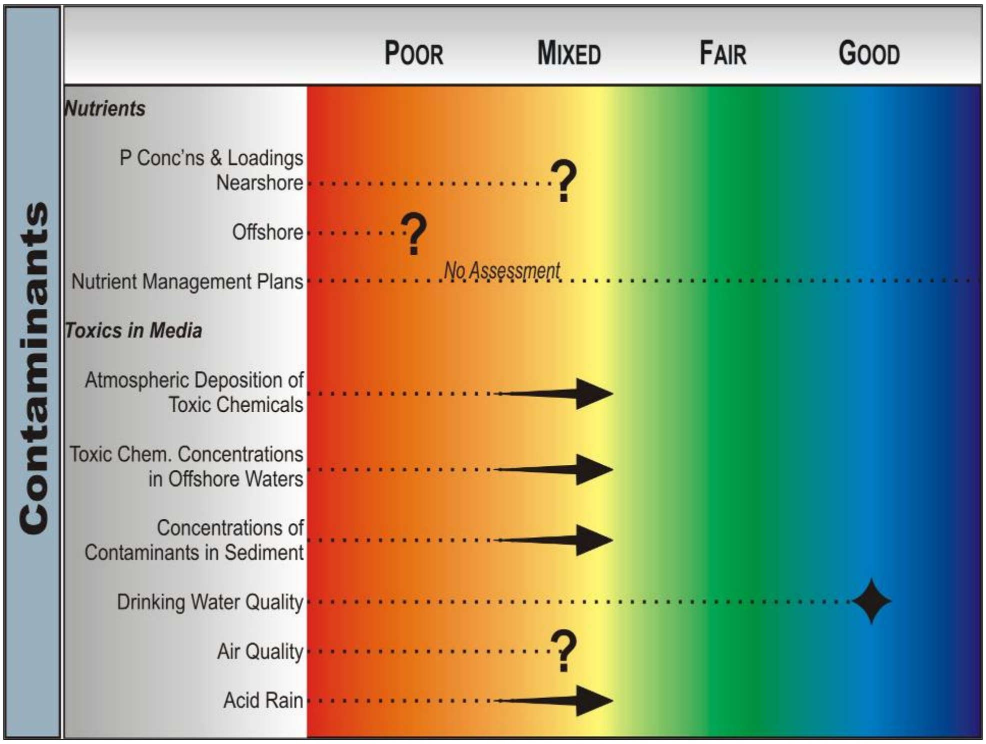
Good morning.

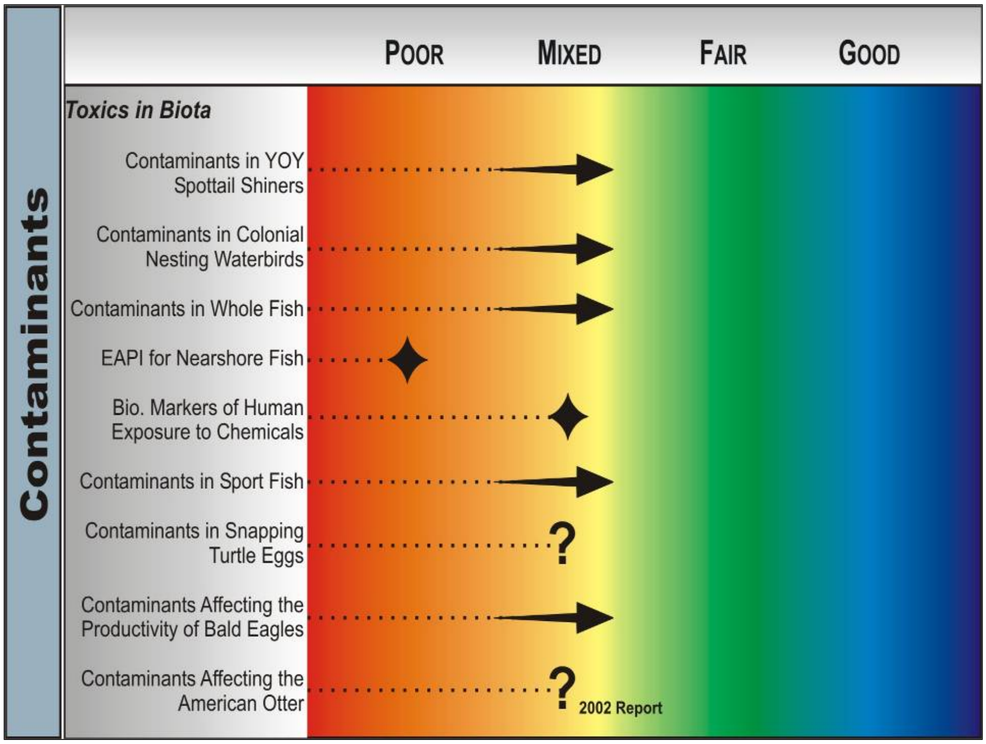
The status is mixed and the trend improving for Great Lakes contaminants. Some 70,000 commercial and industrial compounds are now in use and estimated 1,000 new chemicals are introduced each year. These chemicals provide us with products we use everyday. The impacts of legacy chemical contaminants and emerging chemicals to human and ecosystem health, however, are important issues. Tomorrow, the conference will be devoted to plenary presentations and discussions about both anthropogenic and naturally occurring chemicals.



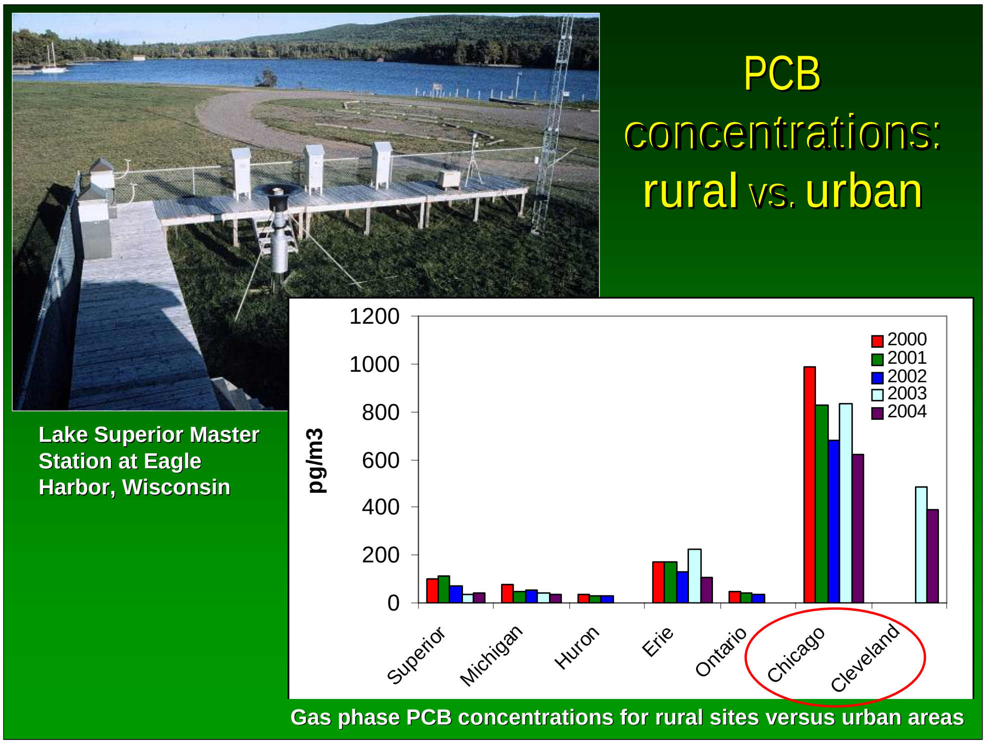
The indicator rainbow diagram and symbols shown here will be used by the first three presenters to summarize the assessment of categories of indicators. The Arrows represent trends; question marks indicate a need for additional or updated information; and the diamonds represent trends that are unchanging at this time.

A summary of a number of indicators highlight trends in the contaminants category. Conclusions from the indicator reports are based on various monitoring initiatives focusing on contaminants in the air, water, as well as in animals.

Generally speaking, the status and trend of Great Lakes Basin contamination is improving due to management efforts and regulations governing the many pollutant sources. Although air and water quality, as well as contaminant levels in animals have improved overall, much of the progress is site-specific. Contamination levels in areas with dense population and Areas of Concerns still often exceed acceptable levels as set forth in the Great Lakes Water Quality Agreement criteria.



In this continuation of the rainbow diagram, we see the indicators representing Toxics in Biota. As you can see from the consistent line of arrows in the yellow zone, most fall in the ‘mixed’ category.



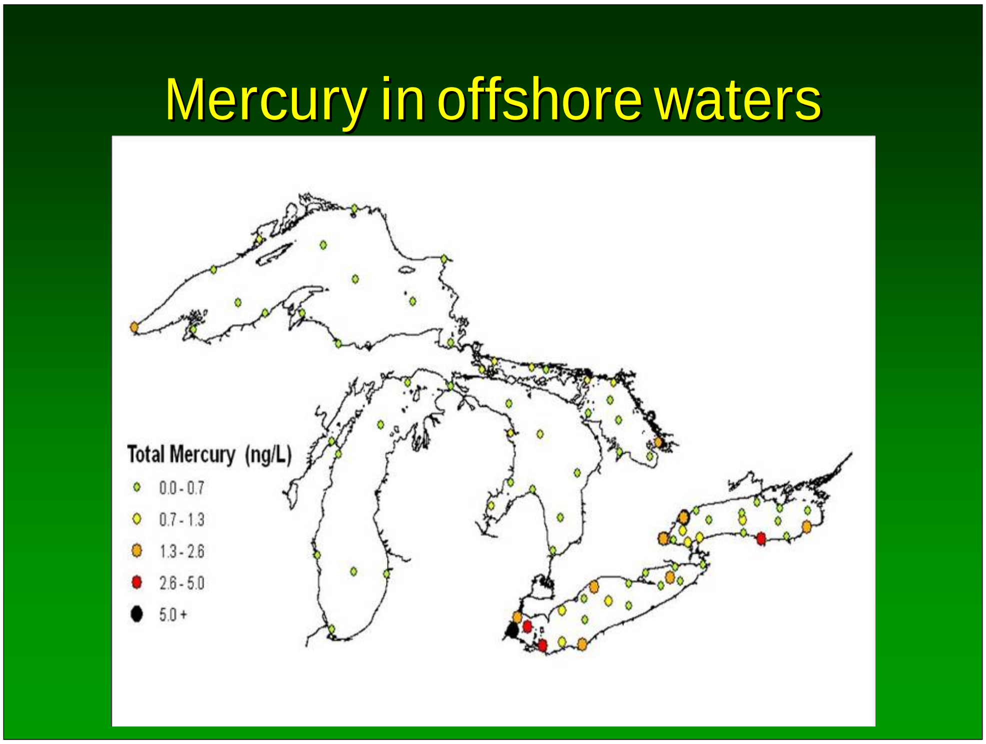
Moving to our first contaminant indicator, we look at Atmospheric Deposition of Toxic Chemicals.

Data from air monitoring programs show that concentrations of PCBs, banned organochlorine pesticides, and dioxins and furans are decreasing over time in the Great Lakes region. Levels of PAHs have been relatively constant since the early 1990s, but are starting to show signs of a decline, particularly at the IADN site in Chicago.

The figure in this slide shows that PCB concentrations at urban satellite stations in Chicago and Cleveland—circled on the lower right—are on average about 10-15 times higher than at the remote master stations at Eagle Harbor on Lake Superior and Sleeping Bear Dunes on Lake Michigan.

Data from the Canadian Atmospheric Mercury Network for the IADN stations at Egbert and Burnt Island on Lake Huron and Point Petre on Lake Ontario show that median total gaseous mercury concentrations decreased by 7-19% from 2000 to 2004. However, while U.S. data from the Mercury Deposition Network show that concentrations of mercury in precipitation are decreasing for much of the U.S., but there is no trend for the stations in the upper Midwest.

PBDEs have been found in the air at the IADN sites at levels about 10 times lower than PCB concentrations present at the same sites.

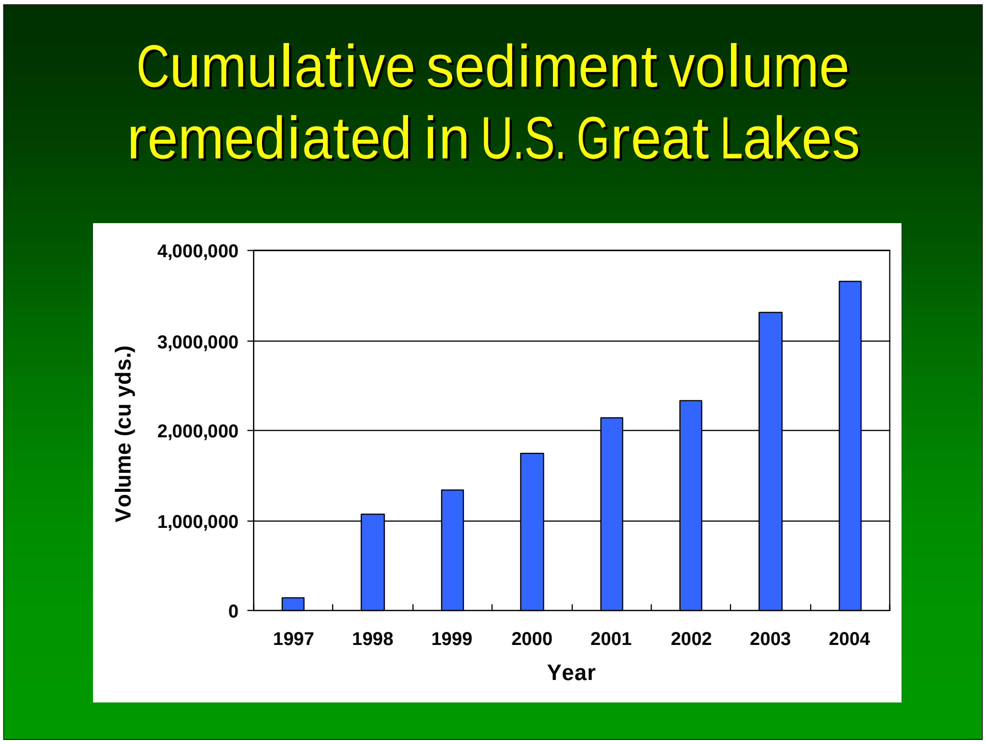


In offshore waters, mercury concentrations overall, as shown here, were well below Great Lakes Water Quality Annex 1 objectives. However, urban areas exceeded USEPA Great Lakes Initiative water quality criterion for protection of wildlife.

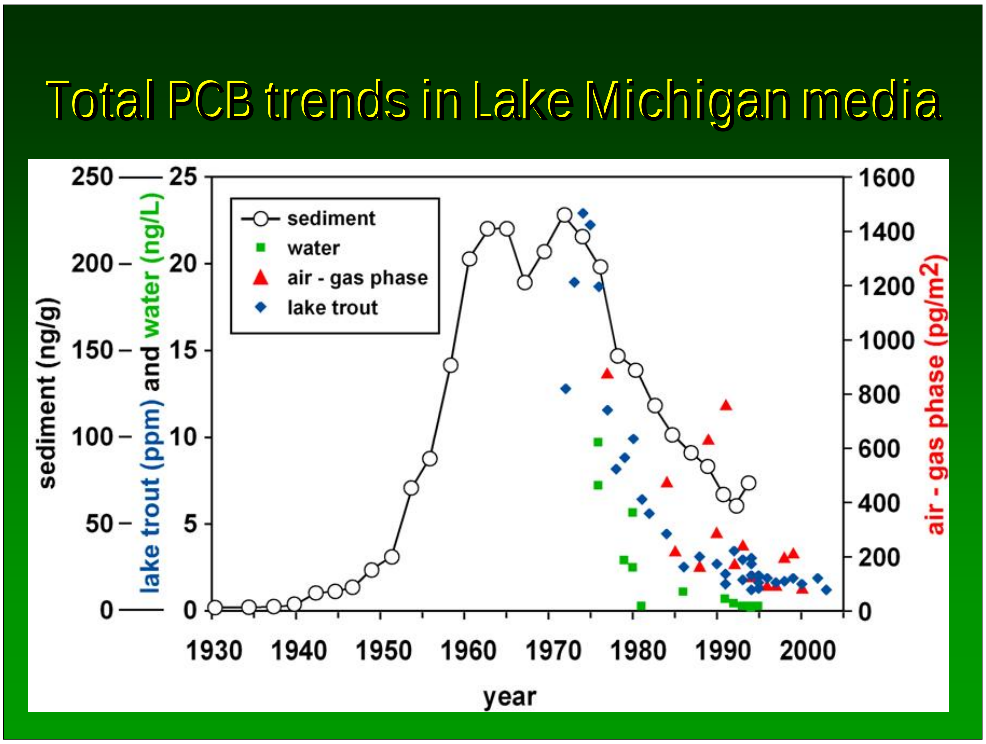
Generally, organochlorine pesticide concentrations exhibit a north to south gradient from lowest to highest based on work done by Environment Canada. Distributions and concentrations reflect ties to agricultural land-use practices. Loadings of currently used pesticides have greatly diminished to the point where indirect discharge is the more likely source. Sources of indirect discharges include atmospheric deposition, agricultural land runoff, and re-suspension of contaminated sediments.

Environment Canada and USEPA integrated available data from the open waters of each of the Great Lakes to develop a Sediment Quality Index using data on lead, zinc, copper, cadmium, and mercury. Generally, results show decreasing contaminant concentrations in the Great Lakes open-water sediments for the standard list of chemicals. This trend proves that management efforts to control inputs of historical contaminants have been successful.

Areas of Lakes Erie, Ontario and Michigan show the poorest sediment quality as a result of historical urban and industrial activities. Additional chemicals such as brominated flame retardants and some current-use pesticides may represent emerging issues and potential future stressors to the ecosystem.

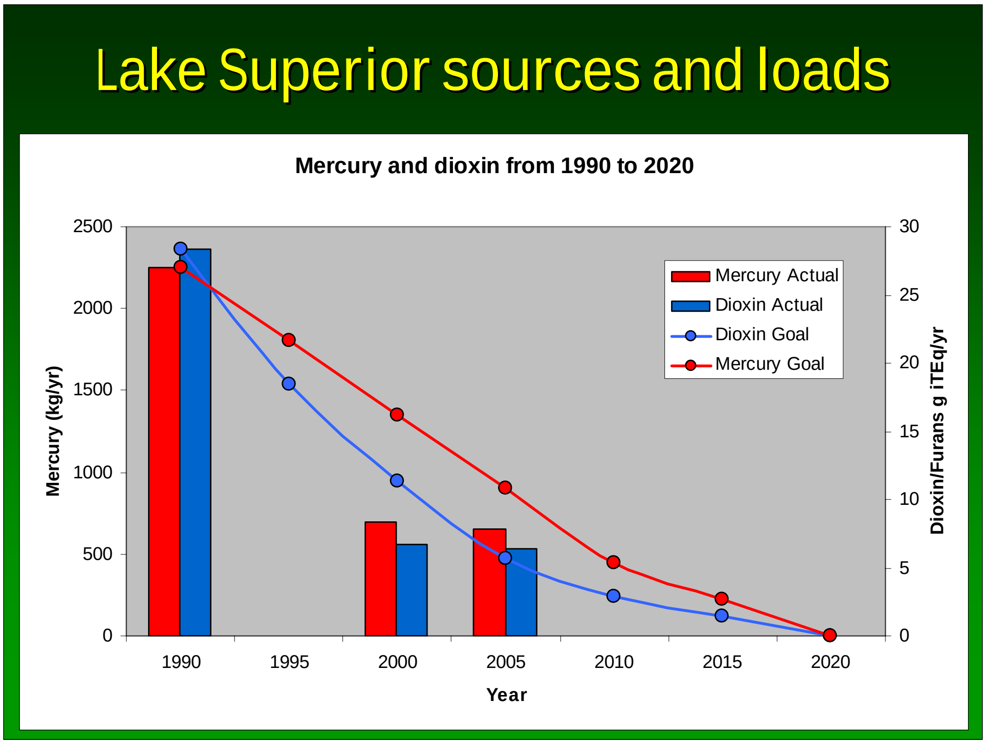


The remediation of contaminated sediments has aided the decrease of contaminants found in sport fish that is currently being seen throughout the Great Lakes basin. In this U.S. example, between 1997 and 2004 more than 4.5 million cubic yards of contaminated sediment have been remediated. However, the U.S. Policy Committee estimates that approximately 75 million cubic yards of contaminated sediment remain, which will cost 1.6 to 4.4 billion dollars to remediate.



There has been great progress in reducing some legacy contaminants, such as PCBs, in the Great Lakes. For example, this graphic shows the long term downward trend of PCBs in Lake Michigan sediments, lake trout, air, and water since peak concentrations in the 1970's.

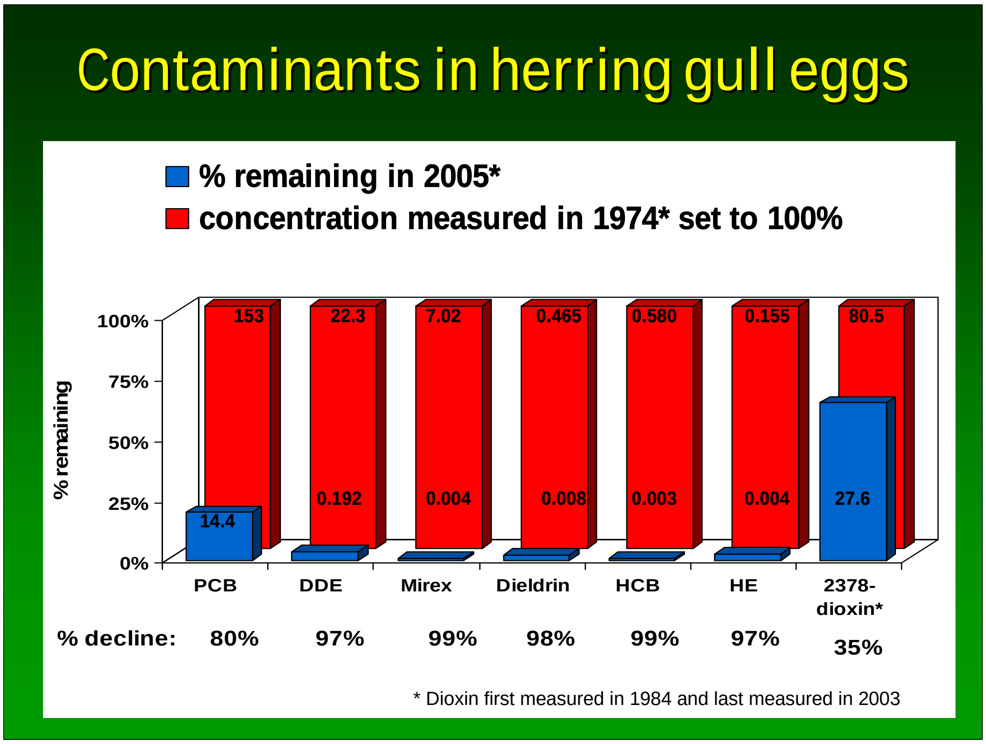
The rates of decline somewhat differ for the media and some exhibit a slowing of the rate of decline, but the take home message is that past and present actions have reduced PCB concentrations in Lake Michigan and it appears that they will continue to decline.



Decreases in contaminants in Great Lakes air, water and fish are directly related to the decrease in loading from sources within and outside of the Great Lakes watershed. In this Lake Superior example, the amount of mercury and dioxin released from sources within the Lake Superior basin have decreased significantly since 1990. The red bars show the mercury load and the red line shows the LaMP Stage 2 reduction schedule. The blue bars and line are for dioxin. For both chemicals, the loads are close to or below the Stage 2 milestones.

From here, we will look at indicators based on monitoring of contaminants in biota.

30 years ago the effects of contaminants on aquatic birds were very obvious and had dramatic population level effects, such as eggshell breakage due to eggshell thinning, and other effects on reproductive success, such as gross congenital deformities which caused population declines. Contaminant levels have decreased substantially. We are now learning that impacts from some substances can be much more subtle, often at the physiological level. Effects may involve suppression of the immune system, possible feminization of male birds, enzyme induction, hormone suppression, and disruption of the endocrine system. Eggs from Great Lakes aquatic birds are tested for numerous contaminants including organochlorines, PCBs, dioxins and furans, and PBDEs.

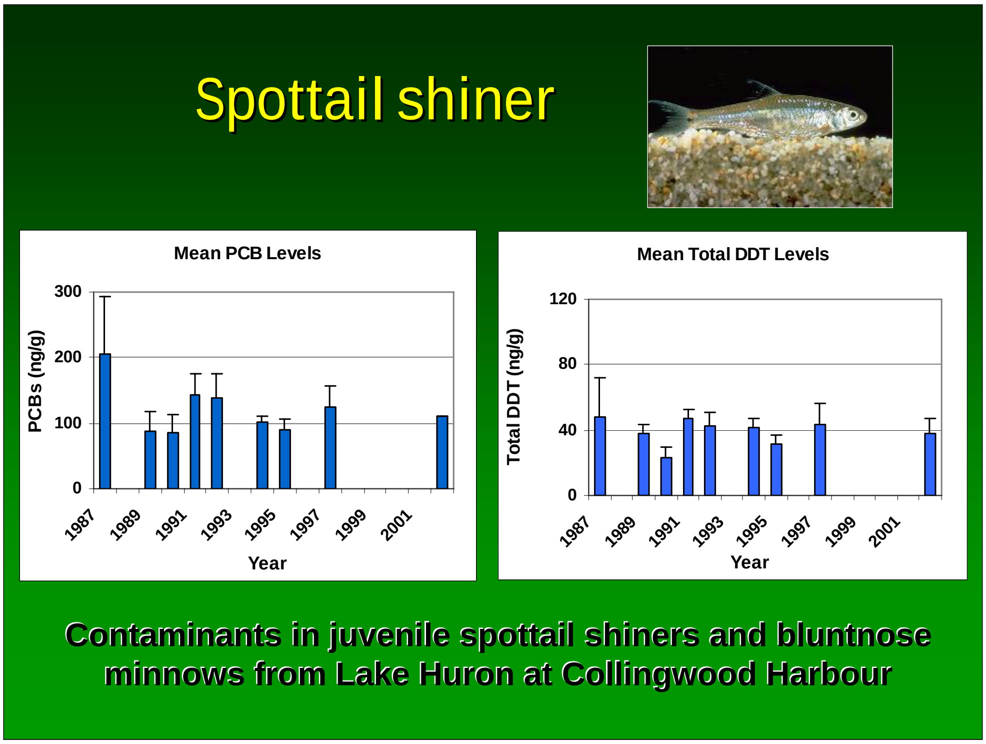


Overall, evidence of pollutants in herring gull eggs tested at monitoring sites between 1974 and 2005 showed a substantial decline,(>90%) as shown in the graph displayed here.

However, recent data collected by the Canadian Wildlife Service have shown that PBDEs are on the rise in aquatic birds. The levels of these compounds derived from flame retardants have risen by about 25% from 2000 to 2005, and appear to be the only measured contaminant in herring gull eggs that has shown a consistent increase.

The snapping turtle is another long-lived species that holds potential for the monitoring of wetland contamination levels, but sampling is currently limited. Work done by the Canadian Wildlife Service has shown that contaminants in snapping turtle eggs differ over time and among sites in the Great Lakes basin, with significant differences observed between contaminated and reference sites.

PBDEs are an emerging concern and have been detected in snapping turtle eggs, with concentrations showing an order of magnitude higher in urbanized areas as compared with monitoring sites in undeveloped areas. This is indicative of urban regions being the main source of PBDEs in the environment.



The juvenile spottail shiner is an important prey species for other fish such as white bass, smallmouth bass, and northern pike. As such, this small minnow is an important link for contaminant transfer to higher trophic levels.

Although the overall trend is improving, the contaminants detected in juvenile spottail shiners showed that the total DDT tissue residue still exceeds acceptable levels as set forth in the Great Lakes Water Quality Agreement criteria at most locations. PCB is the contaminant most frequently exceeding these guidelines after total DDT.

Contaminants conclusions

- PCBs, DDT, dioxins and furans and other “legacy” chemicals are declining
- More monitoring and research on chemicals of emerging concern is needed
- We continue to learn new things about potential chemical exposures
- Mixed status is locally-dependant

To conclude this contaminants category,

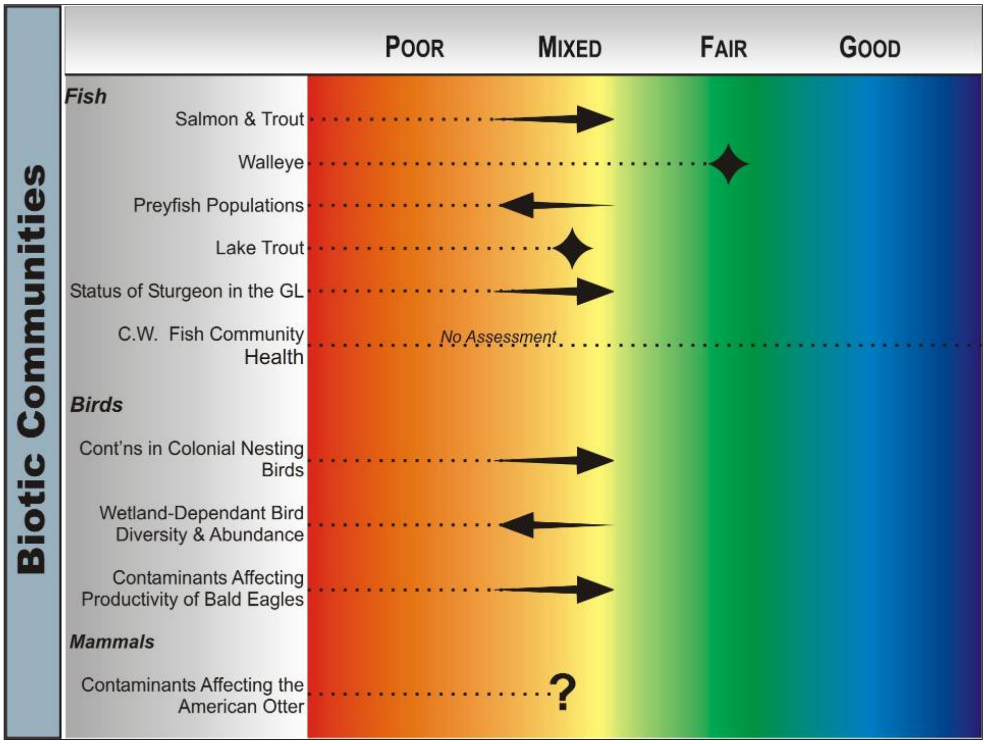
•Legacy Chemicals such as PCBs, DDT and dioxin have declined significantly due to reductions in sources and loads and are are now dropping at a slower rate.

•Chemicals have been measured in the Great Lakes for which there has been no or incomplete assessments of potential risks to human health and the environment. Some assessments have identified contaminants that could raise concerns, including: PBDEs, PFOS, chlorinated paraffins and naphthalenes; various pharmaceuticals and personal care products; phenolics; and approximately twenty current use pesticides. More monitoring and research on chemicals of emerging concern is required.

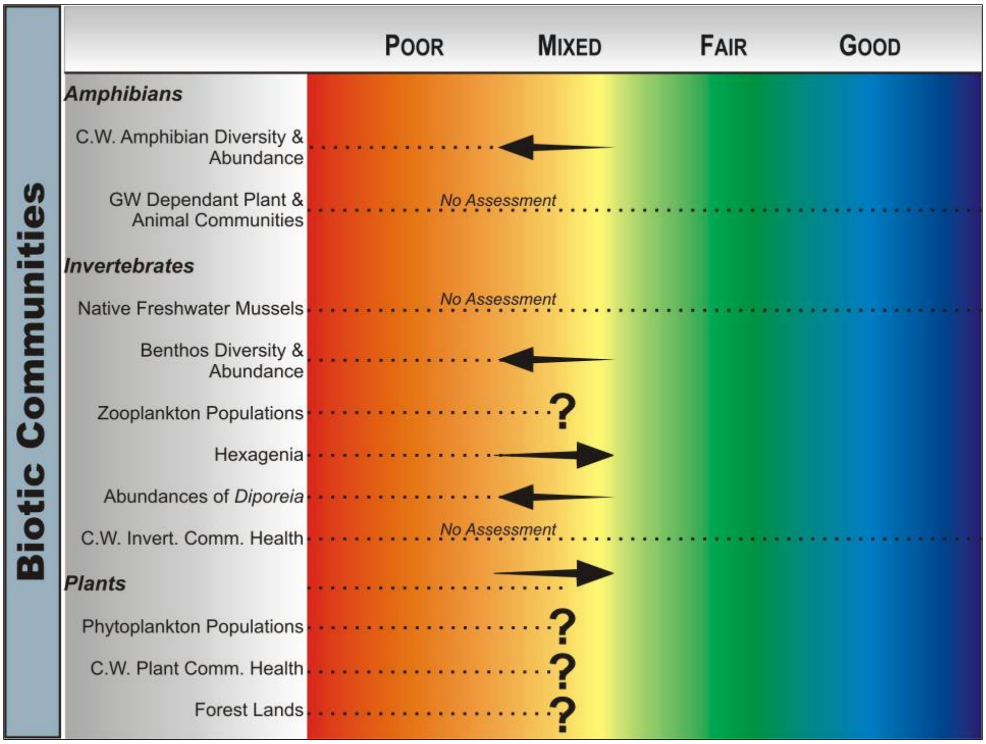
•We continue to learn new things about potential chemical exposures. Now that contaminant levels have declined, continued monitoring shows that some chemicals such as PCBs, DDT, dioxins, mercury and toxaphene may have effects at lower levels than previously suspected. More study is needed to determine the significance of these responses.

•Also, mixed status is locally-dependant: Areas with high population density and areas of concern still have elevated levels of contaminants, while levels of certain contaminants are improving in specific biota and media.

In the biotic communities and invasive species categories the status is mixed and the trend undetermined for biotic communities. The status is poor and trend deteriorating for invasive species. This next group of indicators addresses biotic communities and the biological integrity in the Great Lakes. Disruptions, such as contamination, the introduction of non-native species, and reduction of predator species have had cascading effects, significantly transforming the community structure, populations, and health of individual species in the basin. Disruptions of biotic communities in turn, affects ecosystem services, local communities, and national economies.



A number of indicators have been developed for the purpose of measuring impacts on biotic communities as well as the results of management and restoration projects and policies.



In these rainbow charts we see that particular aspects of the biotic community can be considered 'fair' or 'good,' while other components are better classified as poor. The 'poor' status is result of the bottom-up as well as top-down affects of habitat loss and deterioration, introduction of invasive species and contaminant levels throughout the region.

Diporeia

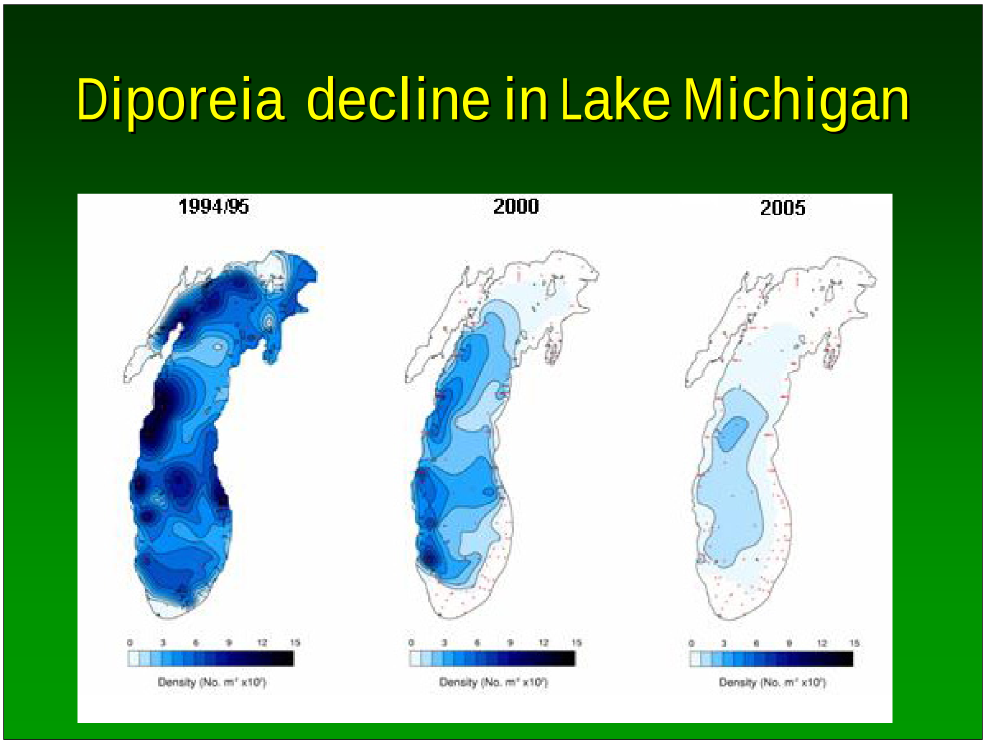
Lake Michigan	Declining
Lake Huron	Declining-absent
Lake Ontario	Declining
Lake Erie	Very rare-absent
Shallow waters	Rare-absent
Offshore waters	Declining

Abundances of the benthic amphipod Diporeia continue to decline in Lakes Michigan, Huron, and Ontario. While populations are presently gone or rare in shallow waters in each of these lakes, they are also declining in deeper, offshore waters. These declines coincide with the range expansion and increase in abundance of quagga mussels.

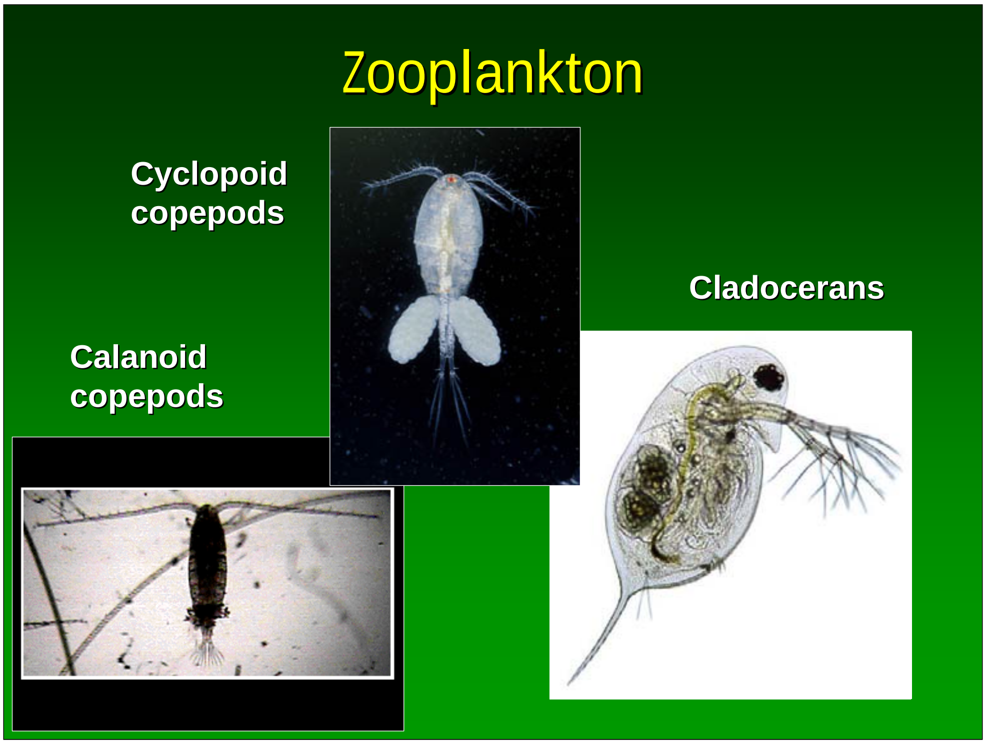
Decreases in the abundance of Diporeia in Lake Huron are particular severe. They are now completely gone from depths less than 60 meters, except in the northeastern end of the lake, and they continue to decline at depths greater than 60 meters.

Diporeia are naturally not present in the Western and Central basins of Lake Erie. However, in the Eastern basin, Diporeia populations began declining in the early 1990s and have not been found since 1998.

Data sets are conflicting on current trends of Diporeia populations in Lake Superior. Some monitoring programs show that Diporeia abundances are declining in offshore areas, greater than 90 meters, but others do not demonstrate changing abundances in either offshore or nearshore areas.

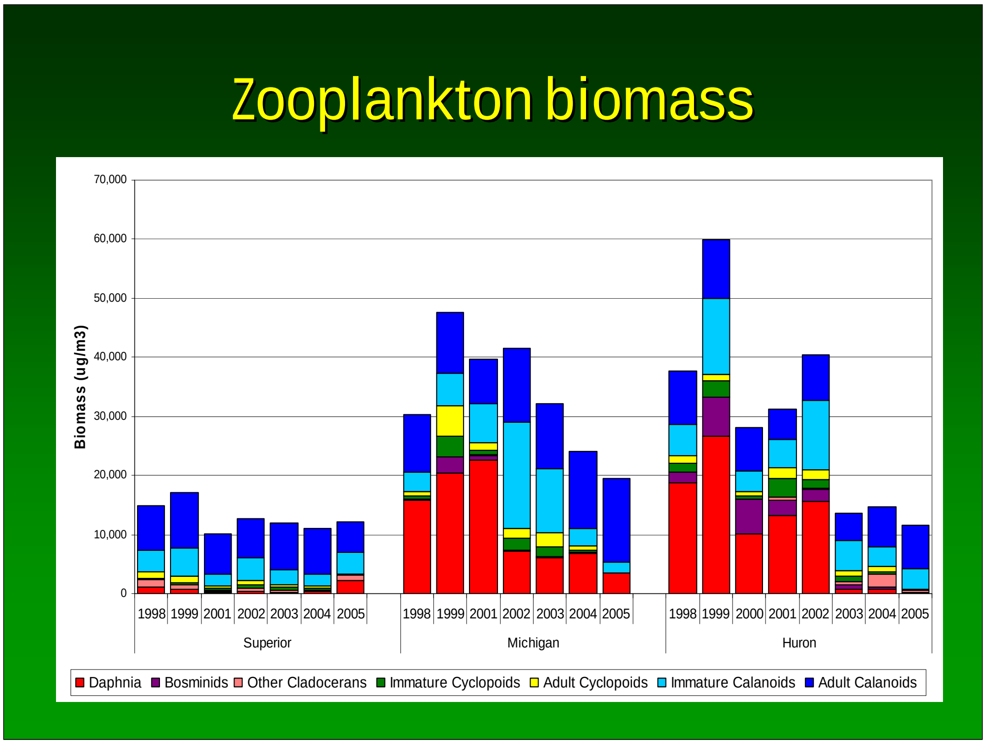


Diporeia abundance in Lake Michigan is in poor shape and getting worse. A lakewide survey conducted in 2005 indicated abundances were 84 % lower than were found in the year 2000. Compare the abundance map on the right with the one in the middle. Diporeia are now completely gone from depths less than 80 meters over most of the lake, and abundances are in the state of decline at depths greater than 80 meters.



Changes in zooplankton populations reflect changes in aquatic food webs, because zooplankton are food for species in other trophic levels. In lakes Huron and Michigan and, more recently, in Lake Ontario, there has been a shift in zooplankton summer biomass and in the types of dominant zooplankton groups.

In the following figure, I will be comparing abundances of calanoid copepods, an example is seen here on the left, with those of cyclopoid copepods, shown here in the middle photo, and cladocerans. Generally calanoid copepods are more abundant in cold, oligotrophic waters, while cyclopoid copepods and cladocerans are more often associated with warmer, mesotrophic waters.



Stay with me on this graph. Calanoid copepod biomass is represented by the blue colors, cyclopoid copepods by the green, and cladocerans by the red.

From 1998 through 2005 in Lake Superior, on the left, total summer biomass has been relatively constant and dominated by a calanoid copepod community, the blue bars. Remember the calanoids are typical of cold, oligotrophic conditions.

In Lake Huron, on the right, since 2003 we see that the biomass of cladocerans (the red bars) and cyclopoid copepods (the green bars) had declined dramatically, and the zooplankton community was dominated by calanoid copepods (the blue bars). As you can see in these graphs, Lake Huron is beginning to resemble Lake Superior in terms of both zooplankton biomass and species composition.

In Lake Michigan, here the middle set of stacked bars, beginning in 2002 and especially in 2005, the data suggest that a similar change in the zooplankton community may be occurring.

Preyfish

- **Consists of native and non-native species**
- **Biomass supports predator fish populations and is declining**
- **Loss of preyfish food source (*Diporeia* and zooplankton)**
- **Impact of non-native zooplankton, spiny water flea and fish hook water flea**

Preyfish populations are a mixture of both native and non-native species. Unfortunately, the deterioration of preyfish populations is common across all lakes except in Lake Superior. Their biomass is important for its role in supporting predator fish populations, so the recent decline in alewife and smelt abundance could therefore have important implications in other parts of the food chain.

Recognition of this decline has resulted in recent salmon stocking cutbacks in Lakes Michigan and Huron, and only minor increases in Lake Ontario. In all lakes but Superior, the introduction and establishment of quagga mussel which is linked to the collapse of Diporeia, may be causing additional pressure, although this link is not yet proven.

Walleye

- Status improving in most lakes

Success of:

- Phosphorous loading reductions
- Inter-agency management

An exceptionally strong 2003 hatch, due to ideal weather conditions and a decline in alewife populations, has bolstered walleye abundance in nearly all the Great Lakes. However, low reproductive success post-2003 will not permit populations to increase in many areas keeping the populations at low to moderate levels for the next several years. As such, fisheries harvests have improved in recent years but remain below targets in nearly all areas.

With commercial and sport fisheries data, the status of walleye populations is used to measure of the quality and quantity of mesotrophic habitats. Reproductive success of walleye is affected by changes in nutrient concentrations, by weather, water-levels, and from predation and competition by non-natives.

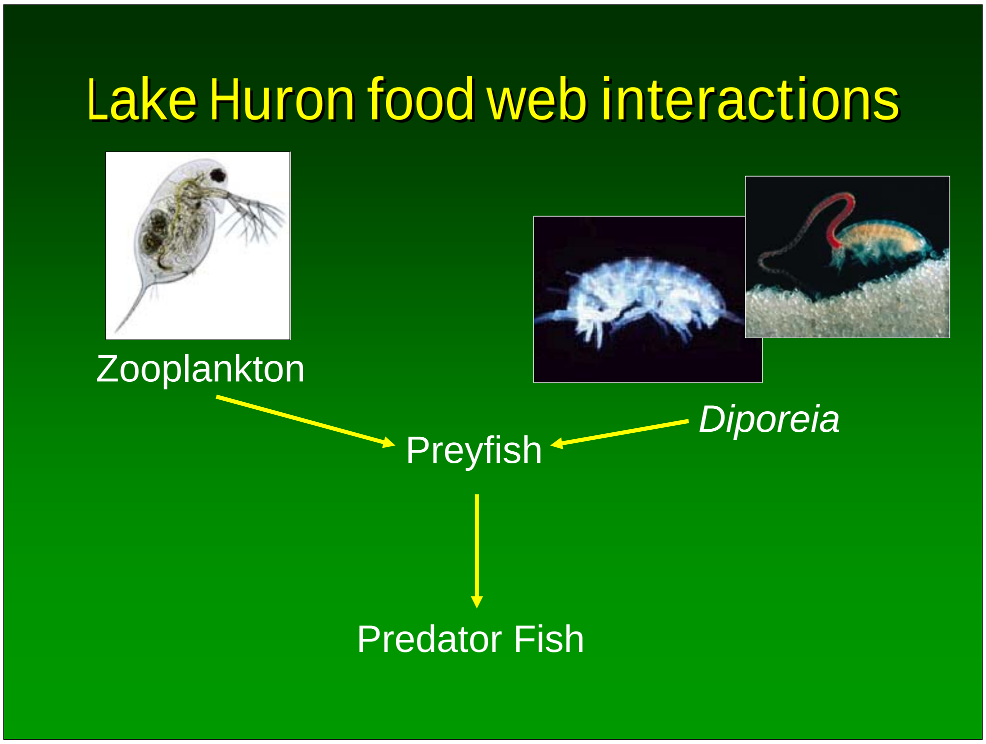
Reductions in phosphorus loadings during the 1970s substantially improved spawning and nursery habitat for many fish species in the Great Lakes, including walleye. Walleye abundance has increased in every Great Lake. High water levels also may have played a role in the recovery in some lakes or bays. For this reason, the status of walleye is considered “fair” Lakes Michigan, Huron, Erie, and Ontario. But concerns about food web disruption, pathogens (such as botulism and viruses), noxious algae, and watershed management practices persist.

Lake trout

- **Lake Superior stocking has been discontinued**
- **Increased abundance in all lakes**
- **Result of sea lamprey control, stocking, and harvest control**

In Lake Superior, lake trout stocks have recovered such that hatchery-reared trout are no longer planted; the trend in recovery continues to improve. In other Great Lakes, status and trend vary. The outlook is worse for Lake Michigan where lake trout status is poor and declining. Status for Lake Erie is mixed, with stocks unchanged.

The status in Lake Huron is improving possibly due to lack of predation pressure on juvenile lake trout by alewives. In Lake Ontario, stock status is mixed and declining. Following significant reductions of sea lamprey, combined with large releases of hatchery-reared trout and with controlled harvests, expectations were that lake trout stocks in all 5 lakes eventually would revive and become self-sufficient. At present, this has only happened for stocks in Lake Superior.



The food web situation for Lake Huron presents a particular example of the trends presented in the previous slides. Correlations exist between many of these trends, but the actual mechanisms for the presented changes continue to elude Great Lakes scientists.

Interestingly, the disappearance of the preyfish alewife is potentially tied to a positive trend in the Lake Huron fishery. Reduced adult alewife predation on juvenile walleye and lake trout is resulting in increased survival rates of these species.

Declines in alewife abundance may alleviate nutritional diseases in some top predator fish. Deficiencies in the vitamin thiamine, resulting from alewife-dominated diets, can cause early death in lake trout and other salmon species.

Note, it is still important that another native preyfish fill the niche vacated by alewife if predator fish are to have enough prey items for consumption.

The conclusions for the biotic community category of indicators are:

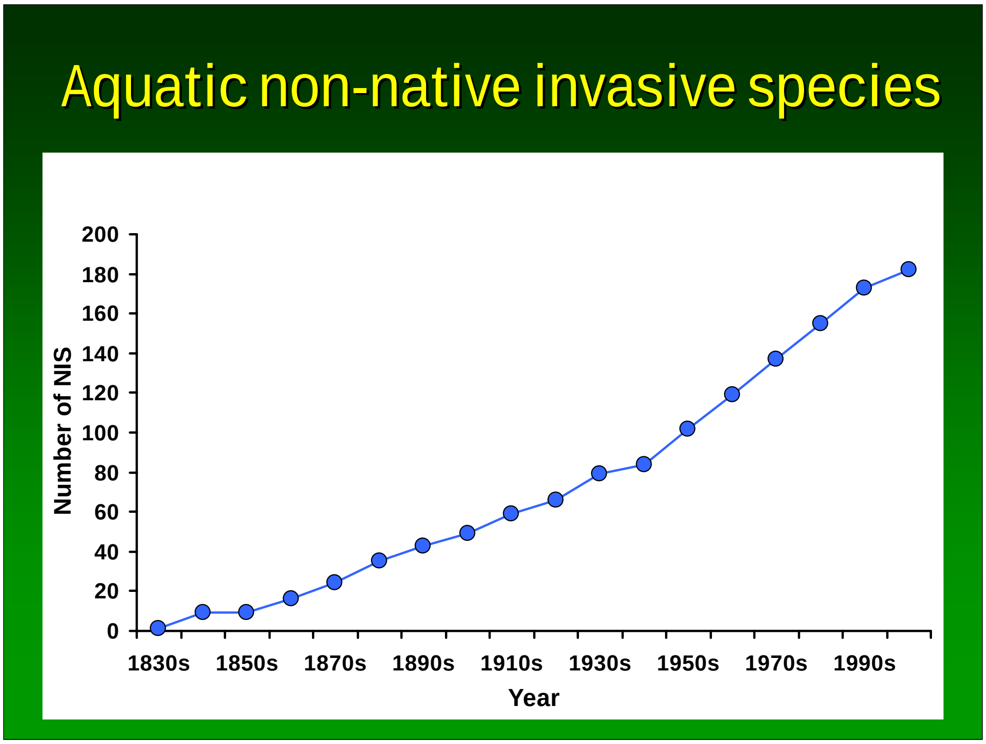
•First, is the decline in the abundance of the benthic invertebrate, Diporeia in Lakes Huron, Michigan and Ontario, and its disappearance from Lake Erie.

•Also notable is the dramatic decline in Zooplankton in Lake Huron; and the similar decline underway in Lake Michigan.

•Preyfish populations are deteriorating in all lakes but Superiors.

•Walleye harvests have improved, but are still below targets.

•Hatchery-reared trout are no longer planted in Lake Superior, the conclusion is less positive in the other lakes.

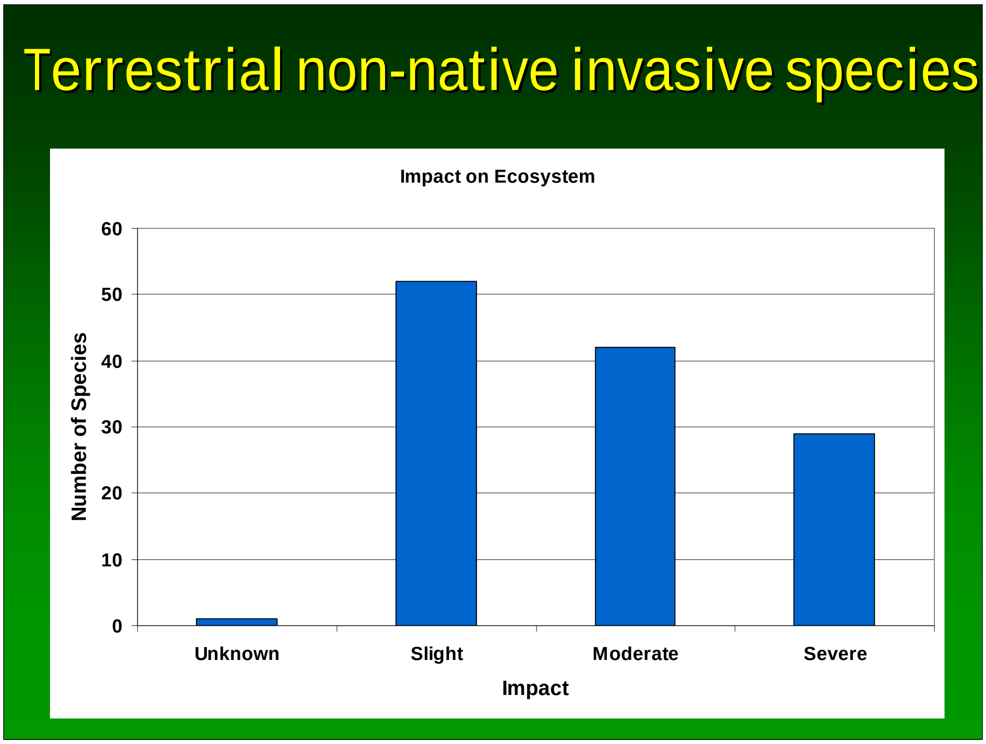


I would like to spend several minutes on invasive species.

As we have noted, invasive species are a major driver of change to the biological integrity of the Basin. Here we see a graph showing the number of introduced aquatic invasive species steadily increasing since the 1800s. Over 182 species of exotic algae, fish, invertebrates, and plants have become established in the Great Lakes.

The most problematic of these include the: alewife, common carp, Eurasian ruffe, Eurasian water milfoil, quagga mussel,round goby, rusty crayfish, spiny waterflea, and, of course, the infamous zebra mussel.

Great Lakes shipping ports have become major points of entry for several exotic aquatic species in recent years. Improvements to ballast water regulations--is necessary to prevent new invasions.



Onshore, we also see an increase in the number of terrestrial invasive species.

This figure shows the estimated impacts of 157 non-native plants and animals located in the basin, as described by experts. The data shows that most invaders have only a "slight" impact. However, as we have learned from management, the impacts of those in the "severe" group are highly detrimental and costly. Examples include:

•Garlic mustard

•Dutch elm disease

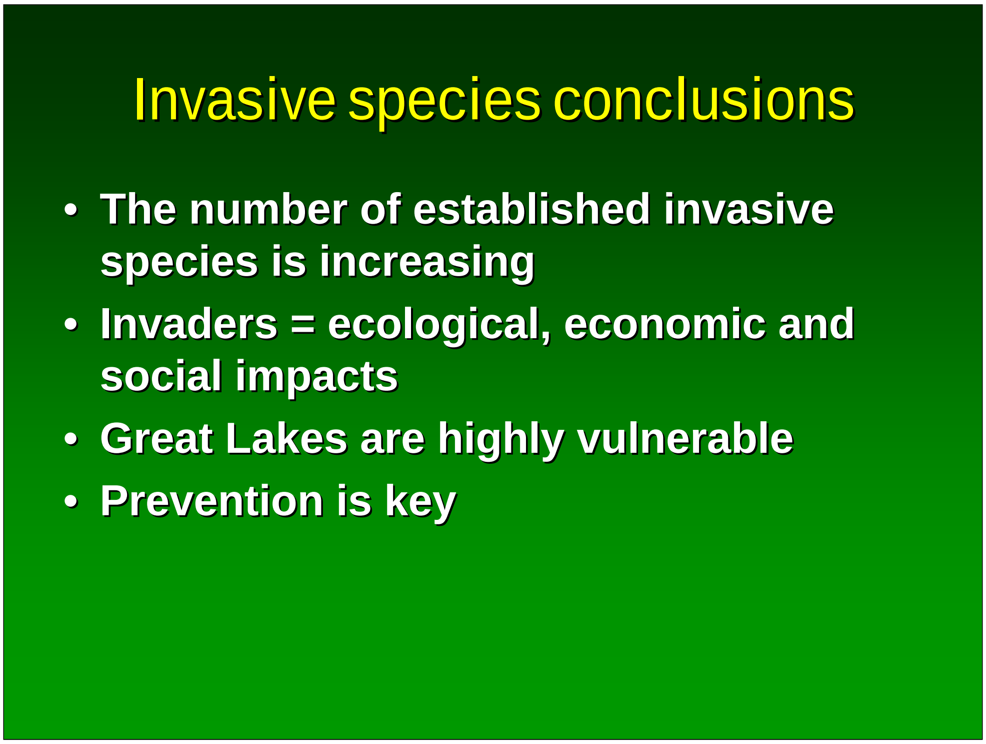
•The Emerald Ash Borer

Invasive plants, which make up the majority of the species described here, tend to arrive as seeds accidentally in other plant materials. Other terrestrial non-native invasive plant species enter the United States and Canada in agricultural produce, nursery stock, cut flowers, or timber.

One such invader that is assumed to have arrived in wood packaging from a ship or plane is the Emerald Ash Borer. This highly destructive insect from Asia was first spotted in North America in 2002. In the Great Lakes region the Emerald Ash Borer distribution is rapidly expanding despite extensive containment, quarantine and eradication measures.

Since 2003 in Ontario, the borer has infected 23 new sites to the east, all beyond a management firewall. In Michigan, the borer was reported at 29 new sites in 2004. New infestations were also reported in Ohio and Indiana.

The beetle has already killed millions of ash trees in Southwestern Ontario, Michigan and surrounding states, and could cost billions of dollars in lost timber and ornamental trees, and dramatically change the forest and neighborhood landscape in eastern North America.



And the conclusions for the invasive species category of indicators are:

•Non-native species continue to invade and become established in the Great Lakes basin at a increasing rate.

•Invaders already present have had serious ecological, economic, and social impacts.

•The basin is particularly vulnerable to invaders because it is highly populated, is a major pathway of trade, and is already disturbed.

•Given the difficulty and costs associated with eradication and control programs in large open-water systems, prevention is the best medicine.


Information and photo acknowledgments & sources
• Great Lakes Fishery Commission
• IADN
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Environment Canada
Environnement Canada