This is Lake Superior - on the Canadian north shore - Nipigon Bay in this photo, and coming to life at Marathon's cobble beach. My name is John Marsden. It is my privilege to be Environment Canada's Lake Superior Coordinator responsible for the Lake Superior Lakewide Management Plan and the Canadian Areas of Concern, and the Canadian co-chair of the Lake Superior Binational program's Work Group.

In the short time I have, I will give you a flavour for Lake Superior - its watershed and land use, and touch on a few examples of biological integrity issues, indicators, emerging issues, and the Binational Program.

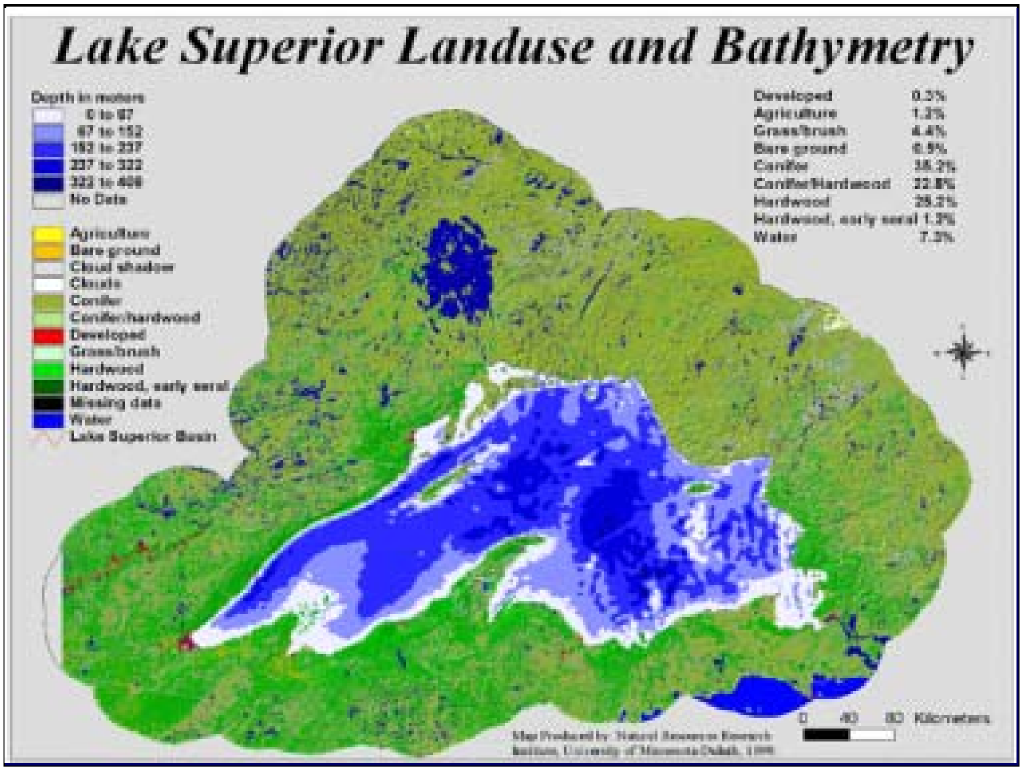
Lake Superior is the largest fresh water lake in the world by area and third largest by volume.

The total watershed area is 228,000 km^2 including Lake Nipigon and two major diversions.

Six percent of the water supply comes from the Ogoki and Long Lac diversions in Canada shown in light green. These two hydro electric diversions are significant to the water levels of all the Great Lakes.

Lake Superior discharges into Lake Huron through the St. Marys River at Sault Ste. Marie.

Areas of Concern, or AOCs, are marked on the map by red triangles. There are eight AOCs including the Binational St. Marys River.



As for land use - the US shoreline is forested with hardwoods while the Canadian shoreline is a coniferous/ hardwood mixed forest

The original red and white pine forests have been cut in the US, but Ontario still retains 3800 hectares of old growth red and white pines.

The watershed also contains such globally rare vegetation types as arctic alpine communities, sand dunes and pine barrens.

Red areas on the map represent areas of human development.

In Canada, 90% of the basin is crown land while 54% of the US basin is in private hands.

The State of Lake Superior was listed as “mixed” in the 2001 State of the Great Lakes Report

Biological Integrity Issues

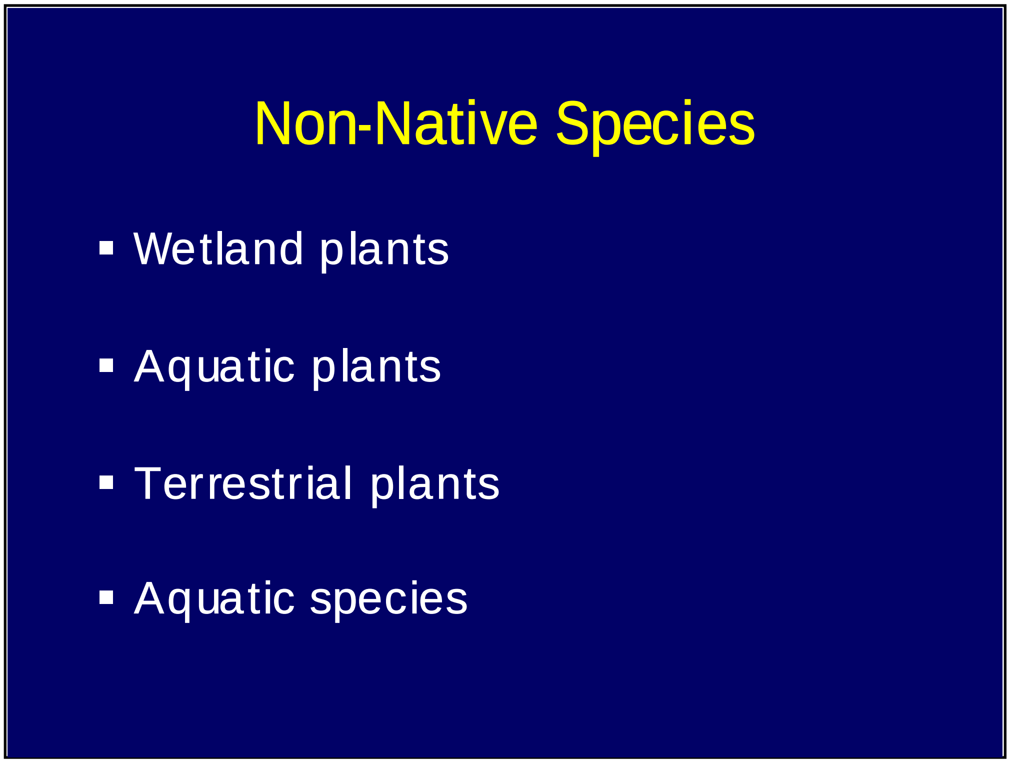
- Endangered species
- Non-native species
- Habitat fragmentation
- Chemical impacts

I would like to briefly touch on four biological integrity issues for Lake Superior. The first, endangered species, was raised at SOLEC 2000. The other three - non-native species, habitat fragmentation, and the impact of chemical contaminants - were explored for this SOLEC.

The first biological integrity issue is endangered species. Fourteen Lake Superior species are listed nationally by Canada and the U.S. as either endangered (3), threatened (6) or vulnerable (5)

However , there are 400 species in the basin listed by provincial or state jurisdictions as endangered, threatened or of special concern.

Nearly 300 of these are plants.



The second biological integrity issue is non-native species. Non-native species in Lake Superior can be placed in four categories shown here.

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Doug Jensen of Minnesota Sea Grant reported observations of 28 non-native species in Lake Superior in 2000; 17 fish, 5 aquatic invertebrates, and 6 aquatic plants. Most of these were introduced since 1960. Of these non-native species, 8 were introduced intentionally. Ship ballast is the primary source of unintentionally introduced non-native species in Lake Superior

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Here are some examples of non-native species found in Lake Superior:

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for wetland plants: Purple Loosestrife

Eurasian water milfoil

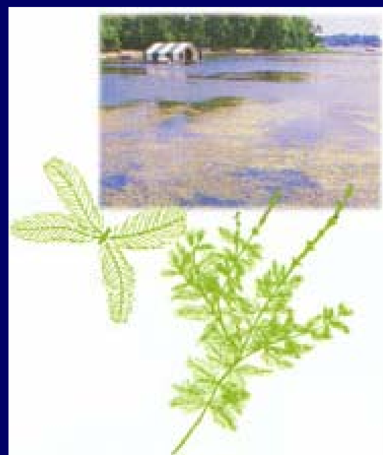


photo credit: a field guide to aquatic exotic plants and animals, Minnesota Sea Grant

for aquatic plants: Eurasian Water Milfoil

leafy spurge

photo credit: Ontario Ministry of Agriculture and Food

for terrestrial plants: Leafy Spurge

(ref: http://www.gov.on.ca/OMAFRA/english/crops/facts/ontweeds/leafy_spurge.htm#pics) garlic mustard

photo credit: Theodore G. Scott, Virginia Native Plant Society.

garlic mustard

ref: http://www.nps.gov/plants/alien/fact/alpe1.htm

buckthorn

photo credit: Ontario Ministry of Agriculture and Food

Buckthorn

ref: http://www.gov.on.ca/OMAFRA/english/crops/facts/ontweeds/european_buckthorn.htm

non-native honey suckle

photo credit: Penn State - College of Agricultural Sciences, School of Forest Resources

non-native honey suckle

source: http://rnrext.cas.psu.edu/honeysuckle.PDF

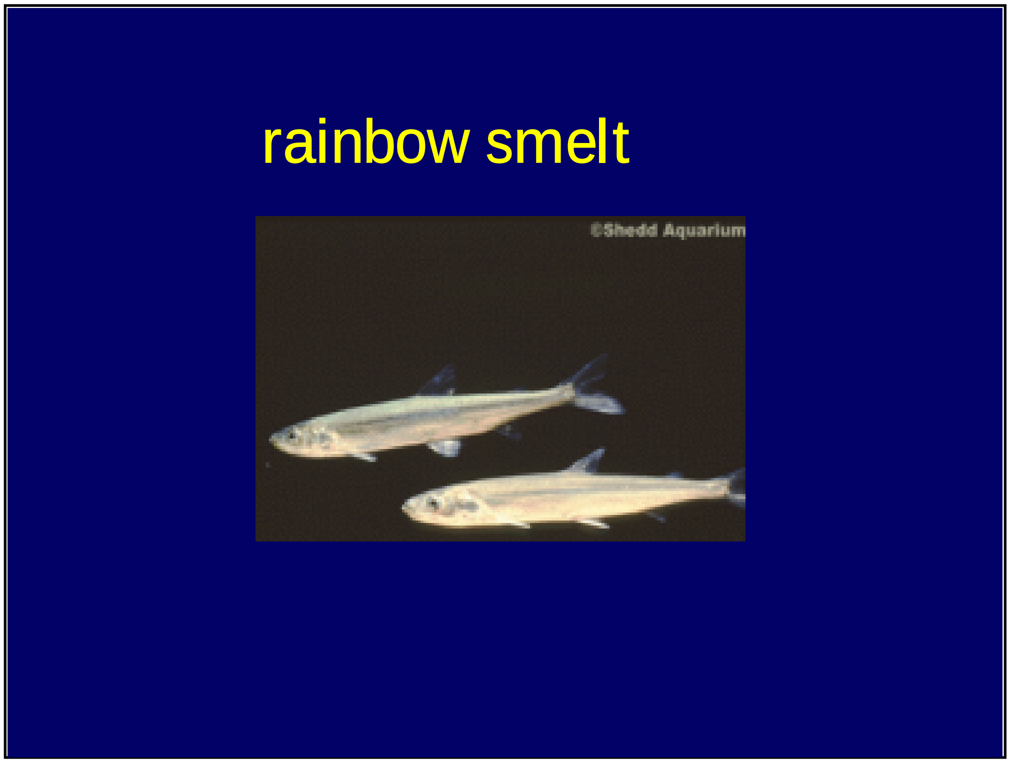
knapweed

source: Ontario Vegetation Management Association
http://www.ovma.on.ca/Weeds/knapweed.htm

for aquatic species: Sea lamprey

The lake contains 84 fish species, including 17 non-native species. Although the number of introduced fish across all lakes is 14-17 species, Lake Superior has the highest percentage of non-native to native species - at about 20% of the total number of species.

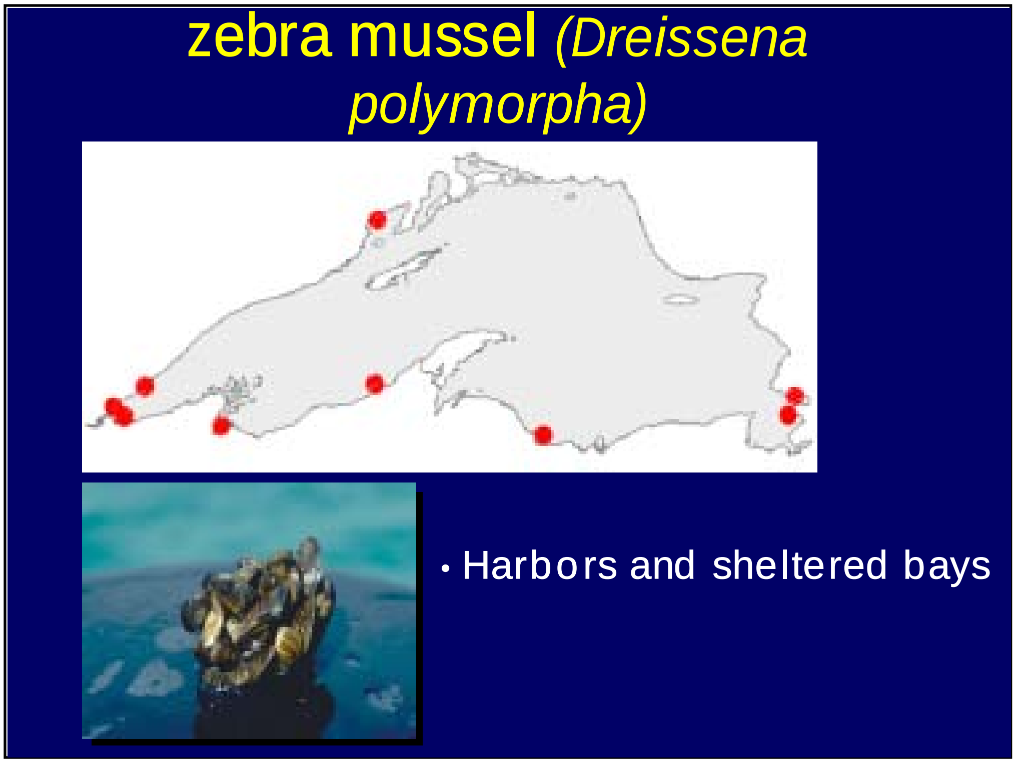
ref: (Based on Mills et al. 1993, D.A. Jensen (manuscript in prep 2000)) - from GLFC State of Lake Superior Conference 2002 - presentation by Mark P. Dryer & Gary Czypinski - USFWS-Ashland Fishery Resources Office, and Douglas A. Jensen - Minnesota Sea Grant Program)



another non-native aquatic species is the rainbow smelt

source: Wisconsin Sea Grant

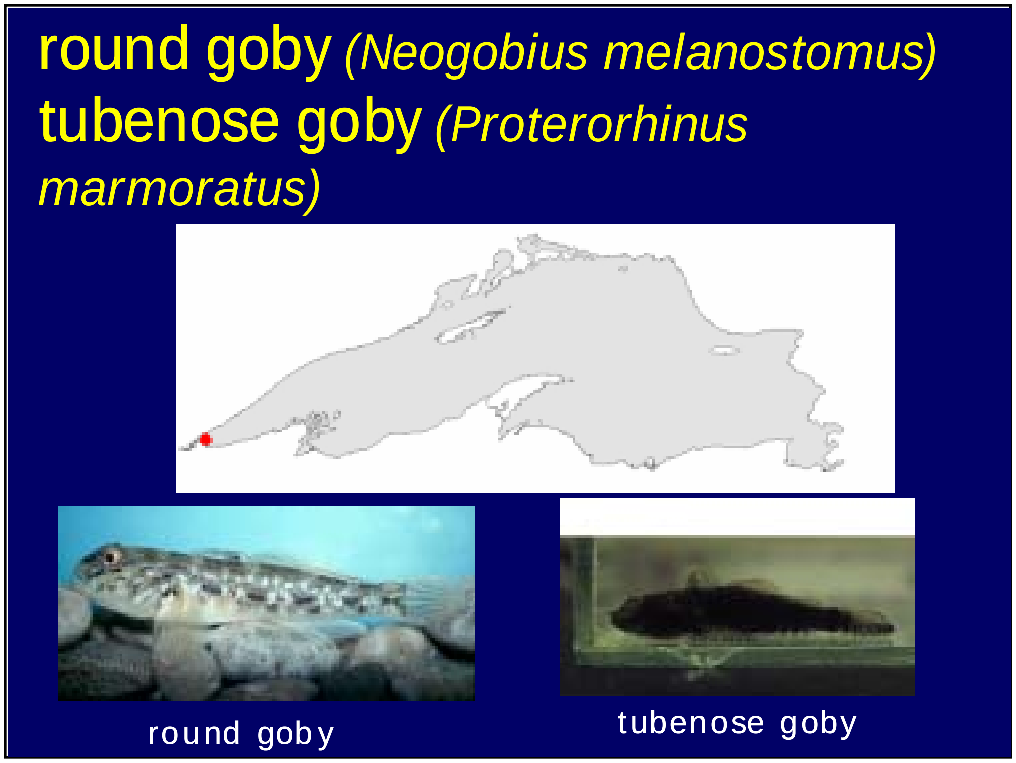
http://www.seagrant.wisc.edu/greatlakesfish/rainbowsmelt.html



courtesy of Mark Dryer and colleagues at the U.S. Fish and Wildlife service, I have a number of slides showing non-native aquatic species and their distribution in Lake Superior.

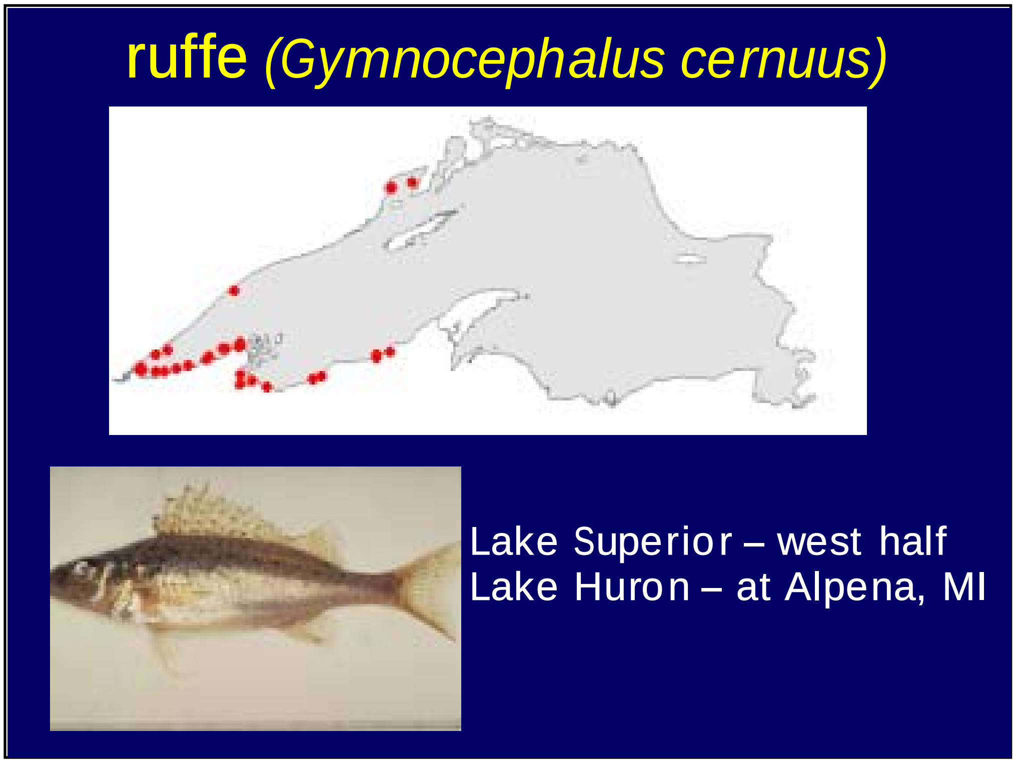
this is the zebra mussel - Found in harbors and sheltered bays across Lake Superior

You will notice that the St. Louis estuary is ground zero for entry of many non-natives.



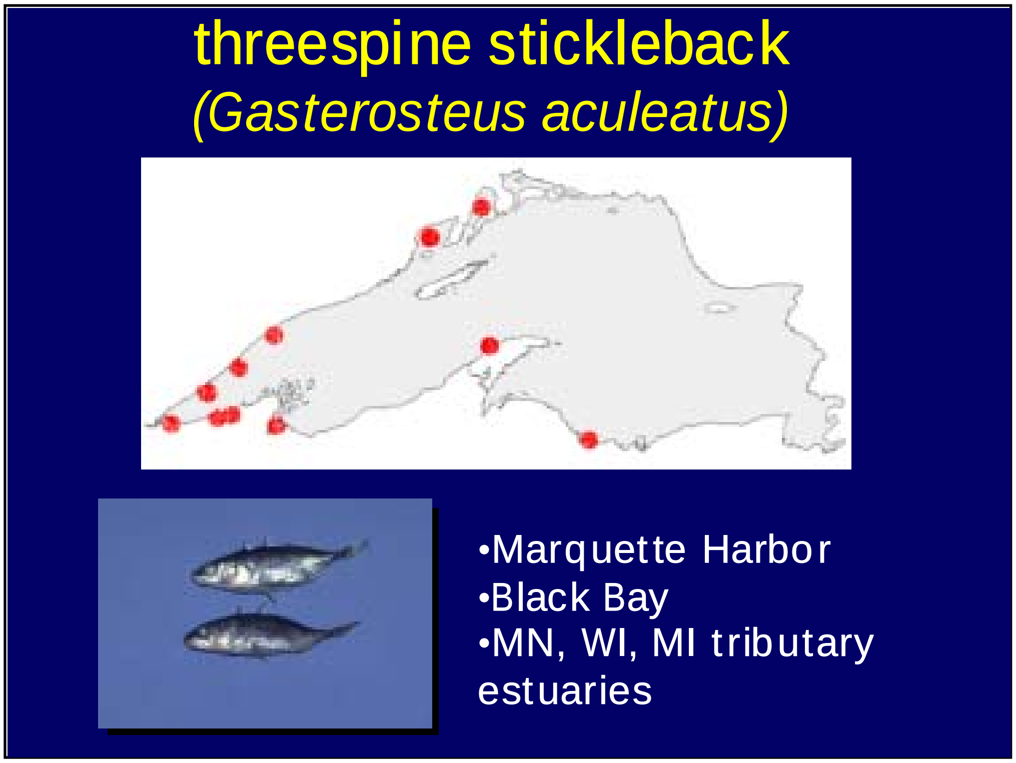
•the Roundnose goby and tubenose goby are only known to occur in Lake Superior in the St. Louis River estuary

source: from GLFC State of Lake Superior Conference 2002 - presentation by Mark P. Dryer & Gary Czypinski - USFWS-Ashland Fishery Resources Office, and Douglas A. Jensen - Minnesota Sea Grant Program



the ruffe is found in the west half of Lake Superior

•source: from GLFC State of Lake Superior Conference 2002 - presentation by Mark P. Dryer & Gary Czypinski - USFWS-Ashland Fishery Resources Office, and Douglas A. Jensen - Minnesota Sea Grant Program



the threespine stickleback was initially found in Thunder Bay Harbor in 1987, and now has spread to the locations shown here

Non-Native Species (2)

- Like Extinction, introduction is forever
  - persistent biological pollution
  - still uncertain of all possible associated impacts
- Need to integrate the results of biological indicators
  - requires a multi-disciplinary; multi-jurisdictional response
  - focused, systematic monitoring

While it is commonly understood that extinction is forever, so too is the introduction of new species. There is general agreement that the introduction of non-native species is rarely, if ever, reversible and, therefore, complete restoration of the original ecosystem and communities may not be possible. Sea lamprey populations, for example, can be controlled, but only with significant effort and monetary resources. In this way, non-native species represent a persistent form of biological pollution. In Lake Superior, we are uncertain of all the associated impacts from the introduction of non-native species.

To answer the question "Is Lake Superior healthy with respect to non-native species?" may only be possible by *integrating* the results from individual biological indicators. Since most of the plant and animal communities in and around the lake are good indicators of ecosystem health, the key may be the way in which the information is combined to provide an overall picture that is useful for decision makers and managers. In general, to determine overall biological integrity, it has been suggested that we use ***community-based indices***, as one species may not give adequate information. This requires a multi-disciplinary, multi-jurisdictional response.

Limited resources in monitoring and control techniques demand a stronger focus and a need to approach monitoring in a systematic way. We need to understand what activities, in a given area, promote the spread and introduction of non-native species.

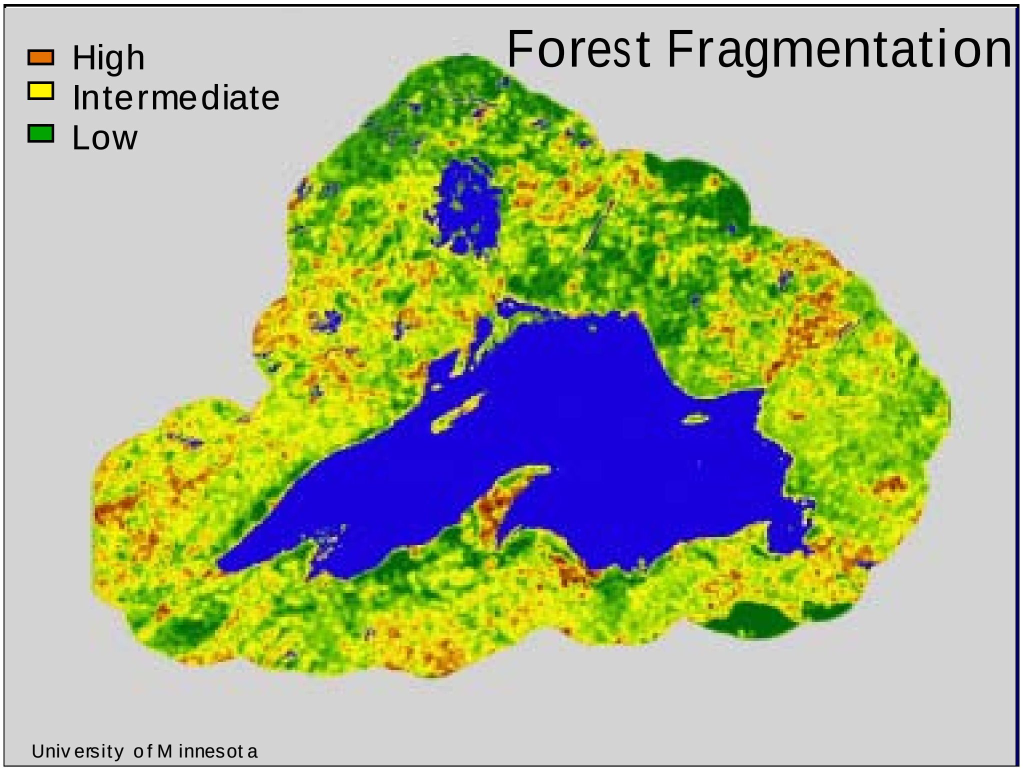
Habitat Fragmentation and Alteration

- Need to address changing landscape patterns in terrestrial systems
- Build an understanding of physical processes and historic dynamics
  - then begin to understand natural thresholds

The third biological integrity issue is habitat fragmentation and alternation.

In addition to coping with impacts on habitat from the loss of aquatic and other critical habitat, the influence of non-native species, and atmospheric transport of toxins from out of basin sources, our Lake Superior experts noted the importance of addressing changing landscape patterns in terrestrial systems.

In examining habitat loss, fragmentation, and degradation, managers and decision-makers need to ask the question "what happens when humans create conditions that are considerably outside the natural range?" Once we understand the physical processes and the historic dynamics of the Lake Superior ecosystems, we can begin to understand the natural thresholds. These processes include the frequency and intensity of human-based disturbance in relation to natural, background levels (e.g., forest fires). For instance, trees in the boreal forest require 25-30 years before they produce adequate seed supplies for their regeneration. Disturbances that occur more frequently than this cycle are a serious threat to ecosystem integrity.



Fragmentation of forest habitat is an indicator of terrestrial habitat conditions, and can result in the extirpation of native species.

The map shows areas of relative fragmentation in red, yellow and green. The scale is based on a index that takes into account natural distribution and human influence. Twenty-five percent of the basin is considered fragmented.

Pressures from forest cutting and associated road building, residential and recreational development are likely to increase in the future.

The long term consequences of incremental landscape change should be anticipated and avoided.

Chemical Contaminants

- Chemical contaminants impact Biological Integrity in Lake Superior in many ways: e.g.
  - Individual Species
  - Habitat
  - Human Health

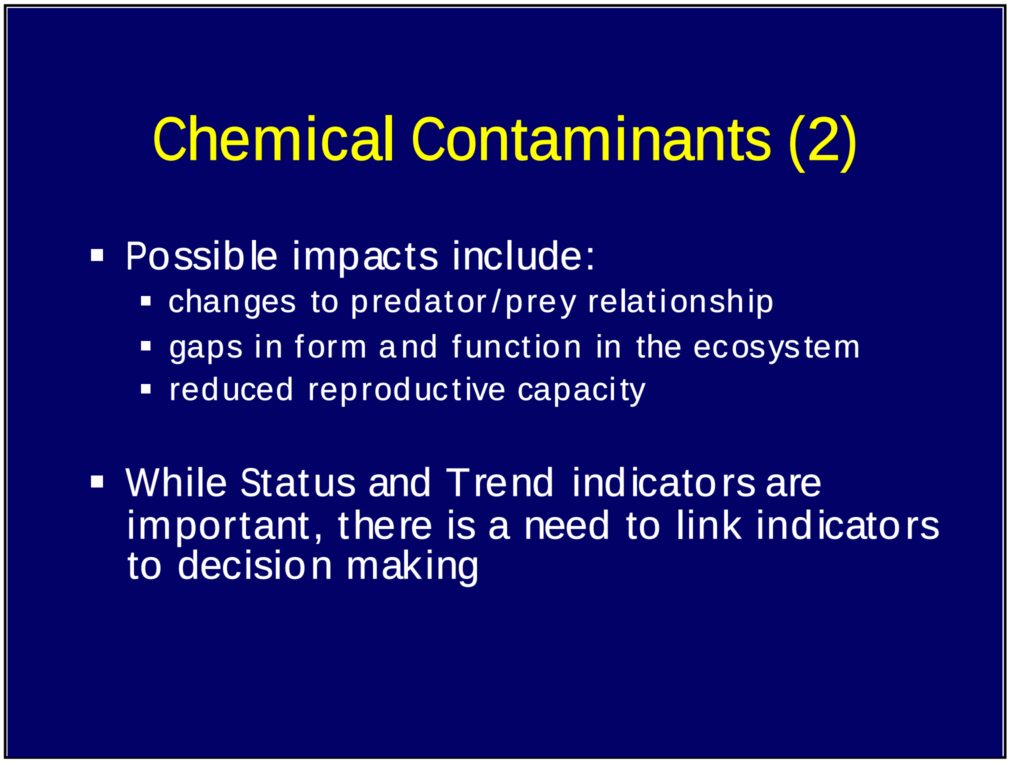
the fourth example of a biological integrity issue is chemical contaminants - in particular how they impact biological integrity the Biological Integrity of individual species, of habitat, and of human health.

At the species level, impacts can include acute and chronic effects in pelagic and benthic organisms, and the bioaccumulation of hydrophobic organic chemicals and metals. For example, effects on fish reproductive parameters have been observed in the effluent receiving waters of some pulp and paper mills, and toxicity testing of both industrial effluent and contaminated sediment has shown effects on aquatic organisms.

Habitat: By reducing the quality of habitat, contaminants affect survivability.

Habitat may be impaired by a loss of biological diversity. Increase in pollutant tolerant species, and physical alteration of habitat (due to sedimentation, dredging, etc.) For example, the cleanup of contaminated sediments at Northern Wood in Thunder Bay has involved the replacement of lost fish habitat due to dredging and infilling operations. As part of this compensation approximately 48,000 m2 of new or altered aquatic habitat has been created.

Human Health: Fish advisories illustrate the presence of chemical contaminants in fish and demonstrate the need to reduce contaminant levels in birds, fish, waterfowl, and wildlife. Exposure to contaminants may contribute to increased probabilities of cancer and other physiological effects (e.g., developmental problems such as learning disabilities, skin rashes, chronic disease) in humans.



- so possible impacts include changes to predator/prey relationship, gaps in form and function in the ecosystem, and reduced reproductive capacity

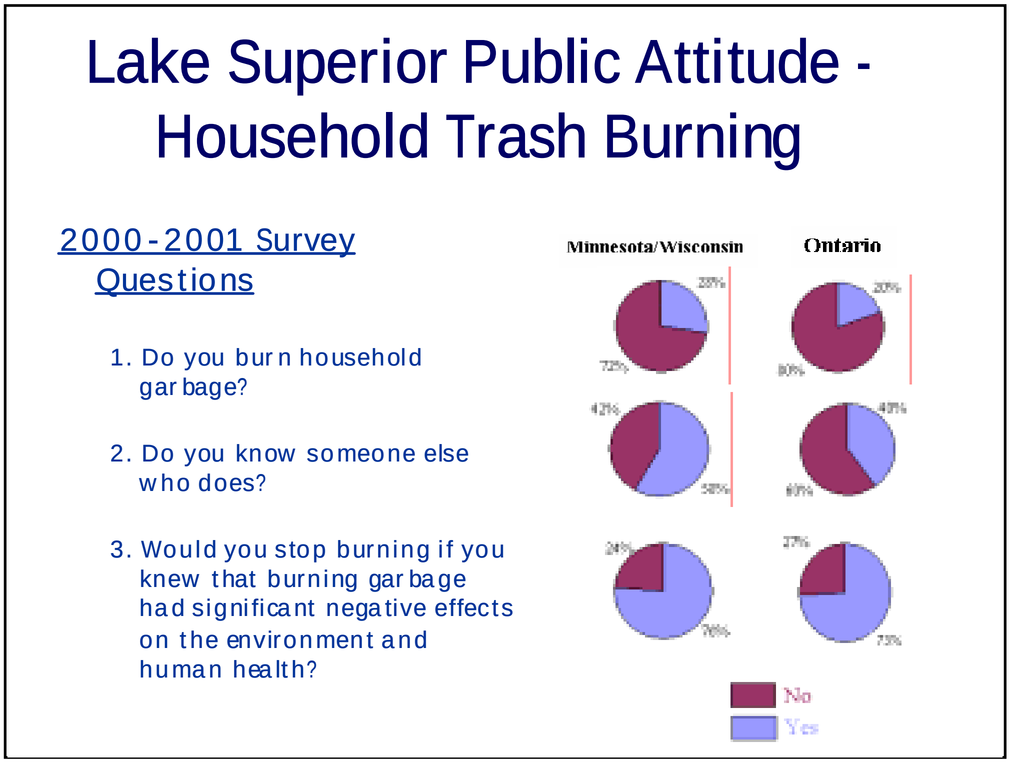
Several indicators exist which address the concentrations of contaminants in various media in Lake Superior. They are appropriate for "status and trends analysis" of contaminants, and are useful in pinpointing areas that are most severely impacted.. However, that they do not necessarily adequately measure the overall biological integrity. There is a need to determine a method to integrate the indicators, or combining indicators to fully assess impacts on biological integrity related to contaminants. To accomplish this, indicators need to be linked not just to the contaminants themselves, but to more practical applications of information such as fisheries, or the analysis of indicators needs to be better framed for decision-makers.

Chemical Contaminants (3)

- Need remediation and source reduction activity
- Expand monitoring programs for sources and ecosystem (e.g. track mercury emissions from coal fired power plants as well as heavy metal contamination in western Lake Superior)

While remediation activities may be needed to reduce contaminants in birds, fish, wildlife and people to acceptable levels, the sources of contamination must also be eliminated, reduced and tracked.

The Lake Superior Binational Program includes a goal of "zero discharge and zero emission of certain designated persistent, bioaccumulative toxic chemicals which may degrade the ecosystem of the Lake Superior basin." A number of source indictors are being used to track progress towards zero, however expanded monitoring of both source and ecosystem indicators is needed.

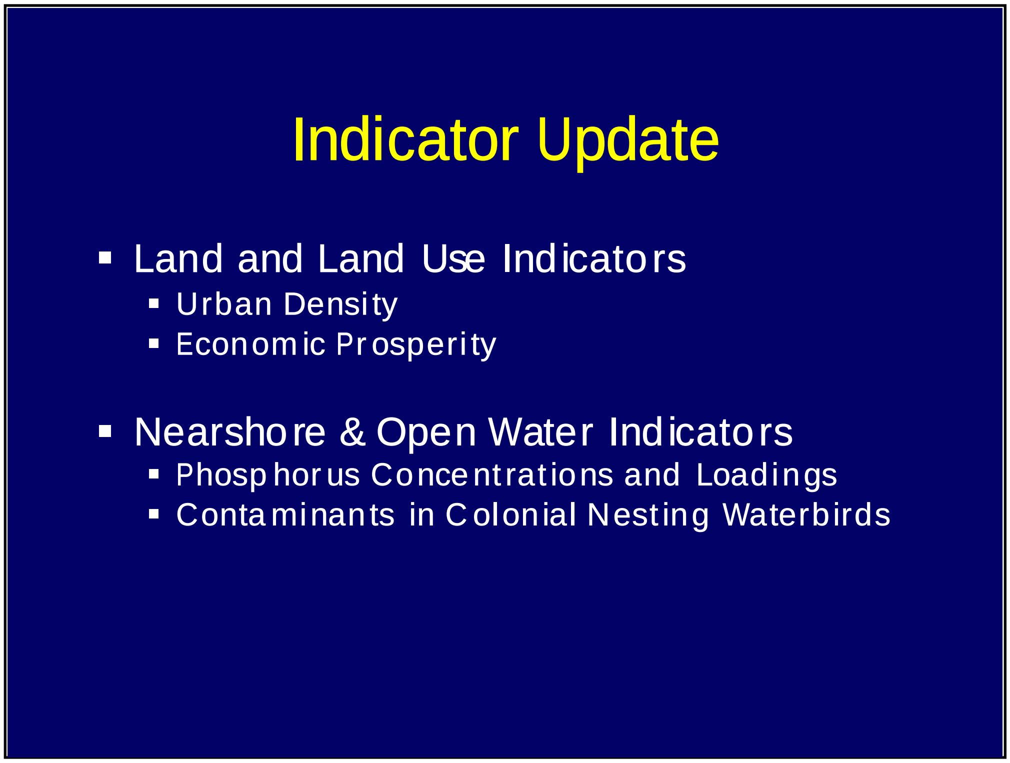


one such source that is currently being addressed is household trash burning. In 1990, many thousands of small inefficient incinerators were a major source of dioxin emissions in the basin. Air emission controls required by governments in the 1990s in large part have controlled this dioxin source. Burn barrels or backyard garbage burning is a continuing challenge in the rural Lake Superior basin. This practice produces dioxin that enters the environment and can be deposited on agricultural crops, posing human health risks through food consumption.

Environment Canada's February 2001 Inventory of Releases of Dioxin identified Burn Barrels as the third largest source nationally behind conical burners and medical waste incinerators. The United States Environmental Protection Agency (EPA) "Dioxin Re-Assessment" indicates that residential burning of household garbage generates 19 percent of the total quantifiable annual releases for 1995 of dioxins/furans. As air pollution control on incinerators improves, the relative percent contribution of dioxins/furans emissions from burn barrels is expected to increase and become the dominant source

projects of both the Binational Program and the Binational Toxics Strategy are underway to determine the best strategy for reducing this source.

this slide shows...



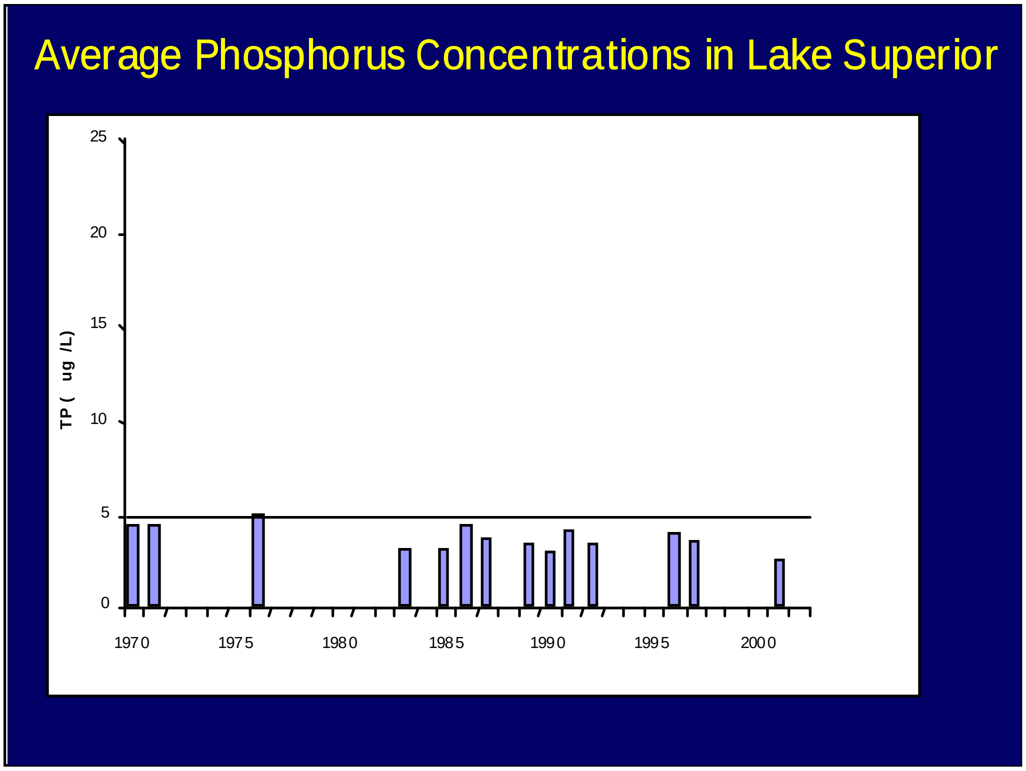
The indicator update papers which have been prepared for this SOLEC include information on Lake Superior. Here are four of those indicators.

Under land use indicators, urban density and economic prosperity are assessed as follows:

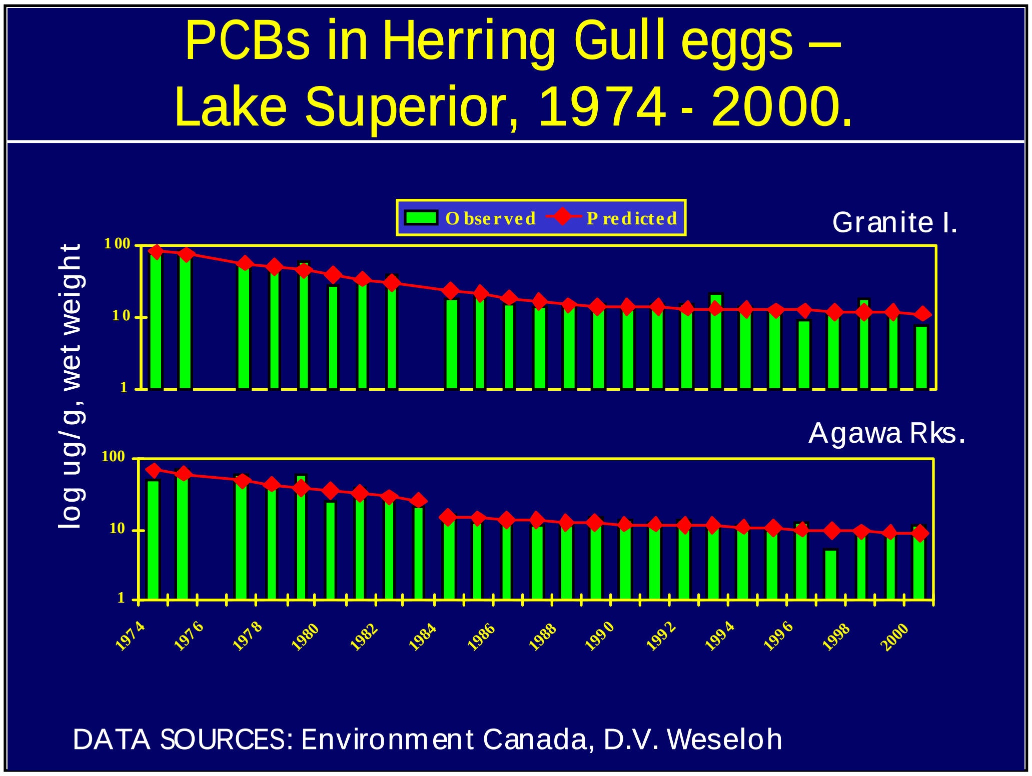
Overall population for the 16 U.S. Lake Superior basin counties dropped 1.4 percent from 1990 to 2000. Data from Statistics Canada shows an overall population density of 1 person per square kilometer (includes land and water) which was unchanged through the 1990s. For comparison, the population density for the U.S. part of the basin is 9 persons/km2)

For five years chosen from annual data (1975, 1980, 1985, 1990, and 1995), the civilian unemployment rate in the 16 U.S. Lake Superior basin counties averaged about 2 points above the U.S. average and above the averages for their respective states. In Ontario, the 1996 unemployment rate was 9-12 percent. Clearly, the goal of full employment (less than 5% unemployment) was not met in either the Canadian or the U.S. portions of the Lake Superior basin during the years examined.

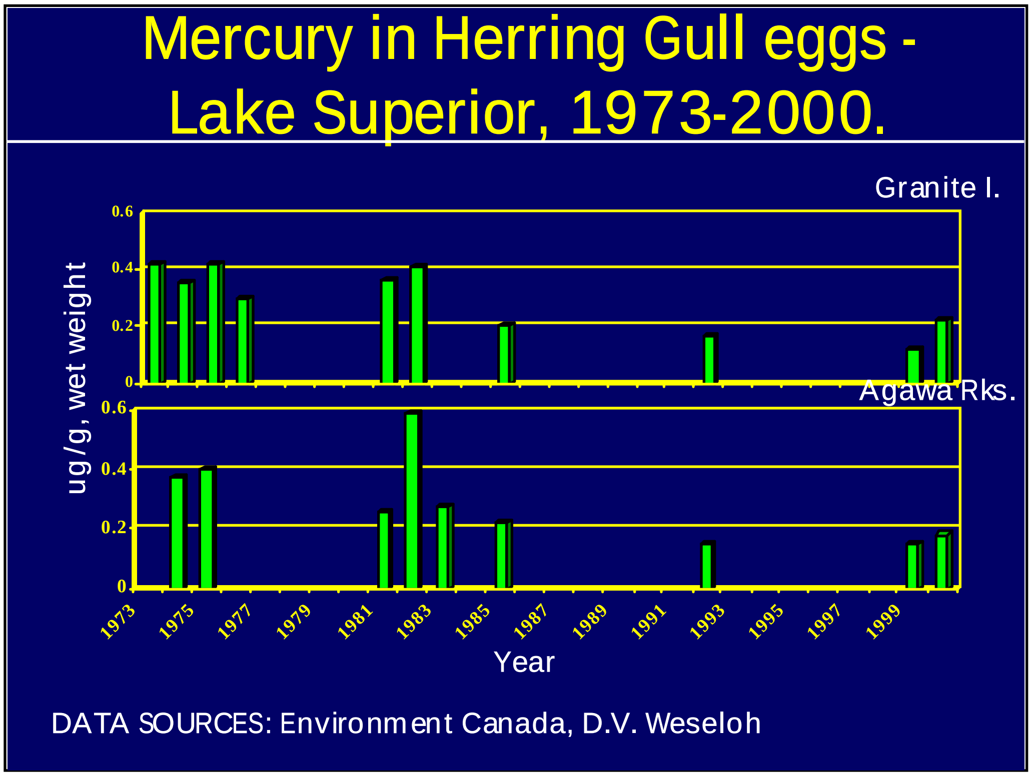
The next slides show phosphorus concentrations and contaminants in waterbirds.



Average concentrations of phosphorus in the open waters of Lakes Superior, Michigan, Huron, and Ontario are at or below expected levels of 5 micrograms per litre (based on P loads listed in the GLWQA)

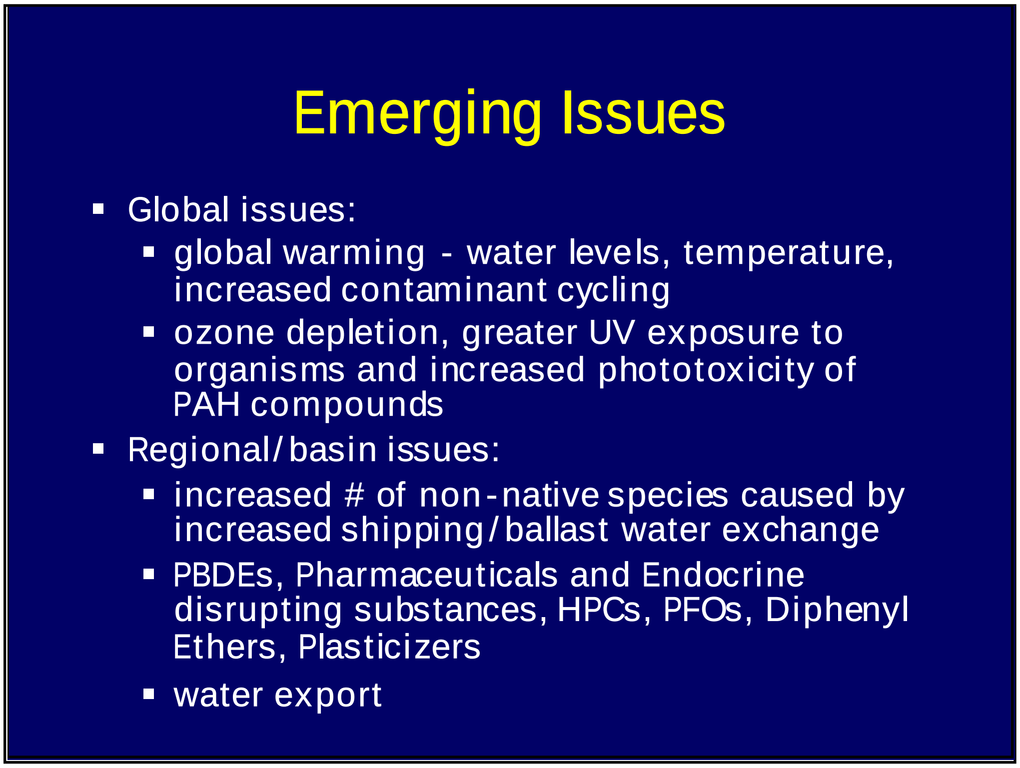


PCB levels in herring gulls from Lake Superior sites show a continuing decline.



Mercury levels have declined from levels seen in the 1970s and 1980s, but current trends are unclear.

A year by year analysis of the concentrations of 7 contaminants (PCBs, HCB, DDE, HE, 2,3,7,8-TCDD, dieldrin and mirex) in Herring Gulls at 15 Great Lakes annual monitor sites from showed that 78% of the comparisons had declined. Granite Island (Lake Superior - Black Bay) showed the greatest number of repeatedly declining comparisons



Emerging issues are defined here as those which have the potential for doing harm to the Lake Superior ecosystem, and which therefore require monitoring, research, and/or regulatory controls to prevent or minimize further harm to the ecosystem. These are issues to be studied and understood - in some cases there is already evidence of impact.

global issues include global warming (e.g., climate change effects and changes in habitat structure due to warmer water temperatures), Fluctuating water levels (e.g., related to climate change and resulting in exposure of previously buried contaminants in sediments to the air and to land-based organisms) non-native species (e.g., zebra mussels can affect the cycling of bioaccumulative contaminants), and the

ozone depletion - UV exposure to organisms and increased phototoxicity of PAH compounds.

regional or basin-wide issues include: the increased number of non-native species caused by increased shipping and ballast water exchange, new chemicals such as

Certain Polybrominated diphenyl ethers (PBDEs; flame retardants),

Pharmaceuticals and Endocrine disrupting substances (e.g., personal care products, hormones, antibiotics); approximately 30 classes of chemicals, some are not adequately addressed by the regulatory community,

Halogenated phenolic compounds (HPCs, such as hydroxylated PCBs),

Perfluorochemicals (PFOs)

Diphenyl Ethers; look and act like the chlorine compounds they replaced, aren't presently being regulated in US or Canada.,

Plasticizers (e.g., phthalates), and water export

In response to the IJC fifth biennial report, the Lake Superior Binational Program was *launched* in 1991. The program represents a partnership of federal, state, provincial, and Tribal/First Nation governments working together with citizens to ensure the protection of this international treasure. In 2001, the Binational Program celebrated ten years of progress toward achieving its goals of zero discharge of critical pollutants and protecting and restoring the ecosystem. The *zero discharge demonstration* is one of the unique features of the program. The Binational Program is working cooperatively with the Binational Toxics Strategy and the State of the Lakes Ecosystem Conference (SOLEC) to meet our goals.

Our 2002 progress report notes progress in several areas; (read slide)

You can access the LaMP 2000 and our 2002 LaMP Progress Report online at: http://www.epa.gov/glnpo/lakesuperior/.

BI issues information was contributed by:

The Lake Superior workgroup is made up of government and tribal agencies.