WORKING UNDER THE UPDATED AGREEMENT: CANADA’S GREAT LAKES NUTRIENT INITIATIVE

National Conference on Ecosystem Restoration
Brad Bass, PhD
Great Lakes Issues & Management Report Section
July 31, 2013
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The Great Lakes Water Quality Agreement – centerpiece of action

“...you’re glopping the pond where the Humming-Fish hummed! No more can they hum, for their gills are all gummed. So I’m sending them off. Oh, their future is dreary. They’ll walk on their fins and get woefully weary in search of some water that isn’t so smeary. I hear things are just as bad up in Lake Erie.”

— The Lorax, by Dr. Seuss
GLWQA Annex 4 Nutrients Commitments

- Lake Ecosystem Objectives
- Establish phosphorus objectives, loading targets and allocations for each lake
- Implement programs and other measures to manage excess phosphorus
- Identify priority watersheds for nutrient control and develop management plans for these watersheds
- Develop phosphorus reduction strategies and domestic action plans
1. Establish current **nutrient loadings** from selected Canadian tributaries.
2. Enhance knowledge of the **factors that impact tributary and nearshore water quality**, ecosystem health, and algae growth.
3. Establish **binational lake ecosystem objectives**, phosphorus objectives, and phosphorous load reduction targets.
4. Develop **policy options** and strategies to meet phosphorous reduction targets.
5. Develop a binational **nearshore assessment** and management framework.
6. Framework for other lakes

Source: Patricia Chambers, Environment Canada
Phosphorus Essentials

• Essential for life, crucial for global food supply
• We contain approx. 1.5 kg of P
• No known substitute
• Cannot be manufactured, cannot be destroyed
• We excrete 3-4 grams daily in urine
• Cows, hogs excrete 15 – 20 times that amount
• 95% of high quality, economically recoverable P in 5 countries, a group that does not include Canada
Excessive Phosphorus

Efforts in the 1970s to reduce phosphorus loadings were largely successful. However, an increase in dissolved phosphorus has led to a re-emergence of excessive algae and cyanobacteria blooms in the Great Lakes.

- The increasing proportion of the total phosphorus is dissolved and thus biologically available to fuel nearshore algal blooms.
- *Cladophora* fouling of shoreline has been reported for Lakes Huron, Michigan, Erie and Huron.
- Cyanobacteria blooms occurring in Lakes Michigan, Huron, Erie, and Ontario.
- *Plectoma Lyngbya* blooms identified in the western basin of Lake Erie.
What Does This Look Like in Pictures?

October 2007 – Microcystis bloom

Hand courtesy of Tom Bridgeman

2007 Lyngbya bloom near Toledo
Picture courtesy of the Toledo Blade
Lake Erie Dissolved Oxygen

- Algae exhausts nutrients and dies.
- Bacteria thrive on organic decay of algae and lower dissolved oxygen.
- Rapidly growing bacterial populations need exponentially increasing amounts of oxygen.
- Hypoxia / Anoxia: Fish and invertebrates die when oxygen gets too low.

Maximum area of anoxia measured in 2010

Credit: U.S. Environmental Protection Agency
Excessive Phosphorus

Total Phosphorus in the Nearshore

Lake Huron and Lake Ontario: some nearshore areas and embayments experiencing elevated levels

Lake Erie: extensive lawns of *Cladophora* are common place over the Eastern nearshore lakebed

Status of phosphorus can be quite different between the nearshore and offshore waters of each lake
Cladophora

- Nuisance accumulations on shoreline affect recreation and property values
- *Cladophora* in water affects utilities operations and water quality management
- May be a factor in avian botulism
- May be a factor in water *E.coli*
What are local-scale interactions between *Dreissena* and benthic algae?

**System level**
- Increased light penetration

**Local level**
- Resource importation
- Structural complexity

**Benthic Primary Production**

Patricia Armenio
Department of Environmental Sciences and the Lake Erie Center
University of Toledo
<table>
<thead>
<tr>
<th>Land-Use</th>
<th>TP (kg/yr)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban SW</td>
<td>2192</td>
<td>3.03</td>
</tr>
<tr>
<td>Urban CSO</td>
<td>867</td>
<td>1.2</td>
</tr>
<tr>
<td>Urban WWTP</td>
<td>7442.83</td>
<td>10.3</td>
</tr>
<tr>
<td>Agriculture</td>
<td>58993.63</td>
<td>81.67</td>
</tr>
<tr>
<td>Other*</td>
<td>2738.54</td>
<td>3.79</td>
</tr>
<tr>
<td>Total</td>
<td>72234</td>
<td>100</td>
</tr>
</tbody>
</table>
Review of Agricultural Phosphorus BMPs

- **BMP Component Functions**

<table>
<thead>
<tr>
<th>BMP</th>
<th>Farm Setting</th>
<th>Primary Functional Component</th>
<th>Primary Form of Phosphorus (P) Affected</th>
<th>Effect of Tile on BMP Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock fencing</td>
<td>Stream</td>
<td>Source</td>
<td>Dissolved &amp; particulate</td>
<td>n/a</td>
</tr>
<tr>
<td>Tile water treatment</td>
<td>Stream bank</td>
<td>Source</td>
<td>Dissolved &amp; particulate</td>
<td>Complementary</td>
</tr>
<tr>
<td>Streambank Stabilization</td>
<td>Stream bank</td>
<td>Transport</td>
<td>Particulate</td>
<td>Variable</td>
</tr>
<tr>
<td>Tile outlet control structures</td>
<td>Stream bank</td>
<td>Transport</td>
<td>Dissolved &amp; particulate</td>
<td>Complementary</td>
</tr>
<tr>
<td>Tile outlet stabilization</td>
<td>Stream bank</td>
<td>Transport</td>
<td>Particulate</td>
<td>Complementary</td>
</tr>
</tbody>
</table>

- Majority (89%) reported as functional for controlling P (e.g. sufficiently developed)
- Approximately 62% of the BMPs were ranked M-H effective.
- Under CC scenarios some BMPs may require modifications with shift in growing seasons/increased storm events.
- A majority of BMPs (83%) are not currently in use by Ontario farm industry (due to large choice and lack of decision/advice).
- BMPs that provide an economic benefit are more readily adopted.
<table>
<thead>
<tr>
<th>Common Practices in Lakes Erie, Simcoe</th>
<th>Achievable Conc. (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bio. treatment + chem. precipitation</td>
<td>0.5</td>
</tr>
<tr>
<td>• Tertiary treatment + fixed film</td>
<td>0.33</td>
</tr>
<tr>
<td>• Activated sludge + cloth disk filter</td>
<td>0.25</td>
</tr>
<tr>
<td>• Lagoons + intermittent sand filter</td>
<td>0.3-0.04</td>
</tr>
<tr>
<td>• Tertiary sand filtration + chem. prec.</td>
<td>0.1</td>
</tr>
<tr>
<td>• Sequencing batch reactor</td>
<td>0.1</td>
</tr>
<tr>
<td>• Solids contact clarifier + chem. prec.</td>
<td>0.03</td>
</tr>
</tbody>
</table>
## Urban Policy, Program and Legislation (PPL) Summary

<table>
<thead>
<tr>
<th>PPL Category</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Sanitary</td>
<td>Aging STPs and CSO issues. Current limits may be too high</td>
</tr>
<tr>
<td>Stormwater</td>
<td>Lack of monitoring to assess effectiveness</td>
</tr>
<tr>
<td>Residential Unsewered</td>
<td>Addressed in Building Codes and Bylaws</td>
</tr>
<tr>
<td>Urban NPS</td>
<td>Very few PPLs address P loads; distance decay effect from Lake</td>
</tr>
</tbody>
</table>

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<th>PPL Category</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watershed NPS</td>
<td>Many organizations with water quality PPLs, but only monitoring is of trends in L. Erie</td>
</tr>
<tr>
<td>CSO</td>
<td>Addressed at through LID &amp; other BMPs. Province starting to monitor</td>
</tr>
<tr>
<td>Urban Fertilizers and Detritus</td>
<td>No fertilizer bans</td>
</tr>
<tr>
<td>LID</td>
<td>Insufficient monitoring</td>
</tr>
</tbody>
</table>
Grand River Cost-Benefit Analysis

- **Ecological Services:**
  1. Agricultural production
  2. Provision of raw water for drinking water supplies
  3. Water-based recreation (boating and swimming)
  4. Fisheries productivity/angling.

- **P Management Techniques:**
  1. WWTP upgrades
  2. Timing and amount of fertilizer/manure application
  3. Shifting land from intensively managed crops to forage crops
  4. Installation/operation/maintenance of measures to control runoff
Future Concerns – Urban Growth

Summer Oxygen Level Downstream of Guelph & Guelph Population

- Guelph Wastewater Treatment Plant improvements
- Reservoir operation changes

Summer Oxygen Level at Blair & Kitchener-Waterloo Population

Minimum Dissolved Oxygen Level (mg/L) vs. Year

Courtesy of GRCA, Water Mgt Plan, Partners Workshop 2013
Scatterplot
Air Temperature - Mean (2m) (degC) vs Precipitation - Total (%)
Area selection: 41.24N 83.41W - 43.20N 78.66W
Baseline Years: 1971 - 2000 (vs: 2011 - 2041), Summer - JJA
Future Concerns – Climate Change

• Decreasing Snow:Rain ratio in Winter
• Rain on frozen or not-frozen, bare soils
• Drier Summer with more severe storms
• Stable late Summer / Fall lake temperatures delay overturning
• Impacts on BMPs
The four basic personality types

- Planners
- Conservationists
- Ecologists
- Clients
Conclusions

• Population Dynamics of Nearshore Algae
  – Cannot completely resolve this issue

• Policies, Programs, Legislation and BMPs
  – There are policy gaps, but there are also policies that work against efforts to reduce phosphorus
  – BMP choices: barriers to adoption

• Future Considerations
  – becoming proactive instead of reactive
Population & Municipal Discharges - Canada

System Type, CSO
- WWTP (CSO: yes)
- WWTP (CSO: no)
- Lagoons (CSO: yes)
- Lagoons (CSO: no data)

Phosphorous Discharge Limit
- Value: mg/L (ND: No Data)

Borders
- Lower Tier
- Upper Tier District
- US/Canadian Border
- Lake Erie Watershed

Population Growth between 2009 and 2022 (%)
- 10.00 - 16.22
- 5.00 - 9.99
- 0.00 - 4.99
- 0.2 - 0.01
- No Data

Map showing distribution of population and municipal discharges in Canada, with areas highlighted for population growth and discharge limits.
Thank you!