



---

---

---

## *Setting Water Quality Targets for the Nearshore*

November 18, 2011

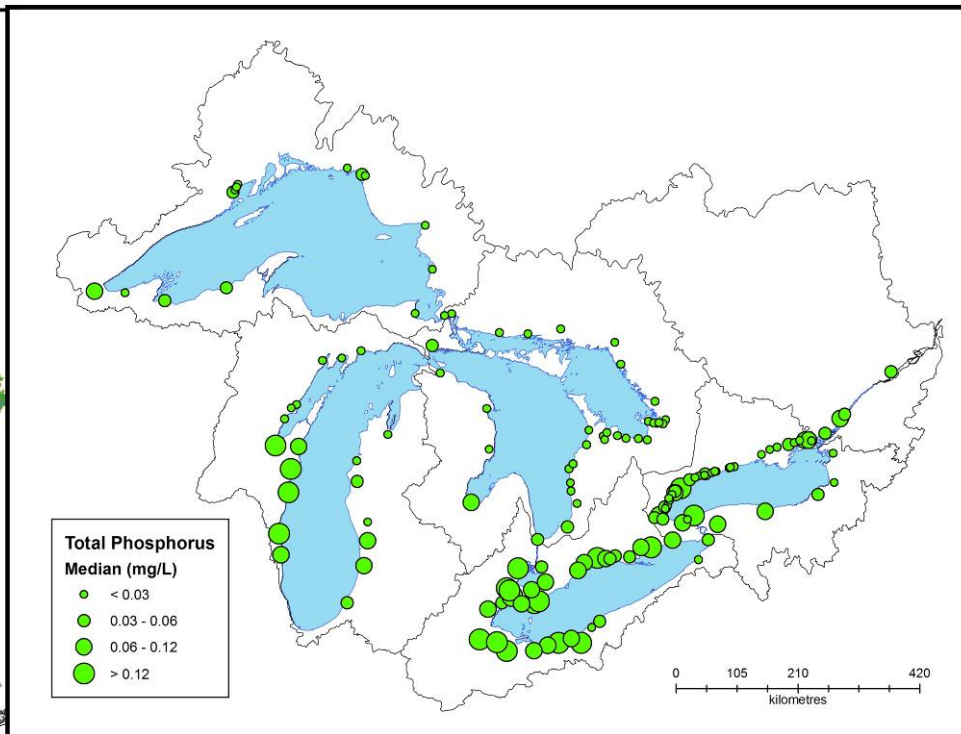
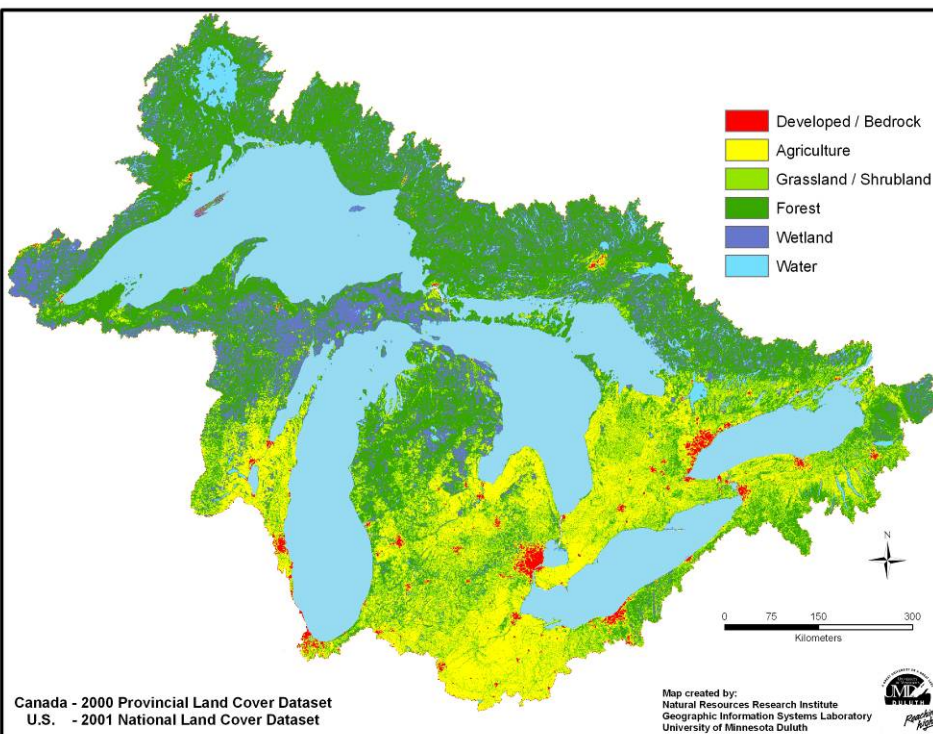
Mary Thorburn

Ministry of the Environment

# Purpose

- Demonstrate the need to set new water quality targets to manage current issues in the Great Lakes.
- Share results and lessons learned from recent Great Lakes monitoring and research projects.
- Highlight some of the challenges around setting water quality targets for the highly variable nearshore area of the Great Lakes.

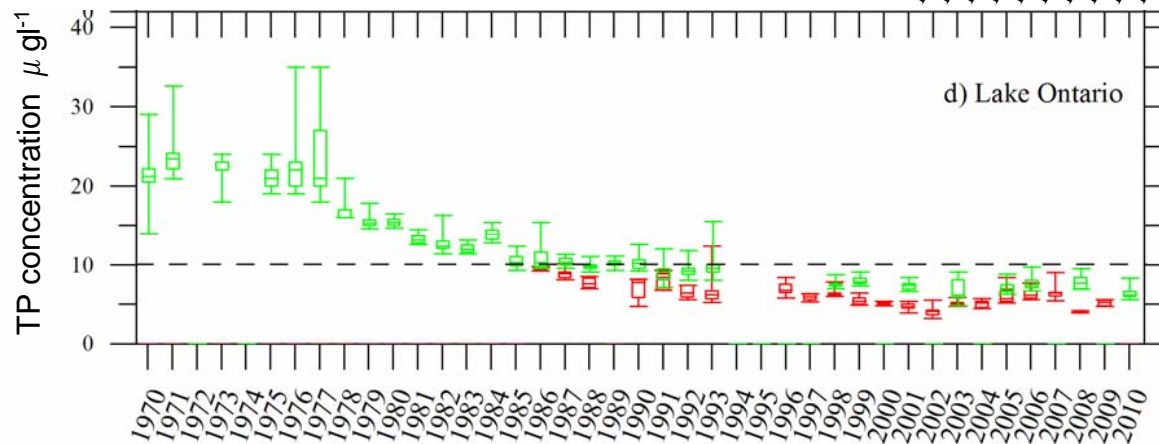
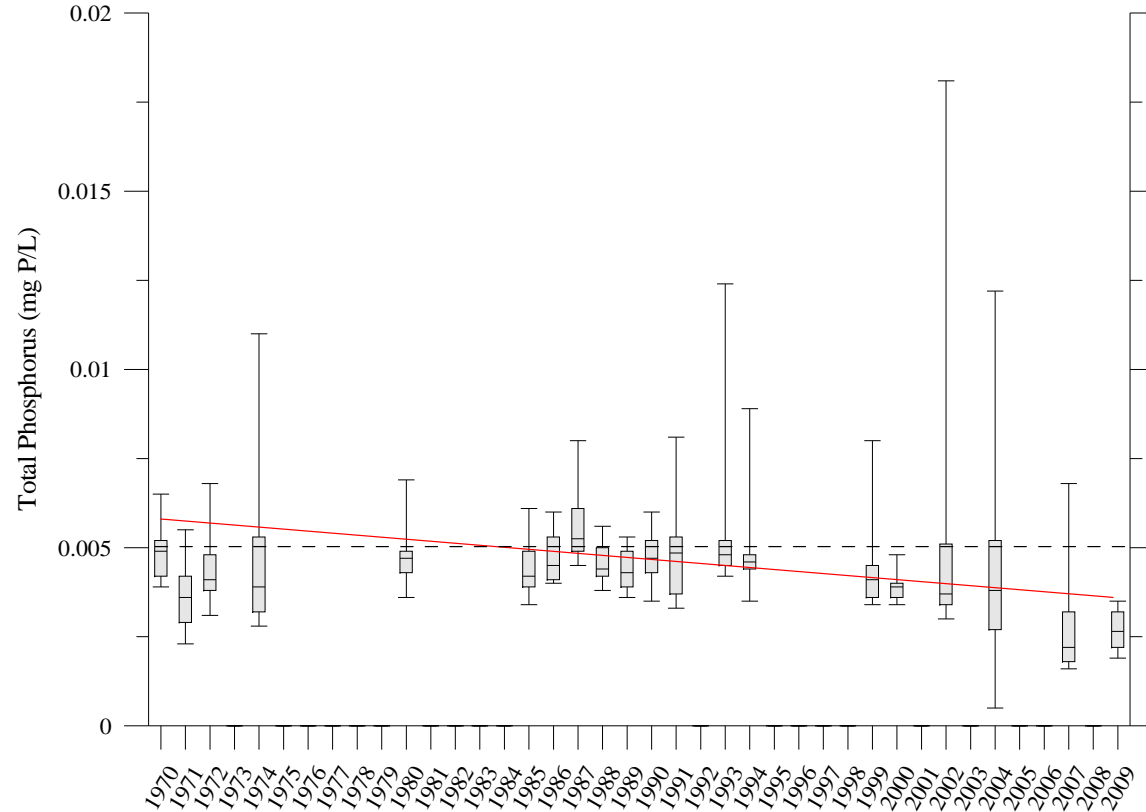
# We know that....



Average Total Phosphorus Concentrations are above Provincial Water Quality Objectives in both urban and agricultural tributaries.

# We know that ...

- Open Lake Total Phosphorus (TP) concentrations are below Great Lakes Water Quality Agreement (GLWQA) targets in Lakes Huron and Ontario.



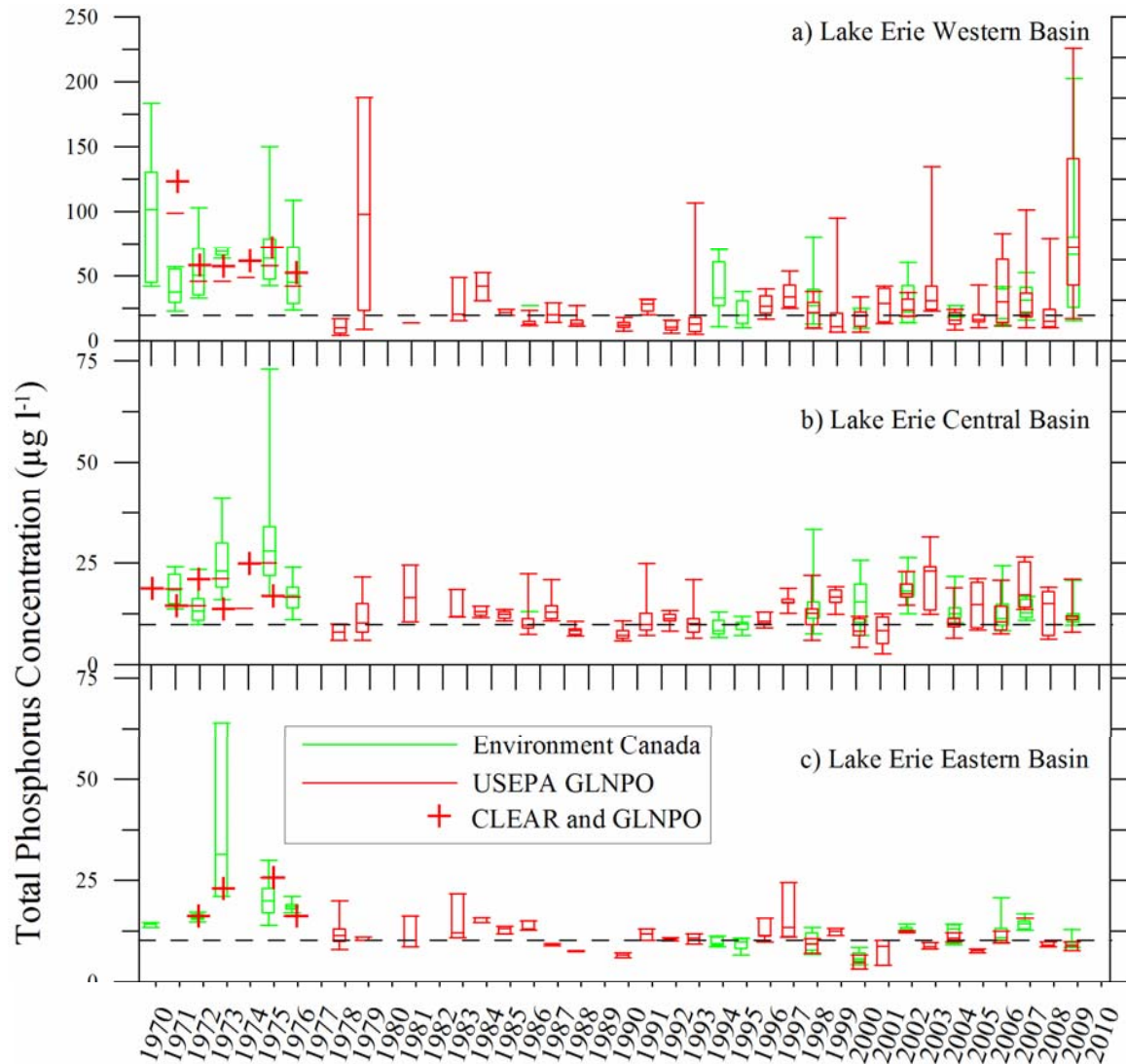
Environment Canada, Great Lakes  
Surveillance Program

State of the Lakes  
Ecosystem Conference  
(SOLEC) 2011

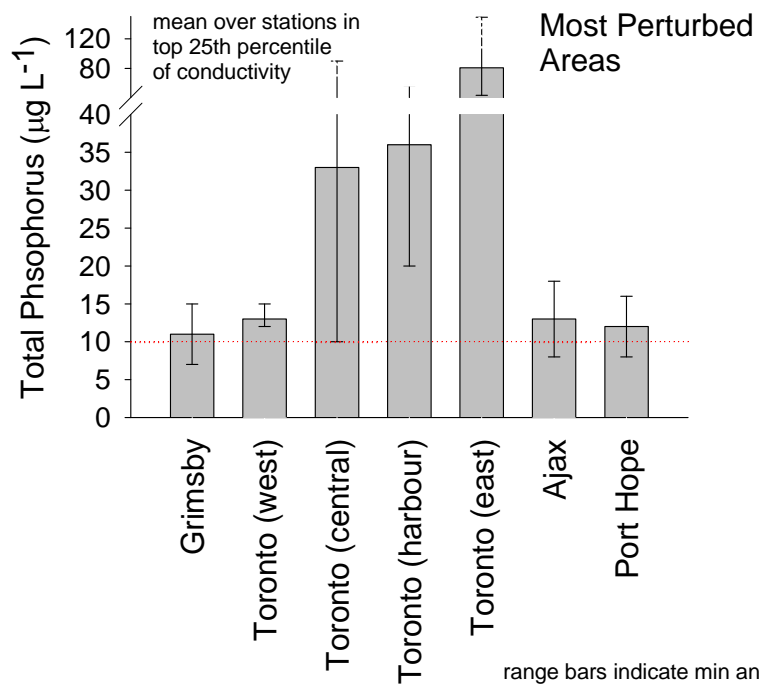
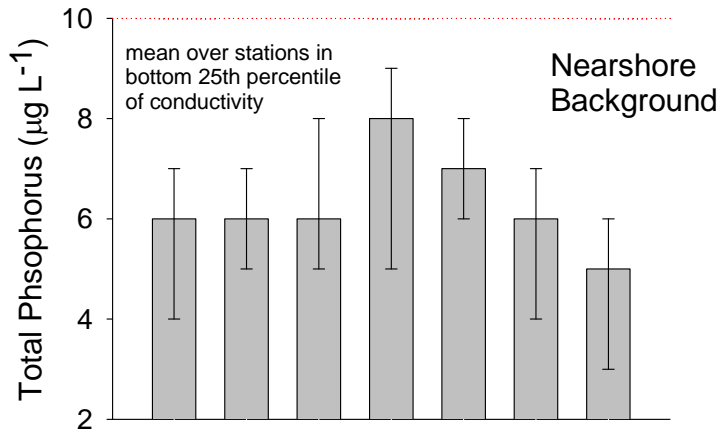


# We know that...

- Open Lake TP concentrations in Lake Erie frequently exceeded GLWQA targets and conditions are deteriorating.



State of the Lakes Ecosystem Conference (SOLEC) 2011



range bars indicate min and max values of means over 4 to 5 surveys

# We know that in...

**Lake Ontario:** ambient nearshore TP concentrations are similar to the open lake and are less than the GLWQA target level of 10 µg/L

**Lake Huron:** ambient nearshore TP concentrations are similar to the open lake and are less than the GLWQA target level of 5 µg/L

**Lake Erie:** nearshore TP concentrations are the most variable and often exceed the GLWQA targets of 15 µg/L in the western basin and 10 µg/L in the eastern and central basin

# The Need: Algae Problems

## Harmful Blue-Green Algal Blooms (HABs):

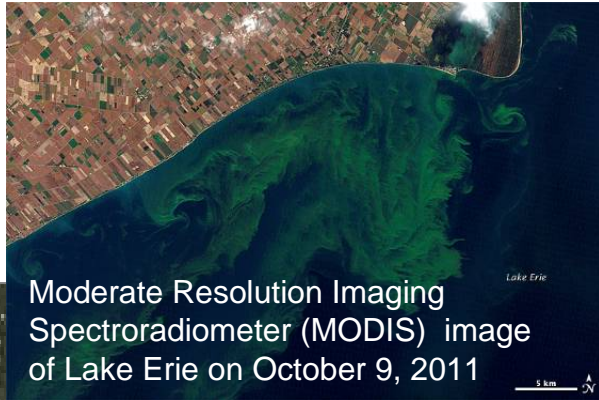
- Some forms of blue-green algae can produce toxins that have the potential to harm pets, cause skin irritation in people, taint fish, and restrict use of drinking water

## Benthic Algae:

- Attached filamentous benthic algae (predominantly *Cladophora*) is a nuisance. It breaks away from anchor points and accumulates and decomposes on shore in unsightly foul-smelling piles and clogs intakes at Power plants potentially resulting in emergency shutdowns



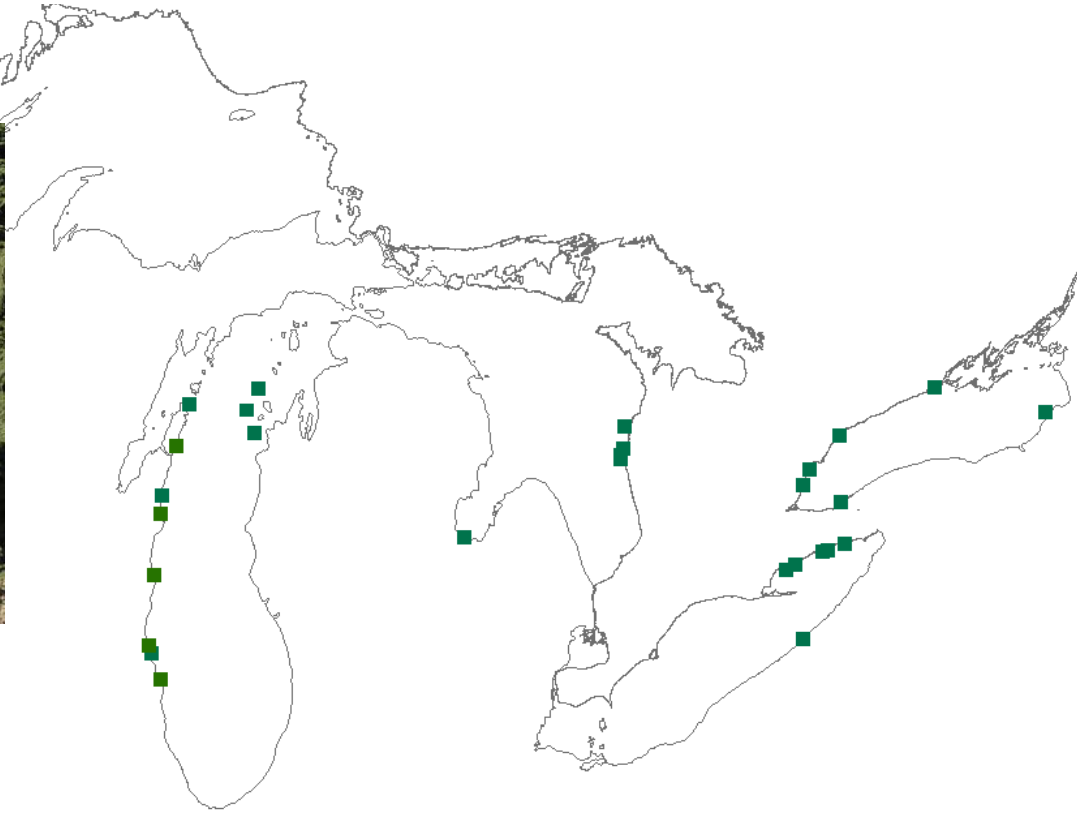
# HABs in Lakes Erie and Ontario



- Lake Erie commonly experiences HABs -- the largest bloom in decades occurred in October 2011.
- In 2011 U.S. researchers measured algal toxin concentrations 50 times greater than World Health Organization recommendations for safe recreation and 200 times the Drinking Water Standard in untreated water
- Decaying blue green algae consume oxygen and contributes to Lake Erie's Central Basin low oxygen "dead zone".
- HABs are also common in Hamilton Harbour and the Bay of Quinte Area of Concerns.

# Cladophora in Lakes Erie, Ontario and Huron

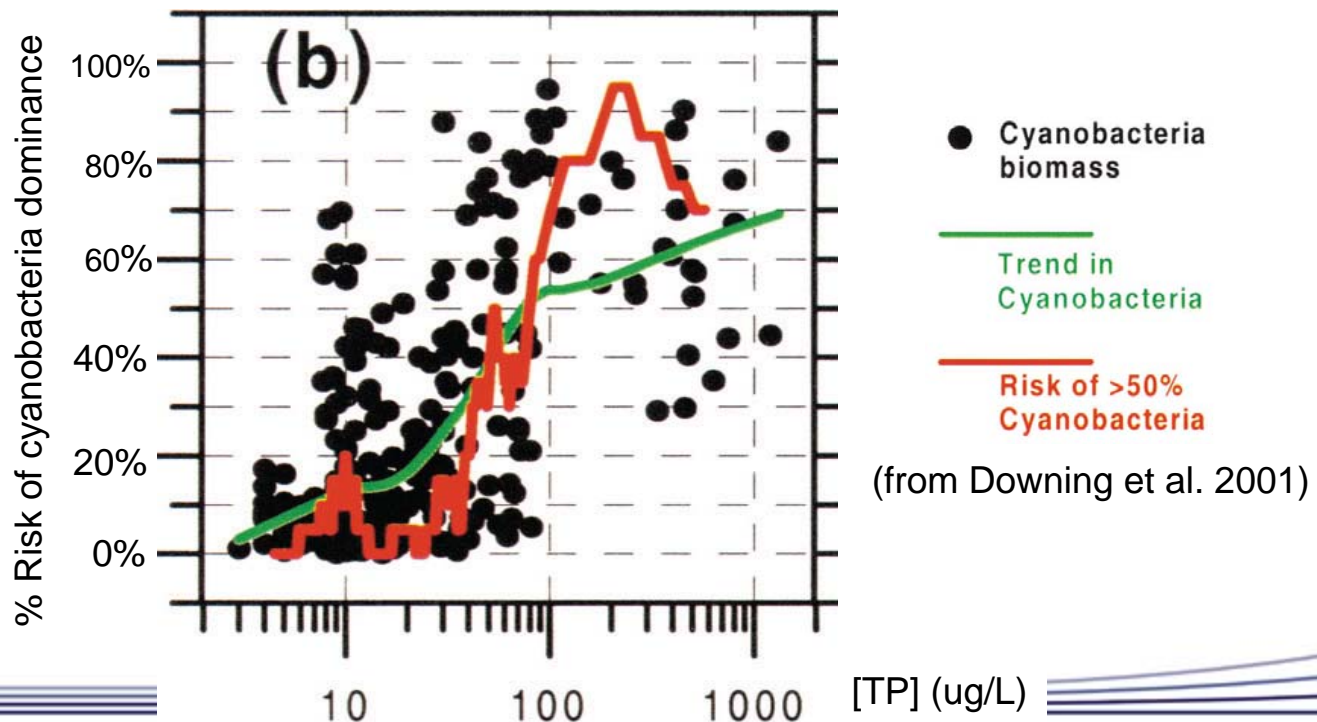
Locations where nuisance Cladophora has been reported in literature, media or by local sources since 1995



SOLEC 2011

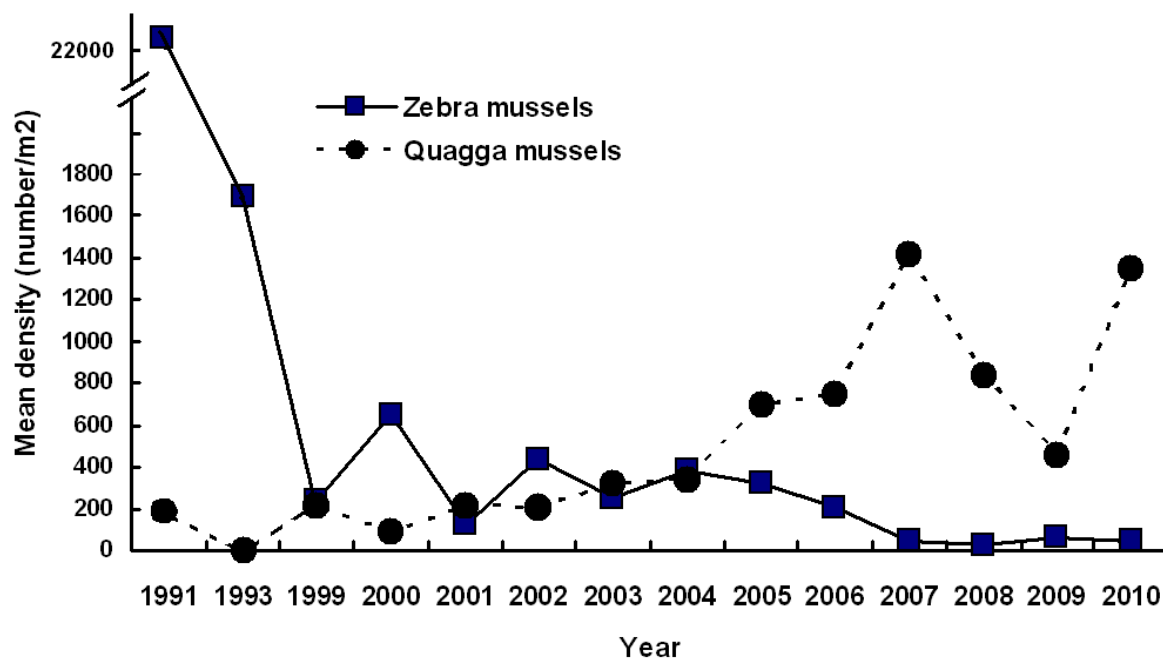
# Current Targets are Inadequate

- Average water column TP is NOT a good predictor of nearshore benthic algae problems.
- The probability of HABs is controlled by phosphorus, but there is much variation.



# Changed Ecosystem: Quagga & Zebra Mussels

- Colonization of the Great Lakes by the invasive Quagga & Zebra mussels has been linked to blue-green algae blooms
- Mussels promote blue-green algae blooms by selectively filtering other algae out of the water (less competition) and by releasing nutrients to grow more algae.



Mean Density of mussels in Western Lake Erie between 1991 and 2010; n=30. USGS

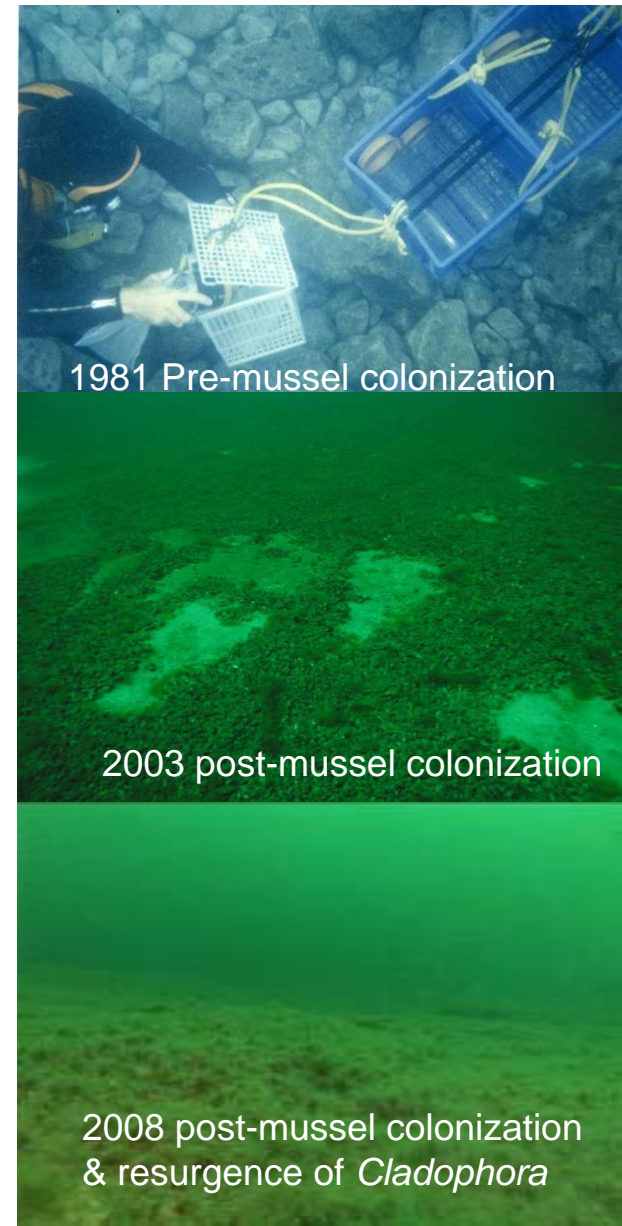
# Changed Ecosystem: The “Nearshore Shunt”

## Nearshore Phosphorus shunt:

- Invasive zebra & quagga mussels remove phytoplankton and other particles from the water
- Increased water clarity leads to a larger zone for *Cladophora* growth
- Mussels release nutrients at the lake bed, providing more food for *Cladophora* growth
- Mussels harden the substrate, providing the right surface for *Cladophora* to grow on

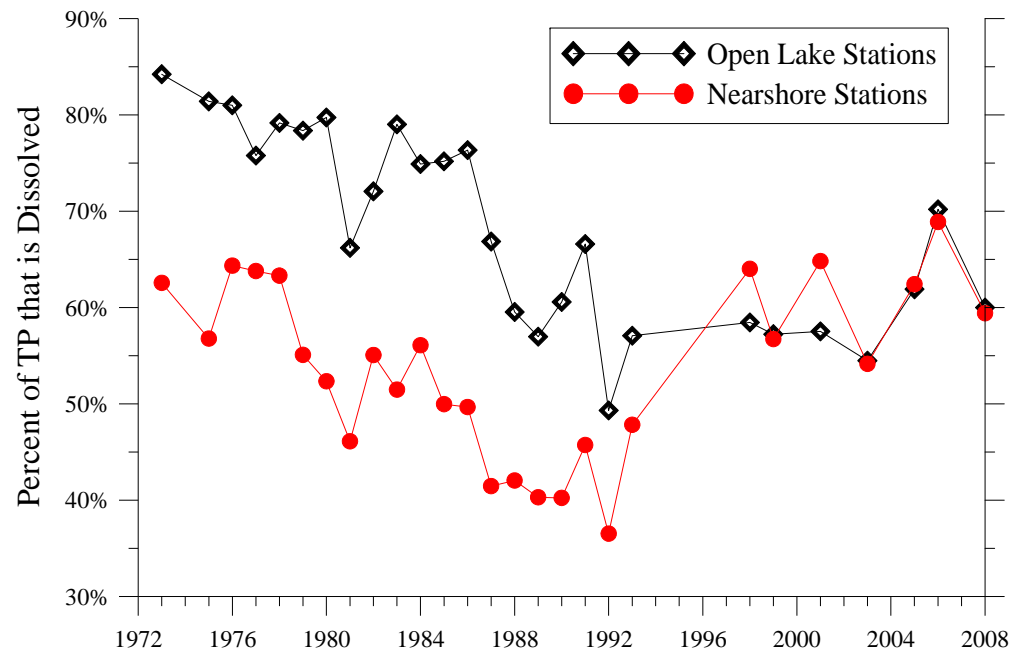
Nearshore shunt concentrates nutrients and productivity in the nearshore at the lake bed and diminishes productivity in the offshore:

*Too many invasive mussels, too much algae nearshore  
Too little fish food, too few fish offshore*



# Availability of Phosphorus

- Total phosphorus comprises many forms.
- Some forms of phosphorus are more bioavailable than others.
- Quagga & Zebra mussels remove particulate forms of phosphorus from the water column (changing the proportions) and concentrate phosphorus on the lakebed (changing the gradients).
- The forms of phosphorus coming off the landscape also appear to be more bioavailable.

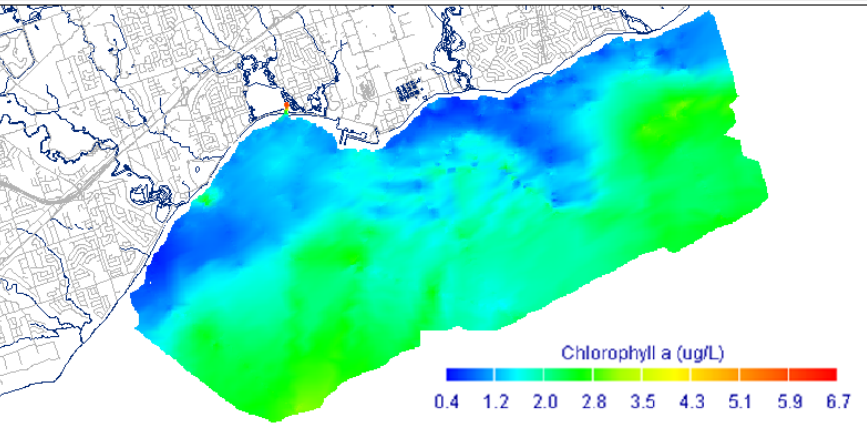
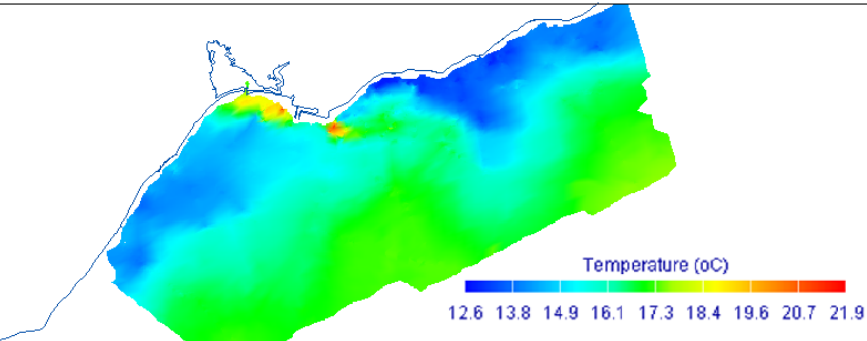
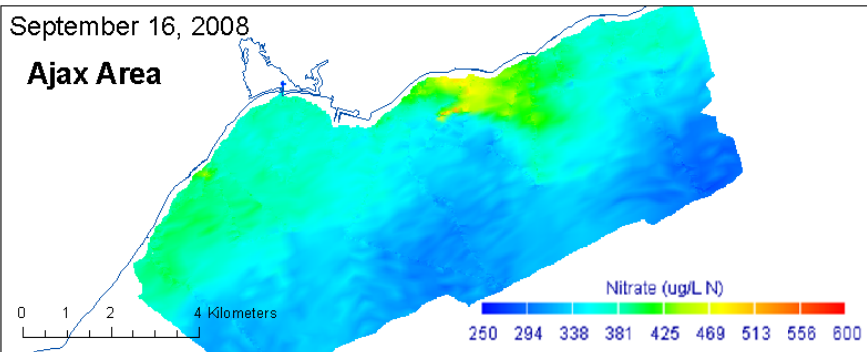


Alice Dove, Environment Canada, Great Lakes Surveillance Program

# Spatial and Temporal Variability

September 16, 2008

Ajax Area



## Hydrological Variability

- Volume of Discharge (watershed size, wet weather events, spring runoff)
- Quality of Discharge (concentration of contaminants)

## Physical Limnology

- Spatial Orientation of the Area
- Current flows
- Frequent reversals of flow directions
- Density gradients due to temperature differences

# There is a Need to Better....

## Understand Nearshore Processes:

- Intensively map water quality in problem areas in conjunction with intensive tributary monitoring
- Model nearshore water dynamics and biological (algae) response to nutrients
- Identify nearshore ecosystem targets
- Derive restoration objectives, related water quality targets for problem areas

## Understand Land-based Processes:

- Intensively monitor key tributaries during storm events
- Develop GIS-based models to estimate relative loadings and identify priority watersheds
- Validate the pollution impacts of best management practices (urban and rural watersheds)
- Estimate potential watershed contaminant load reductions

## Understand Nearshore-Offshore Processes:

- Model water dynamics and ecosystem response to nutrients (e.g. lower food web productivity, fish community response)
- Identify offshore ecosystem restoration objectives (e.g. fish community objectives), related water quality targets for problem areas

# Moving forward we will need to ...

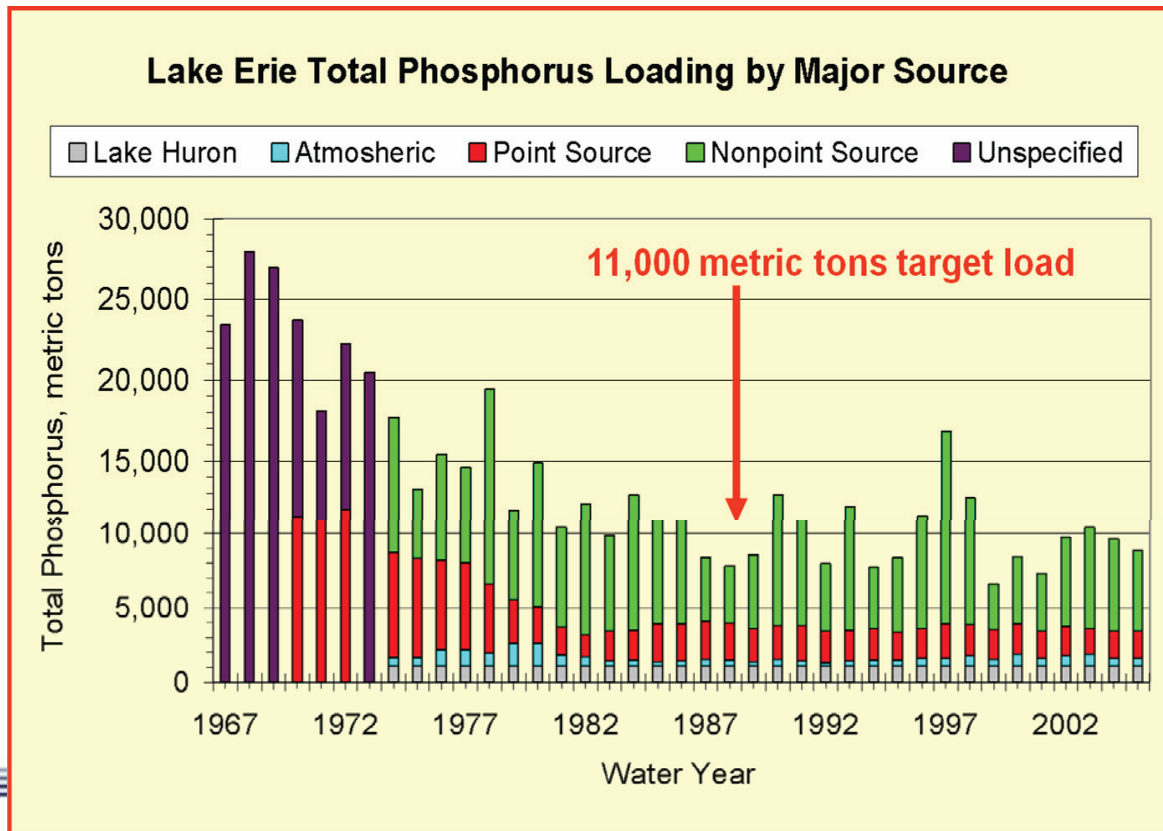
- Better quantify the significant effect of mussel-algae phosphorus recycling.
- Quantify and predict the biological response of reduced external loads (assume a significant lag due to internal sources)
- Undertake source modelling and quantification of the effectiveness of best management practices.
- Identify source watersheds where targeted actions would lead to measurable/achievable reductions

# Targets to Reduce Cladophora Growth

- Set a Cladophora growth target that can be related to a corresponding reduction in available TP near the lake bed.
- Perhaps a new trophic index that:
  - uses near-maximum total phosphorus rather than an average measure.
  - includes measures of benthic conditions in the target

# Regardless of the Targets ...

- Current nutrient loads to Lakes Erie, Ontario and Huron are adequate to sustain HABs and *Cladophora* growth in the post-Dreissenid nearshore.
- Algal growth is strongly P limited and likely would respond to an increase P supply to the nearshore – it can and will get worse



Long term trends in total phosphorus loading to Lake Erie 1967-2005. (Baker et al. 2009)

# Conclusions

- The Great Lakes ecosystem is stressed and changing.
- Establishing targets will be challenging.
- We will need to better manage point sources and especially non-point sources of phosphorus if we hope to reduce HABs and benthic algae problems in the Great Lakes.



I would like to acknowledge Duncan Boyd,  
Todd Howell, Aaron Todd, Pradeep Goel and  
Alice Dove