



Good morning.

I am reporting on **four categories** of Great Lakes indicators (Resource Use, Climate Change, Land Use/Land Cover and Human Health) and most of the indicators track trends in human resource use and waste generation. Overall, the pressures on Great Lakes resources are growing, primarily due to population growth in the basin, but also to some increasing rates in per capita resource use.



Just two weeks ago, the U.S. population topped the 300 million milestone and is expected to reach **400 million in about 37 years**. In the **Ontario Golden Horseshoe Area** alone, forecasts predict **that portion of the Canadian population will grow by an additional 3.7 million people by 2031**.

Two PopClock websites provide **real-time estimates** of both country's populations. The U.S. and Canadian populations posted on this slide represent estimates **as of 10 o'clock** this morning.

Given that roughly **10% of Americans and 30% of Canadians** live in GL Basin, the up to the hour GL Basin population is an estimated **39,812,870**.

Keep your eye on the counter.

U.S. PopClock <http://www.census.gov/main/www/popclock.html>

Canadian PopClock <http://www.statcan.ca/english/edu/clock/population.htm>



According to the U.S. Census Bureau, one person is added to the U.S. population **every 11 seconds**. In Canada one person is added to the population **every minute and 36 seconds**.

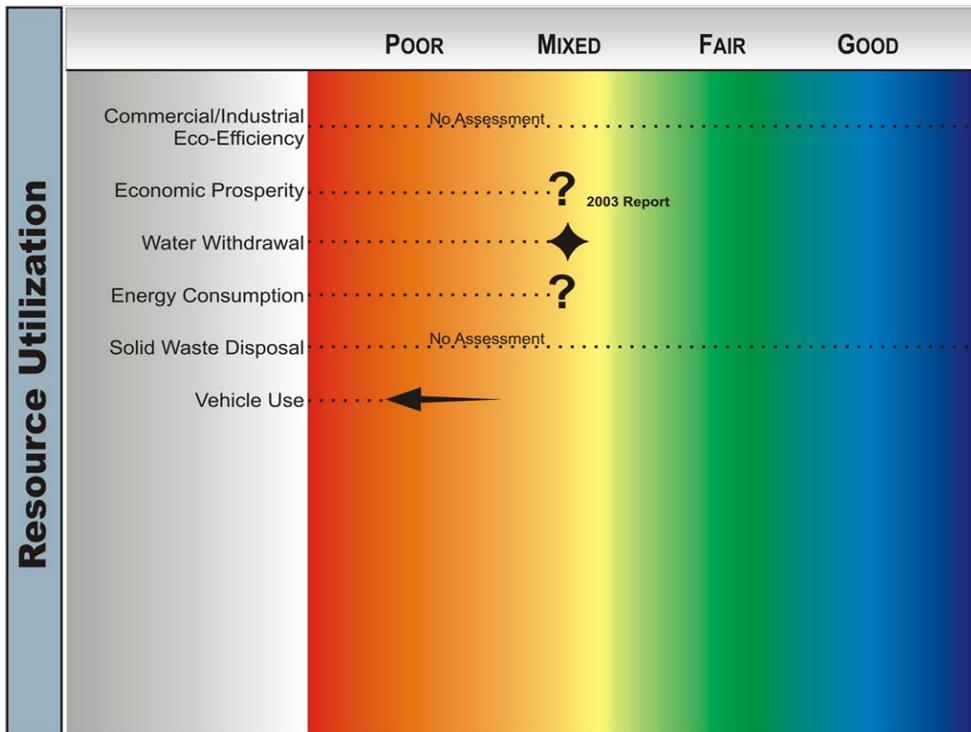
About **60%** of the U.S. gain is from birth rates outpacing death rates and a whopping **40%** is from net immigration.

Not only are there more of us, but **increasingly, more of us are living alone**. **One-person households** account for **more than a quarter** of the U.S. population (Population Reference Bureau). That means, on average, we are using more resources -- more housing, more water, more energy and more land.



By nature, most resources are finite. But **pressures on them are continually increasing** -- in the Great Lakes basin and the rest of the world.

If we monitor our use – of water, energy, land – and waste production, we gain a better understanding of our impact on the region and its carrying capacity.



The status of Great Lakes resource utilization is mixed, and the overall trend is often undetermined due to incomplete data, inconsistent reporting or a lack of assessment.

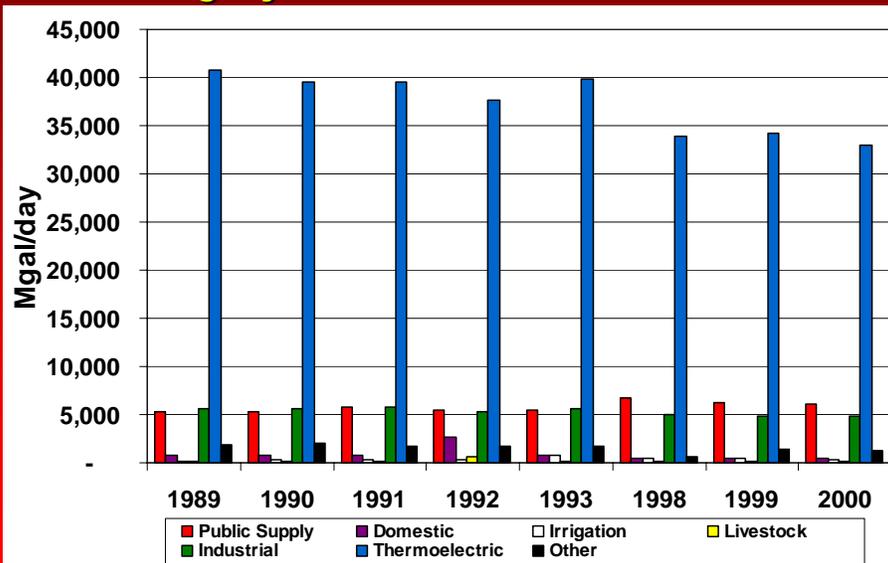
## Great Lakes basin water withdrawal

- **Net Basin Supply estimated at 132.3 BGD**
- **In 2000, 46 BGD withdrawn from basin, or 35% of the available daily supply**
- **3% from groundwater**
- **Majority of water returned, 7% lost or depleted**

The **net basin supply of water** is estimated at slightly **more than 132 billion gallons per day**. In 2000, water was withdrawn from the Great Lakes at a **rate of 46 billion gallons per day**. Three percent of the total comes from groundwater. That means we are **using about 35% of the available daily supply**.

The **majority** of water withdrawn is **returned to the basin** through discharge or run-off; however, approximately **7% is lost** through evapo-transpiration **or depleted** by human activities.

## Great Lakes basin water withdrawal by category 1989-1993 and 1998-2000



This chart shows water withdrawals by user category for two periods of years.

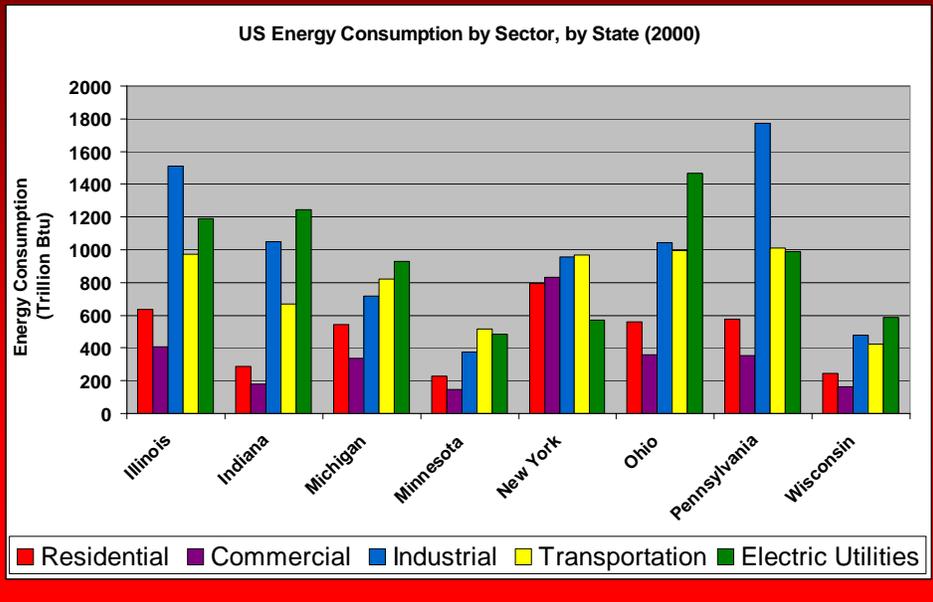
- A little more than 80% of the total was withdrawn by thermolectric and industrial users, with power plants using the greatest volumes;
- 13% was withdrawn for public water supplies;
- 2% by agricultural sectors; and
- 3% was withdrawn for environmental, recreational, navigational, and quality control purposes.

**Canadian withdrawals have decreased by roughly 30% since the 1990s while U.S. withdrawals have decreased by more than 20% since 1980. However, the declines are largely due to reduced withdrawals by thermolectric generators which mask generally increasing use for public water supply.**

In the immediate future, the greatest pressure for increased withdrawals will come from communities bordering the basin, where existing water supplies are scarce or of poor quality. These localities might look to the Great Lakes as a source of water.

To reduce water demand, higher water prices have been widely advocated. Public education on water conservation and promotion of water-saving technologies will also help.

# Energy consumption



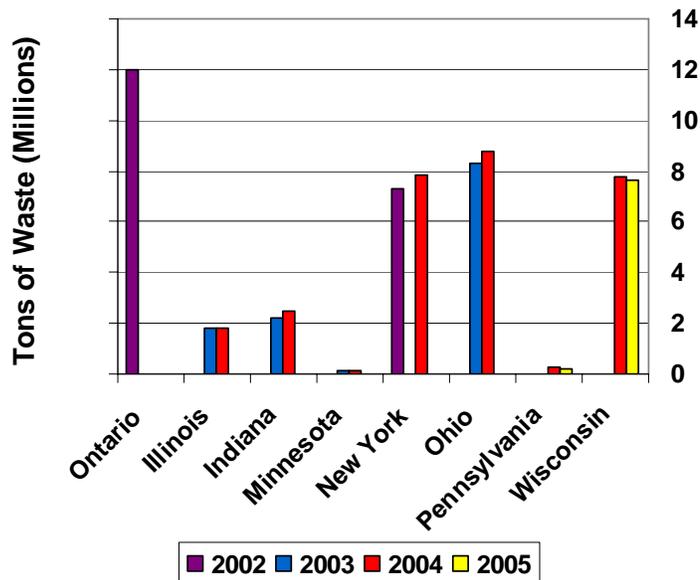
Canada and the U.S. are among the largest energy **producers and consumers** in the world.

Between 1999 and 2000, the **per capita energy consumption decreased in the U.S. by nearly 1% but increased in Ontario by 2%**. With growing populations, energy consumption will likely continue to rise.

The graph shows energy consumption by sector for Great Lakes states in 2000. **Industries and electric utilities** are generally the largest consumers with **transportation a close third**. Other data for **Ontario** (not shown on the chart), indicate the largest change in energy consumption between 2000 and 2002 was a **4.4% increase in the commercial sector**.

**Fossil fuels are the leading source** of energy consumption on both the U.S. and Canadian sides of the basin. However, many Great Lakes **industries are now using bio-fuels**, resulting in a decrease in fossil fuel consumption. And there is a **growing investment in renewable energy** sources.

## Solid waste disposal



Over time, the **change in waste disposal tonnages** can be used as an **indicator for solid waste generation**. But **more consistent and comparable data are needed**. Data are incompatible from one jurisdiction to the next.

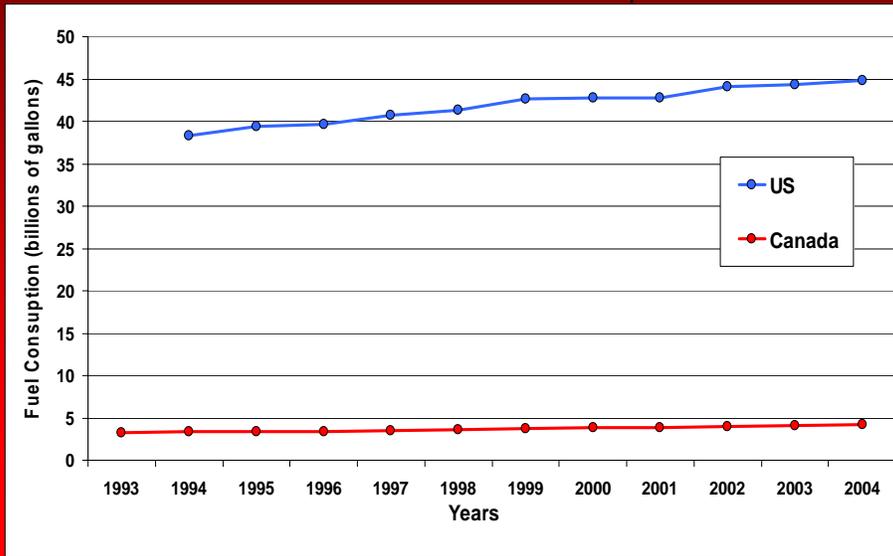
The chart shows that **recording periods between states and provinces vary**. Further complicating the assessment, waste may be generated in one jurisdiction and disposed of in another.

There is **good news in the three “Rs”**. Programs that **reduce, reuse or recycle** waste are underway. **Ontario’s Waste Diversion Act was passed in 2002**, providing a mandate to reduce, reuse or recycle waste. The goal is to **divert 60% of the waste by 2008**.

In addition to prolonging the life of landfills, waste prevention and recycling also reduce greenhouse gases by decreasing methane emissions, saving energy, and increasing forest carbon sequestration, since fewer trees are harvested.

# Vehicle use

## Great Lakes basin fuel consumption

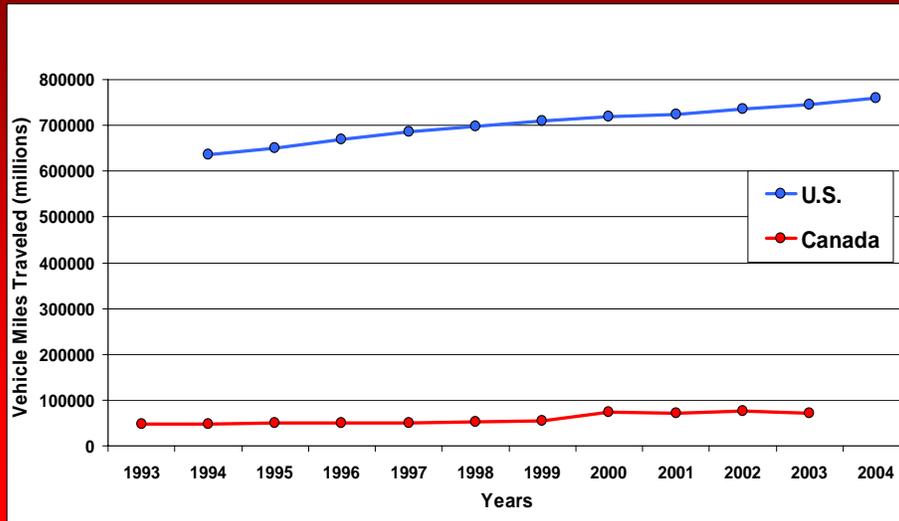


Population growth and urban sprawl in the Great Lakes basin has led to an increase in the number of vehicles on the roads, fuel consumption, and miles traveled.

This **graph shows fuel consumption** in thousands of gallons **by states and provinces** in the basin. While the total fuel consumed by the states is substantially larger, the **rate of increase is slightly greater for the provinces**. **Over ten year periods (1994-2004 for U.S. data and 1993-2003 for Canadian data) fuel consumption increased by 17% in the U.S.** portions of the Great Lakes basin and by **20% in the Canadian portion**.

# Vehicle use

Vehicle miles traveled in U.S. and Canada



In addition to rising fuel consumption, **we're traveling more miles, and probably liking it less** as the roads become more congested. This figure shows a trend similar to the previous graph. During 10 year time frames, the total number **vehicle miles traveled** in the U.S. portion of the basin was substantially greater than total miles for the Canadian portion. However, the rate of increase in miles traveled was greater in the Canadian portion. Miles traveled within the basin **increased 20% for the U.S. and 54% for Canada.**

Another upward trend is that the increase in registered vehicles continues to outpace the increase in licensed drivers. **For example**, in the Great Lakes states, the number of licensed drivers increased by 8% between 1994 and 2004, while the number of registered vehicles increased by about 11%.

## Resource utilization conclusions

- While water withdrawals declined slightly, demands for water from bordering basin communities may increase pressures
- Per capita energy consumption is down slightly for the U.S. and up for Canada
- Increases in the number of licensed drivers, licensed vehicles, fuel consumption and vehicle distance traveled

Great Lakes Basin Pop.

**39,832,032**

Conclusions about the resource use indicators are:

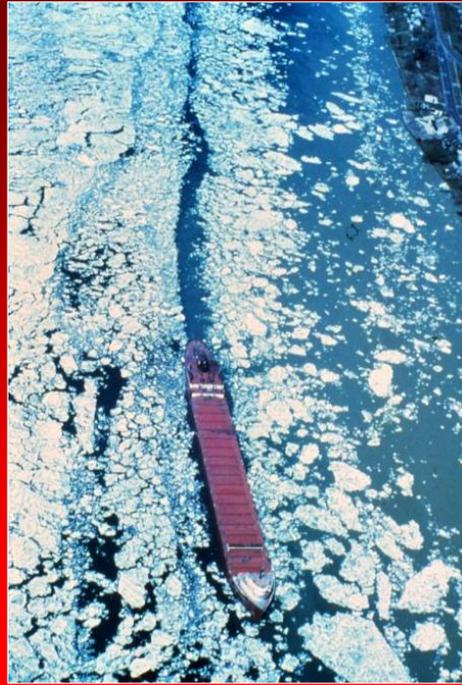
While total water withdrawals from the basin declined slightly, demands from communities bordering the basin are expected to rise.

Per capita energy consumption has changed only slightly (down for U.S. and up for Canada), but total **energy consumption may rise with increasing populations.**

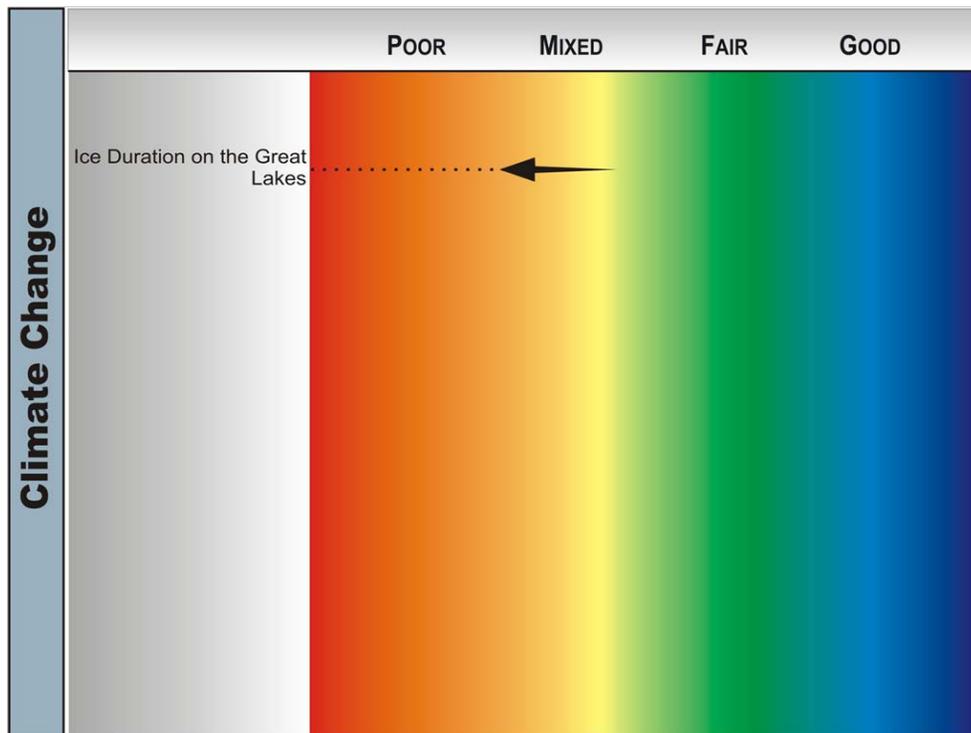
Population growth and urban sprawl have lead to an increase in the number of licensed drivers, number of vehicles on the road, gallons of fuel consumed and total miles traveled.

And the PopClock keeps ticking.

## Climate change undetermined



There is no scientific doubt that our climate is warming.



The status and trend of climate change and impacts to the Great Lakes ecosystem are incomplete.

Additional work is needed to develop robust indicators and establish long term monitoring that assesses impacts over time and helps coastal communities adapt to the changes that are coming.

# Climate change signals and expectations



Computer models, still under development, suggest that the climate of the Great Lakes region will grow warmer and **possibly** drier during the 21<sup>st</sup> century. Any increases in precipitation are not expected to compensate for the drying effects of increased evapotranspiration in a warmer climate. Therefore, surface waters, groundwater and soil moisture are all predicted to decline.

Many impacts to the region are expected. Some of the changes ahead may include:

- Continued declines in the duration of winter ice cover and possible declines in lake levels as evaporation during winter increases.
- The costs of shipping and dredging would increase with lower lake levels; and the shipping season may become extended.
- Invasions by species found south of the region and by warmwater, non-native species will likely increase the stress on native species.
- A change in the distribution of forests and an increase in forest pests are expected.
- Lower water levels combined with warmer water temperatures may accelerate the bioaccumulation of mercury and other contaminants in the food chain.
- And an increase in the frequency of winter runoff and intense storms may deliver more non-point source pollutants to the lakes.

## Climate change conclusions

- Duration of winters and ice cover are getting shorter
- Annual average temperatures are growing warmer
- Extreme heat events are occurring more frequently
- Heavy precipitation events, both rain and snow, are becoming more common
- Changes are expected to continue but future impacts are unclear

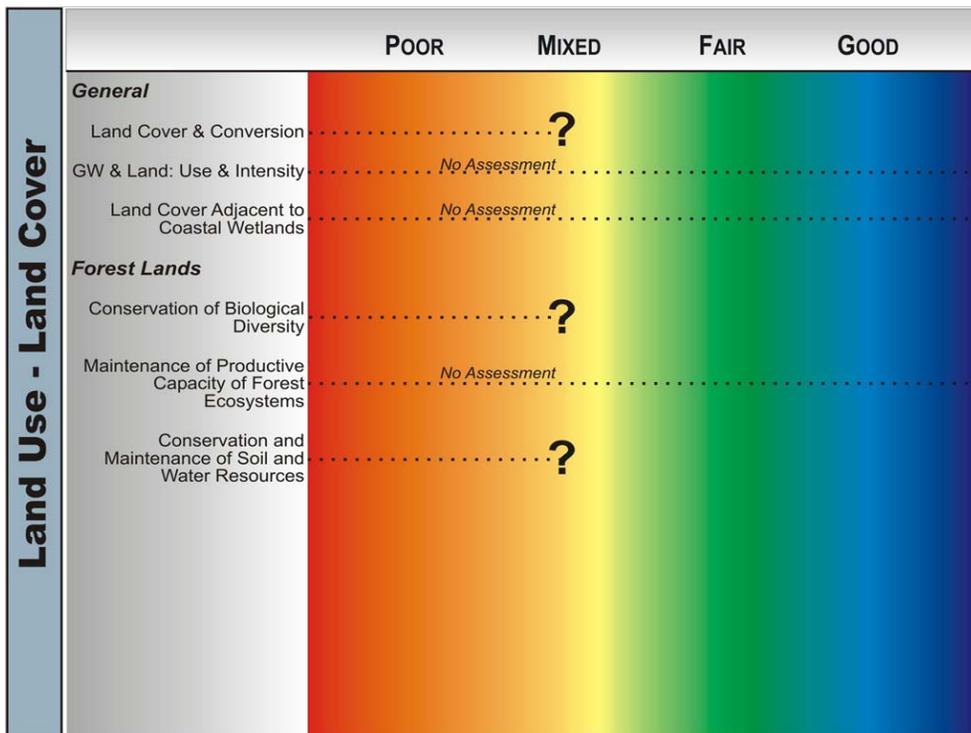
**Known conclusions** with regard to climate change are:

- Duration of Great Lakes winters and ice cover are getting shorter.
- Annual average temperatures are growing warmer.
- Extreme heat events are occurring more frequently.
- Heavy precipitation events, both rain and snow, are becoming more common.
- And changes are expected to continue, but the extent of future impacts remains unclear.

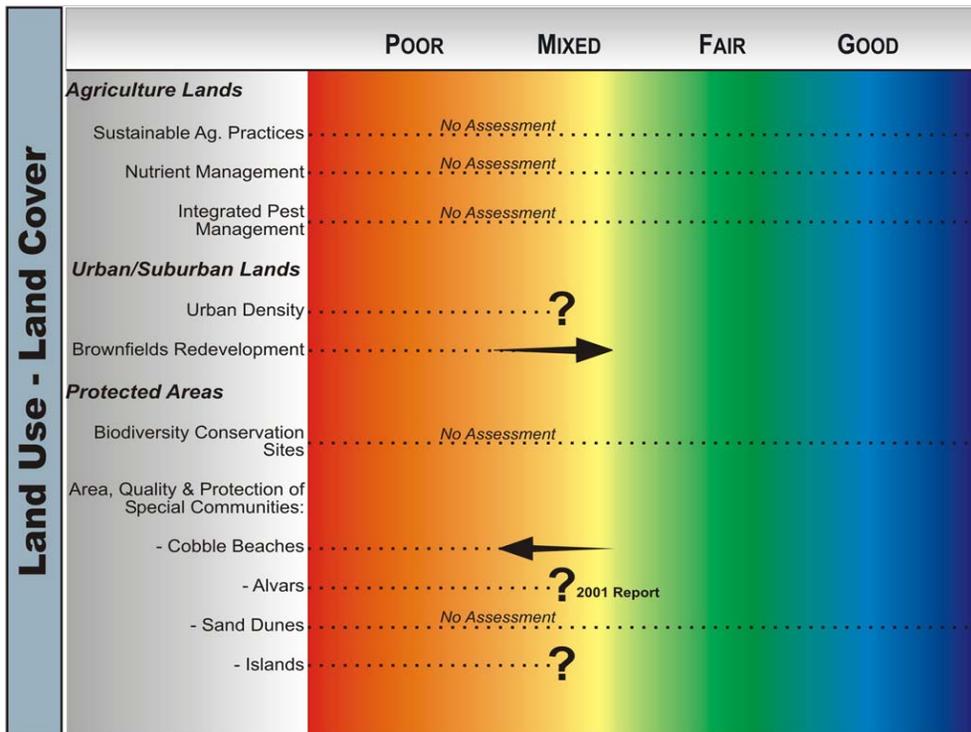


The entire Great Lakes basin **encompasses an area** of more than **765,000 square kilometers** (295,000 square miles). The **land drainage area** is **roughly two thirds of the entire basin** or 521,000 square kilometers (201,000 square miles) while **surface waters make up the remaining third**.

How land is used impacts not only water quality of the Lakes, but also biological productivity, biodiversity, and human economies.



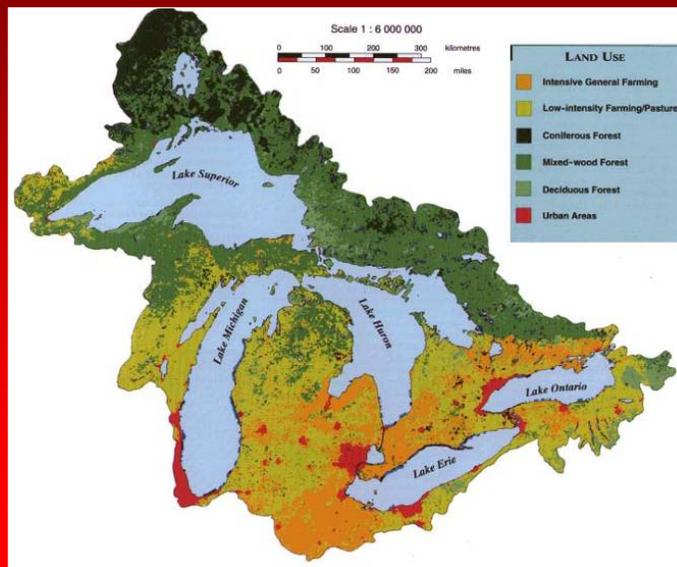
The land use/land cover category includes some 17 indicators. I will be reporting on only handful. The overall status of land use in the basin is mixed, and many indicators need more assessment,



but the trend is generally declining due to more development and the loss of productive agricultural lands and important habitats.

# Land use

1992-2001 800,000 hectares were converted



Remote sensing **imagery from 1992 and 2001** were used to assess land use changes during the **nine year period**. The **four major land use categories** are: **water** as indicated by the blue color; **forests** in green; **urban** in red; and **agriculture** in orange and yellow.

Currently, **forested land covers over 60% of the Great Lakes land area** while **agriculture** makes up approximately **35%** of basin land. Between 1992 and 2001, **nearly 800,000 ha., or 2.5%** of the basin's land area was converted to some other use. **Within nine years, low-intensity development increased 33.5%, road area increased 7.5%, and forest cover decreased 2.3%.**

**As the proportion of impervious surfaces in urbanizing watersheds increases,** the negative impacts on local water resources, as well as the Great Lakes, will also increase.

## Agriculture lost 210,000 ha to development



Between 1992 and 2001, **agriculture lost 210,000 ha to development, mostly to urban and suburban sprawl**, and slightly more than 16% of this ag land conversion occurred within 10 km of the Great Lakes shoreline.

Although reliance on pesticides in agriculture remains significant, **pesticide use continues to decline** due mostly to application of **more effective pesticides and wide-spread use of Integrated Pest Management practices**. Since the late 1980s, there has been **increasing participation** by basin farmers in various soil and water management programs. **Conservation practices are now the norm and have reduced the rates of U.S. soil erosion by 38%** in the last few decades.

## "Protected" forest land

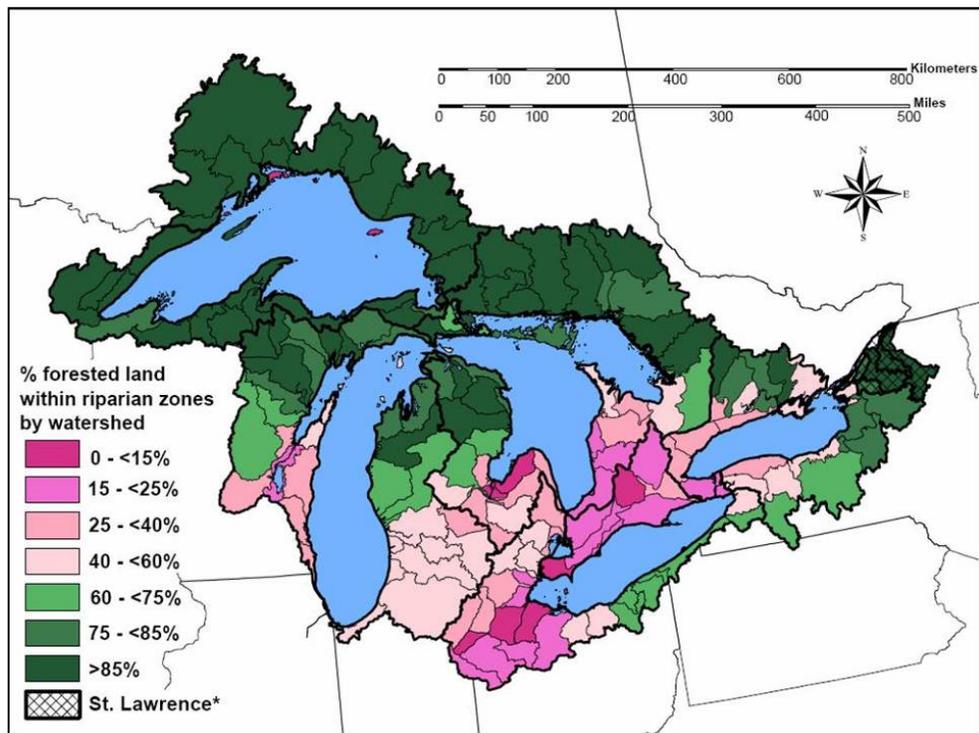
Region Analyzed	Total Area of Forest Land (ha)	% Protected
U.S. counties in Great Lakes basin	20,204,626	7.8%
Canadian watersheds in Great Lakes basin	14,908,617	10.6%

**Forests cover 61% of the total land area within the Great Lakes basin. About 9% of these lands (7.8% of forests in U.S. counties and 10.6% of forests in Canadian watersheds) are classified as protected, or held in public ownership and reserved from harvest.** However, it must be noted that **many privately owned forests are also reserved from harvest and many harvested timberlands are sustained through best management practices.**

In fact, the **acres of forested lands enrolled or certified under forest stewardship programs have increased dramatically** in recent years, as **forest industry professionals** continue to make a **greater commitment** to sustainable management.

**However, parcelization** into smaller, privately-owned tracks **is increasing, fragmenting forest ecosystems and disrupting habitats.** The **average size of land holdings is a proposed metric** for forest ecosystem integrity.

The **greatest threats** to forest lands are **seasonal home construction, urbanization and recreational use,** along with **disruptions from timber harvest and forest fires.**

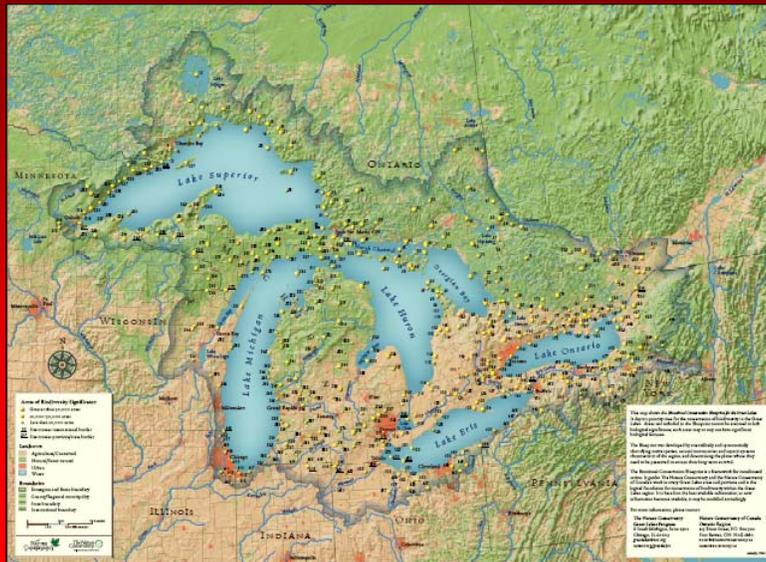


**Forest cover in riparian zones is a significant metric for watershed health. The map shows the percent of riparian forest coverage for each Great Lakes watershed.**

The **overall average of riparian forest cover** for the entire Great Lakes basin is approximately **70%**. The **U.S. watersheds have forest cover on 61% of the riparian zones** (as of 1992) while **Canadian watersheds have forest cover on 76% of the riparian zones** (as of 2002).

Riparian buffers **not only provide important habitat and migration corridors, they also help protect water quality by reducing nutrient and sediment loading and maintaining cooler stream temperatures** required by cold water fish species such as trout.

# Biodiversity conservation sites



The Nature Conservancy launched an initiative in 1997 to identify a **collection of conservation targets** which would **represent the full range of biodiversity** within the Great Lakes region.

They **also identified** more than **500 high priority conservation sites** throughout the region. **Only 5% of all U.S. conservation sites are fully protected.** They estimate that **79% of the Great Lakes sites require conservation attention within the next ten years**, while **more than one-third of these sites need immediate attention** in order to protect conservation targets.

Bottom line is the **biodiversity of the Great Lakes region is not adequately protected.**

## Brownfields redevelopment

State/ Province	Acres remediated	Sites remediated
WI	1,220	18,000
PA	13,229	1,097
OH	4,204	156
MI	Not tracked	5,539
MN	Not tracked	382
IL	7,047	462
IN	6,412	899
NY	55	16
ON	92	13
QC	741	309
<b>Total</b>	<b>33,143</b>	<b>26,873</b>

Since brownfields programs began in the basin, nearly **27,000 sites, covering over 33,000 total acres have been remediated** within the Great Lakes states and provinces. Nearly **two-thirds** of these **sites** were located in the state of **Wisconsin**, while **40% of the total remediated area occurred within Pennsylvania**.

## Land use-land cover conclusions

- **Urban sprawl and development continue to be major stressors to Great Lakes ecosystems**
- **Forested riparian zones act as buffers to reduce nutrient and sediment loads**
- **79% of Great Lakes biodiversity sites require conservation attention in the next 10 years and one-third require immediate attention**

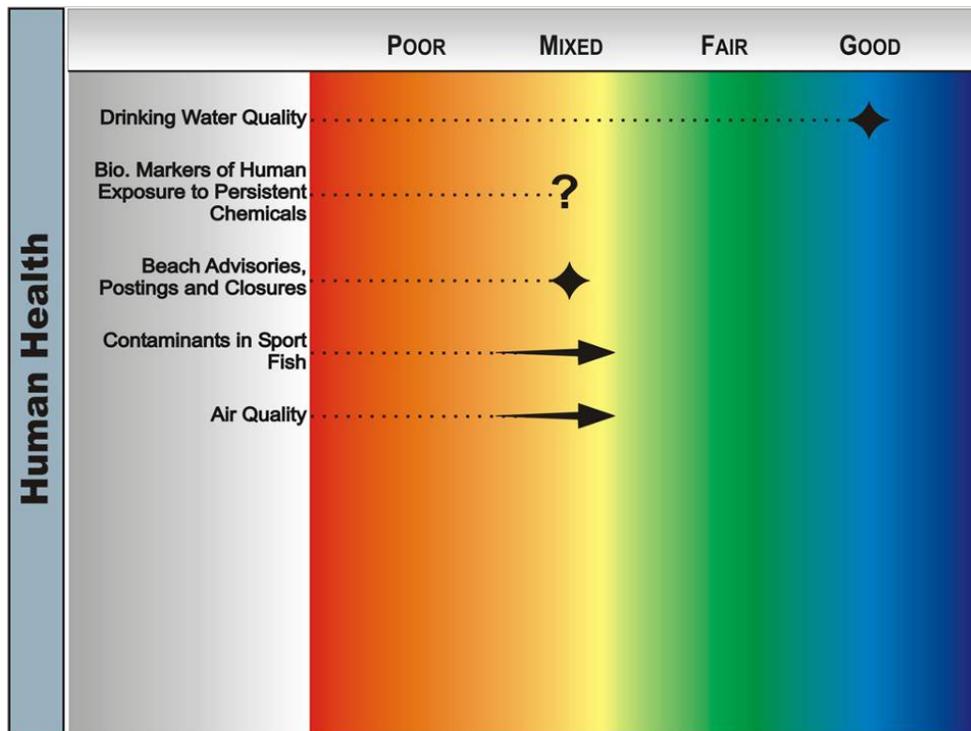
Some key conclusions:

- Urban sprawl and development continue to be major stressors to Great Lakes ecosystems.
- Forested riparian zones act as buffers to reduce nutrient and sediment loads.
- 79% of Great Lakes biodiversity sites require conservation attention in the next 10 years and one third require immediate attention.

## Human health mixed, undetermined



The status of Great Lakes human health indicators is mixed and some trends remain undetermined.



- Drinking water quality remains good;
- there are overall improvements in air quality and contaminants in sport fish;
- but, fish consumption advisories and beach closings continue.

The overall trend is undetermined because some of the indicators, particularly biomarkers of human exposure, are not well understood or have mixed results.

## Drinking water



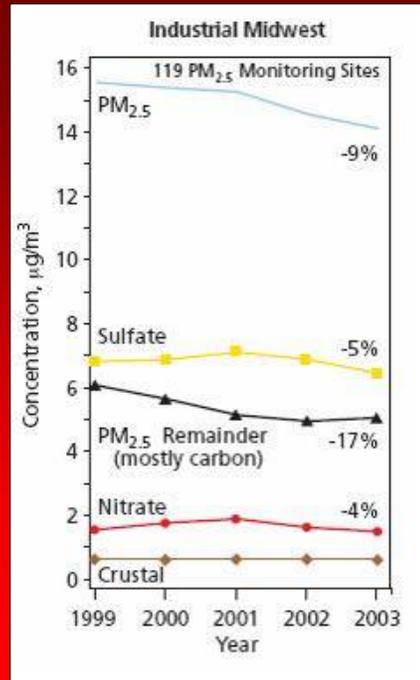
The **status of treated drinking water** throughout the Great Lakes region can be **considered good**, and the **trend is unchanging**. **Few, if any, violations of federally regulated standards** have been reported. Therefore, the **risk of human exposure to regulated chemical and microbiological** contaminants is **generally low** and the **potential for developing health complications** as a result of drinking Great Lakes basin water is **also low**.

The **status** of this indicator is **based on annual reports** (U.S. Consumer Confidence/Water Quality Reports and Ontario Drinking Water Surveillance Program) **from 133 water treatment plants** serving populations > 50,000 in the U.S. and > 10,000 in Canada. **Therefore the assessment provides a partial view** of drinking water in the basin. The **quality of smaller public systems or private wells** are not included in this assessment. There are **geologic regions** where groundwater sources are **naturally high in radium, arsenic or fluoride**. Also, the information is **based on finished, or treated water, not raw source water**.

The **greatest threat to source waters** in the basin is **degraded land runoff and contaminant infiltration to shallow aquifers**.

## Air quality

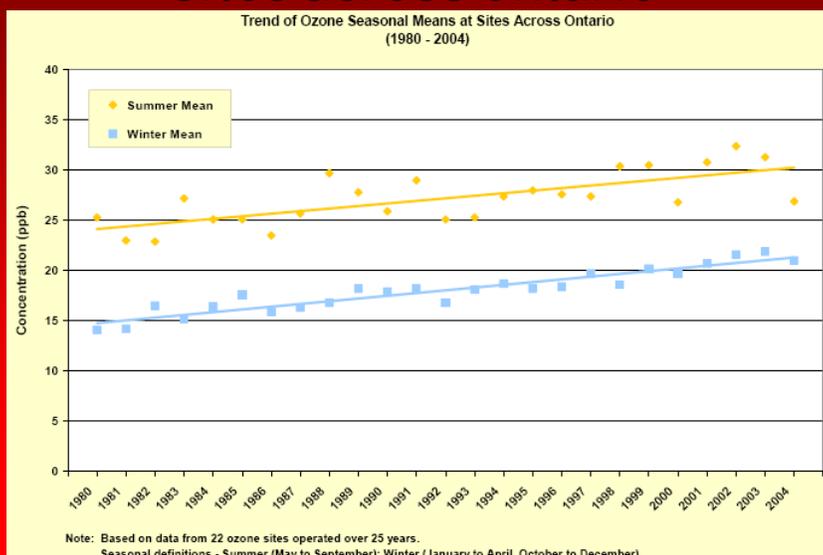
### Trends in PM<sub>2.5</sub> and its chemical constituents in the U.S. Industrial Midwest 1999-2003



**Although** the status of air quality in the Great Lakes basin is mixed and the trend is improving, there is **still much work to be done**.

Overall, there have been **improvements in reducing urban/local air pollution** over the past decade. For example, in **2004** the U.S. **annual average concentration of particulate matter** with a diameter of 2.5 microns or less, **was the lowest since nationwide monitoring began in 1999**. This graph shows a **9% decrease** in particulate matter since 1999 for **119 industrial midwest monitoring sites**. **Emission reductions** are believed to be **largely responsible** for this decline, and new standards for PM 2.5 will be going into effect in mid-December of this year.

## Trend of ozone seasonal means at sites across Ontario

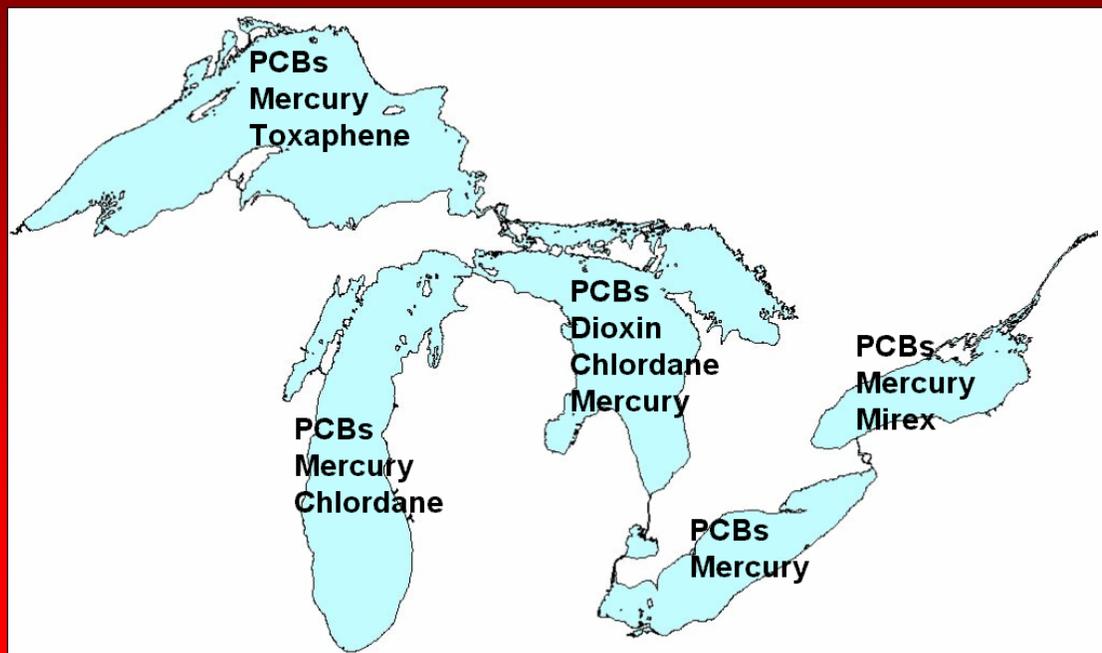


However, **some areas experience continuing air quality problems**, notably the **Detroit-Windsor-Ottawa** corridor, **portions** of the **Lake Michigan** basin, and the **Buffalo-Niagara** area. Regional pollutants such as, **ground-level ozone** and fine particulates, are **steadily increasing** in **areas across Ontario**.

**Canada's Clean Air Act** was recently introduced which will **strengthen regulation of air pollutants**.

Again, population growth and climate change may negatively impact air quality, and an increase in the number of identified toxins present in the air further complicates this assessment.

## Contaminants that drive Great Lakes fish consumption advisories in the U.S. and Canada



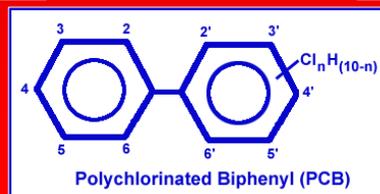
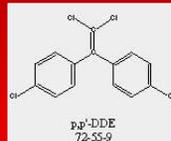
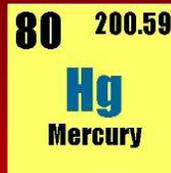
**Although** there has been a **decline** in many persistent bioaccumulative toxic (PBT) **chemicals** in the Great Lakes since the 1970's, **fish consumption advisories persist for all of the lakes**. The **contaminants that drive consumption advisories are shown for each lake**.

Data collected for **PCBs in coho salmon and lake trout** show **concentrations are generally declining** in all of the lakes. **Mercury levels in walleye are also declining**, although **no significant decline is evident in Lake Ontario**. As organochlorine contaminant levels decline, **mercury is expected to become a more important contaminant of concern**. Contaminants such as **mercury, PBDEs and dioxins need to be better understood and monitored more frequently**.

Since **each state, province and tribe are responsible** for developing their advisories, the advice is sometimes **different for the same lake and fish species within that lake**. To **eliminate this confusion and better protect fish consumers**, the United States has developed a **uniform fish advisory protocol for PCBs** for the entire basin and **protocols for chlordane and mercury are being finalized**.

**Consumption advisories are important** for protecting the public from exposure risks, **especially for sensitive populations**. **Education and outreach are also essential to help people choose** and prepare their fish wisely, **and to recognize** that while some fish may pose health risks, others provide substantial health benefits.

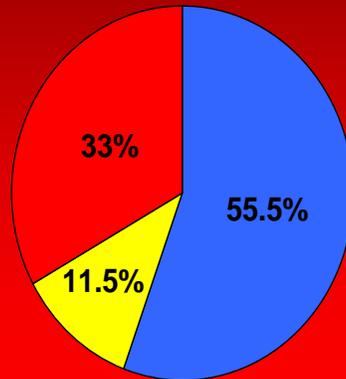
# Biological markers of human exposure



**No routine programs presently exist to monitor biological markers of human exposure to persistent bioaccumulative chemicals. Individual epidemiological studies have been conducted, and additional studies are ongoing within specific Great Lakes populations.** In these studies, **blood serum from women of child-bearing age served as biomarkers for mercury, PCBs, and DDEs, and hair samples were also shown to be a good biomarker for mercury.**

Generally, **people who ate more frequent fish meals had the highest levels of contaminants.** Because there have been **no large-scale or basin-wide studies,** the **status of this indicator is mixed and no trends can be determined.**

## Health risk at Great Lakes beaches during 2005 swimming season (June, July, August)



- Low Risk
- Moderate Risk
- High Risk

There has been an **increase in beach monitoring and in the number of beaches reporting** in both the United States and Canada. Over the last 8 years, the **percentage of beaches open** during the swimming season **remains relatively constant in the U.S.** (at roughly 70%) and **is slightly declining in Canada** (at 52%). This chart shows that **in 2005, 67% of Great Lakes beaches** in the U.S. and Canada had a **low to moderate risk** of closure while **33% were at high risk** for closure.

Closures are due to a variety of reasons, including *E. coli* bacteria counts, poor water clarity, algae abundance, or preemptive beach closures based on storm events and predictive models.

Measures to track and remediate bacterial sources are being taken to improve conditions at many problematic Great Lakes beaches. However, **as populations and coastal communities grow, additional point and non-point source pollution may result in additional beach postings**, particularly **during wet weather** conditions.

## Human health conclusions

- **Quality of treated drinking water remains good**
- **Urban and local air pollutants are decreasing, however, population growth may impact future air pollution levels**
- **A decline in some contaminants has not eliminated the need for fish consumption advisories**
- **One-third of Great Lakes beaches are at high risk for closures**

•Quality of treated drinking water remains good.

•Urban and local air pollutants are decreasing, however, population growth may impact future pollution levels.

•A decline in some contaminants has not eliminated the need for fish consumption advisories.

•There has been an increase in beach monitoring; however, a third of monitored beaches still have a high risk for closures.



During this presentation, the Great Lakes basin population has increased by an estimated **18 people**. By the **end of our conference**, this number will increase by **nearly 2200 people**.

As resource managers, we're often challenged to do more with less. Perhaps **our greatest challenge is how do we do less damage to the Great Lakes with ever more people?**

# Information and photo acknowledgments and sources

- Blue Flag Canada
- Missouri Department of Health and Senior Services
- NOAA
- Ontario Ministry of Natural Resources
- Province of Manitoba
- State of Michigan
- The Nature Conservancy
- U.S. Department of Agriculture Forest Service
- U.S. Department of Health and Human Services
- U.S. District Court for the Western District of Michigan
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- Walkerton Clean Water Centre



Thank you.