Joel Ingram and I are presenting this report on behalf of the Great Lakes Coastal Wetlands Research Consortium.

Presentation overview

- Indicator list and overview
- Overall status assessment
- Individual indicator discussions
- Future developments

The key points to be covered are: (Go over each point on list)

Coastal Wetland indicators (reported)

- Coastal Wetland Area by Type
- Plant Community Health
- Invertebrate Community Health
- Fish Community Health
- Amphibian Diversity and Abundance
- Wetland Bird Diversity and Abundance
- Contaminants in Snapping Turtle Eggs
- Effect of Water Level Fluctuations

The Coastal wetland indicators reported include: (Read through them quickly). While we do not have complete data for a long enough period of time to establish long term trends for any of these indicators, we do have progress to report on each of them.

Coastal Wetland indicators
(not reported)

- Coastal Wetland Restored Area by Type
- Land Cover Adjacent to Coastal Wetlands
- Phosphorus and Nitrogen Levels
- Sediment Flow and Availability
- Human Impact Measures

We have not made enough progress to report at this time or have opted to not work on these wetland indicators selected at previous SOLEC conferences.

Index of Biotic Integrity (IBI)

- Biological indicators assessed using IBIs
- IBI combines many biological metrics into a relative scoring system
- Adjusted for major regional differences and water level influences
- Allows for relative comparison across basin
- System tested by comparing across wetlands with a range of disturbance

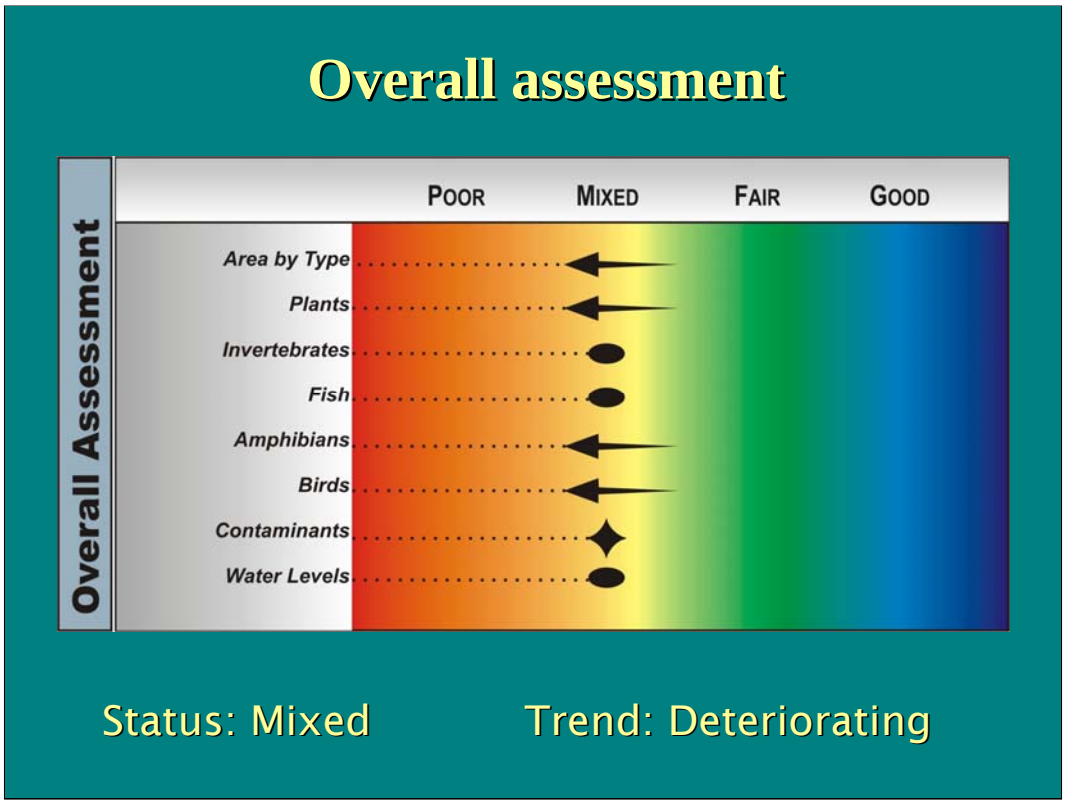
(1) An IBI An index of biotic integrity (IBI) relies on attributes of biological systems to measure its condition

(2) is based on several (usually 8-12) metrics which are attributes of the biota that show a predictable response to human disturbance.

(3) IBI's are developed regionally (in our case, for each of the Great Lake and/or for wetland types across the basin) and have to be robust enough to work across a wide range of natural water level fluctuation.

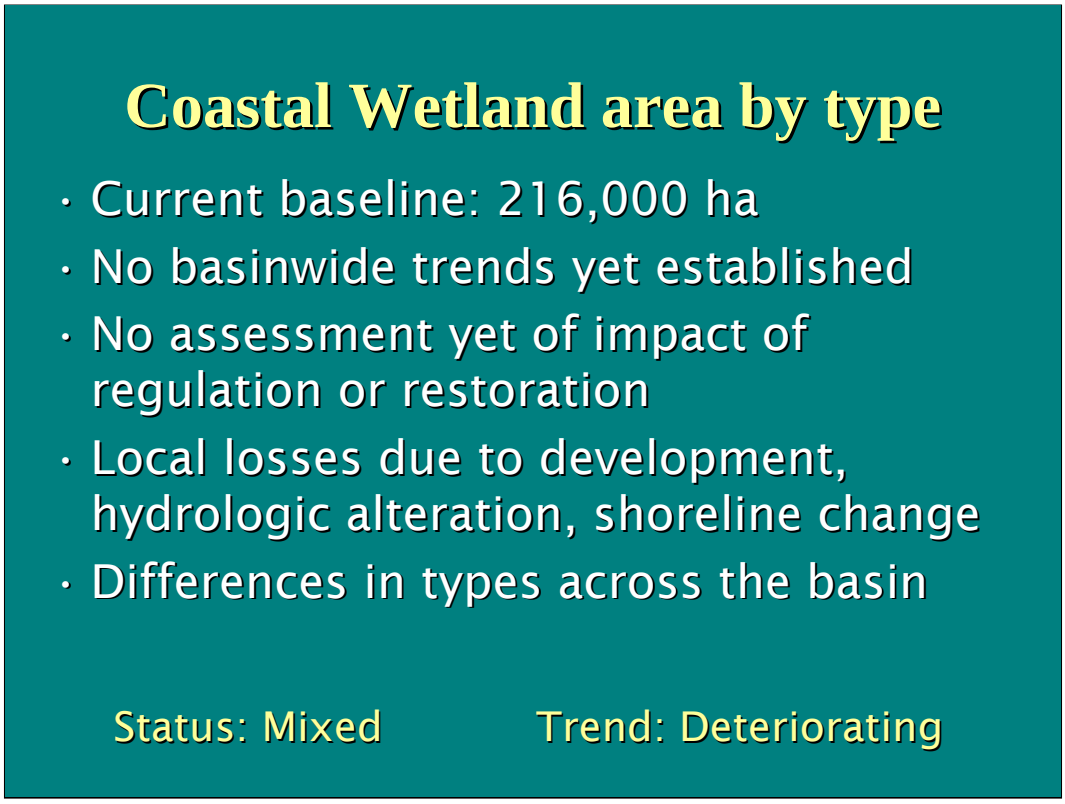
(4) If they are based on the same metrics, they allow comparison across the basin.

(5) We have developed systems and tested them across a range of disturbance types for lacustrine (lake edge) wetlands across all 5 Great Lakes. These systems have been tested across a range of disturbance.



This is a listing of the 8 indicators that we have been able to assess, although, in some cases, the assessment is based on local regions or selected wetland types.

Read through them.



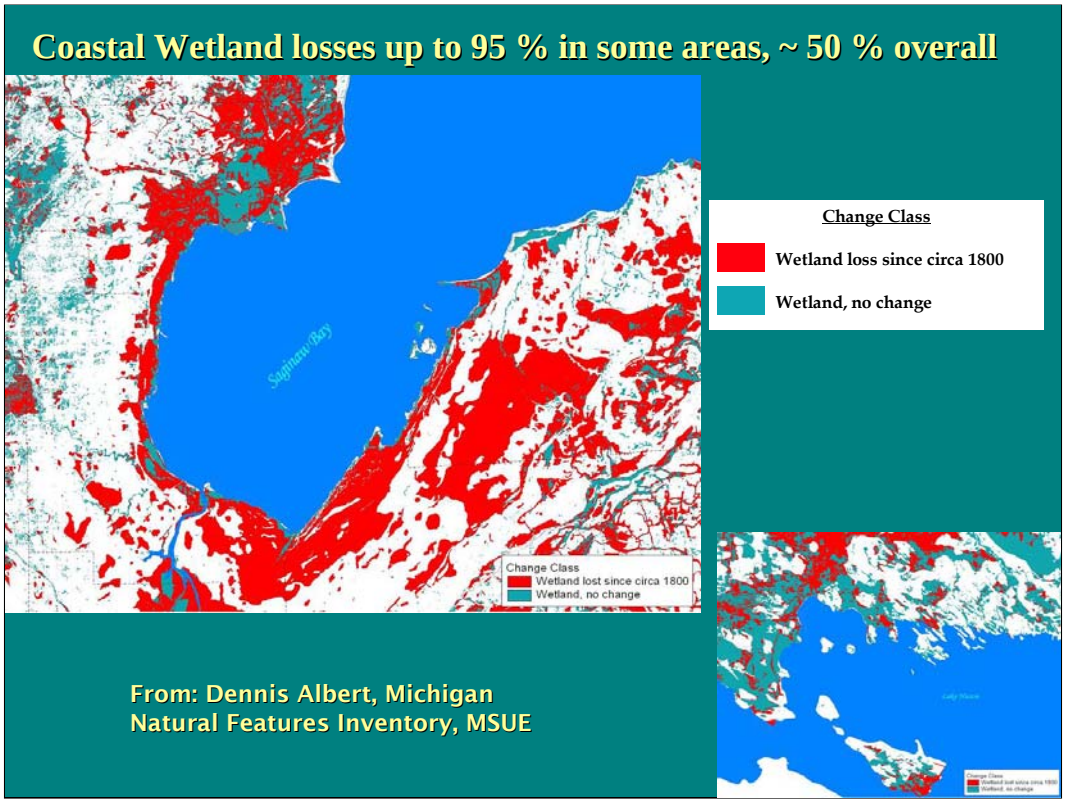
A binational project recently completed by GLCWC members has established an estimate of just over 216,000 ha of coastal wetlands within the Great Lakes system.

Project Investigators acknowledge that this is still an underestimate of current wetland area for some regions of the GLs where existing federal, state or provincial data is limited.

A basin wide trend cannot be reported at this point, however there continue to be many regionally documented cases of wetland loss due to land development and shoreline alteration.

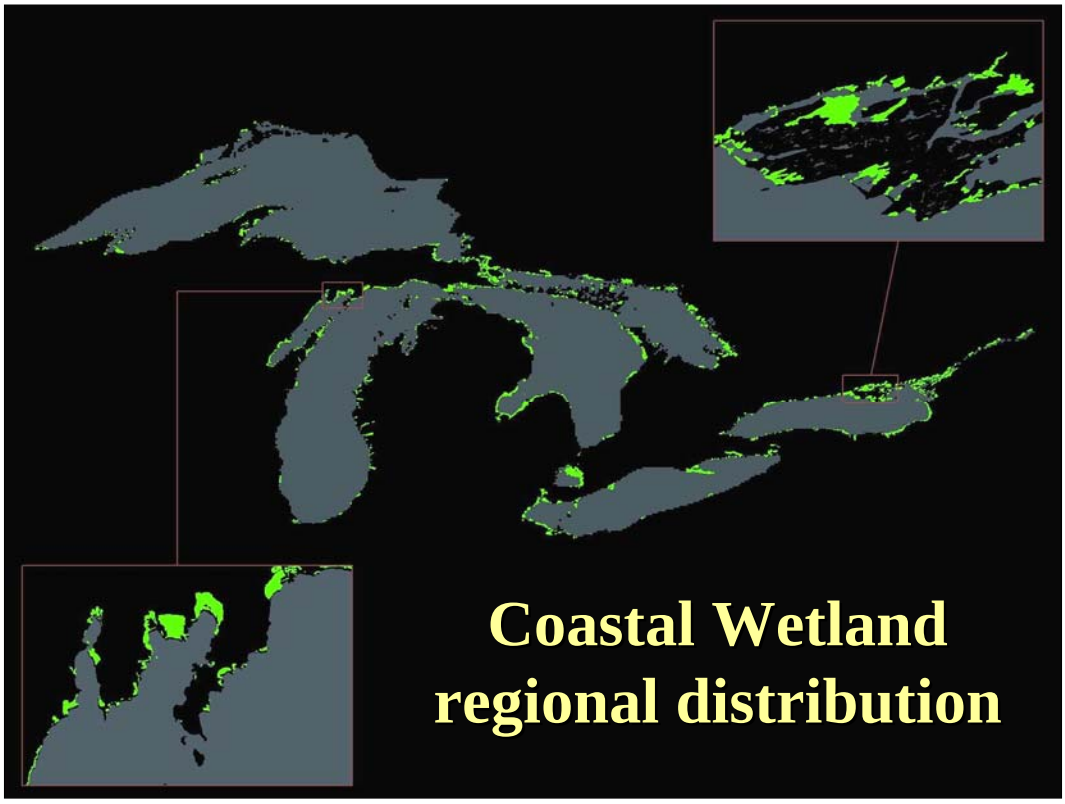
A standardized hydrogeomorphic classification system was also used to classify the coastal wetlands and this has highlighted the unique geomorphologies along the Great Lakes shoreline.

Status: Mixed Trend: Deteriorating



From a pre-settlement to current estimate, up to 95% of the coastal wetlands have been lost in some areas such as Saginaw Bay in Lake Huron. While in other regions, such as along the north shore of Lake Huron, historic loss of coastal wetlands is much less.

Dennis Albert, from the Michigan Natural Features Inventory has estimated that approximately 50% of the pre-settlement Great Lakes coastal wetlands have been lost.



As you can see from this general GIS map of coastal wetland distribution, many shoreline reaches still support a very high density of coastal wetlands.

The lack of wetlands along some shorelines, such as the north shore of Lake Superior is due to a coastal geomorphology and shoreline exposure that is not suitable for wetland development.

Area estimates by lake/river basin

Lake / River	Area (ha)
Lake Superior	26,626
St. Mary's River	10,790
Lake Huron **	***61,461***
Lake Michigan **	***44,516***
St. Clair River/Lake St. Clair/Detroit River	16,452
Lake Erie	25,127
Niagara River	196
Lake Ontario	22,925
Upper St. Lawrence River	8,454
Total	216,545

** Note: ½ of total is located within Lake Huron and Lake Michigan basins

The current area estimate by Lake and river within the basin, shows that Lake Huron and Lake Michigan alone support almost 50% of the estimated coastal wetland area.

Lake Superior currently supports a similar area of coastal wetlands to that of the Lower Great Lakes where historic wetland loss has been high.

Lacustrine – open

Search Bay, Lake Huron

Within the hydrogeomorohic classification system, there is primary classification break based upon hydrologic input.

Lacustrine wetlands are those that are open to the lake and thus always have water levels at lake level.

Open Lacustrine wetlands are directly exposed to near shore processes with little protection from the wind and waves. This exposure results in little accumulation of organic sediment, limiting vegetation development to relatively narrow near shore bands.

Lacustrine – protected

Presqu'ile Bay, Lake Ontario

Other Lacustrine based wetlands are protected by bays or sand-spit formations. This protection typically results in increased organic sediment accumulation, shallower off-shore profiles, and more extensive vegetation development.

Riverine – drowned river-mouth

Hay Bay, Lake Ontario

Riverine based coastal wetland have water chemistry and water levels that can be affected by both the lake and associated watershed, depending on Great Lakes water levels, season, and amount of precipitation.

Drowned River-mouth wetlands typically have deep organic soils that have accumulated due to deposition of watershed-based silt loads and protection from lake-based waves, currents, seiches.

Riverine – connecting channel

St. Mary's River

Connecting channel wetland types include the large connecting rivers between the Great Lakes, specifically St. Marys, St. Clair, Detroit, Niagara, and St. Lawrence Rivers. These wetlands are distinctive from the other large river wetlands because of their general lack of deep organic soils and their often strong currents.

Riverine – delta

St. Clair River delta

Riverine delta wetlands consist of rich alluvial materials. These are extensive wetlands and typically support large areas of wet meadow type of vegetation.

Barrier protected – barrier beach

Big Sand Bay, Lake Ontario

Barrier Protected wetlands are protected behind shoreline beaches. Because of the barrier, there is reduced mixing of Great Lakes water and the exclusion or significant reduction of coastal processes within the wetlands.

Water levels within these wetlands can occur above or below that of the adjacent lake during periods of reduced connectivity.

Barrier protected – swale complexes

Stockton Island, Lake Superior

Swale complexes occur between sand spits or relict beach ridges. These are known respectively as *sand-spit swales* and *ridge and swale complexes*.

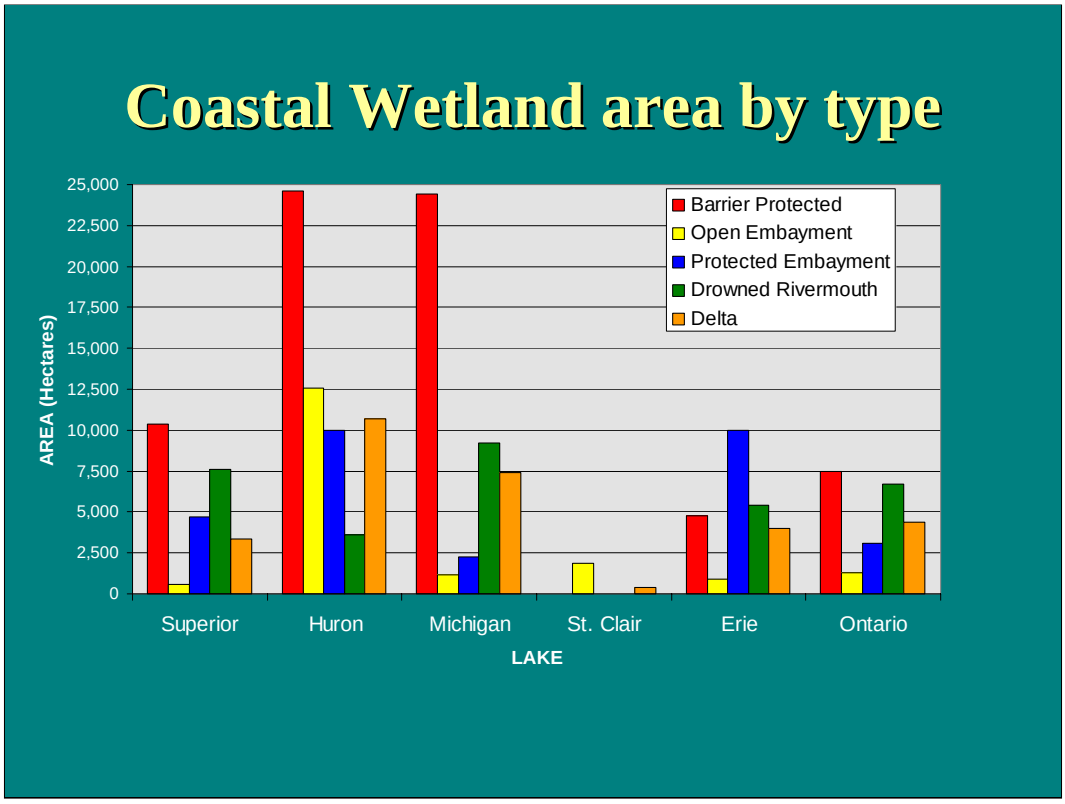
The numerous small swales are typically connected to the Great Lakes via groundwater, often supporting shrub swamps with shallow organic soils.

Modified wetlands

Metzger Marsh, Lake Erie

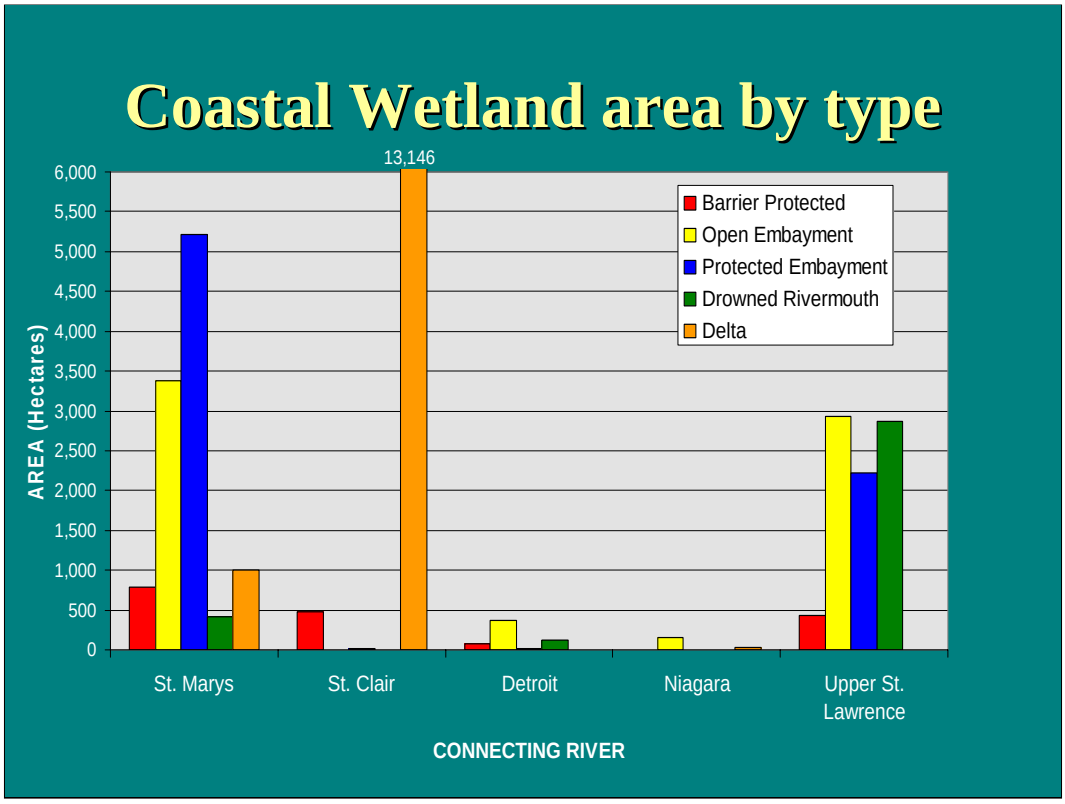
The hydrology and/or geomorphology of all Great Lakes coastal wetlands have been impacted to some degree by human activities.

Modifications can occur at several levels including, whole-lake regulation, watershed alteration, or activities such as diking and dredging within the wetland itself.



A break down of wetland area by type shows that barrier protected wetlands are a dominant coastal feature and support the largest area of wetland within most of the Great Lakes.

Open embayment wetlands account for over 12,000 ha of wetlands in Lake Huron



Within the connecting rivers, the St. Clair River delta estimated at just over 13,000 ha remains a prominent coastal wetland feature.

The many islands and bays within the St. Mary's River support a large cumulative area of open and protected embayment wetlands.

Wetland bird diversity and abundance

- 53 wetland species monitored by Marsh Monitoring Program (MMP)
- Significant declines in seven sensitive species

John Mitchell

- Significant increases in three tolerant species: Willow Flycatcher, Common Yellowthroat, and Mallard
- Declines may be due to change in water levels
- Habitat change may also be a factor

Status: Mixed Trend: Deteriorating

53 species of birds that use wetland marshes within the basin have been recorded at 419 MMP routes from 1995- current.

As a long term population monitoring program with 9 years of data, the MMP is still in its infancy as documentation of bird occurrence and abundance varies naturally among years.

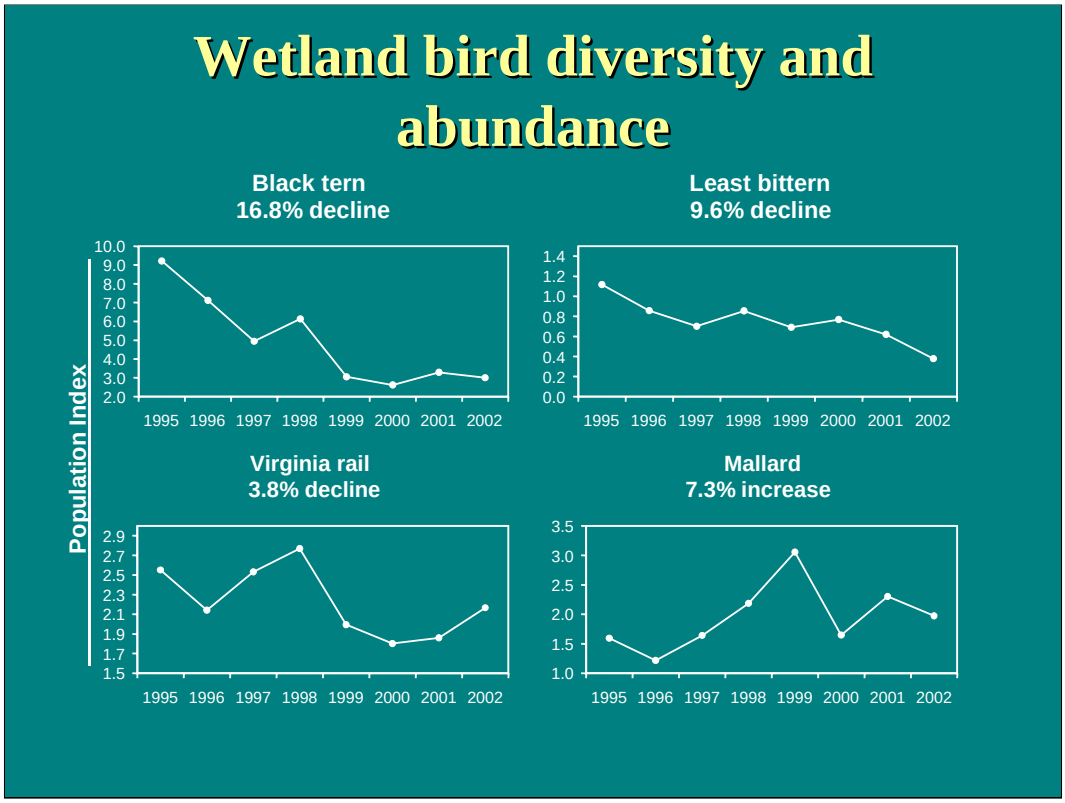
Despite this, statistically significant basin wide declines in population indices have been reported for some of the 53 species. LEBI, BLTE, MAWR, AC/CM, PBGE, RWBL, and VIRA.

Where as statistically significant increases have been reported for WIFL, COYE, and MALL.

The trend toward a decrease in wetland specialists typically found in emergent marsh and an increase in wetland edge and generalist species suggest a possible shift in habitat availability due to loss or degradation of specific marsh habitat types.

A recent analysis completed by Bird Studies Canada and EC has shown that population indices trends for several marsh species are positively correlated with lake water levels. Indicating that long term Great Lakes water level fluctuations may be significantly influencing annual index estimates for some species.

Status: Mixed Trend: Deteriorating



BLTE, LEBI and VIRA all have long term statistically significant declining trends. With the average annual rate of decline being the most dramatic for BLTE at 16.8% annually.

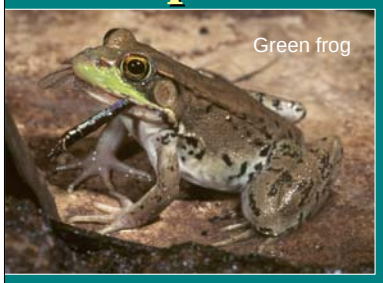
The annual VIRA population index is highly correlated with Great Lakes water level trends. Showing increases during high water years in the 1997-98, decreases during the following low water years, and a recent increasing trend corresponding to water level increases in the Great Lakes.

The BLTE pop. Index also shows a slight increase in the 1990's, but has a overall steep declining trend, with some indication of recent leveling.

The LEBI population index shows a fairly consistent slow annual rate of decline

The MALL population index is erratic but increasing has an increasing trend over the survey period

Amphibian diversity and abundance



John Mitchell

- Significant basinwide declines detected in four amphibian species – American toad; chorus, green, and northern leopard frogs
- Habitat loss and deterioration are the major threats
- Further work to develop basinwide IBI

Status: Mixed Trend: Deteriorating

Since 1995 the MMP volunteers have also collected amphibian data at 469 routes across the GL basin.

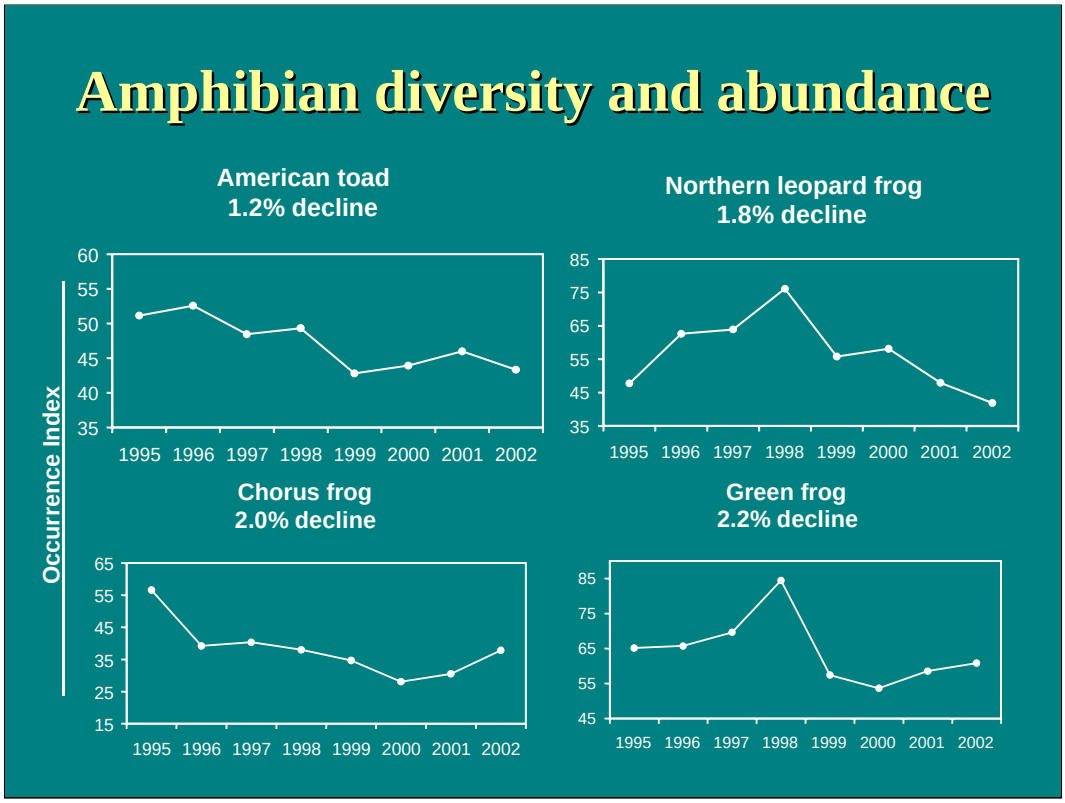
13 amphibian species are being recorded, but trends in amphibian occurrence are assessed for eight species commonly detected on MMP routes.

Statistically significant declines in occurrence have been reported for American Toad, Chorus Frog, Green Frog and Northern Leopard Frog.

It should be recognized however that wide variations in surveyed occurrence at a given route can also be a natural phenomenon, additional years of MMP data will help to determine whether the patterns reported are real long term trends.

For both the Amphibian and Bird MMP data, BSC is working to develop multi-metric Biological indices for use in future reporting of basinwide and coastal wetland trends.

Status: Mixed Trend: Deteriorating



Trends in occurrence of the four declining species show the annual variation that has been observed in some species especially the N. Leopard and Green Frog.

Some species also show spikes in occurrence during high lake level years, similar to that of the marsh birds, also indicating that long tern lake level fluctuations may also be influencing annual changes in species occurrence.

Contaminants in snapping turtle eggs

- Site specific trends show stable contaminant levels in eggs from most Area of Concern wetlands
- Total PCB levels remain above consumption guidelines

Impact: High levels found to impair turtle development

Status: Mixed

Trend: Unchanging

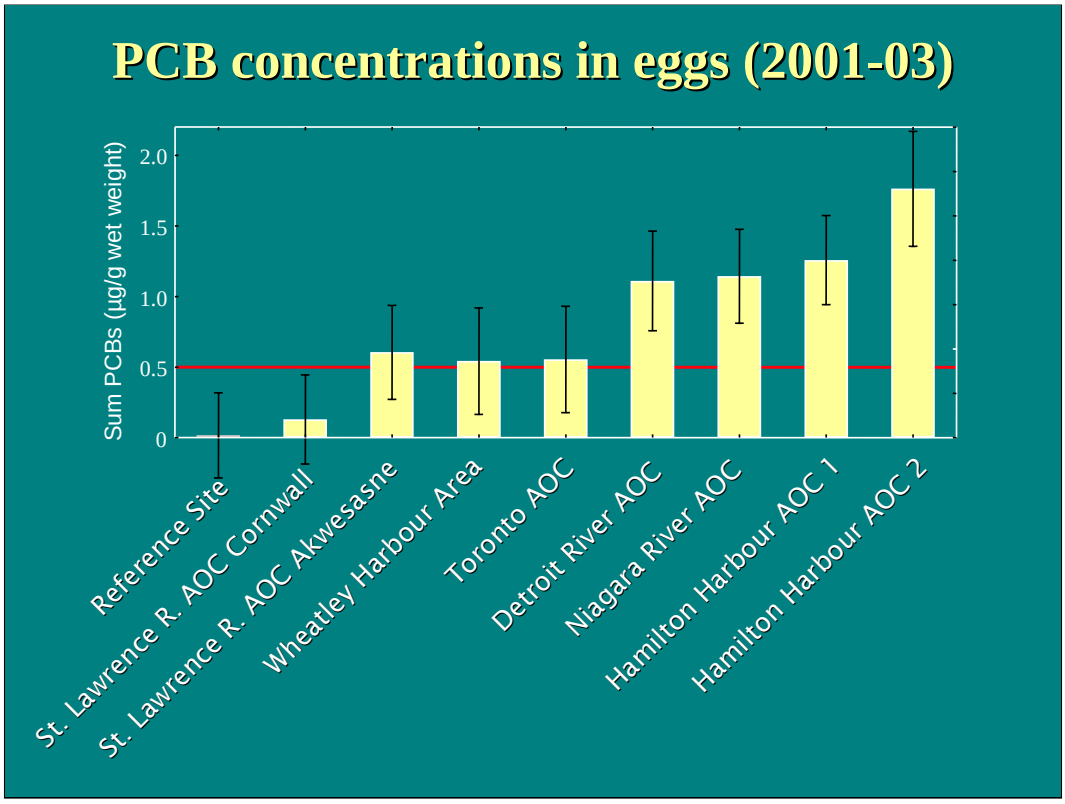
Basin wide estimates or trends of contaminants in Snapping Turtle eggs are not available.

However, monitoring has occurred in or near several AOCs, and at some sites contaminant levels in Snapping turtle eggs exceed established environmental guidelines.

Sites with repeated monitoring indicate that levels of most historically measured contaminants are not increasing. With declines in PCB levels occurring in the Hamilton Harbour AOC

Eggs form sites with the highest contaminant levels had poorer turtle development and increased rates of deformities in juveniles.

Status: Mixed Trend: Unchanging, limited sites and mixed trends



Estimates of sum PCB levels vary across the AOCs sampled in 2001-03. With the lowest levels occurring at the reference site in Algonquin.

Sum PCBs in eggs from most of the sites sampled exceeded 0.5 ug/g, a restriction guideline for fish consumption.

Dioxin equivalents of sum PCBs in eggs from the Detroit River, Wheatley Harbour, and St. Clair River sampling sites also exceeded the Canadian Environmental Quality Guidelines.

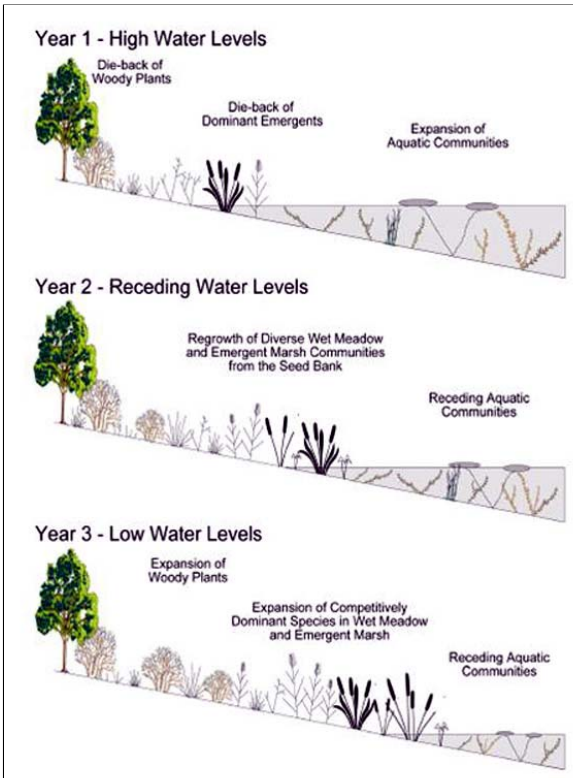
Effect of water level fluctuations

- Periods of water level fluctuation favor diversity and native plant species
- Water level control in Lake Ontario and Superior has resulted in:
  - More narrow wetland zones
  - Lower diversity
  - Increasing dominance of invasives

Status: Mixed Trend: Undetermined

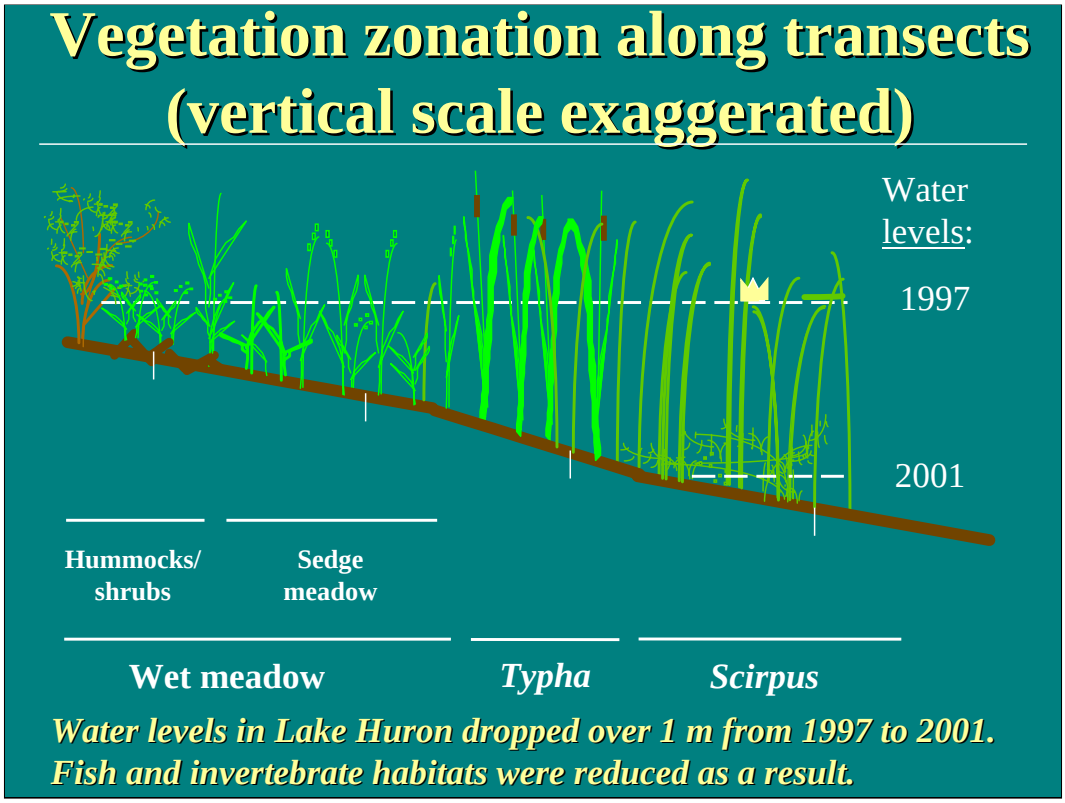
Natural water level fluctuations from high water years to low water years and back represent a natural disturbance that result in greater diversity of plant species and also inhibit invasive species from establishing dominant populations. Native species are thus able to maintain a niche in these coastal wetlands.

In lakes such as Ontario and Superior, where water levels are controlled within more narrow limits, coastal wetland plant communities have displayed several effects. 1) Coastal wetland zones (and therefore, effective coastal wetland area) is narrowed as the range of high to low water is narrowed. 2) The more constant water levels may prohibit the emergence of a wider diversity of plant species. 3) More fixed water levels allow invasive species to better establish dense, dominant populations and prohibit the growth of native species. In some cases, wetlands can exhibit near monotypical conditions.

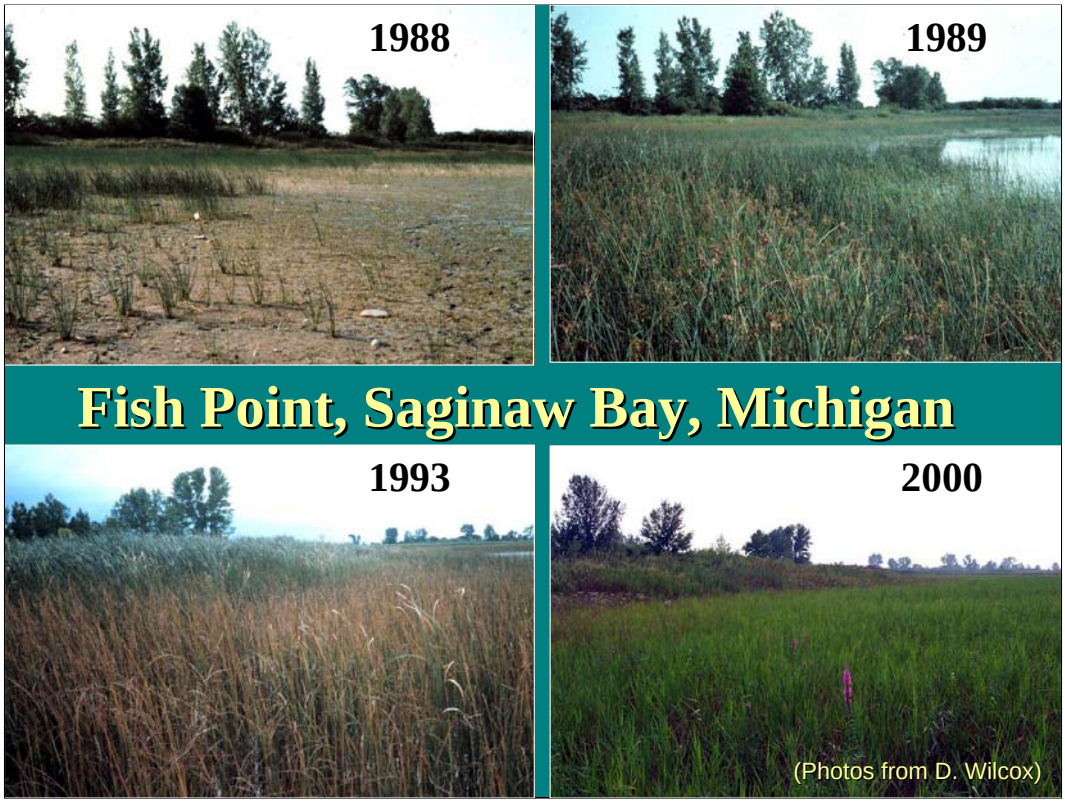


- Wetland zones "migrate" shoreward following high water; lakeward following low water
- Rate of migration is function of wave exposure (fetch), storm surges
- Aquatic invertebrates and fish use inundated zones
- Highest invertebrate diversity & density at intermediate depths
- Fish use related to water clarity, quality & depth; invertebrate density

Lake edge (lacustrine) wetlands migrate shoreward and lakeward following water level changes. The rate of migration is a function of exposure to wind (fetch) and storm surges. Aquatic invertebrates and fish use inundated zones and recolonize wetlands after water rises and floods them. Bioassessment has to take this natural variation into account. A few invertebrates are found primarily in only one plant zone but most are generalists; maximum diversity and density occur at intermediate depths. Plant zonation is the most important factor explaining fish distribution in wetlands, more important than lake or ecoregion.



Much of our testing of indicators was conducted during a period of rapidly declining water levels from a 1997 high to lows in 2002, the year of data collection by the GLC wetland consortium for testing metrics. Despite the water level decline, the invertebrate IBI developed previously during high water periods performed well over this period of water level decline and also ranked data collected in 2002 according to disturbance level.



Pictorial illustration of water level changes on the plant community at Fish Point in Saginaw Bay.

(click) Upper left – declining water levels from the 1986 high resulted in exposure of bare mud flats in 1988; this led to germination of buried seeds and expansion of adjacent plant stands.

(click) Upper right – the mud flats have been colonized by a well developed emergent zone with open water areas.

(click) Lower left – 1993, the emergent plant zone has continued to expand.

(click) Lower right – extended dry period from 1997 high has allowed germination of some annuals and invasion of some exotics such as purple loosestrife in the foreground.

Plant community health

- Total area of plant communities is correlated with water level change
- Shoreline and hydrologic alterations result in spread of non-native species (e.g. purple loosestrife)
- Turbidity in wetlands in lower lakes, Green Bay and Saginaw Bay impairing submergent plant diversity

Status: Mixed Trend: Deteriorating

As you have seen, the total area of plant community varies with lake level and this has to be taken into account when developing plant based IBIs. Denny Albert has developled some metrics for use in a plant based IBI. Two of the most useful metrics may be percent of area invaded by non-natives and/or invasive species and submergent plant cover and diversity. Shoreline and hydrologic alterations are particularly conducive to the spread of non-native plants such as purple loosestrife and some invasives such as Phragmites. Submergent plant diversity is low in those wetlands receiving suspended sediments in runoff including those in Green Bay, Saginaw Bay and in Lakes Erie and Ontario.

Invertebrate community health

- 61 lacustrine wetlands investigated basinwide
- IBIs assessed within plant zones to account for lake level change
- Northern wetlands have higher IBI scores
- Saginaw Bay and southern wetlands have lower scores

Status: Mixed Trend: Undetermined

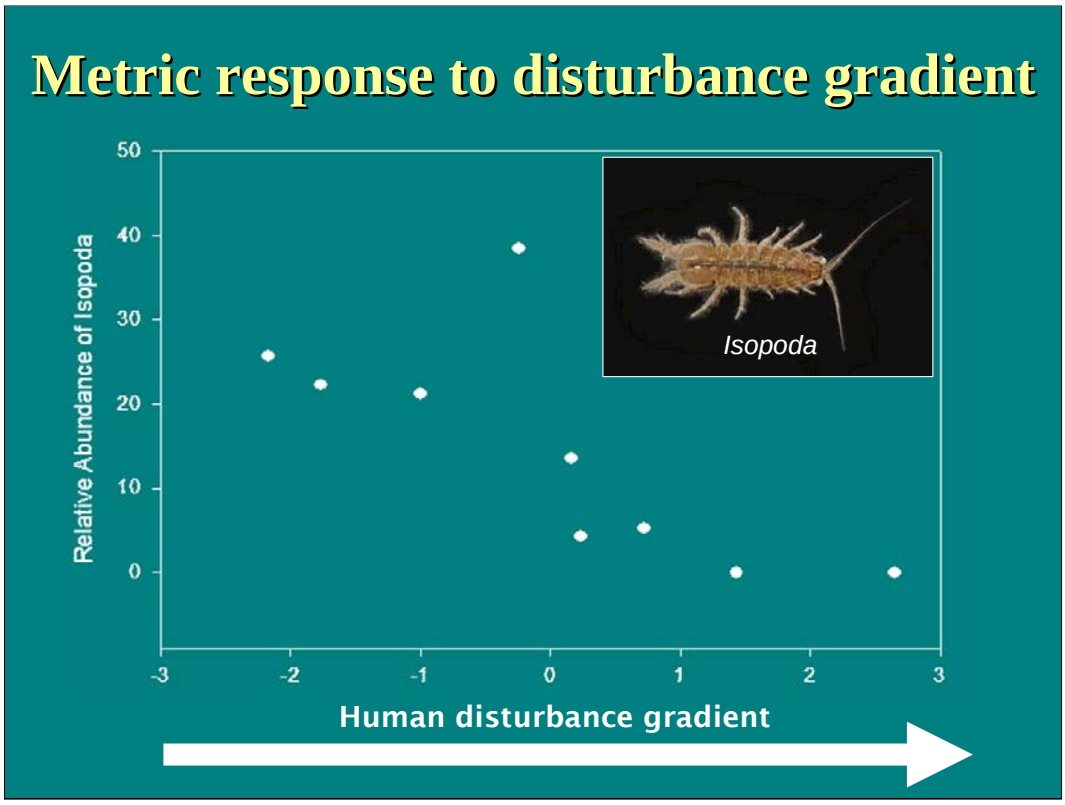
Consortium researchers collected data from 61 lacustrine (lake edge) wetlands in 2002. IBIs have been developed and will soon be published for these wetlands based on fish, invertebrates and plants. In general, IBI scores are higher indicating the high quality of many northern Lake Huron and Michigan wetlands. Conversely, IBI scores for Saginaw Bay and Lake Erie and Ontario wetlands are generally lower than those for the more northern wetlands.

The Invertebrate IBI developed for Lake Huron works with minor modification for all five Great Lakes. For example, Joel Ingram and his colleagues used it for Lake Ontario wetlands. All metrics except one responded to disturbance level as predicted base on the original Lake Huron research.

Invertebrates in lacustrine wetlands

- Over 250 species documented for wetlands of Northern Lake Huron and Saginaw Bay
- Densities as high as 50,000 m^2
- Highest diversity and density in medium depths and inner edge of deep emergent zone
  - Lowest at the outer edges of emergent zones

During development of the IBI in the mid-90's working with Pat Hudson from USGS and Brian Armitage of the Ohio Biological Survey, we identified more than 250 species of macroinvertebrates from wetlands of N. Lake Huron and Saginaw Bay. Nearly 500 species were identified when microinvertebrates were included. Densities as high as 50,000 m2 have been recorded from Saginaw Bay wetlands and elsewhere. Highest diversity and density occurs in medium depths and in the deep emergent marsh far enough towards shore so that wave energy has been dampened by the plants at the outer edge of the emergent zone



The Macroinvertebrate IBI is based on 10-12 metrics for each of the major plant zones present. Each metric responds in a predictable way to a disturbance gradient as in this example shown for Isopod relative abundance. When the higher wet meadow and transition zones are dry, metrics for the deeper emergent zone still rank the wetlands along disturbance gradients

Fish community health

- Round gobies and ruffe do not thrive in wetlands even when common in adjacent lakes
- Fish community composition is correlated with plant community composition
- Dominance by cattail or other invasive species correlates with lower fish diversity

Status: Mixed Trend: Undetermined

We recently submitted a paper with an IBI for all 5 of the Great Lakes based on several metrics. This should be published next year in the JGLR. Some observations are (Read the 3 above).

· Wetlands may offer refugia for native species from invasive non-native species

· Recent invaders have not done well in these systems (round gobies, ruffe, and zebra mussel)

Round goby

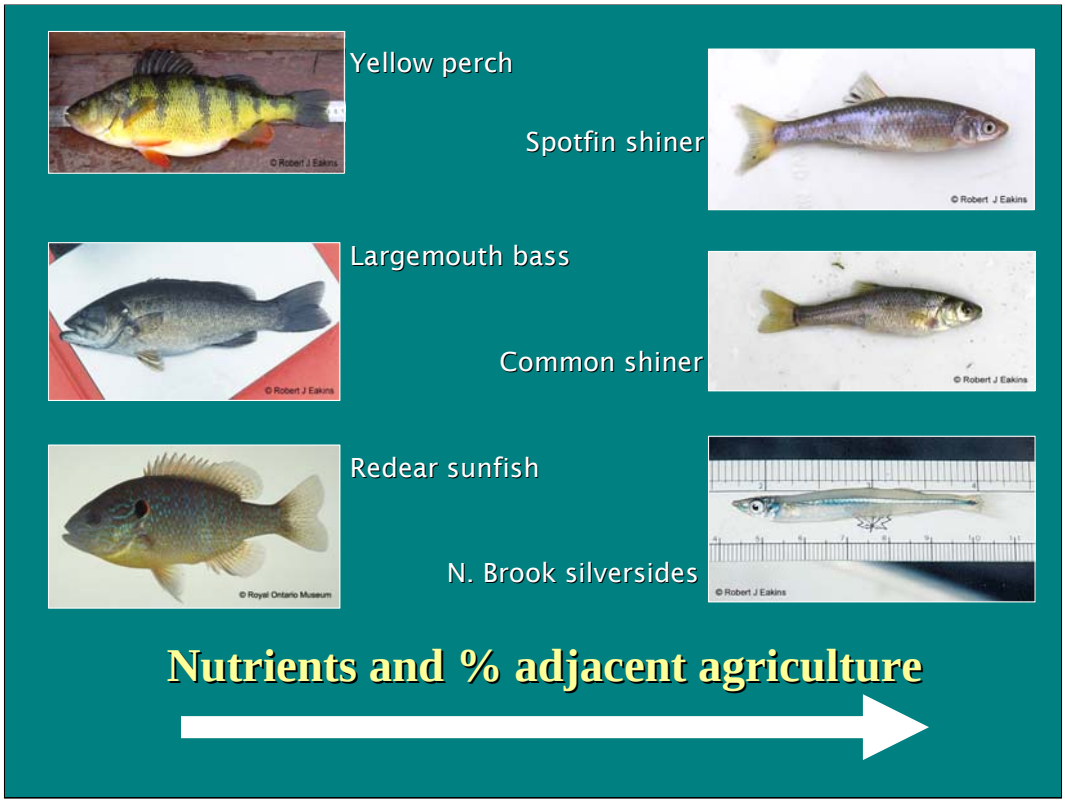
Ruffe

Zebra mussel

• Coastal wetlands do not harbor an abundance of mosquitoes – of the 56,000 invertebrates collected from coastal wetlands in 2002, a total of 80 were mosquitoes

Certain of the recent exotic invaders do not thrive in coastal wetlands even when they are very common in adjacent lake habitat. Thus, wetlands may serve as a refugium for certain native species against some of these invaders. (go over each example above quickly).

Many people think that lake edge wetlands produce huge numbers of mosquitoes. Our data do not support that. Instead, the mosquitoes are coming from nearby inland habitat not directly exposed to waves from the lakes.



Some of the fish metrics that work are illustrated on this slide. The 3 species on the left contribute much more of the catch in wetlands with low disturbance, and their relative contribution to catch per unit effort declines as wetland quality declines. Conversely, the species on the left increase as nutrients and % of land in adjacent agriculture increase.

Summary

- Coastal wetland area declining locally
- Natural water level fluctuation maintaining native communities
- Non-native plants spreading in altered wetlands
- Several IBIs have been developed and are ready for basin wide use in assessment
- Native fish potentially using diverse coastal wetlands as refuge from non-natives

Some key findings: Coastal wetland area is declining locally but we still do not have the data to assess this on a basinwide basis. An important step in that direction was the completion of the wetland data base for the entire basin.

Natural water level fluctuations are important in maintaining broad wetland zones with diverse plant assemblages in them. In areas such as in lower Lake Ontario where water levels have been controlled, the zones have narrowed and are becoming dominated by cattails or other invasives.

We have developed several IBIs that are now ready for basin wide use in assessment.

Native fish being affected by competition from round gobies and ruffe in the lake are not affected much in lake edge wetlands.

Summary

- Northern invertebrate communities more diverse than southern communities
- Sensitive bird and amphibian species declining
- Little change in biological accumulation of historically monitored contaminants

Read these three points.

Future developments

- Finalize work on methods and indicator development (including IBIs)
- Develop implementation plan
- Collect data broadly across basin
- Report regularly at SOLEC

Read these points

Acknowledgments

Information taken from indicator status reports and other information contributed by the following authors:

- Joel Ingram, Environment Canada
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- Kim Fernie, Environment Canada
- Shane de Solla, Environment Canada
- Karen Rodriguez, U.S. Environmental Protection Agency
- Tom Rayburn, Great Lakes Commission
- Ric Lawson, Great Lakes Commission

Just leave this on screen while I ask for questions.