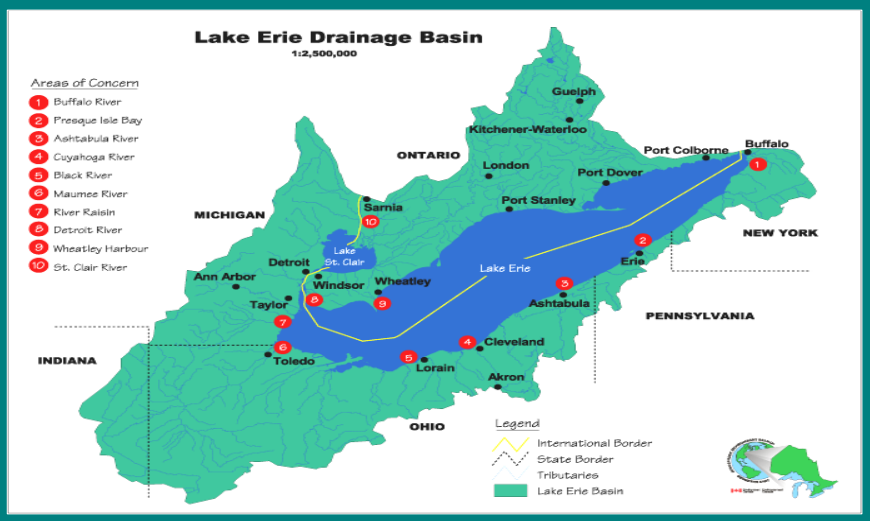
Good Morniing – my name is Sandra George – I work for Environment Canada and it is my pleasure to present to you the State of Lake Erie for 2004.

About Lake Erie



•Lake Erie is the smallest by volume and the shallowest of the Great lakes. It has the shortest water retention time at 2.6 years and the largest watershed relative to it size. It is divided naturally into 3 basins, the west , the central and eastern basins. The western basin is the shallowest and the eastern basin is the deepest.

•80% of its inflow comes from the Detroit River, 11% from precipitation and 9% from tributaries. The Niagara River is the main outflow for the lake.

•By virtue of its complex basin morphometry and its southern location Lake Erie is the most biologically productive of the Great lakes supporting a rich diversity of habitats and species..

•Lake Erie is one of the most intensively used large lakes in the world supporting multiple uses related to fisheries, navigation, hydropower, municipal , industrial and recreation.

•It has the highest population density mostly located in its 17 major cities and the most farmland.

•There are 10 Areas of concern in the Lake Erie watershed reflecting the intensive landuse in the basin.

•This combination of social and geophysical factors make the Lake Erie ecosystem highly vulnerable to the impacts from the many stresses that influence it.

•In the past decade the level of ecological change in Lake Erie has been extensive and in many cases it appears irreversible.

Physical Integrity

•The physical integrity of Lake Erie has a direct bearing on how the lake ecosystem reacts to the various stressor imposed upon it. Physical integrity “is the physical components or elements that support and influence sufficient and appropriate habitat in order to provide sustainable ecosystem function” Climate ,geology, and hydrology combine to form a complex network of terrestrial, tributary nearshore and offshore habitats and the processes that maintain them. Threats to physical integrity are those events or activities - natural or man-induced , that alter or fragment these habitats so that their function in the ecosystem is impaired or lost.

•Lake Erie today is the product of a long history of natural and cultural changes. Over the past 200 years the mature forests, savannas and wetlands that comprised the Lake Erie watershed have been cleared to make way for urban, industrial and agricultural uses. Tributaries have been dammed and channelized, coastal wetlands filled in, shorelines and river mouths dredged and hardened. New species have been introduced intentionally and unintentionally. Today less than 20 % of the terrestrial landscape exists as “natural habitats” and many of these are isolated “ islands” of habitat on the landscape. The western basin has been the most impacted by these changes where less than 6% forest cover and 3% of the original wetlands remain.

Tributaries

- 89% of flow (80% Detroit River)
- Link between the land and the lake
- Plumes important habitat feature
- Spawning, nursery and forage habitats for many fish species
- Estuarine/riverine wetlands essential

•Tributaries directly discharging to Lake Erie provide 89 % of the flow however their influence on the ecology of Lake Erie is more valuable than the quantity of water they contribute.

•Tributaries provide the link between the land and lake transporting materials such nutrients, sediments to Lake Erie's nearshore habitats. River plumes have been shown to be an important organizing feature for biological communities in the lake. Over time plankton and fish communities have evolved to take advantage of seasonal inputs and refuges provided by these features. Changes to stream hydrology affects the quality and the timing of the delivery of these materials in some cases limiting their utility to nearhshore communities.

•Tributaries also provide important spawning and nursery habitats for migratory fish species such as walleye and lake sturgeon.

•Coastal, estuarine and riverine wetlands moderate hydrographs , process nutrients and sediments and are necessary habitats for many of lake Erie's fish and wildlife species to successfully their life history

Tributaries

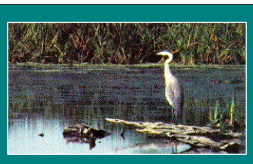
- Lower reaches of many tributaries highly degraded even though >50% reduction in sediment and nutrient inputs since GLWQA
- Structures alter river channels
  - Increasing temperature and
  - Suspended sediments
  - Decreasing oxygen and habitat complexity
  - Alter hydrology
  - Timing of spring runoff

Since the implementation of the Great Lakes Water Quality Agreement nutrient and sediment inputs to tributaries have been reduced by as much as 50% in some cases however many of Lake Erie's tributaries are still overwhelmed with sediment and nutrients by the time they reach the lake. As you progress downstream the cumulative impacts of landuses to baseflows, hydrographs, wetlands and instream habitats becomes severe.

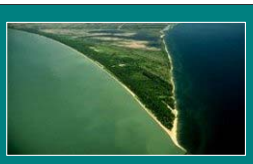
Dams and other barriers such as bridges and culverts further exacerbate the problem by altering river channel characteristics such that channels are wider, slower, warmer and less able move sediment resulting in further degradation of water quality and habitat complexity.

They prevent fish and other organisms access to upstream spawning and nursery habitats limiting the reproductive success and genetic diversity of many species. Fishways in some cases allow for the movements of some species however to fully address the range of impacts related to these structures consideration must be given to their removal where they are not required for other purposes such as flood control.

Intensifying urban and agricultural landuse is going to further stress tributaries. As growth occurs it is conceivable that many of the gains we have realized over the past 3 decades could be undone. It is essential that institutions responsible for landuse decisions are engaged in the rehabilitation and protection of these landscapes to ensure that the progress continues. Watershed and Natural Heritage and Coastal Management planning offer promise as effective means to balance the needs of expanding populations and those of the ecosystem.



Nearshore



- Over 80% characterized as nearshore
- Nearshore and offshore biotic communities dependant on physical integrity of nearshore
- Highly modified especially in western basin
- 80% wetlands lost
- 50% shorelines altered
- Rates of loss declining

•Over 80% of Lake Erie may be characterized as nearshore habitat. These diverse habitats are interconnected and dependant on the physical integrity of nearshore coastal processes to maintain them.

• Physical changes in the nearshore have been brought about ,shoreline hardening and alteration, harbour development , infilling and diking of wetlands and the introduction of invasive species resulting in altered substrates and habitats , increasing water transparency and temperature and changes to the foodweb and nutrient dynamics

•The natural processes that maintain nearhsore habitats have been disrupted, functionally eliminating many land margin connections.

•Today more 80% of Lake Erie's coastal wetland have been lost and over 50% of the shoreline has been altered by some sort of man made structure. Tributaries plumes have been isolated from the nearshore environments they were intended to nourish and along shore transport of materials is dysfunctional in many areas leaving beaches without sand and wetland isolated from nearby habitats.

•While overall there continues to be a net loss of neashore habitats to development the good news is that as our undertsanding of value of these habitats increases more effort is being put into protecting and rehabilitating nearshore habitats especially wetlands effectively slowing loss rates over time.

Zebra and quagga mussel impacts

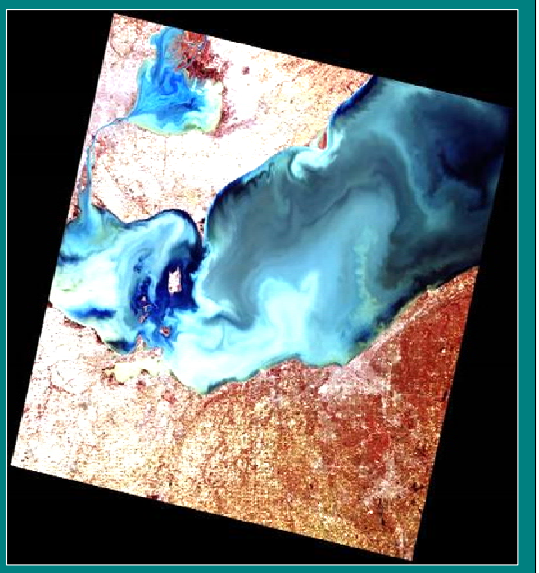
- Prodigious filter feeders
- Dreissenid mussels have altered substrates transparency, food web
- Resulted in extirpation of native mussel, altered substrates, increased macrophytes and Cladophora
- Reduced benthic diversity
- Mussels are here to stay!

While it is possible to reverse or manage the impacts that landuses and man-made structures have had on nearshore habitats this is not the case with introductions of invasive species.

Dreissennid mussels have colonized much of the nearshore environment physically changing the quality of habitats and intercepting nutrients and suspended materials that previously would have been utilized by the offshore pelagic community. Their large filter feeding capacity has increased water transparency which has had both positive and negative consequences. Improved water transparency has allowed for the resurgence of aquatic vegetation in nearshore coastal habitats providing benefits to many fish and wildlife species, however it is thought that transparency changes are also responsible for the resurgence of Cladophora in the eastern and central basins. Cladophora fouls spawning shoals and beaches and is poor source of nutrients for invertebrate and other organisms. Decomposing Cladophora has also hypothesized to be one of many contributors to the environmental conditions that caused outbreak of avian botulism in the eastern basin from 1999 -2002.

Offshore

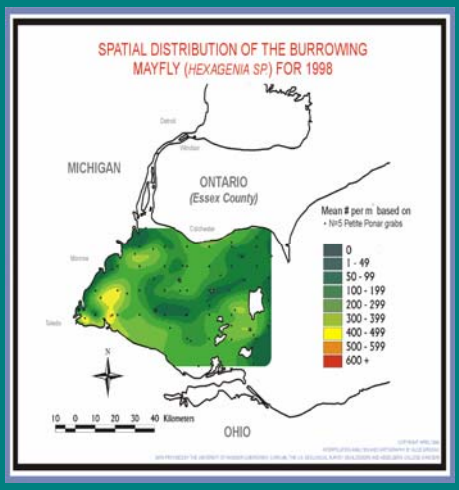
- Reliant on coastal inputs, current patterns, bathymetry and climate
- West to east movement nutrients and sediments
- Storm events – more frequent winter and summer re-suspension of material



As mentioned earlier lake Erie is divided into three basins each basin getting progressively deeper and colder as you progress east. Each basin has within its own unique water masses which circulate in predictable patterns. The majority of the nutrient loading is to the western basin though the Detroit and Maumee Rivers. Sediment and nutrients move through the lake on a west to east gradient. The central and eastern basins stratify seasonally. You can see from the slide that inputs from tributaries and coastal process obviously influence offshore habitats. Historically there were thousand of hectares of wetlands and submerged vegetation in the western basin to assimilate nutrient and sediment inputs. Today most of that is gone leaving open waters subject to sedimentation from tributary and resuspension events. In the 60's and 70's these sediments were highly contaminated due to industrial pollution. Regulation of discharges have resulted in a much improved sediment conditions.

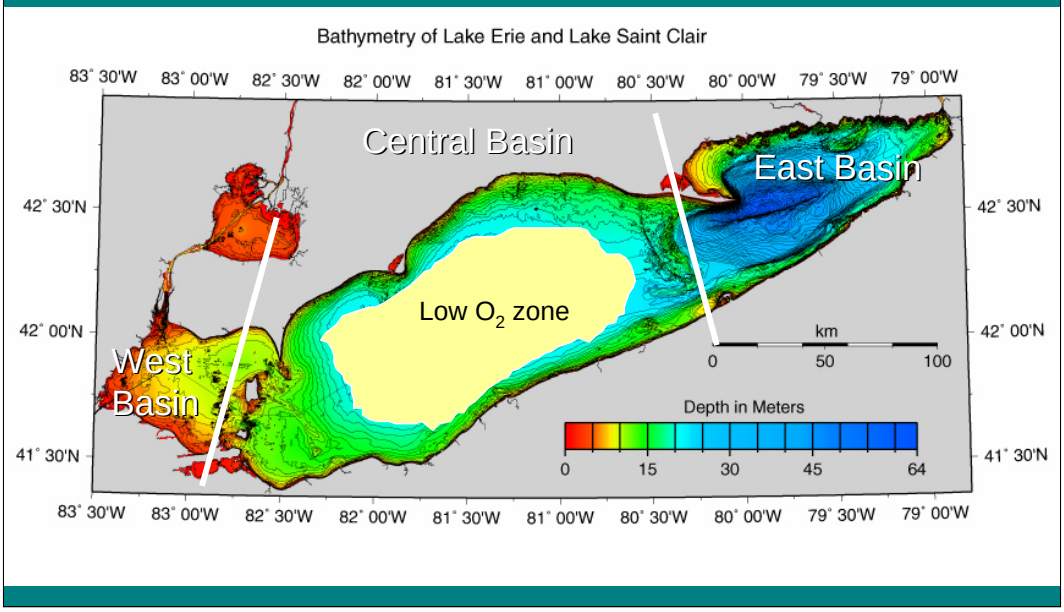
Hexagenia

- Rapid expansion in western basin late 1990s due to improved sediment quality
- Predominantly western basin
- Key component in food chain
- Distribution different from historical
- No further expansion since 2000



As a result of improved sediment conditions- Hexagenia or burrowing mayflies have returned to the western basin populations expanded rapidly throughout the basin in the late 1990's. Little change has been seen since then . While the return of the mayflies is encouraging there has been no further expansion in since the late 1990's. Close monitiong of their status is warranted.

Offshore – Central Basin anoxia



Low oxygen condition in the central basin has been a topic of interest for decades, the concern being the when O2 drop below 4mg/l conditions are not suitable many organisms especially fish. The GLWQA calls for the elimination of central basin anoxia, at the time it was thought that this could be accomplished through P controls. For several years in the early 1990's oxygen conditions in the hypolimnion of the central basin where much improved over the previous decades and scientists thought that the goals of eliminating anoxia in the central had been achieved.

However as with most things in Lake Erie this didn't last long and by 1995 the zone of oxygen depletion was back and has remained since. Further research has shown that oxygen conditions in the hypolimnion are a function of hypolimnion thickness and the oxygen depletion rate. Hypolimnion thickness is predominantly driven by climate variables such as frequency of storms, tempertature and duration of calm periods in the summer.

The second factor the oxygen depletion rate, the rate at which oxygen is used by biological community is not as well understood. Changing lake metabolism due to introduced species and landuse stresses have the potential to affect how quickly oxygen is used up in the hypolimnion. The EPA funded The Lake Erie Trophic Transfer study currently underway should assist in improving our understanding of these changes and how they combine to determine oxygen conditiond in the central basin

Offshore

- Dreissenid mussels have altered substrates and water quality
- Other invasive species further altered the system
- Benthic communities presently favoured
- Potential changes to mass sedimentation rate a concern
- Dreissenid abundance declining?

As in the nearshore - dreissenid mussels have altered substrates offshore invading soft and hard substrates changing their character and structure. Additional invasive species such as round gobies Bythothrephes and Cercophagis have altered the system further.

Species that can take advantage of these changes such as gobies (another invader) and burbot of are doing well , others such as Diporeia are not.

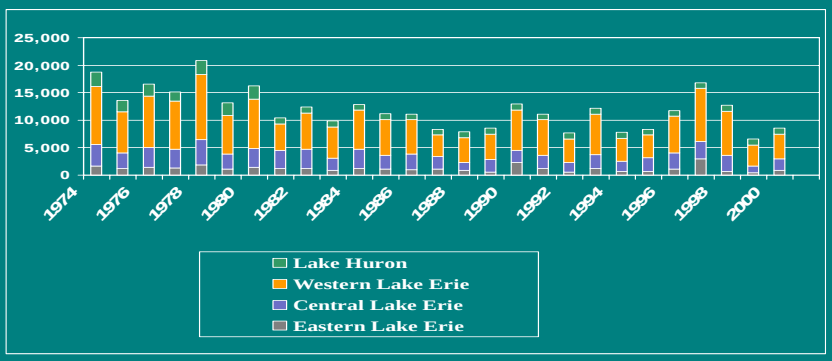
Increased water transparency has reduced habitat available to light sensitive species such as walleye.

Modelling has shown that mass sedimentation rates have changed since the arrival of mussels. Current thinking suggests reductions in nutrient and sediment loads and mussel filter feeding in the nearshore have reduced the amount of suspended biotic and abiotc material in the offshore waters Changes to sedimentation rates has significant implications for how contaminants and nutrients are internally processed in the lake potentially making the aquatic ecosystem more vulnerable to their effects..

It appears that driessenid abundance in Lake Erie is declining. This year EC/EPA in cooperation with many lake Erie agencies and University partners has funded the first systematic look at Lake Erie benthic communties. Once completed we should have a much better understanding of the current abundance of dreissenids and the role they play in the changing ecology of the lake.

??? Phosphorus ???

- Lake-wide P loadings at or below target
- P concentrations increasing spring and summer
- Loading-concentration-productivity relationships breaking down
- Number of factors contributing – loadings, internal cycling, sedimentation coefficients, central basin oxygen



No discussion on the State of Lake Erie would be complete without some comment made on nutrient status especially phosphorus. Since the mid 1980's P loading estimates have been at or below the GLWQA of 11,000 metric tonnes per year. However since 1995 both spring and summer P concentrations have been increasing. Offshore algal communities remain at levels anticipated from the load reductions but community structure has changed favouring smaller organisms. Ideally P concentration should follow the same pattern as P loading.

The reasons for this apparent contradiction are unclear. A number of factors could be contributing. P loadings to the lake may have increased and we are not reporting them accurately , internal metabolism of the lake has changed due to a combination of dreissiend mussels and other invasive effects , changes to mass sedimentation rates , potential for P regeneration due to anoxic conditions in central basin and changing physical conditions such as reduced ice cover and increased frequency and severity of storms .

There is a real need to discover the relative contributions of each of these factors so that management actions can be adapted to offset these trends if necessary.

Future challenges

- Climate changes - exacerbate current conditions
- Prevent further introductions of non-native invasive species
- Tributaries and nearshore communities are highly degraded must be rehabilitated and protected to restore functional habitat connections
- Protect and restore remaining natural landscape features
- Expanding human populations exert increasing pressure

In the future the physical integrity of Lake Erie will continue to be challenged.

Climate changes modelinig suggests that over the next 100 years Lake Erie will experience increased air and water temperatures, increased sever weather events and significantly reduced water levels and connecting channel flows. This will result in the further isolation and degradation tributary wetland and aquatic habitats.

Additional introductions of invasive species are expected unless effective means of prevention are implemented immediately.

Landscape ecologists suggest that 30% of the landscape and 75% of riparian corridors should be naturalized for the maintenance of functional ecosystems. Today there is less than 20% of natural cover basinwide. Clearly current landuse practices cannot be sustained. Commitment to thoughtful long term watershed natural heritage and coastal managements planning integrated basinwide is required to manage expanding human populations and intensying urban and agricultural uses.

Rehabilitation of tributary and nearshore coastal processes and habitats are necessary to improve in stream and in lake habitats. Special attention needs to be given to the removal of dams and other structures. Restoration of natural flow regimes and functional habitats build resilience into the ecosystem against future stressors.

Status of Lake Erie: Mixed

- Recognition of the impacts of land use
- Tributaries and nearshore habitats degraded but improving
- Improving sediment quality
- Future introductions of invasive species likely
- Uncertainty around phosphorus dynamics and central basin anoxia

For 2004 Lake Erie is rated as mixed. While much work remains we have recognized that landuses in the basin have been overcommitted and positive gains have been made toward rehabilitating and protecting habitats. However the continued introduction of alien invasive species and unprecedented rates and the uncertainties around nutrient dynamic, oxygen depletion in the central basin and impacts of climate change temper expectations for the future.

Acknowledgments

- Dr. Jan Ciborwoski – University of Windsor
- Murray Charlton – Environment Canada - National Water Research Institute
- Glenn Warren/Dave Rockwell – United States Environmental Protection Agency
- Dr. Scudder McKay – University of Windsor
- Lake Erie LaMP Workgroup

Finally I would like acknowledge the following individual who contributed information and insights to this presentation.