and loadings. New data and new management approaches indicate a potential for reversing the deteriorating conditions identified in some locations.*

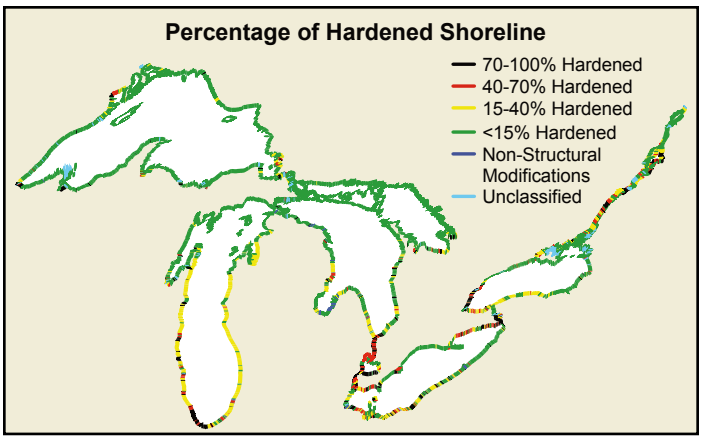
The alteration of natural **lake level fluctuations** significantly impacts nearshore and coastal wetland vegetation. Water levels are regulated in Lake Superior and Lake Ontario and are less variable than in the other Great Lakes. In Lake Ontario, the reduced variation in water levels has resulted in coastal wetlands that are markedly poor in plant species diversity.



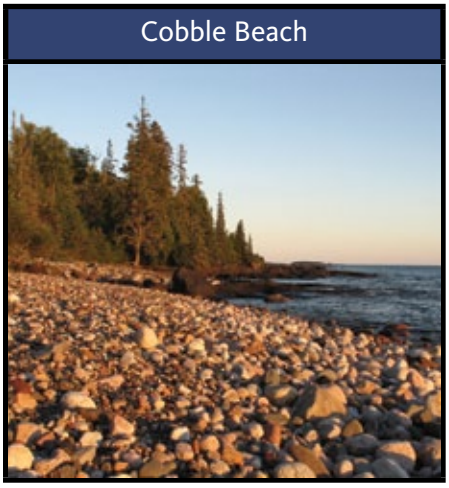

Source: *State of the Great Lakes 2009* report.

The St. Clair, Detroit, and Niagara Rivers have 44 to 70 percent of their **shorelines artificially hardened**. Of the lakes, Lake Erie has the highest percentage of its shoreline hardened, and Lake Huron and Lake Superior have the lowest. Whether the amount of shoreline hardening can be

reduced is uncertain; perhaps there may come a time when shorelines can be restored to a more natural state.




Source: National Oceanic and Atmospheric Administration.




Credit: Matt Hudson, Great Lakes Indian Fish & Wildlife Commission.

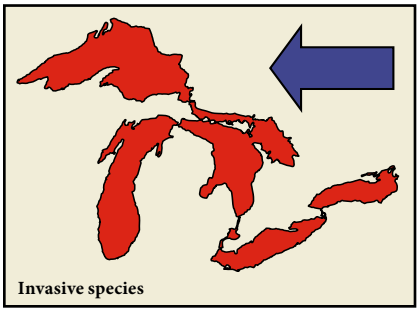
The ecological importance of the Great Lakes **special lakeshore communities** such as alvars, cobble beaches and sand dunes are increasingly being recognized. More than 90 percent of Great Lakes **alvars**, open habitats occurring on flat limestone bedrock, have been destroyed or substantially degraded, but conservation efforts now recognize their importance as habitats for rare plants and animals. **Cobble beaches**, another unique habitat, are decreasing due to shoreline development. Increasingly, human development damages the connectedness and quality of the **sand dune** system; however progress is being made in protecting and restoring critical dune habitats.

The more than 31,000 Great Lakes **islands** form the world's largest freshwater island system and their biological diversity is of global significance. Islands are of particular importance for colonial nesting waterbirds, migrating songbirds, unique plants, endangered species, and fish spawning and nursery areas. Islands are vulnerable to impacts from shoreline development, invasive species, recreational use and climate change.

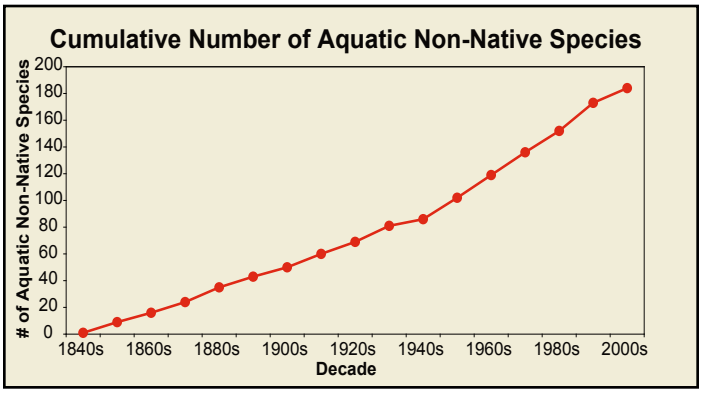
### *Management Challenges:*

- Regulate water levels in a manner that allows for healthy aquatic habitats.
- Protect and restore wetlands, islands, alvars, cobble beaches, sand dunes, and aquatic habitats.
- Implement established binational coastal wetland monitoring programs and protocols.
- Develop indicators for all aquatic habitats: open and nearshore waters, groundwater, rivers and streams, inland lakes and wetlands.

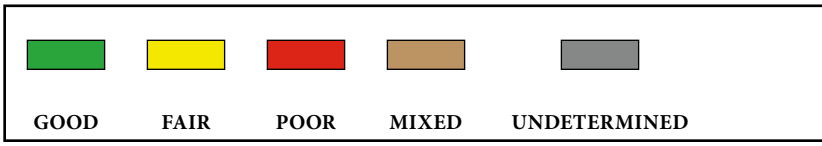
## INVASIVE SPECIES

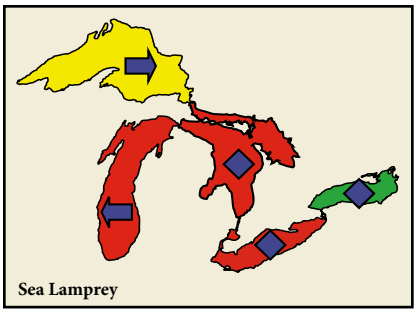



*New non-native species, now totalling 185 aquatic and at least 157 terrestrial species, continue to be discovered in the Great Lakes. Each new non-native species can interact with the ecosystem in unpredictable ways, with at least 10 percent of non-native species considered to be invasive, meaning that they negatively impact ecosystem health. The presence of invasive species can be linked to many current ecosystem challenges including the decline in the lower food web's* Diporeia *populations, fish and waterfowl diseases, and excessive algal growth. Shipping continues to be a major concern for introductions and spread of invasive species. However, the roles of canals, online purchase of aquatic plants, and the aquarium and fish-bait industries are receiving increasing attention.*

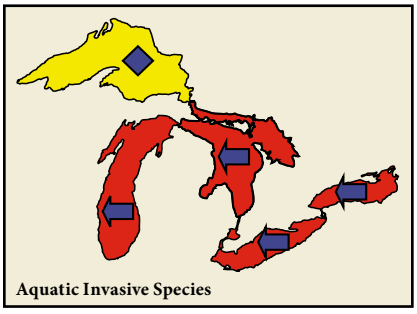



Source: *State of the Great Lakes 2009* report.




Sea Lamprey

Managing the impact of harmful invasive species once they are established is a major challenge. For example, the invasive **sea lamprey** is an established lethal parasite to large Great Lakes fishes. Decades of control measures have reduced the sea lamprey population by over 90 percent from its peak, but the need for sea lamprey control continues. The success of control efforts are measured against sea lamprey target population ranges agreed to by fishery management agencies, which should result in tolerable fish mortality rates.


Aquatic Invasive Species

The Great Lakes ecosystem has been, and will continue to be, extremely vulnerable to introductions of new **invasive species** because the region is a significant receptor of global trade and travel. The vulnerability of the ecosystem to invasive species is elevated by factors such as climate change, development and previous introductions.

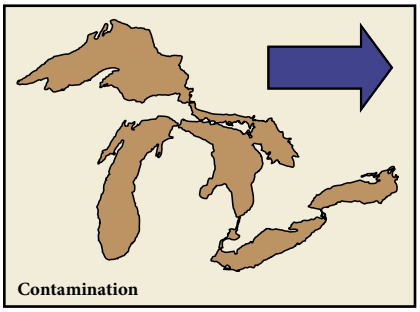
### *Management Challenges:*

- Develop integrated invasive species prevention and control strategies for the entire basin.
- Establish and enforce regulations to inhibit the introduction and spread of aquatic invasive species.
- Gain a better understanding of the links between vectors and donor regions, the reactivity of the Great Lakes ecosystem, and the biology of potential harmful invaders.

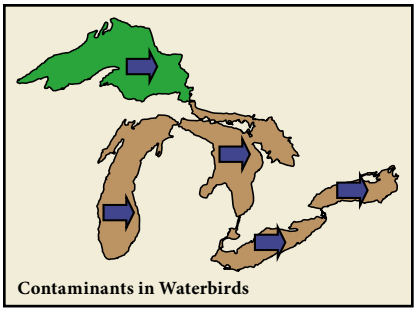

Credit: Ann Dehass, courtesy of W. Paul Sullivan, Fisheries and Oceans Canada.

IMPROVING UNCHANGING DETERIORATING UNDETERMINED

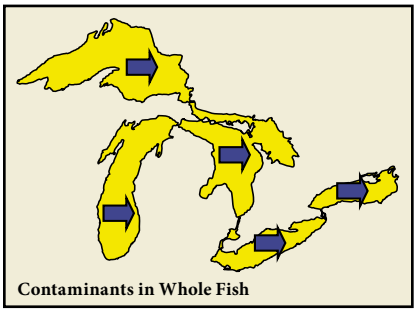
## CONTAMINATION


Contamination

*Releases of targeted bioaccumulative toxic chemicals have declined significantly from their peak period in past decades and, for the most part, no longer limit the reproduction of fish, birds and mammals. Concentrations of contaminants in the open waters are low, and many contaminants are further declining. However, concentrations are higher in some local areas near the shore, such as some bays and Areas of Concern. The lakes continue to be a receptor of contaminants from many different sources such as municipal and industrial wastewater, air pollution, contaminated sediments, runoff, and groundwater.*

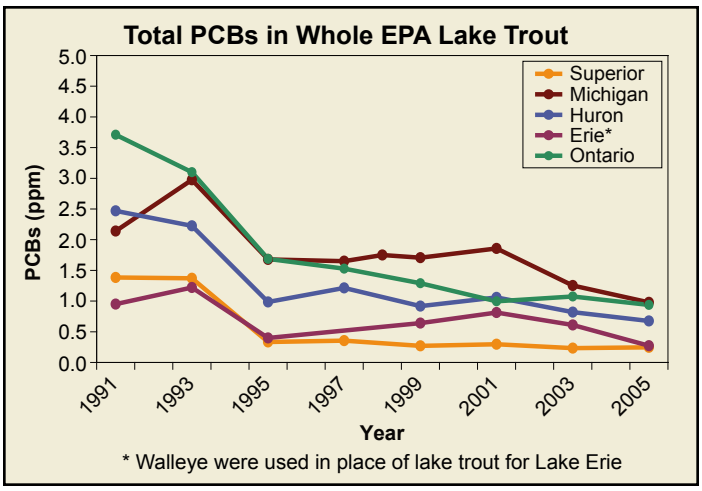

Contaminants in Waterbirds

Colonial waterbirds, such as the herring gull, are fish-eaters and usually considered top-of-the-food web predators. They are excellent bioaccumulators of contaminants and are often among the species with the greatest pollutant levels in an ecosystem. They also breed on all the Great Lakes. Overall, most contaminants in **herring gull eggs** have declined 90 percent or more since the monitoring began in 1974, but recently, the rate of decline has slowed. More physiological abnormalities in herring gulls still occur at Great Lakes sites than at cleaner reference sites away from the Great Lakes basin.

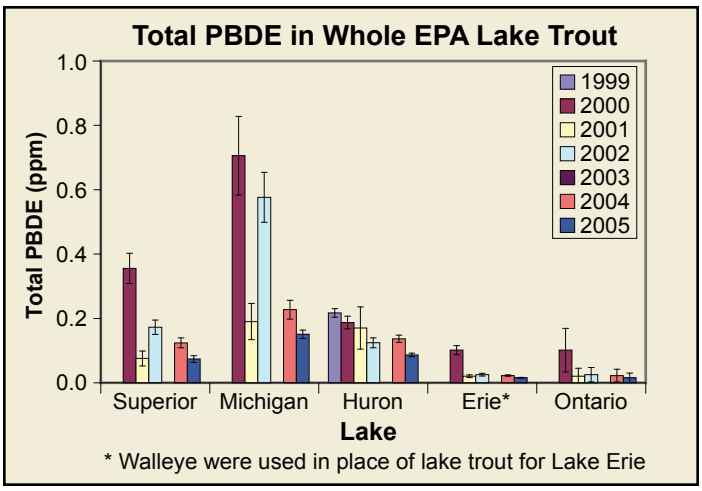

Contaminants in Whole Fish

Since the 1970s, concentrations of historically-regulated contaminants such as polychlorinated biphenyls (**PCBs**), dichloro-diphenyl-trichloroethane (**DDT**) and **mercury** have generally declined in most monitored fish species. Concentrations of other regulated and unregulated contaminants such as **chlordane** and **toxaphene** vary in selected fish communities, and these concentrations are often lake-specific. Overall, there has been a significant decline in these contaminant concentrations. However, the

rate of decline is slowing and, in some cases concentrations are even increasing in certain fish communities.




Source: *State of the Great Lakes 2009* report.

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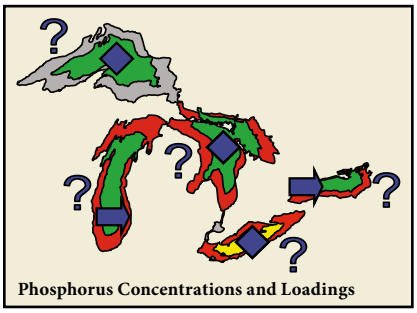


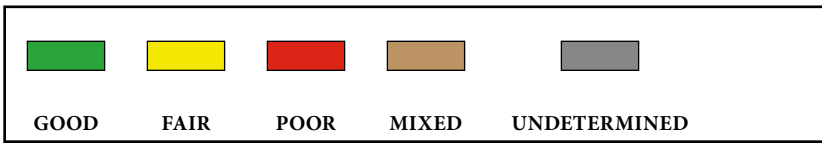

Excessive inputs of **phosphorus** to the lakes from detergents, sewage treatment plants, agricultural runoff, and industrial discharges can result in nuisance algae growth. Efforts that began in the 1970s to reduce phosphorus loadings have been largely successful. However, in some locations, phosphorus loads may be increasing again, and an increasing proportion of the phosphorus is a dissolved form that is biologically available to fuel nearshore algal blooms. The status and trends of phosphorus can be quite different in the nearshore waters compared to the offshore waters of each lake.

**Substances of emerging concern** such as flame retardants, plasticizers, pharmaceuticals and personal care products, and pesticides have been at the forefront of many recent studies because they may pose a risk to fish, wildlife or people. Polybrominated diphenyl ethers (PBDEs, flame retardants incorporated into many products), for example, have recently been added to fish monitoring programs in Canada and the United States. Program results demonstrate that voluntary and regulatory action on the more toxic formulations of PBDEs through the mid-2000s resulted in a prompt decrease of concentrations of these contaminants in Great Lakes fish. Perfluoroctanesulfonate (PFOS), which is a product used in surfactants such as water-repellent coatings and fire-suppressing foams, has been detected in fish throughout the Great Lakes and has demonstrated the capacity for biomagnification in food webs.

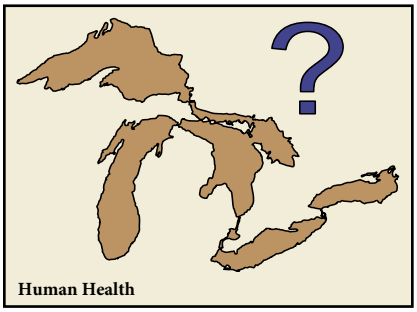
**Atmospheric deposition** of toxic compounds to the Great Lakes will continue into the future. Levels of banned organochlorine pesticides are generally decreasing. Levels of persistent bioaccumulative toxic substances in air tend to be lower over Lake Superior and Lake Huron, but they may be much higher in some urban areas around the lakes.

### *Management Challenges:*

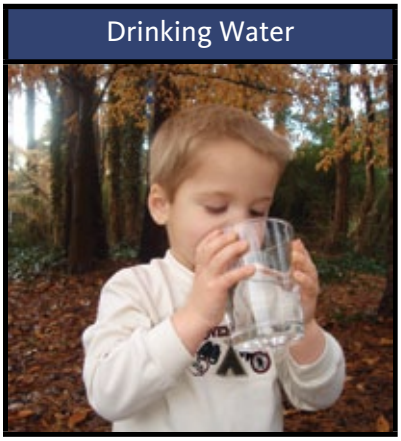
- Eliminate nuisance algae growth through vigilant efforts to control excessive phosphorus loadings to the Great Lakes, guided by a better understanding of the location and relative importance of various sources as well as the role that some invasive species play in the cycling of phosphorus.
- Research human and ecosystem health implications of detected bioaccumulative toxic substances and newly monitored contaminants in the Great Lakes.
- Reduce atmospheric deposition of contaminants to the Great Lakes.
- Remove existing sources of PCBs in the Great Lakes basin.
- Systematically measure toxic chemicals from all vectors to improve source identification and local management actions.



## HUMAN HEALTH




*Improvements in drinking water assessment techniques and beach monitoring, along with continuing declines in concentrations of PCBs in fish and air, are being made and help to protect human health. Incompletely known are global or continental factors that may be limiting the success of air pollution reduction efforts. Continued reduction of pollution sources near beaches and continued study of the impacts of non-native mussels on beach water quality are also needed.*

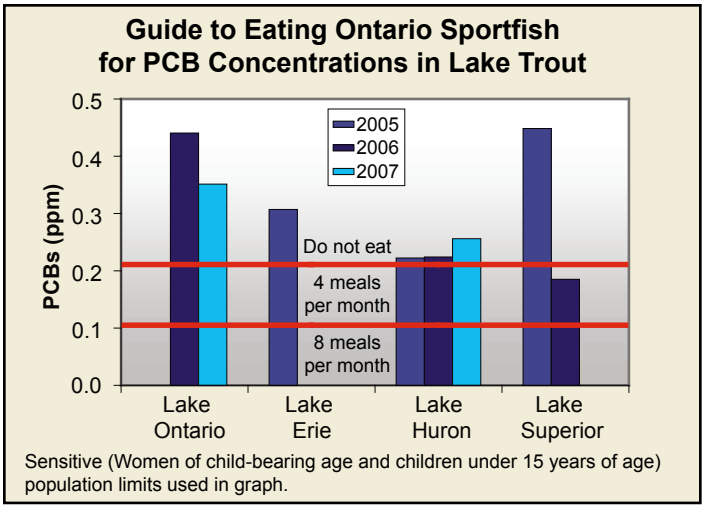



Credit: Jonathan S. Yoder, Centre for Disease Control.

A suite of ten health-related parameters are used to assess treated **drinking water quality** in the Great Lakes region. The parameters include chemical and bacterial contaminants as well as treatment success. According to these parameters, the Great Lakes provide residents with some of the finest drinking water sources found anywhere in the world, and water treatment plants in both Canada and the United States are using successful treatment technologies. However, drinking water treatment facilities generally do not completely eliminate all contaminants.

Based on 2007 data from over 1600 beaches along the U.S. and Canadian coastlines of the Great Lakes, an average of 67 percent were open more than 95 percent of the swimming season. In general, Lake Erie and Lake Ontario have more **beach advisories, postings, and closures** than Lake Superior, Lake Michigan and Lake Huron due to a greater number of both point and non-point sources of pollution in the lower Great Lakes.

A decrease in the concentration of **contaminants in sport fish** can be attributed to the elimination of the use of a number of persistent bioaccumulative toxic chemicals in the environment, mainly organochlorine contaminants such as toxaphene. Although declines in PCB concentrations have been observed in lake trout, concentrations still exceed consumption limits so it is important to continue monitoring. Some new persistent bioaccumulative chemicals of concern have been detected in fish and are now being monitored.




Source: *State of the Great Lakes 2009* report.

**Air quality** seems to be improving on a regional scale, but localized problem areas still exist. In the United States portion of the Great Lakes basin, concentrations of nitrogen oxides and ground-level ozone are decreasing. These successes are attributed to improvements in urban areas. In the Canadian portion of the basin, concentrations of nitrogen oxides have also decreased as a result of improvements in urban areas and although ozone levels remain a concern, there has been an overall decreasing trend in peak ozone concentrations. This decrease is partly due to weather conditions less conductive for ozone production, and the reductions of nitrogen oxide emissions in Ontario and in the United States.

### *Management Challenges:*

- Protect Great Lakes drinking water sources from potential threats to human health, including many contaminants, pathogenic bacteria, salts in stormwater runoff, and chemicals of emerging concern such as pharmaceuticals and personal care products, endocrine disruptors, antibiotics and antibacterial agents.
- Review and standardize U.S. state guidelines for contaminants in sport fish.
- Monitor chemicals of emerging concern such as PBDEs and PFOS.
- Identify human and ecosystem effects from exposure to multiple contaminants, including endocrine disruptors.

- Improve quantitative measurements for water quality improvements that can be expected as a result of implementing various best management practices.

## BIOTIC COMMUNITIES

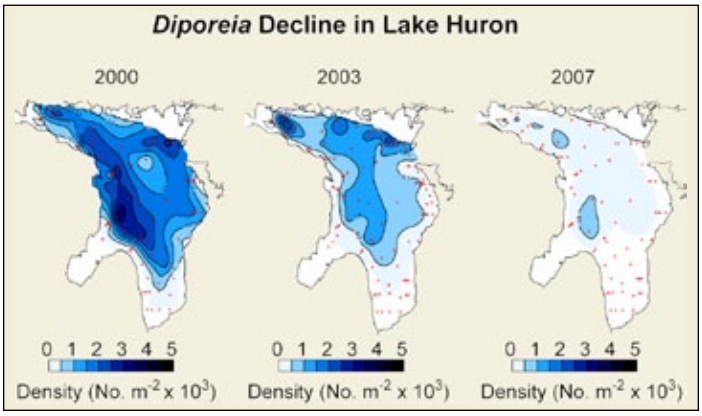

*Overall, the status of biotic communities varies from one lake to another, with Lake Superior generally having a more positive status than the other lakes. Indicators that measure lower food web components generally show more negative status and trends, and most of these can be related back to the impacts of invasive zebra and quagga mussels. Some indicators that focus on higher food web components are more positive and highlight the successes that can be achieved as a result of long-term restoration and protection efforts.*


Credit: G. Carter, National Oceanic and Atmospheric Administration.

Bottom-dwelling, or benthic, aquatic organisms are important to, and indicative of, aquatic ecosystem health. The diversity of **benthic organisms** in Lake Superior, Lake Huron, and Lake Michigan is typical of nutrient-poor, oxygen-rich conditions. In contrast, the community of benthic organisms in Lake Erie is more typical of an aquatic ecosystem with low oxygen, nutrient-rich conditions.

***Diporeia*** is an aquatic invertebrate that is an important food source for preyfish, and its populations have declined drastically in all lakes except Lake Superior. The decline began after the arrival of zebra and quagga mussels, but their continuing downward trend is far more complex. The continuing decline will have serious consequences for the food web, and impacts are being observed in populations of preyfish such as whitefish, bloater and sculpin.

In the lower Great Lakes, over 99 percent of the **native freshwater mussel** population has been wiped out by the establishment of invasive zebra and quagga mussels. There are a few isolated nearshore communities of native mussels that are still reproducing, with coastal wetlands acting as refugia for native mussels. Recent research on native mussels in the St. Lawrence River shows that after a period of time following an invasion, the numbers of native mussels in open waters may stabilize and natural reproduction may resume.




Source: *State of the Great Lakes 2009* report.

**Preyfish**, including bloater and sculpin, are a group of species that eat aquatic invertebrates and are an important food source for trout, salmon and other large predatory fish. Maintaining healthy preyfish populations is essential for supporting lake trout restoration as well as sport and commercial fishing interests. The impacts of the decline of preyfish populations and shift in biotic communities will continue to be an issue of concern for the near future.


Credit: Fisheries and Oceans Canada.

Lake Superior is currently the only lake where natural reproduction of **lake trout** has been re-established and maintained. In Lake Huron, self-sustaining populations occur at a few locations in Georgian Bay in Canada. In the U.S. waters of Lake Huron there are widespread but low levels of natural reproduction. Natural reproduction has been occurring in Lake Michigan and Lake Ontario at very low levels. To improve survival in Lake Erie, a deepwater strain of Lake Superior lake trout is being introduced and is also being considered for Lake Ontario. These fish may be better suited to survive in offshore habitats not colonized by traditional strains.

GOOD FAIR POOR MIXED UNDETERMINED

Most **salmon** populations are successfully reproducing and are now considered to be naturalized to the Great Lakes ecosystem.

Lake Sturgeon

Credit: U.S. Fish & Wildlife Service.

Many self sustaining populations of **lake sturgeon** still exist in the Great Lakes but at a very small fraction of their estimated historical abundance. Successful river spawning sites remain on each of the Great Lakes, with a total of twenty-seven confirmed locations. Larger than average populations still reside in the North Channel and southern Main Basin of Lake Huron and in the St. Clair / Detroit River connecting waters, including Lake St. Clair. Agencies continue to work together to develop management strategies to strengthen existing populations and reintroduce new ones.

**Walleye** populations in all the Great Lakes connecting channels have benefited from very good hatches in 2003. This has resulted in good angler catches throughout the region and a commercial walleye harvest in Lake Erie. In the Saginaw Bay portion of Lake Huron, the walleye population is nearing the recovery criteria set by the Michigan Department of Natural Resources. However, there is inconsistency in achieving walleye population and harvest targets due to the highly variable quality of walleye hatches in many of the lakes.

Bald Eagles

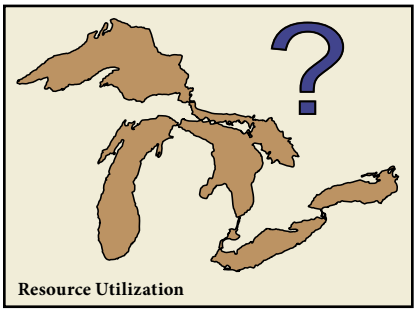
Credit: Laura Whitehouse, U.S. Fish & Wildlife Service.

Despite significant historical declines, the Great Lakes **bald eagle** population is on the rebound. In 2007, the bald eagle was removed from protection under the U.S. Endangered Species Act, although it is still protected by two other pieces of U.S. federal legislation. In Ontario, the Great Lakes bald eagle population is protected by the Endangered Species Act, although the national population does not currently receive federal protection. The governments of Canada and the United States are working together on a binational initiative to identify, prioritize, and improve bald eagle habitat sites.

### *Management Challenges:*

- Enhance native preyfish populations.
- Establish appropriate fish stocking levels in relation to the health of the preyfish population base.
- Improve biomonitoring programs and maintain trend data, including those for bald eagles.
- Protect existing high-quality nearshore areas.
- Plan and implement restoration projects that maximize benefits to all biotic communities, for example by incorporating native mussel refugia into coastal wetland restoration plans.
- Monitor fish communities to understand the relationship between *Diporeia* and zebra and quagga mussels.

## RESOURCE UTILIZATION

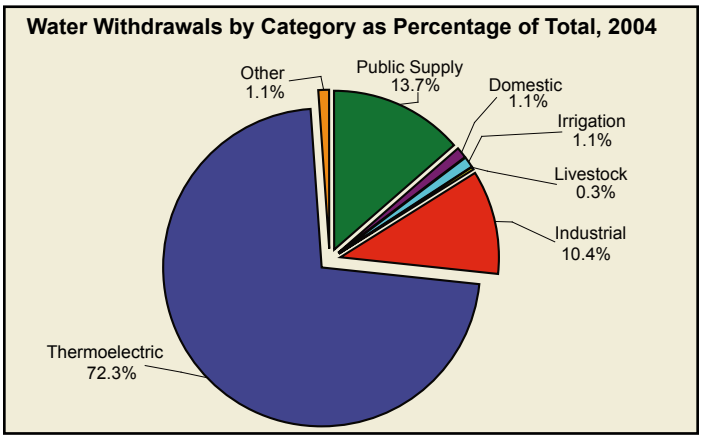



Resource Utilization

*Although water withdrawals have decreased, overall energy consumption is increasing as population and urban sprawl increase throughout the Great Lakes basin. Human population growth will lead to an increase in the use of natural resources.*

Less than 1 percent of the Great Lakes waters are renewed annually through precipitation, run-off and infiltration. The net basin **water supply** is estimated to be 500 billion litres (132 billion gallons) per day, which is equal to the discharge into the St. Lawrence River.

In 2004, **water withdrawn** from the Great Lakes basin was at a rate of 164 billion litres (43 billion gallons) per day, with 95 percent being returned and 5 percent lost to consumptive use. Of the total withdrawals, 83 percent was for thermoelectric and industrial users and 14 percent was for public water supply systems. Due to the shutdown of nuclear power facilities and improved water efficiency at thermal power plants, water use in Canada and the United States has decreased since 1980. In the future, increased pressures on water resources are expected to come from population growth and from climate change.




Source: *State of the Great Lakes 2009* report.

The human population of the Great Lakes basin is approximately 42 million. Parameters such as population size, geography, climate, and trends in housing size and density all affect the amount of **energy** consumed in the basin. Electricity generation was the largest energy-consuming sector in the Great Lakes basin due to the energy required to convert fossil fuels to electricity.

**Total Secondary Energy Consumption in Megawatt-hours (MWh)**

| Sector | U.S. Basin Total Energy Consumption (2000) | Canadian Basin Total Energy Consumption (2002) |
|---|---|---|
| Residential | 478,200,000 | 127,410,000 |
| Commercial | 314,300,000 | 107,800,000 |
| Industrial | 903,900,000 | 206,410,000 |
| Transportation | 714,000,000 | 184,950,000 |
| Electrical Generation | 953,600,000 | 303,830,000 |

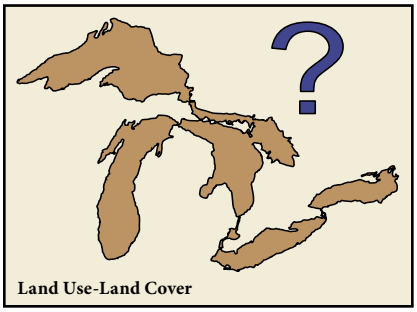
Source: *State of the Great Lakes 2009* report.

Population growth and urban sprawl in the basin have led to an increase in the number of vehicles on roads, fuel consumption, and kilometres/miles travelled per vehicle. In the Great Lakes states, **fuel consumption** for vehicles increased by 15 percent on average from 1994 to 2006, as compared to a 28 percent increase nationally in the United States. In Ontario, sale of motor gasoline increased by approximately 23 percent between 1994 and 2006, on par with the Canadian national average. Kilometres/miles travelled within the same areas increased 19 percent for the United States and 66 percent for Canada.

### *Management Challenges:*

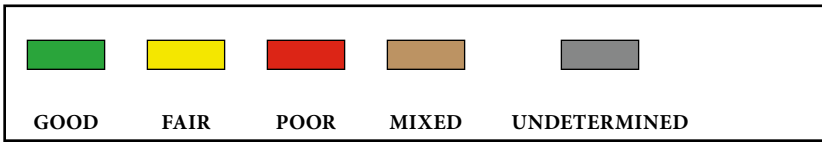
- Research the ecological impact of water withdrawals.
- Manage energy production and conservation to meet current and future demands.
- Meet the challenges of population growth and urban sprawl by improving current and future transportation systems and infrastructures.

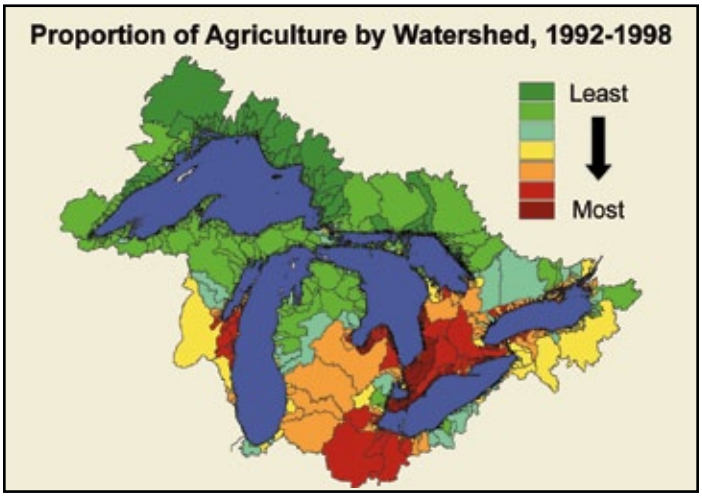
## LAND USE—LAND COVER




*Changes on the landscape, due in part to pressures associated with urban population growth, affect the Great Lakes, especially in the nearshore zone where the land meets the water. Changes in land use and land cover affect how water moves across the landscape, and they alter tributary and nearshore flow regimes. Altered flow regimes affect seasonal timing of water inputs and may result in increased erosion, sediment transport, and reduced water quality in tributaries and nearshore areas of the Great Lakes. These changes may modify nearshore aquatic habitat structure and alter ecological functions.*

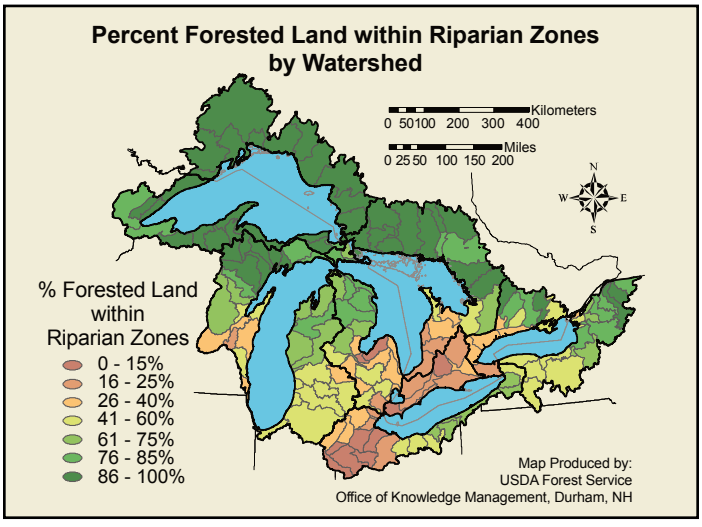
For the period 1992 to 2001, approximately 800,000 hectares (2 million acres) or 2.5 percent of the Great Lakes basin experienced a **change in land use**. These changes were dominated by conversion of forested and agricultural lands to either high or low intensity development, transportation (roads), or upland grasses and brush (early successional vegetation). More than half of these changes are considered to be irreversible and permanent. Conversion rates exceeded predictions based on population growth alone.



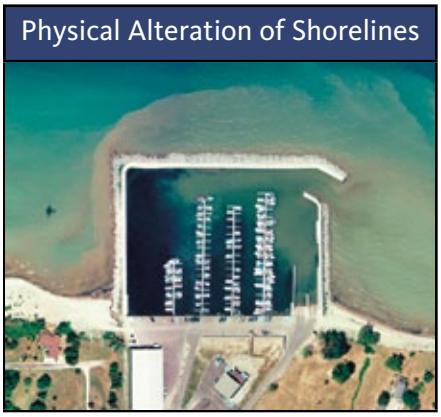



Source: *State of the Great Lakes 2009* report.

While good water quality is generally associated with heavily forested or undisturbed areas, forested buffers near surface water features can also protect soil and water resources, despite land use classes present in the rest of the watershed. Higher percentages of **forest coverage** in these areas reduce local runoff and related problems, while improving the ecosystem's capacity to store water. In the Great Lakes basin, forests cover 69 percent of the land in riparian zones within 30 metres (100 feet) of surface waters.



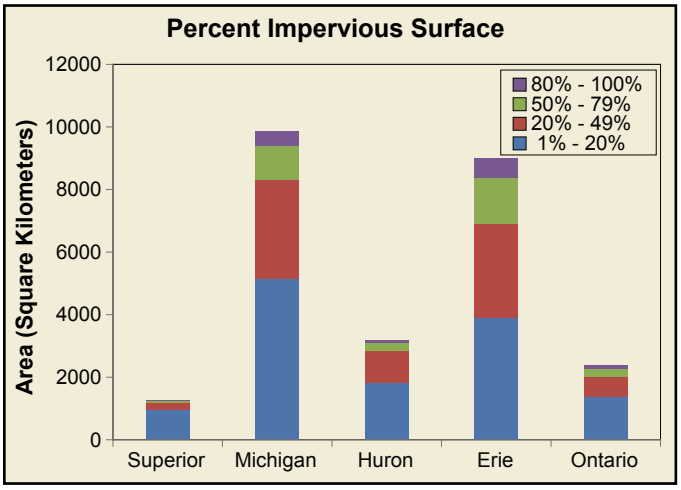

Source: *State of the Great Lakes 2009* report.




Credit: US Army Corps of Engineers, Buffalo District.

As coastal areas are developed, shorelines are armoured to protect property and infrastructure. Large navigation structures, marinas, and launch ramps are constructed to promote commerce and recreational uses. **Physical alterations** to the land/water interface disrupt natural coastal processes which, over time, can have significant regional impacts on nearshore and coastal margin substrates, habitat, hydraulic connectivity, and nearshore water quality. In Ohio, more than 75 percent of the coastline was armored by 2000, and recent recession-line mapping showed a significant increase in the number of shore protection structures installed between 1990 and 2004.

Lake Michigan and U.S. Lake Erie watersheds have the highest proportion of **impervious surfaces**. The Lake Superior watershed contains the lowest proportion of impervious surfaces within the United States portion of the Great Lakes basin.




Source: *State of the Great Lakes 2009* report.

**Urban population growth** in the Great Lakes basin shows consistent patterns in both the United States and Canada. From 1996 to 2006, the population of Canadian metropolitan areas of the Great Lakes basin grew from over 7 million to over 8 million, an increase of 16.3 percent. From 1990 to 2000, the population of United States metropolitan areas of the Great Lakes basin grew from over 26 million to over 28 million, an increase of 7.6 percent. Sprawl is increasing in rural and urban

IMPROVING UNCHANGING DETERIORATING UNDETERMINED

### Urban Population Growth

Credit: Bob Nichols, U.S. Department of Agriculture Natural Resources Conservation Service.

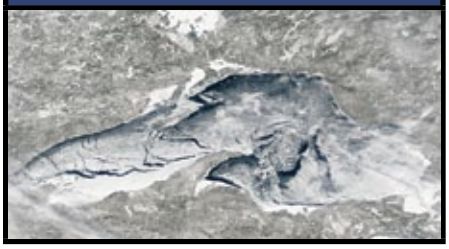
fringe areas of the Great Lakes basin, placing a strain on infrastructure and consuming habitat in areas that previously tended to have healthier environments than those in urban areas. This trend is expected to continue.

### *Management Challenges:*

- Develop a uniform land use/land cover classification system across the basin.
- Update land use/land cover datasets to improve current information availability for management decisions.
- Manage forest lands in ways that protect the continuity of forest cover to allow for habitat protection and wildlife species mobility, therefore maintaining natural biodiversity.
- Develop and promote Green Cities concepts which will accommodate increasing human population while reducing impacts on the Great Lakes basin.

## CLIMATE CHANGE

### Lake Superior Ice Cover March 2009



Credit: NASA image courtesy MODIS Rapid Response Team, Goddard Space Flight Center.

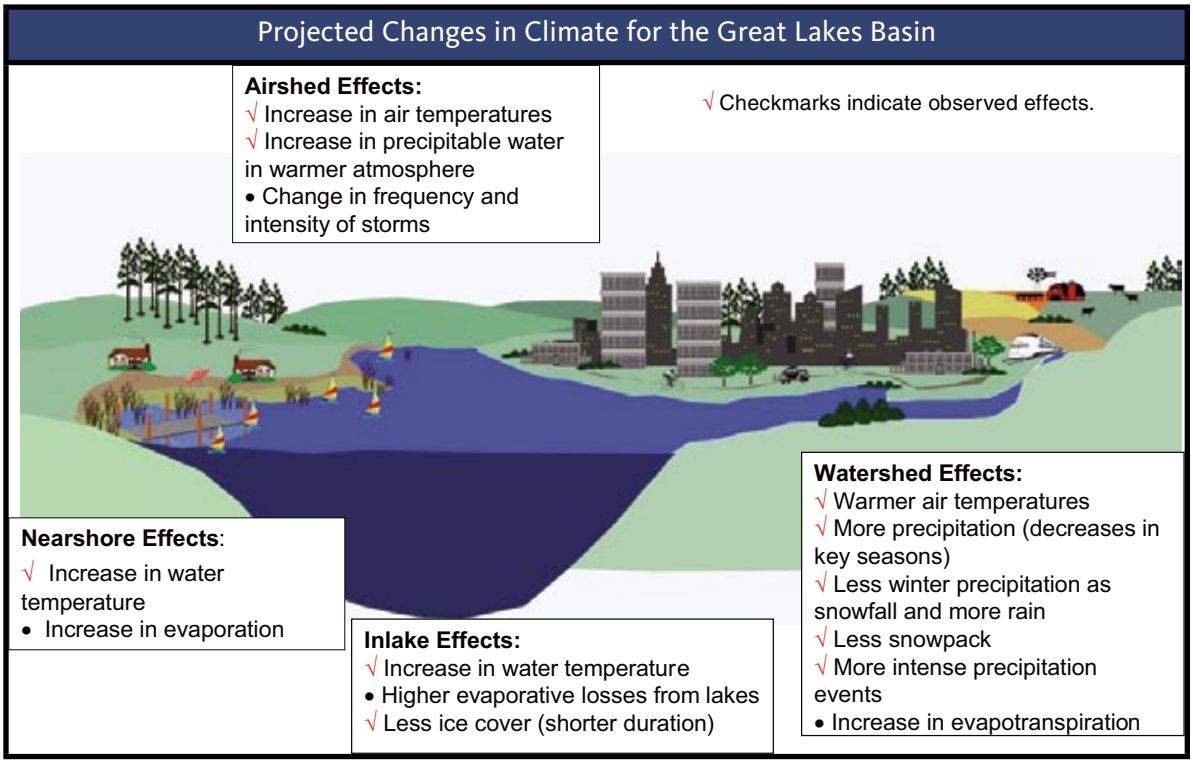
*Climate in the Great Lakes region is changing. Shorter winters, warmer annual average temperatures, and heavy rain and snow and extreme heat events are occurring more frequently. Air and water temperatures are increasing, lake ice cover is decreasing.*

The use of long-term historical Intensity-Duration-Frequency curves to design storm retention ponds and other stormwater facilities is no longer adequate because climate change is dramatically altering precipitation and temperature patterns. These changes are expected to alter lake snow pack density, evaporation rates, and water quality. As a result, jurisdictions in Canada and the United States are studying how to adapt to the anticipated impacts of climate change.

### *Management Challenge:*

- Extend global climate change models to Great Lakes regional and local scales, and where possible link to weather models to assist in planning and designing effective stormwater management facilities.

### Projected Changes in Climate for the Great Lakes Basin




Credit: Linda Mortsch, Environment Canada.

## Lake-by-Lake Overview

### LAKE SUPERIOR

The ecosystem is in generally good condition. Bald eagle, gray wolf and peregrine falcon populations are recovering, fisheries are in good to excellent condition, and the lower food web is robust and stable. Forest cover is increasing, contaminant levels are declining or remaining constant, and there have been important habitat and land acquisitions such as the Lake Superior National Marine Conservation Area in Canada. Stresses include non-native species, toxic chemicals and fish consumption advisories, shoreline development and hardening, habitat loss, land use change, mining and climate change effects.

### LAKE MICHIGAN

The lake continues to be a source of good drinking water for 12 million residents with a decrease in beach advisory days while monitoring efforts are up; the ecosystem exhibits a notable return of bird, mammal and aquatic species due to habitat restoration and dam removal and a continued decline of contaminants in fish though advisories are still necessary. The ecosystem is currently exhibiting dramatic symptoms of major food web disruption as *Diporeia* disappear, viral hemorrhagic septicemia is found in fish, and the invasive quagga mussel is dominant. The interaction of invasives with nutrients leads to detrimental algae growth. Water levels remain below average.

### LAKE HURON

Although degradation is not as severe as in the lower Great Lakes, major changes to the Lake Huron food web, new diseases, and nearshore algal fouling are of serious concern. Beaches are a prominent feature in the southern portion of the watershed. Ongoing stewardship efforts are working toward restoring recreational water quality. The northern watershed contains diverse habitat and many ecologically rich areas. New partnerships are being formed to protect and expand these examples of Great Lakes biodiversity through the development and implementation of a binational biodiversity strategy.

### LAKE ERIE

Nutrient management remains the top priority for improving the lake. Yellow perch stocks are recovering; however, the top predator species populations of walleye, lake trout, and lake whitefish are struggling. Contaminant levels, specifically PCBs and mercury continue to affect fish consumption. Aquatic invasive species, such as zebra mussels, quagga mussels, round gobies and predatory zooplankton, are changing the food web, potentially affecting nearshore algae and the frequency of botulism outbreaks.

### LAKE ONTARIO

The reduction in contaminants continues to improve. Concentrations of many organic compounds in open waters are present in only trace amounts, with some below water quality objectives. Bird populations are plentiful, bald eagles went from having no active nesting territories in the 1970s to 23 established nesting territories in the basin with three along the shoreline. Aquatic invasive species such as zebra mussels, quagga mussels and predatory zooplankton have become established and may be impacting food web dynamics. Complicating the food web further is the reoccurrence of nearshore algal blooms, resulting in problems such as beach closures, drinking water quality concerns, and added costs to industry. This was the focus of an intensive binational monitoring effort in 2008.

Credit: From left to right: Lake Superior credit Nancy Stadler-Salt, Environment Canada; Lake Michigan credit U.S. National Park Service; Lake Huron credit Parks Canada; Lake Erie Point Pelee ©Parks Canada/C. Lamiruy; Lake Ontario courtesy Hans Biberhofer, Environment Canada.

## Nearshore Areas of the Great Lakes


Source: Adapted from *Nearshore Areas of the Great Lakes,* 1997.

In 1996, the State of the Lakes Ecosystem Conference (SOLEC) focused on the nearshore lands and waters of the Great Lakes where biological productivity is greatest and where humans have maximum impact. In 2008, the conference concentrated on what had changed with respect to the nearshore environments since 1996. Additional conditions and issues not evaluated in 1996 were also addressed. For the purposes of SOLEC 2008, the aquatic component of the nearshore was defined as beginning at the shoreline or the lakeward edge and extending offshore to the deepest lakebed depth contour where the thermocline typically intersects with the lake bed in late summer or early fall. Nearshore areas of the Great Lakes are important because this is where land-based activities can impact water quality and where humans generally interact with the Great Lakes.

### Changes from 1996–2008

SOLEC 1996 identified the introduction of **invasive species** as among the most destructive human activity affecting **nearshore waters**. In 1996, there were approximately 166 documented invasions of non-indigenous aquatic species in the Great Lakes since the early 1800s. Between 1996 and 2008, 19 additional invasions were reported. Agencies and organizations across the Great Lakes are exploring techniques and policies to protect aquatic habitats from the impacts of invasive species.

In 1996, SOLEC concluded that the most pressing need for the **nearshore terrestrial** ecosystem was a conservation strategy that would protect ecologically significant nearshore ecosystems within 19 geographic "**biodiversity investment areas**." Efforts such as The Nature Conservancy and Nature Conservancy of Canada's Binational Conservation Blueprint for the Great Lakes, and the Biodiversity Conservation Strategies for Lake Ontario and Lake Huron supported by the Lakewide Management Plans and binational lake action plans process, have furthered the biodiversity investment area idea.


Credit: Bob Nichols, U.S. Department of Agriculture Natural Resources Conservation Service.

**Land use change** in the form of development of farm and natural lands in both urban and rural areas presented the single largest threat to the Great Lakes basin ecosystem in 1996. In 2008, the continued rapid expansion and **growth of urban and suburban areas** and associated infrastructure was the single most significant land use/land cover change (about 60 percent) within the U.S. portion of the Great Lakes basin over the last decade. Much of the newly developed land was converted from agricultural or early successional vegetation lands.


Credit: U.S. Environmental Protection Agency Great Lakes National Program Office.

In 1996, Great Lakes **coastal wetlands** totalled more than 216,000 hectares (534,000 acres) and it was acknowledged that they are a considerable ecological, biological, economic and aesthetic resource. There currently is not enough detailed or comprehensive data about coastal wetlands across the entire Great Lakes basin to report confidently on conditions and trends in viability, health, or success of protection and restoration efforts. A long-term coastal wetland monitoring plan has since been developed and is in the initial stages of implementation.

Although nutrient loadings to the Great Lakes have been reduced in the past 30 years, many physical, chemical and biological changes to the nearshore environment

remain. Emerging issues such as **botulism**, **harmful algae blooms**, **viral hemorrhagic septicemia (VHS)**, and **shoreline development**, among other stressors will require additional research and management strategies to alleviate.

### *Cladophora*

Credit: Brenda Moraska Lafrancois, U.S. National Park Service.

***Cladophora*** is a native, filamentous, green alga that is found attached to solid substrate in all of the Great Lakes. Where phosphorus resources and light penetration are sufficient, the alga can grow to nuisance proportions, fouling beaches and clogging water intakes. It is the nuisance growths of *Cladophora* observed in nearshore regions of Lake Erie, Lake Michigan and Lake Ontario that have drawn the attention of those involved in public recreation, operation of utilities and water quality management.

### Type E Botulism

Credit: Mark Breederland, Michigan Sea Grant.

The frequency and severity of **type E botulism** outbreaks have cycled over the last several decades, with recent increases and expansion of affected areas and species. Over the past few years, botulism outbreaks have been particularly severe in Lake Michigan. In 2007, botulism outbreaks caused an estimated 17,000 avian mortalities for the entire Great Lakes region. The prolific growth of *Cladophora* algae, believed to occur because of increased water clarity and subsequent increase in sunlight penetration resulting from the invasive mussels' water filtration capabilities, may be linked with botulism outbreaks.

### Harmful Algal Blooms

Credit: Joe Barber, Ohio Department of Natural Resources Division of Wildlife.

Recently there has been an apparent resurgence in **harmful algal blooms (HABs)** in the lakes and concern about their potential production of toxins or harmful metabolites. HABs in the Great Lakes involve a variety of species and are particularly problematic in coastal areas. Lake Erie has the most extensive nearshore region due to the shallow nature of the lake, so toxic HABs are a particular concern there and the focus of several recent studies.

### Viral Hemorrhagic Septicemia

Credit: National Park Service, Photo courtesy of Mohamed Faisal, Michigan State University.

**Viral hemorrhagic septicemia (VHS)** can be a deadly fish virus and an invasive species that is a causative factor for significant fish kills in the Great Lakes. VHS is a new introduction into the Great Lakes, probably introduced in 2001 or 2002. It has been confirmed to be present in all of the Great Lakes except Lake Superior, and in inland lakes and streams in Michigan, New York, Ohio and Wisconsin. It is unknown how VHS was introduced into the Great Lakes; suspected vectors for the introduction and spread include ballast water, movement of live fish (including baitfish), and the natural migration of fish.

## State of the Lakes Ecosystem Conference

The State of the Lakes Ecosystem Conferences (SOLEC) are hosted regularly by the United States Environmental Protection Agency and Environment Canada in response to the reporting requirements of the Great Lakes Water Quality Agreement.

The conferences and reports provide independent, science-based reporting on the state of the health of the Great Lakes basin ecosystem. Four objectives for the SOLEC process include:

- To assess the state of the Great Lakes ecosystem based on accepted indicators
- To strengthen decision-making and environmental management concerning the Great Lakes
- To inform local decision makers of Great Lakes environmental issues
- To provide a forum for communication and networking amongst all the Great Lakes stakeholders

The role of SOLEC is to provide clear, compiled information to the Great Lakes community to enable environmental managers to make better decisions. Although SOLEC is primarily a reporting venue rather than a management program, many SOLEC participants are involved in decision-making processes throughout the Great Lakes basin.

For more information about Great Lakes indicators and the State of the Lakes Ecosystem Conference, visit:

**www.binational.net**
**www.epa.gov/glnpo/solec**
**www.on.ec.gc.ca/greatlakes**

# State of the Great Lakes 2009 Highlights

*by the Governments of*

**Canada**

*and*

**The United States of America**

*Prepared by*

**Environment Canada**

*and the*

**United States Environmental Protection Agency**

Credit: Brenda R. Jones