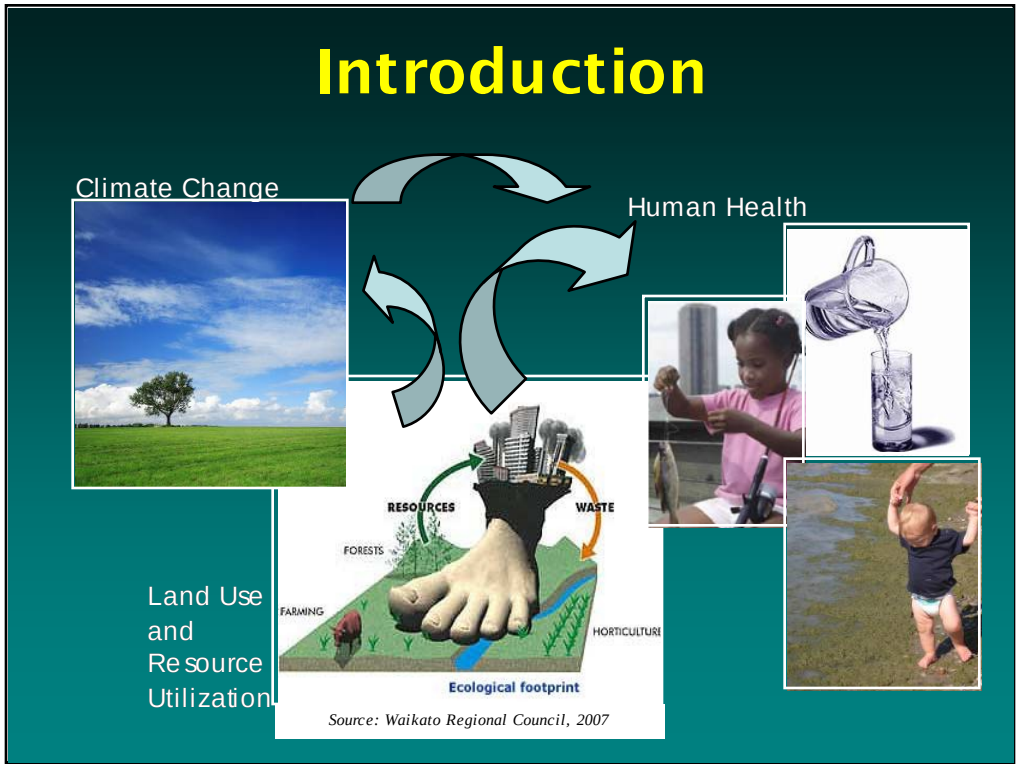
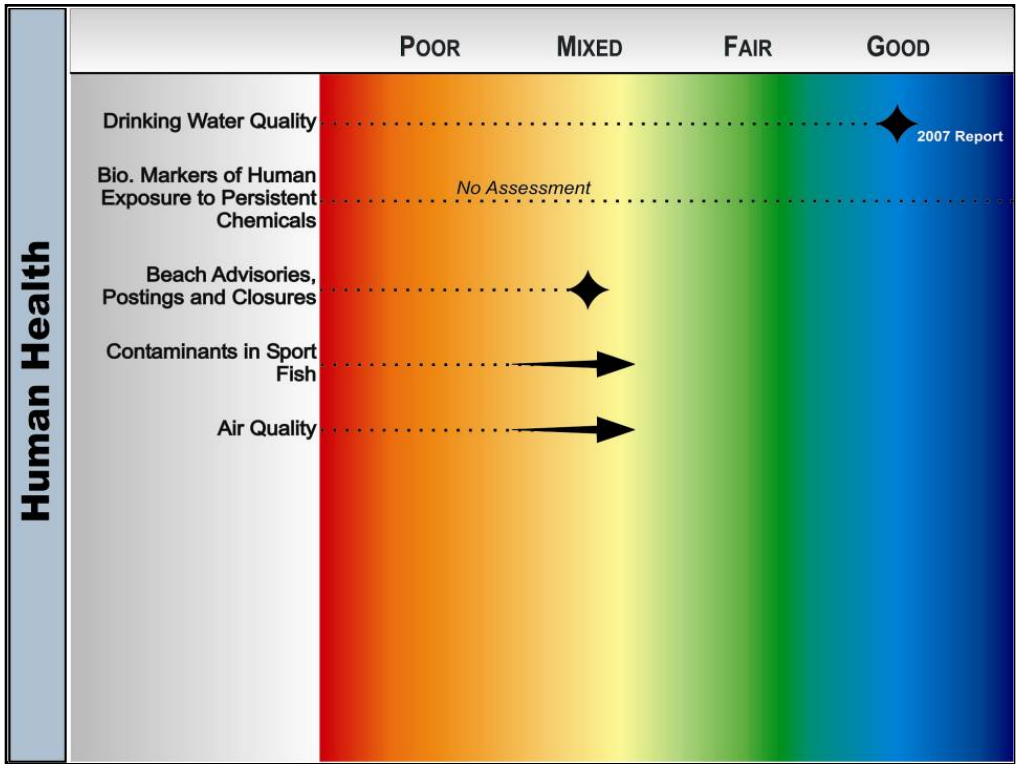
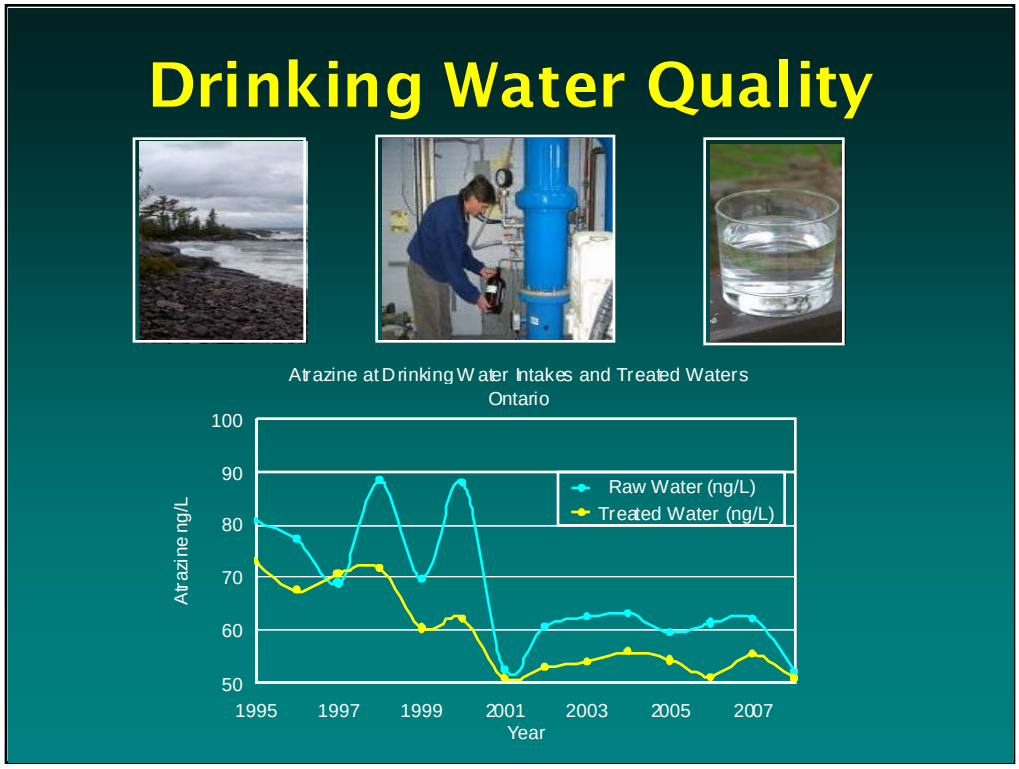
Human Health, Land Use, Resource Utilization and Climate Change
Mary Thorburn
Ontario Ministry of the Environment



Environmental quality of the Great Lakes Ecosystem is the subject of many research projects and it is continuously monitored by all levels of governments in order for us to better understand the health of the Great Lakes region and how it is intrinsically linked to human health, climate change, land use, and resource utilization.



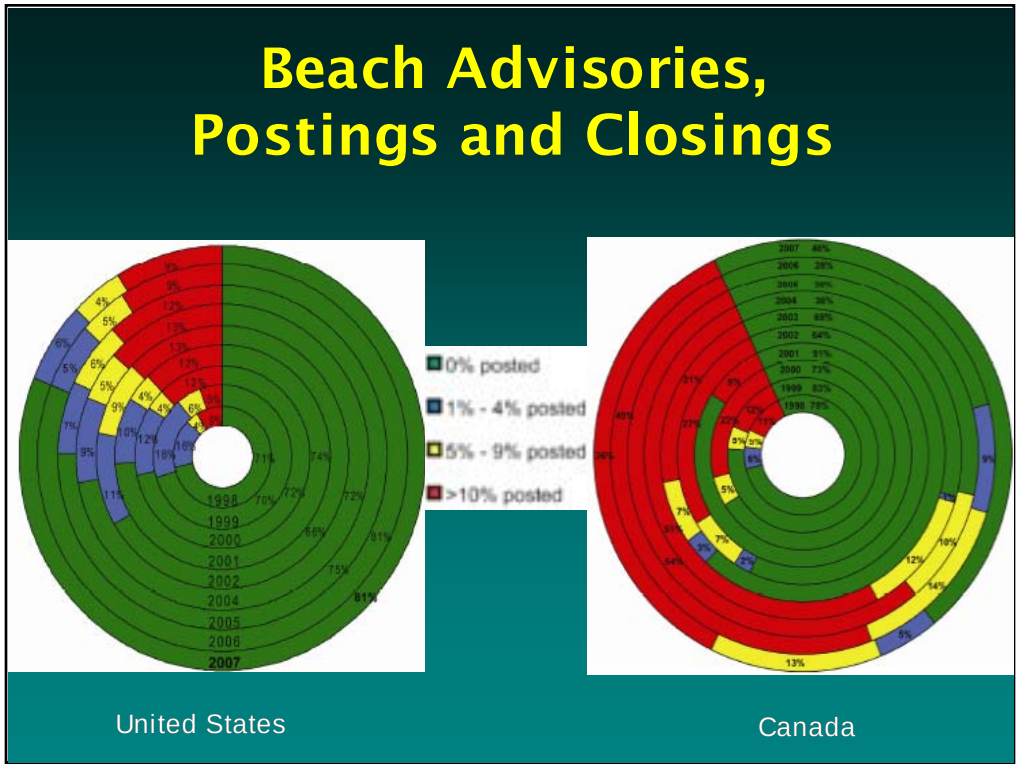
The Human Health indicator category is composed of Drinking Water Quality; Beach Advisories - Postings & Closures; Contaminants in Sport Fish and Air Quality. This category is considered mixed and improving due to better assessments, increased monitoring and continued declines in PCBs in fish and air pollution.



•The Drinking Water Indicator is considered **Good** and **Unchanging** based on annual US and Ontario Drinking water systems reports. The **Great Lakes provide residents of the basin with some of the finest drinking water sources found anywhere in the world** and water treatment plants in both US and Canada are **employing successful treatment technologies**.

•10 health related parameters are used to assess treated drinking water quality in the Great Lakes basin. They include chemical contaminants, microbiological parameters, treatment process parameters and taste & odour. One of the chemical contaminants monitored is the organic herbicide atrazine and the above graph illustrates averaged data collected from 37 Great Lakes Drinking Water Systems that participate in Ontario's Drinking Water Surveillance Program. After improvements to source water and treatment in 2001, atrazine, like other parameters, has remained relatively constant resulting in this indicator category having an unchanging trend.

•However, Great Lakes drinking water sources are vulnerable to many contaminants, for example, bacteria & salts that might be contained in degraded stormwater runoff. New pressures are derived from introduced chemicals and chemicals of emerging concern such as pharmaceuticals, personal care products, endocrine disruptors, antibiotics & antibacterial agents.

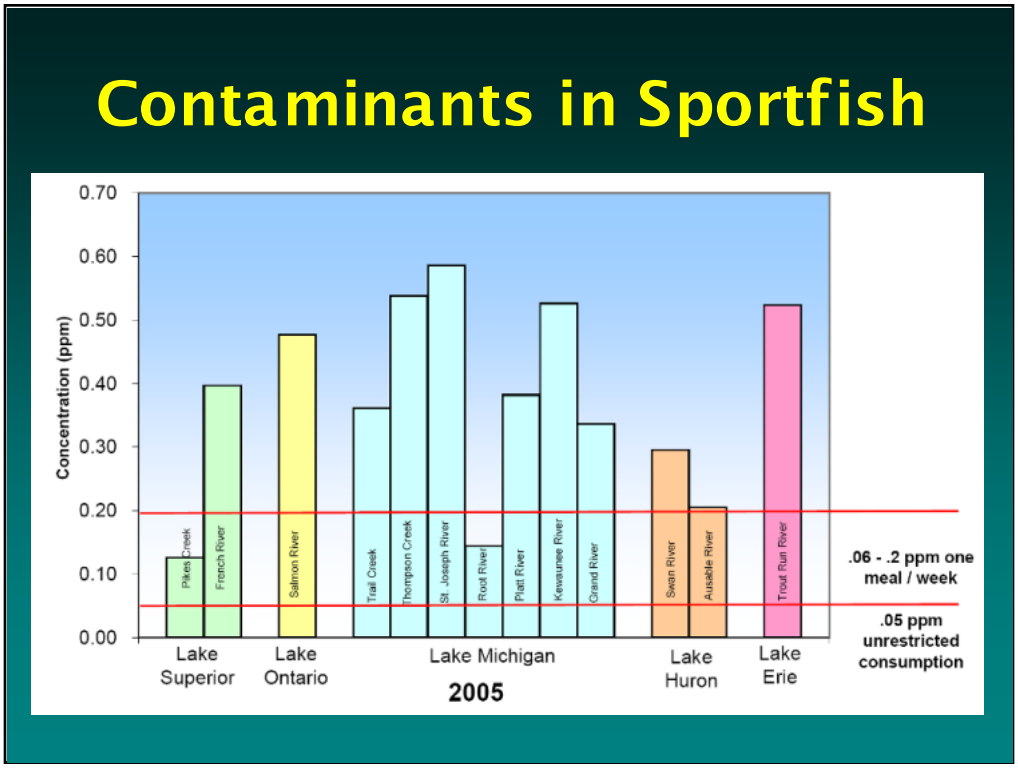


•The status for **Beach Advisories, Postings and Closings** is mixed, with little change in the United States and Canada between 1998 and 2007.

•The **graphs depicted** refer to the proportion of Great Lakes Beaches in the US and Canada with beach postings from 1998 to 2007. Overall, The US boasts a higher percentage of beaches that remained open for the entire bathing season than does Canada. However, the discrepancy between the number of beach closures is attributed to differences in posting criteria Canada uses a criteria of 100 E-coli forming units (CFU) per 100 mL based on a geometric mean of one sample per week from 5 sampling sites whereas the US EPA uses single sample maximum value of 235 cfu per 100ml.

•On the Canadian side, prior to 2004 several non-Great Lakes beaches were included in the assessment and the apparent increase between the 1998- 2003 time period and 2004-2007 time period are due to the reduced dataset.

In general, the Lower Great Lakes have had more postings than the Upper Great Lakes. This is not surprising since there are more **point and non-point sources of pollution** linked to water quality issues. New issues currently being explored include increased algae fouling of beaches resulting from the presence quagga and zebra mussels.

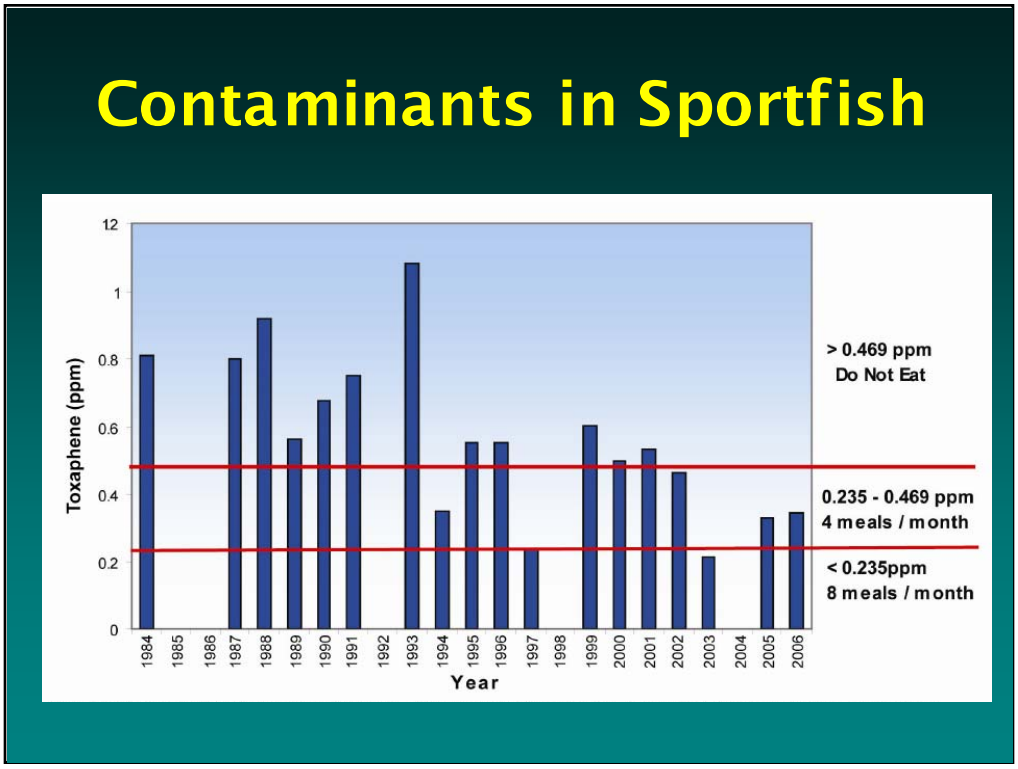


•Another indicator for the Human health category is that of **Contaminants in Sportfish**. This is an important indicator of water quality impacts to the Great Lakes Region because it provides a risk-based measure of how contaminants in the Great Lakes potentially affect our health. Our shared Lakewide Management plan visions state that "The presence of contaminants shall not limit the uses of fish, wildlife, and waters by humans", and Contaminants in sportfish are important drivers to measuring our successes in improving the great lakes.

•Both the US and Canada collect and analyze sportfish to determine contaminant concentrations, relate those values to health protection values and to develop consumption advice to protect human health.

•We've seen declines in the levels of many Persistent Bioaccumulative Toxic chemicals in the Great Lakes Basin due to bans on their use or production, and restrictions on emissions. However, these substances continue to be a problem because of their ability to bioaccumulate and persist in the environment.

•PCBs are the contaminants most frequently limiting fish consumption in the Great Lakes, driving may of the consumption advisories in the US. In Ontario, consumption advisories are generally driven by PCBs, mercury, dioxins and furans, with contribution by toxaphene in some areas of Lake Superior and Lake Huron.



•Trend analysis of the Ontario sportfish shows we're seeing a **mixed** status, with a trend towards **improvement** across the Great Lakes Basin. Most of this improvement stems from an overall decrease in organochlorine contaminants in the great lakes. For example, the graph illustrates toxaphene concentrations in Lake Trout from Lake Superior. Consumption limits in these graphs are based on the most sensitive populations, women of child-bearing age and children under 15.

•Although we've seen declines in contaminants such as PCBs in lake trout in the Great lakes Basin, we still find that PCBs exceed consumption limits, so it's important to continue monitoring to maintain trend data. However, we're also seeing other Persistent Bioaccumulative Toxic contaminants of emerging concern such as PBDE & PFOs that have increased in concentration and now require more monitoring efforts. The potential effects of multiple contaminants, including endocrine disruptors also need to be addressed.

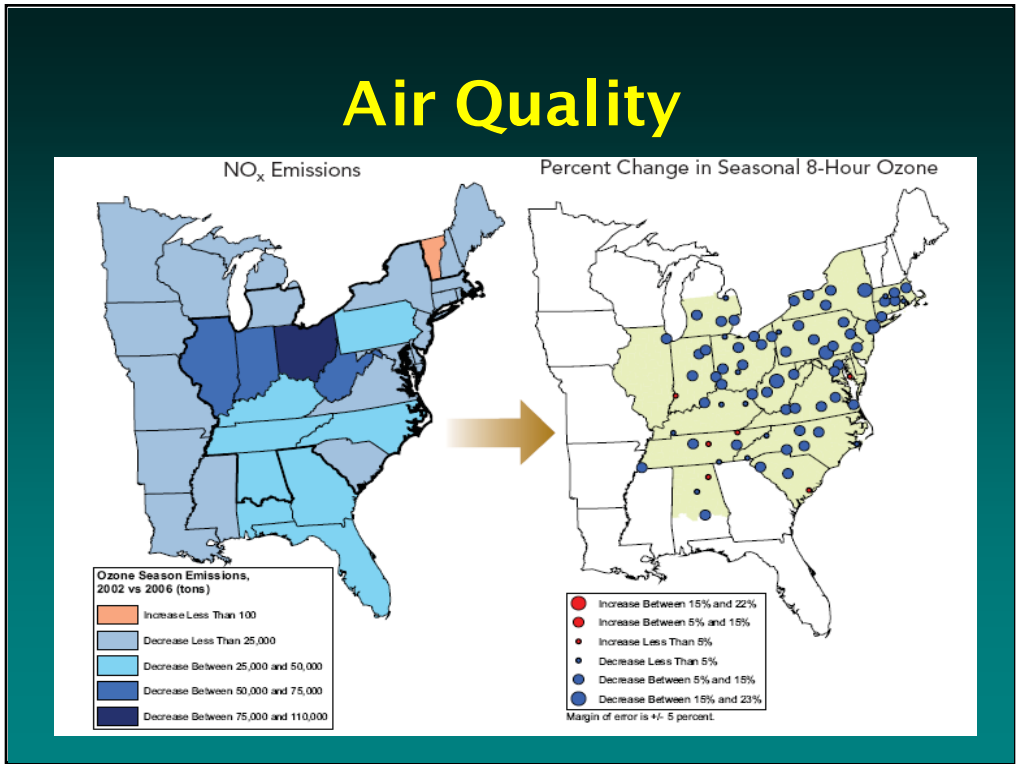
•An improvement on the US data would be to review and standardize risk assessment protocols for the various contaminants, since health benchmarks for fish consumption advisories are based on state or tribal jurisdictions, and not a federal standard. Ontario's sportfish program is consistent with Health Canada's approach for consumption advisories.

As part of an overall ecosystem objective and its implications for **Human Health**, air should be safe to breathe, and overall, we've seen significant progress towards improving **Air Quality** in the Great Lakes Basin with both emissions and ambient concentrations of various substances.

However, progress does not appear to be uniform across the basin, and factors such as differences in weather conditions seem to complicate our abilities to derive trends. Air quality is measured both **locally,** for example in urban areas, and **regionally**, and while the status of some pollutants seems to be improving on a regional scale, we do see problem areas on a local scale.

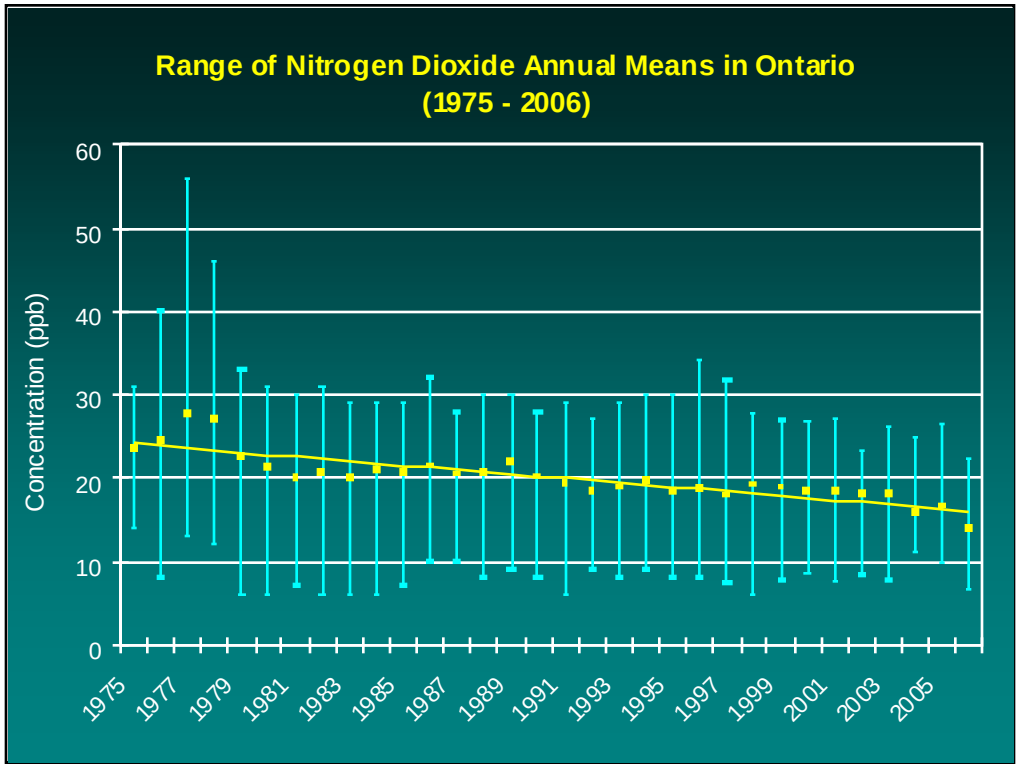
We'll focus today on Nitrogen oxides and ground level ozone.

Ground-level ozone is a secondary pollutant formed by reactions of precursors, such as VOCs and Nitrogen oxides, in the presence of heat and sunlight. Ozone is a problem pollutant over a broad area of the Great Lakes region, which is exacerbated with proximity to the great lakes because of the trapping of pollutants and transport to nearshore air circulation zones.

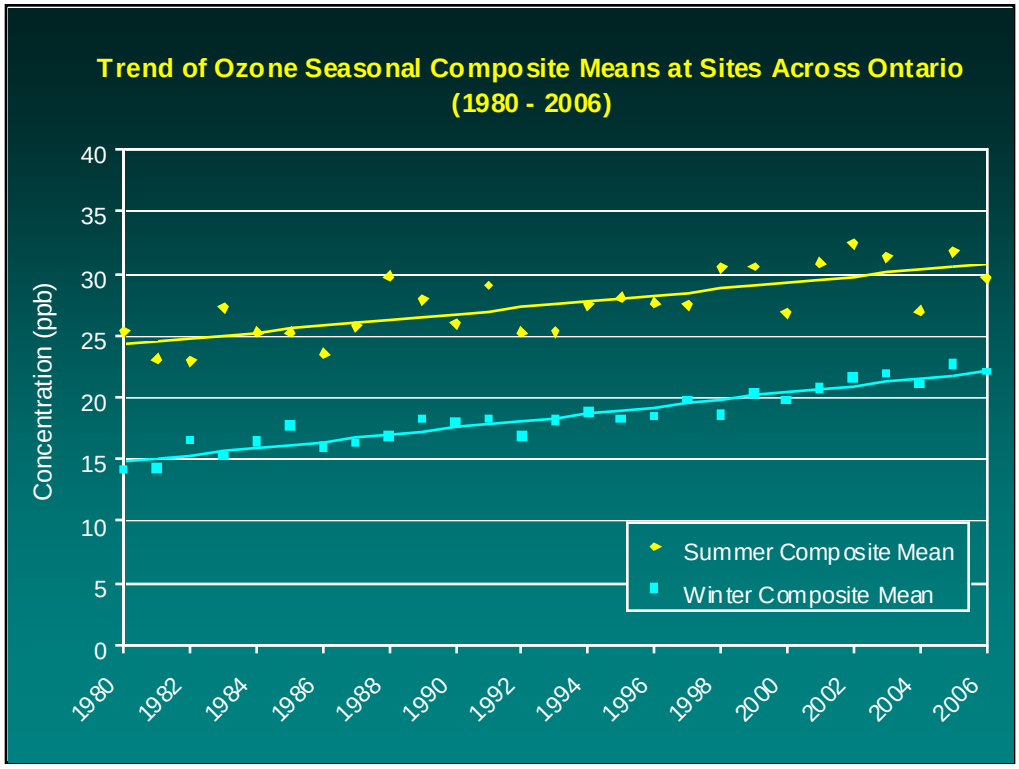


The figures you see here show reductions in Stateside Nitrogen oxide (NOX) emissions from 2002 to 2006 on the left compared against concurrent changes in 8-hour Ozone concentrations on the right-hand side. It implies an **improvement** in overall ground-level ozone concentrations with reductions in nitrogen oxides such as shown by the large blue dots that represent a decrease in ground level ozone. Overall, Annual mean ambient concentrations of Nitrogen dioxide decreased more than 41% between 1980 and 2006 around the great lakes Basin, 33% in Ontario, and this can be mostly attributed to improvements within urban areas.

However, Ontario has seen an overall increase in **seasonal means** of ozone from 1980 to 2006.

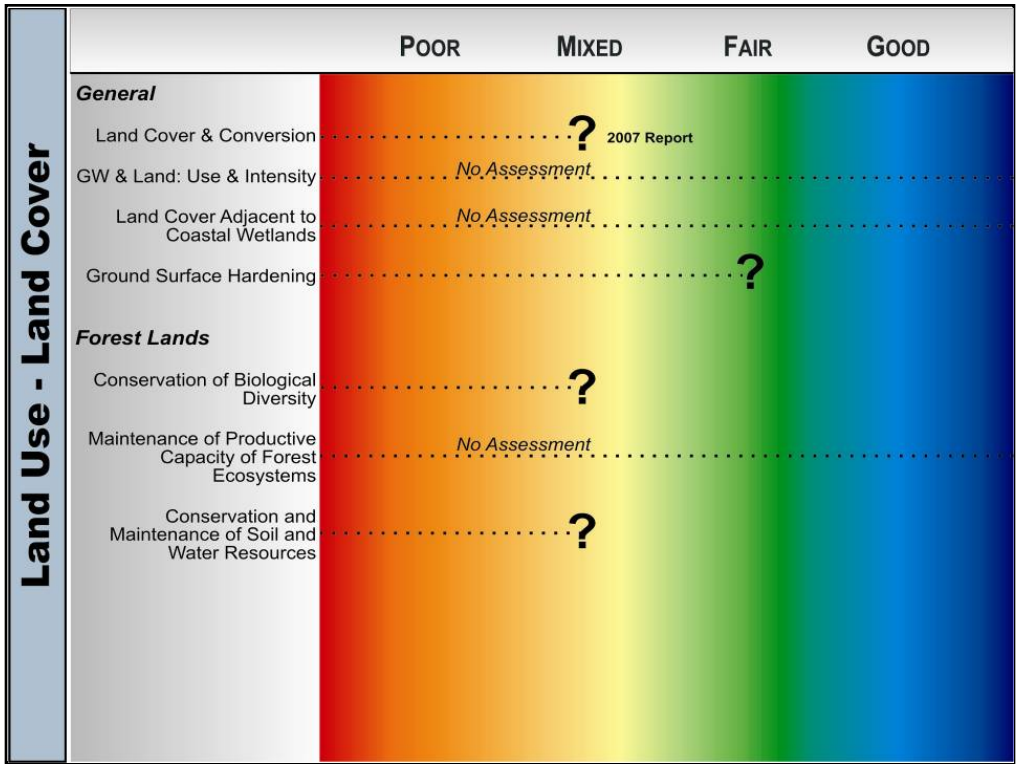


This figure shows the trend of the composite annual means for ambient Nitrogen dioxide concentrations in Ontario from 1975 to 2006. Average Nitrogen dioxide decreased by approximately 26 per cent from 1975 to 1996, and decreased approximately 20 per cent from 1997 to 2006.

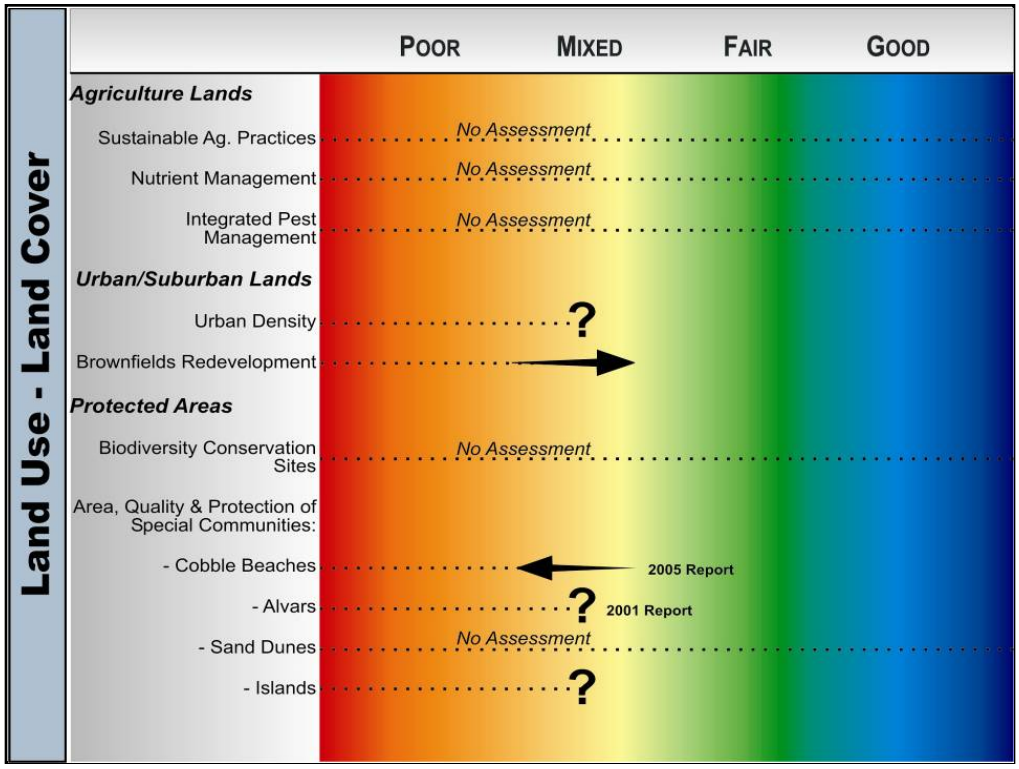


This figure shows that there has been an increasing trend in the ozone seasonal means during the same period, with ozone summer means increasing by approximately 27 per cent and winter means by approximately 50 per cent. The increases in summer and winter ozone means appear to be largely **related to reductions in Nitrogen Oxide emissions**, such as observed by Nitrogen dioxide means on the previous graph, and the **rising global background ozone concentrations**. Potential contributions to the increases in the summer composite means may also be related to **meteorological factors** and **long-range transboundary transport of ozone and its precursors**.

Although many emission reductions have been achieved to reduce air pollution, improvement in **Air quality** in the Great Lakes Basin region continues to be offset by **Economic growth**, **population growth** and associated **Urban Sprawl,** which drives increased **energy consumption** and **vehicle use**. **Climate change** may also affect weather conditions conducive to high ambient pollution concentrations, and there is a need to look at synergistic interactions of multiple pollutants in the great lakes basin, and their effects on **human health**.

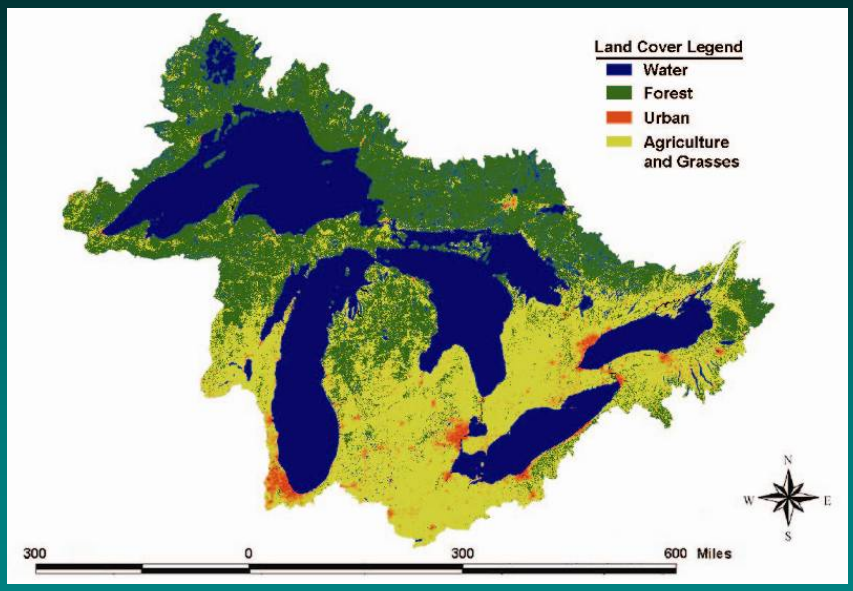


The Indicators of Land Use and Land cover comprise about 17 Indicators, of which a few have been updated since the last cycle, and these will be discussed briefly. Overall, The status of these indicators remain mixed, and many of these indicators need further updating, or are not yet fully assessed.



Trends from the combined indicators seem to suggest an overall decline in the status of land-use and land cover, in part due to **pressures** associated with **urban population growth** within the great lakes basins.

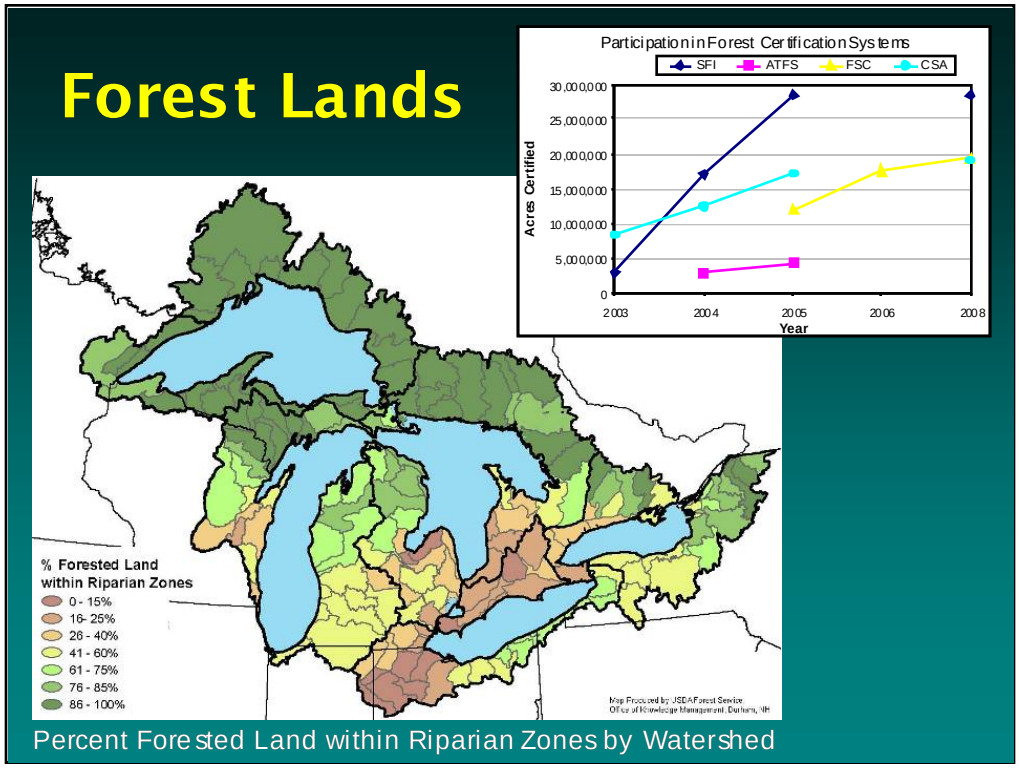
Land Cover



Currently this indicator is mixed and undetermined.

Agriculture accounts for approximately 35% of the land area and dominates the southern portion of the basin. The three agricultural indicators reported through SOLEC have not been assessed for 2008, but due to the recent trend towards increasing farm size and concentration of livestock the face of agriculture in the basin is likely changing.

Current forestry data show that forests cover over half of the land in the Great Lakes basin. As of 2006, the U.S. portion has forest coverage on 51% of its land, while the Canadian portion had coverage on 73% of its land as of 2002.

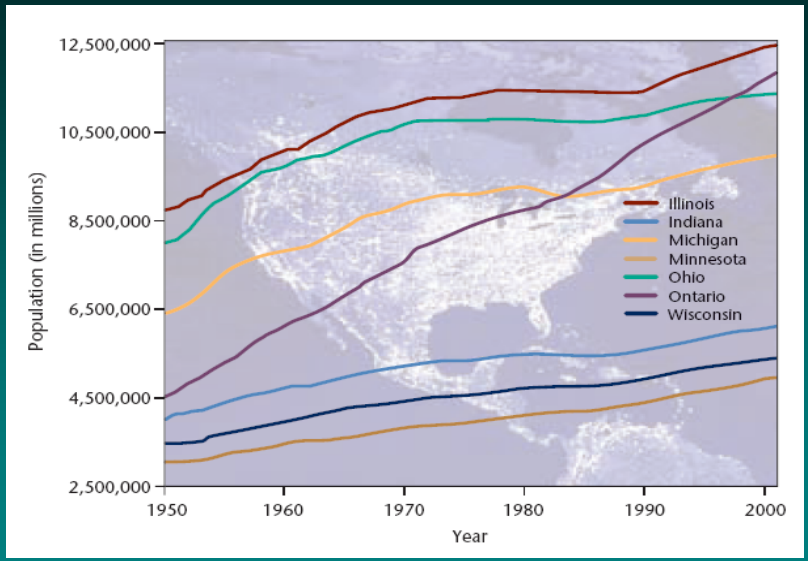


While good water quality is generally associated with heavily forested or undisturbed areas, forested buffers near surface water features can also protect soil and water resources, despite land use classes present in the rest of the watershed. Higher percentages of forest coverage in these areas reduces local runoff and related problems, while improving the ecosystem's capacity to store water.

In the Great Lakes basin, forests cover 69% of the land in riparian zones within 30 meters of surface waters. This is demonstrated by watershed in the map shown here.

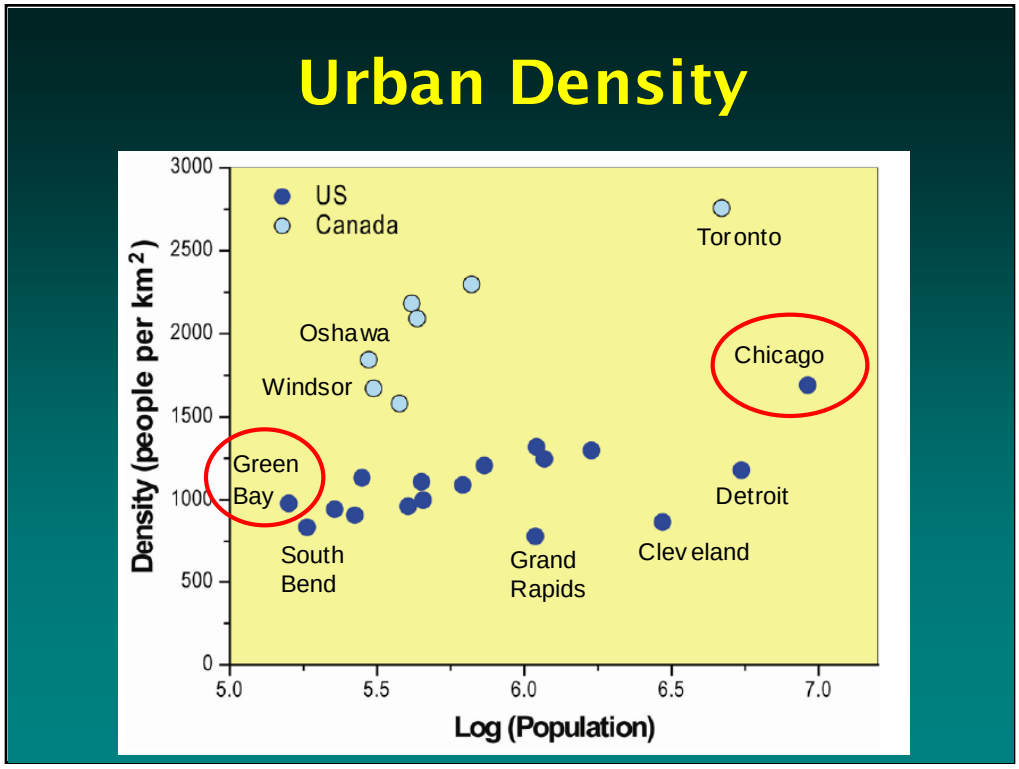
Additional implications for the health of Great Lakes forests and the basin ecosystem are difficult to establish, but it is important to note that an increasing trend is currently evident across the region for participation in various certification systems, as indicated in the graph. This increase can be interpreted as a positive commitment to sustainable forest management amongst forest industry professionals

Population Growth



Source: *Confronting Climate Change in the Great Lakes Region*, A Report By The Union of Concerned Scientists and The Ecological Society of America, 2003

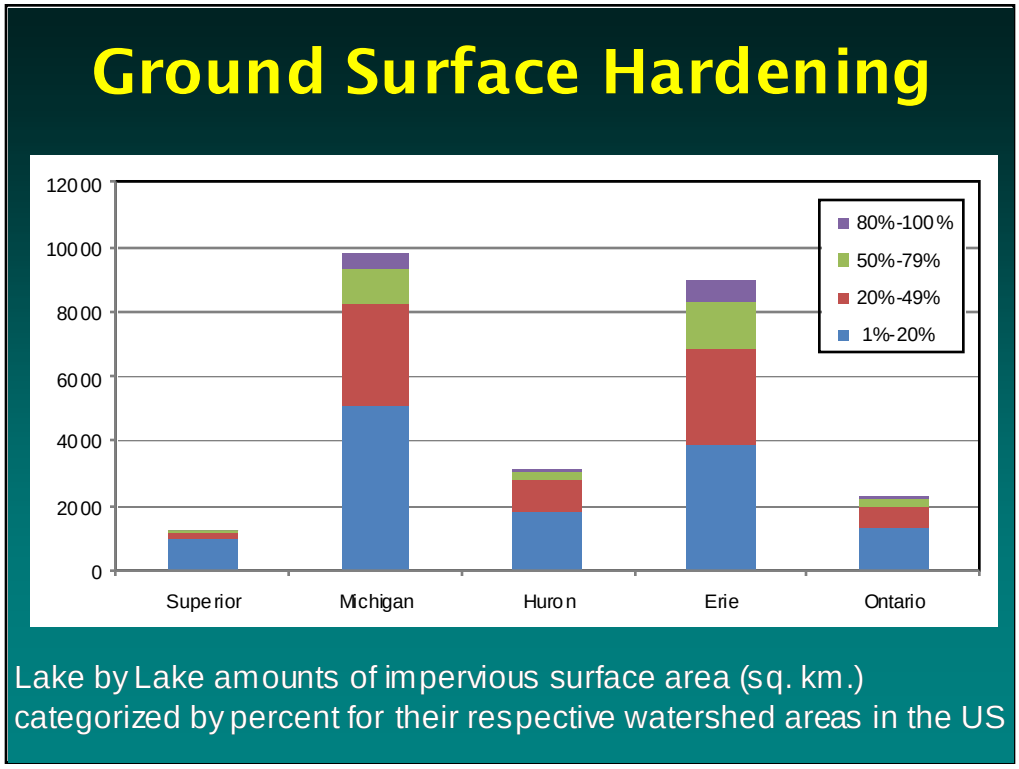
Agriculture and urban growth are the main pressures on land-use in the basin. Here we see that the rate of population growth in the U.S. has been more or less steady since 1950, but Ontario's growth, shown as the dark purple line, has grown much faster. Between 1996 and 2006, populations in the Canadian side of the Great Lakes Basin grew by 16%, while populations in the US grew by 7.6% between 1990-2000.



In this plot, we examine urban density, the number of people per square kilometer, as a function of the population of the largest urban areas around the Great Lakes. The log scale on the bottom serves simply to condense the width of the scale for this presentation.

For comparison, Green Bay (click), Wisconsin, on the left, has a population of about 227,000, while the greater Chicago area (click), on the right, has a population of over 9 million.

There are distinct differences between US and Canadian urban areas, as you see here. In particular, Canadian urban areas seem to have a **greater trend towards increasing density with increasing population** compared to the US urban areas.



Percent impermeability was grouped into four categories which correspond to the National Land Cover Database land use classifications of developed open space, low intensity development, medium intensity development, and high intensity development.

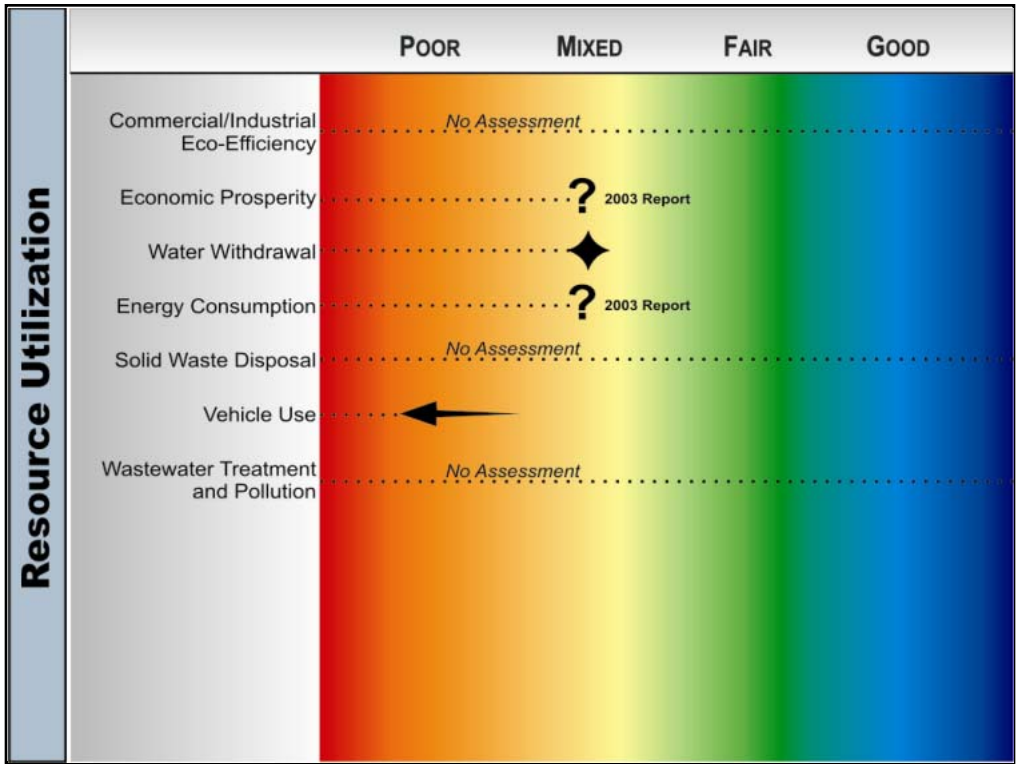
The Great Lakes Basin watersheds of Lake Erie and Lake Michigan have the highest proportion of their watersheds consisting of impervious surfaces, and also the highest proportion of the highest degree of imperviousness, the purple band at the top of each bar. Not surprisingly, the Lake Superior watershed contained the lowest proportion of impervious surfaces within the U.S. portion of the Great Lakes Basin.

Brownfields are abandoned, idled, or under-used industrial and commercial facilities where expansion, redevelopment or reuse is complicated by real or perceived environmental contamination. In 1999, 21,178 brownfields sites were identified in the United States, which was equivalent to approximately 33,000 hectares or 82,000 acres of land. Although similar research does not exist for Canada, and no inventory exists for either contaminated or brownfields sites in Ontario, it is estimated that approximately 50,000 to 100,000 brownfields sites may exist in Canada.

Overall, the status of **Brownfield redevelopment** was considered **mixed**, with a **trend towards improvement**.

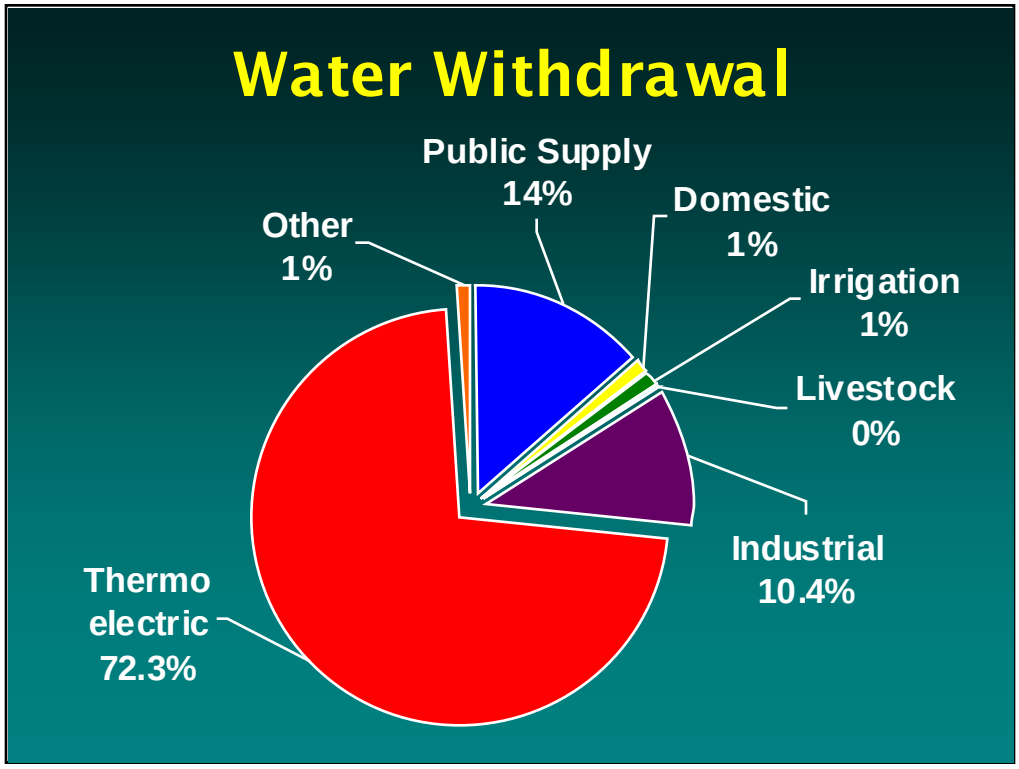
Although **Both countries have programs to promote remediation or clean-up and redevelopment**, it's hard to get a real estimate of the number of remediated and redeveloped sites, because data from the various sources are not consistent.

However, since more sites are being redeveloped or are being planned, there is some trend of an improvement in the Great Lakes basin, but it is not based on a quantitative assessment



The SOLEC category of Resource Utilization also presents a challenge to our assessments.

Of this cluster, two indicators were updated for SOLEC 2008: Water Withdrawal and Vehicle Use. We will look at those two, plus I will provide some comments about some of the others.

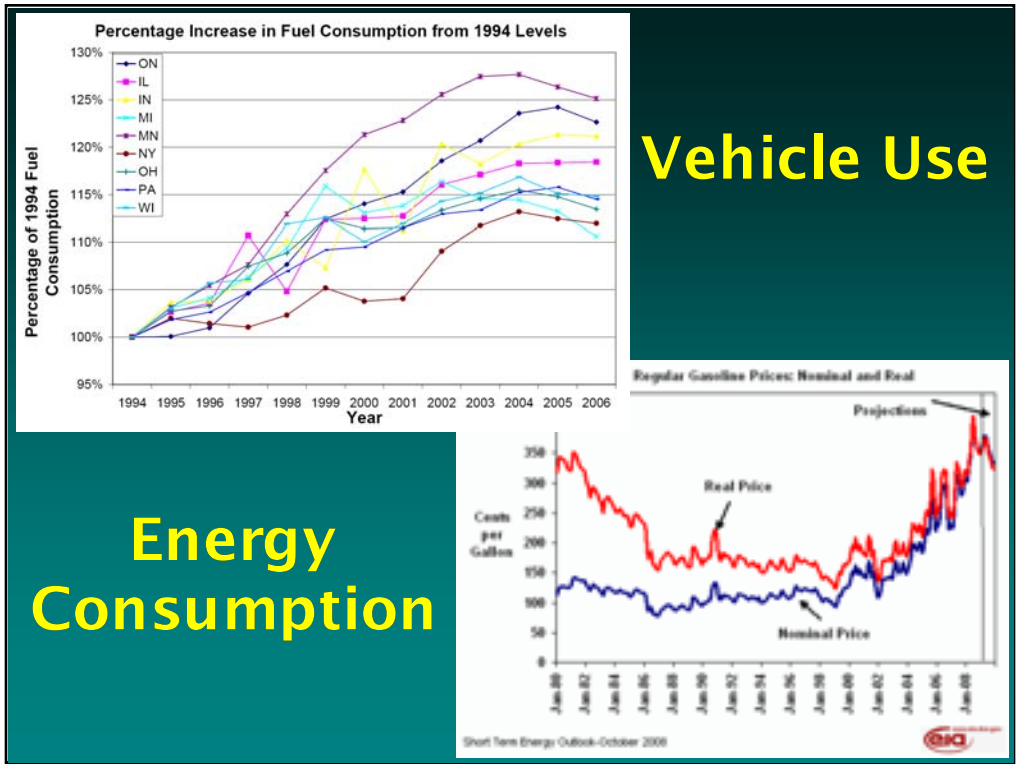


Although the Great Lakes contain a remarkable amount of water, none of us should fall victim to the "Myth of Abundance." Only a tiny fraction – about one per cent – of the water in the Great Lakes is actually renewed through precipitation annually. Each day, over 3,000 billion litres of water are taken from the Great Lakes by all bordering jurisdictions. Most of that water is returned, but not all of it.

We will take a brief look at water withdrawal here and you'll hear more from Peter Annin later this morning. Peter, of course, is the author of the book "The Great Lakes Water Wars."

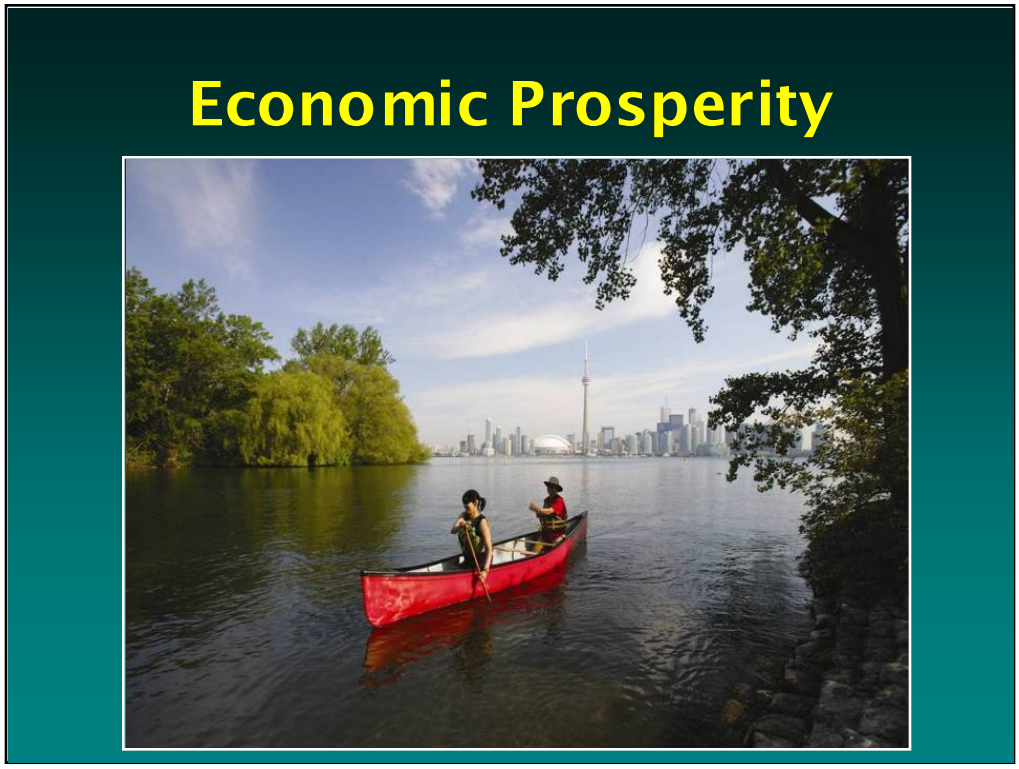
In 2004, water was withdrawn from the Great Lakes basin at a rate of 164 billion litres per day. 80% of that was represented by thermoelectric and industrial users, seen here by the red and purple areas; 14% was used by Public water supply systems, the blue area.

That is not to imply that all this was lost to the Great Lakes basin. Most of the waters withdrawn are returned to the basin, however, about 5% is lost through "consumptive use" on a basin-wide level.



Population growth and urban sprawl in the Great Lakes Basin have led to an increase in the number of vehicles on roads, fuel consumption, and kilometers spent on the road by residents. As a result, this indicator has been described as Poor, and Deteriorating.

The figures here seem to indicate the recent tailing-off of fuel consumption is likely linked to increases in gas prices. Perhaps more of us are choosing to use public transit, fuel efficient vehicles, and or car-pooling.



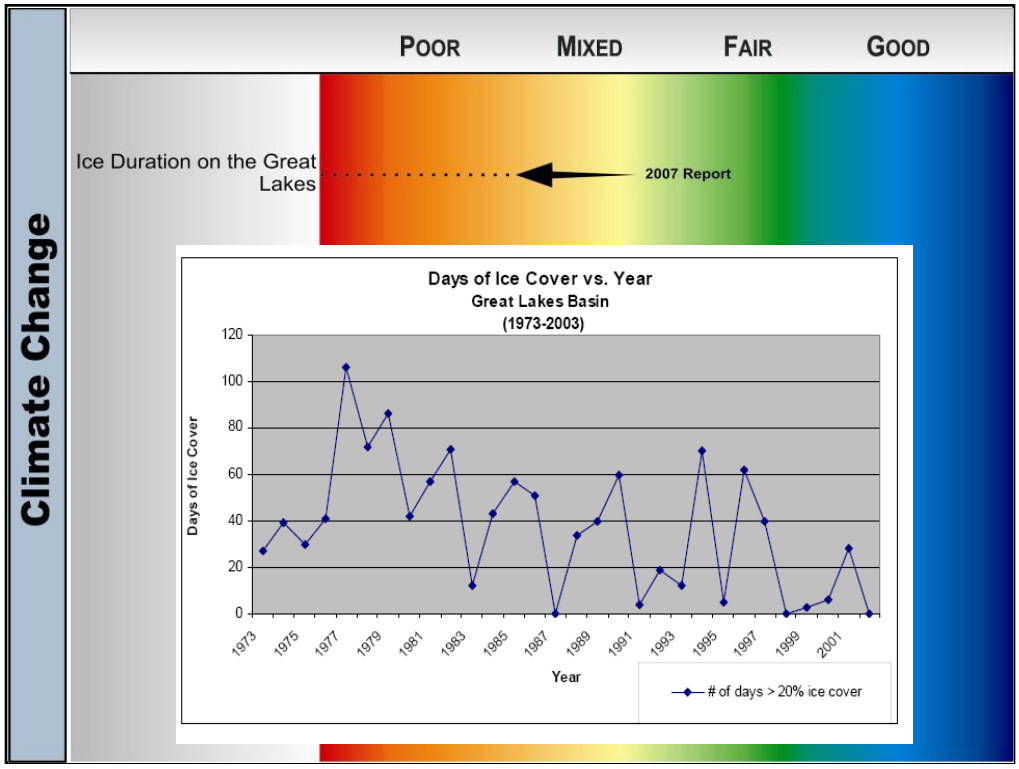
Some Bad News

- Less manufacturing sector jobs
- Growing global competition in the region's traditional manufacturing sectors, oil, price shocks, and rapid advances in worldwide business and communications technology have shaken the foundations of the region

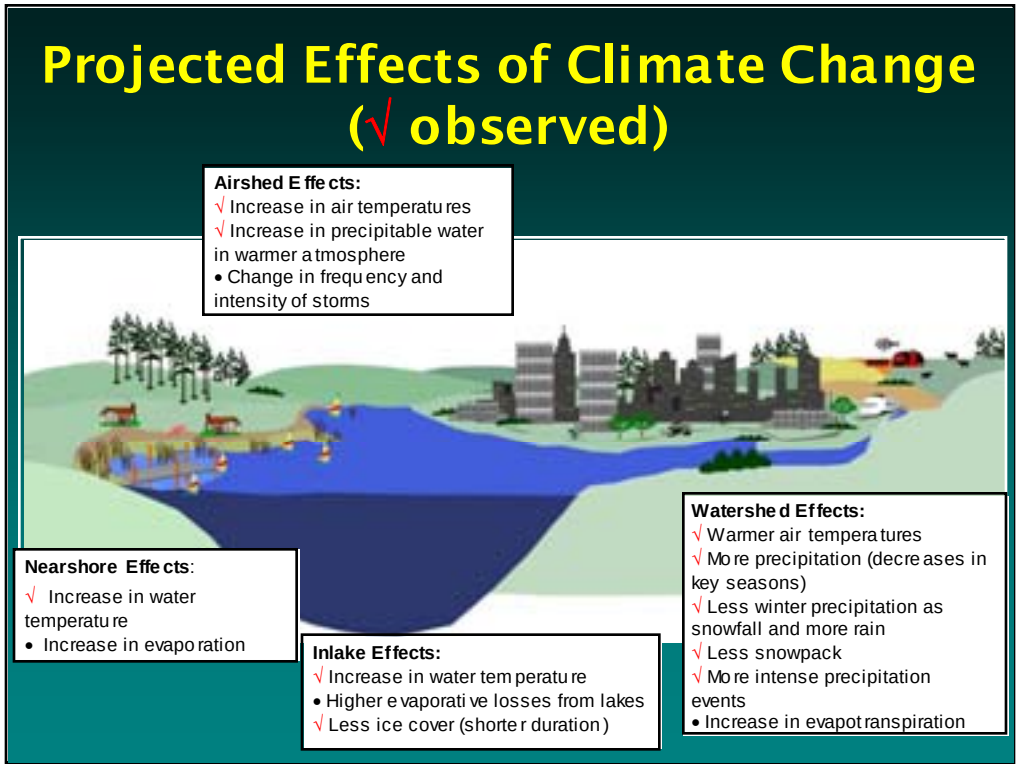
Some Good News

- Many dense urban cities are attractive for "creative class" and new "info-jobs"

According to Austin, John, Elaine Dezenski and Britany Affolter-Caine. 2008. "The Vital Connection: Reclaiming Great Lakes Economic Leadership in the Bi-National US-Canadian Region." Washington: Brookings Institution.



There is currently one indicator included under the climate change assessment, **ice duration on the lakes.** It is considered mixed and deteriorating because our climate is changing… the length of time that ice is on the lakes is declining with time, with ice lasting for fewer days in recent years.



Small effects of climate change, like a change in lake water temperature, can have far-reaching consequences throughout the Great Lakes basin. Impacts to the ecosystems of the nearshore, inlake and watershed environments would all occur as a result of lake water temperature changes. Changes in precipitation quantity and intensity will impact a number of things including snowpack density, evaporation rates, and water quality. As a result we will need to adapt the way we do things.

Jurisdictions in Canada and the US are working to understand how we can adapt to the anticipated impacts of climate change. For example, our Great Lakes communities and ecosystems may also experience weather extremes such as the 2005 storm that caused the washout of Finch Avenue and extensive property damage to northern Toronto within a 2 hour time period.

It is widely believed that climate change is dramatically changing precipitation and temperature patterns from the past and thus, the use of long-term historical Intensity-Duration-Frequency curves to design storm detention ponds and other stormwater facilities is no longer adequate. A climate change model with temporal scale of hours, not annual or seasonal averages, is likely required for planning and designing effective stormwater management facilities.

Management Challenges for the Great Lakes Basin

- Our ability to detect the occurrence of chemicals in environmental media continues to improve. With this in mind, how do we balance actual risks to the environment/ human health with perceived risks?
- Quantitative prediction of tributary/nearshore water quality improvements resulting from urban/rural non-point source Best Management Practices

with the improvements we see in detections in environmental media, do we have enough information to go beyond current details, and focus on understanding what an increase in chemicals will do for human exposures? What are the challenges we face for understanding synergistic processes associated with chemical exposures?"

a list of BMP recommendations is a great starting point, but without an estimate of measureable WQ improvement that may result, we don't know what we can expect from them. For example, if the predicted cumulative effect of various BMP activities on WQ exceeds the range of natural variability associated with wet weather/dry weather we would be confident of observing an improvement. If, however, the normal range of variability exceeds the predicted improvement, the measure of success will be more challenging.

Acknowledgments

- MOE colleagues in EMRB and the Great Lakes Office especially Nadine Benoit and Paul Helm
- Stacey Cherwaty-Pergentile and Nancy Stadler-Salt
- Stephanie Ross, Jackie Adams, Paul Bertram and Karen Rodriguez

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