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
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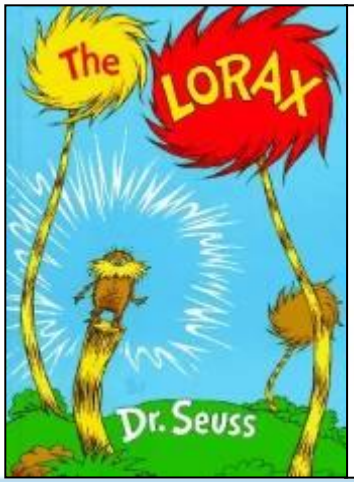
Contents

1. Overview Great Lakes Water Quality Agreement
2. Overview of Great Lakes Nutrient Initiative
3. Phosphorus 101
4. How nutrient dynamics have changed in Lake Erie
5. Contributions of different policies, programs and technology to managing phosphorus
6. Impacts of climate change
7. Ecological Goods & Services Cost-Benefit Analysis
8. Next Steps

The Great Lakes Water Quality Agreement – *centerpiece of action*



"You're glumping 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



Great Lakes Nutrient Initiative

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

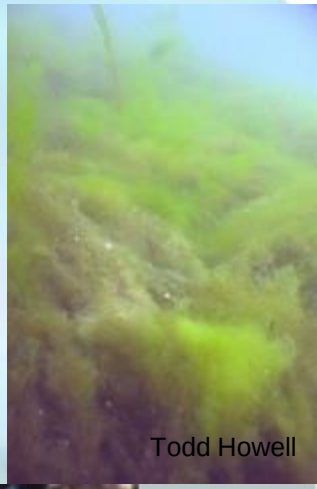
Phosphorus Essentials

- 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

Courtesy of D.S. Mavinic, UBC

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.


Todd Howell

- 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.


Scott Higgins

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.

Credit: U.S. Environmental Protection Agency

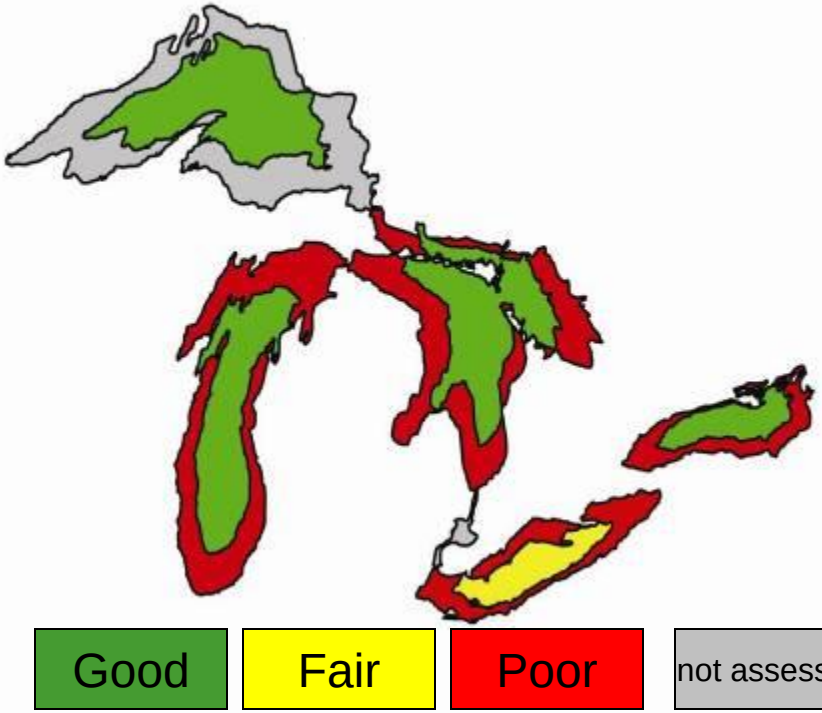
Maximum area of anoxia measured in 2010

Excessive Phosphorus

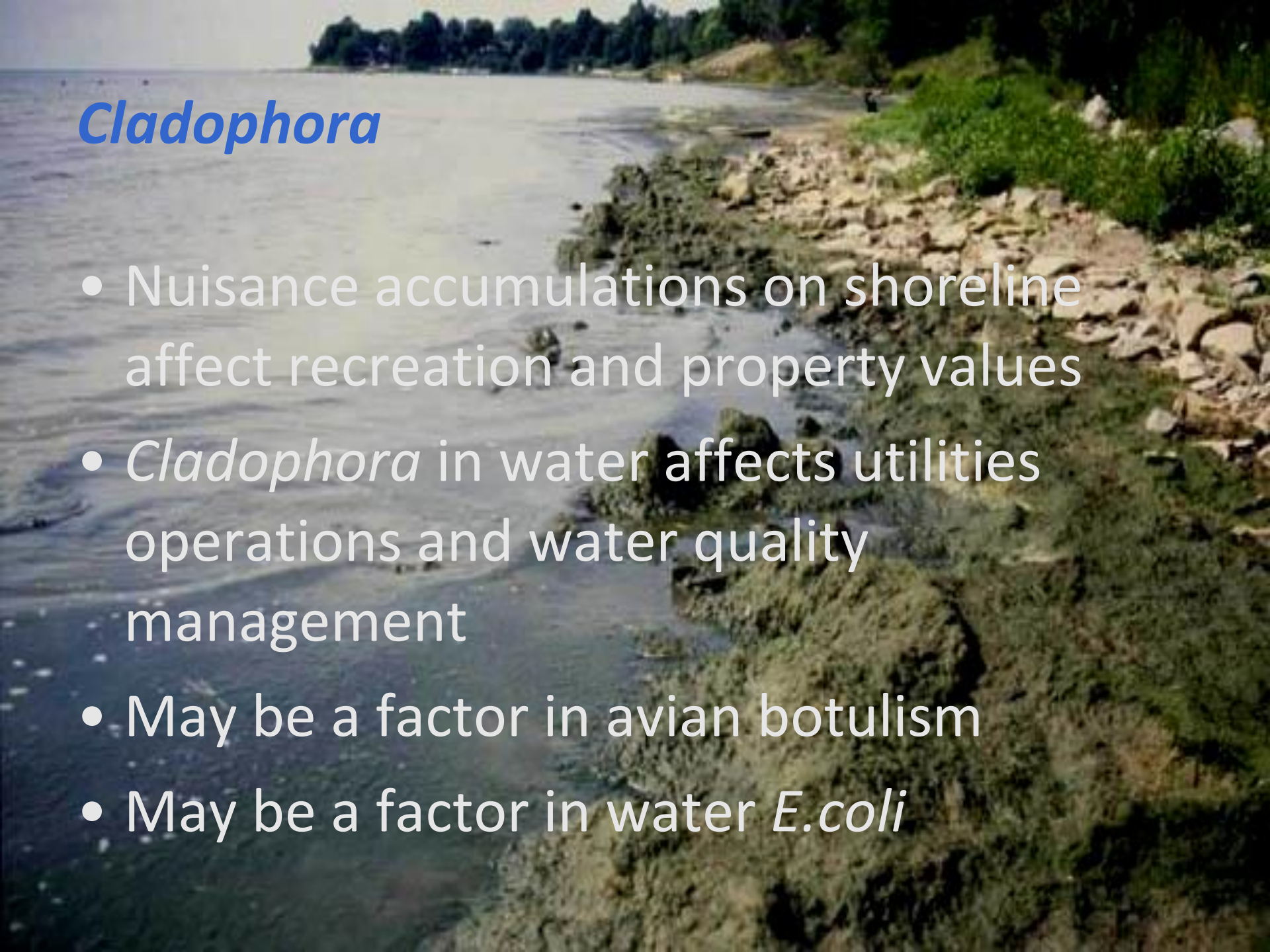
Total Phosphorus in the Nearshore

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



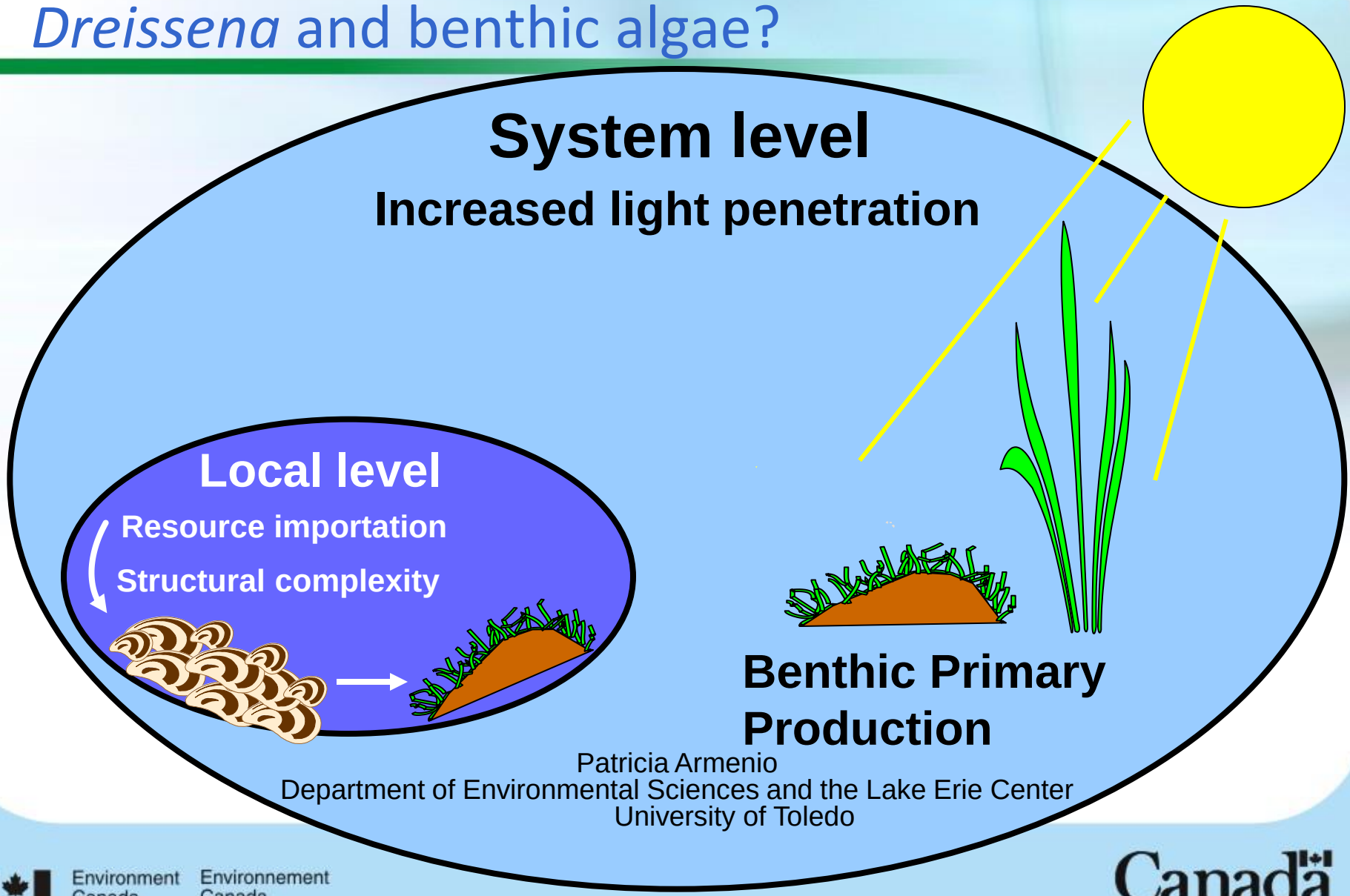
Status of phosphorus can be quite different between the nearshore and offshore waters of each lake



Cladophora

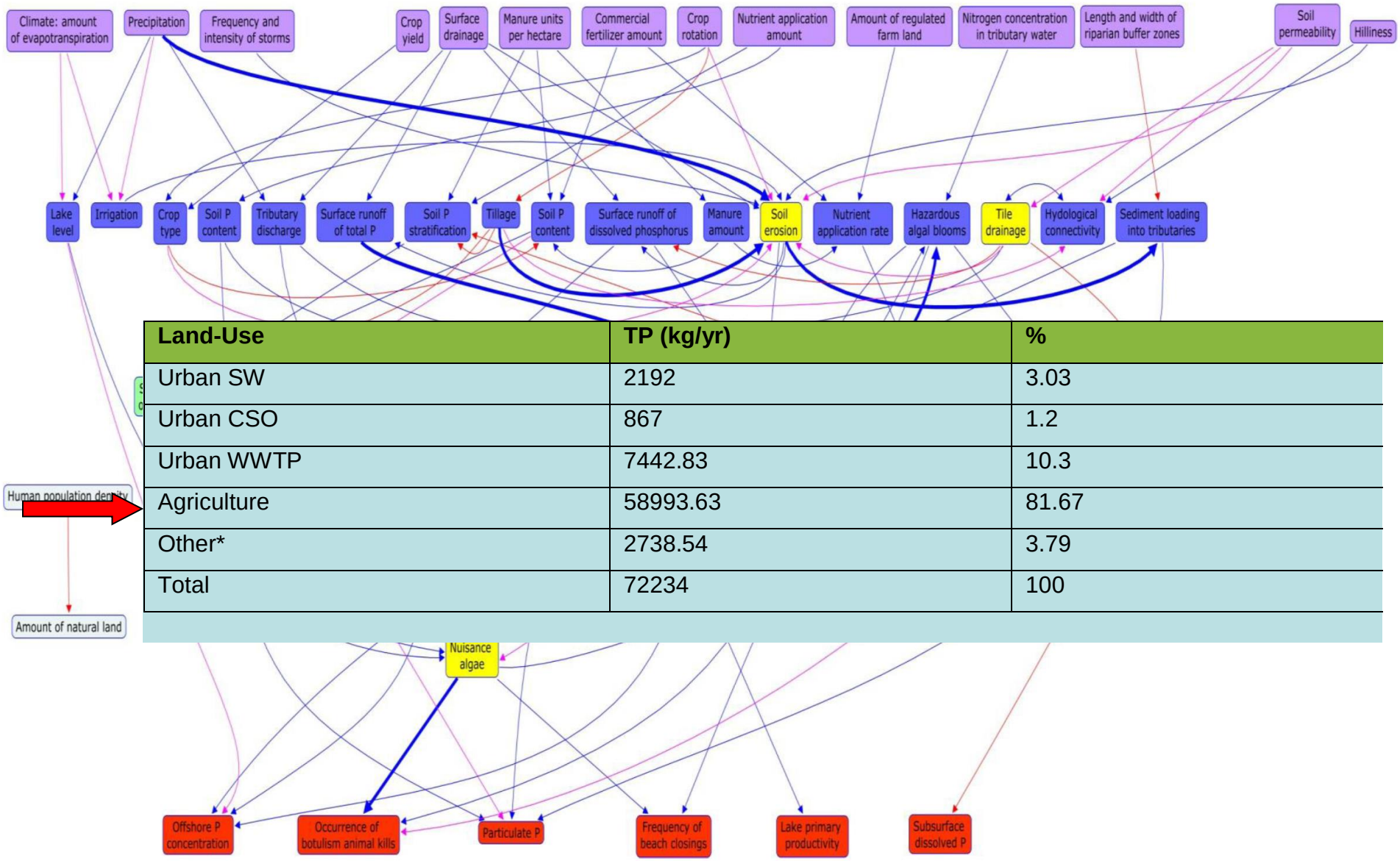
- Nuisance accumulations on shoreline affect recreation and property values
- *Cladophora* in water affects utilities operations and water quality management
- May be a factor in avian botulism
- May be a factor in water *E.coli*

What are local-scale interactions between *Dreissena* and benthic algae?



Patricia Armenio
Department of Environmental Sciences and the Lake Erie Center
University of Toledo

Agricultural Phosphorus Flows



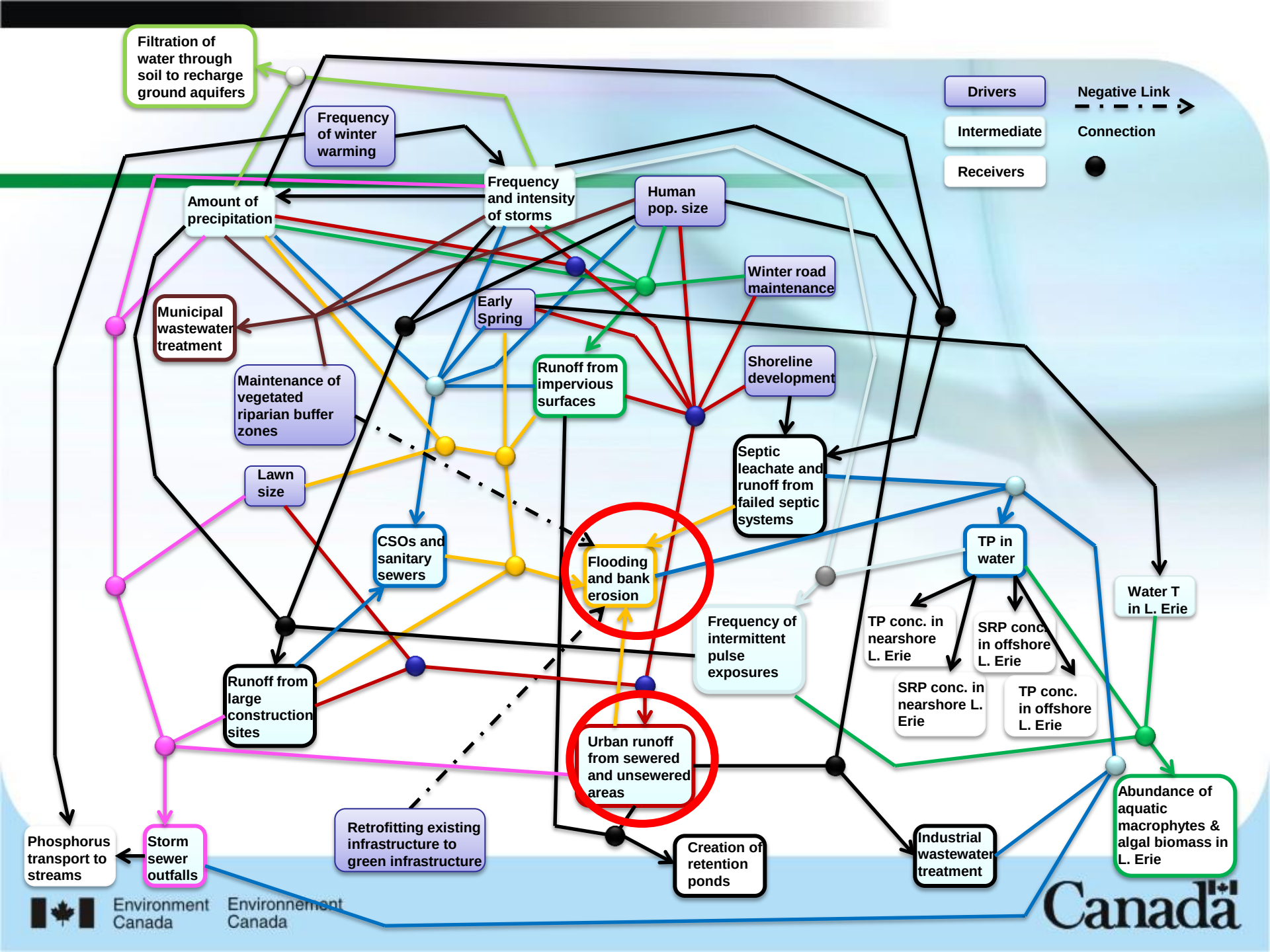
Land-Use	TP (kg/yr)	%
Urban SW	2192	3.03
Urban CSO	867	1.2
Urban WWTP	7442.83	10.3
Agriculture	58993.63	81.67
Other*	2738.54	3.79
Total	72234	100

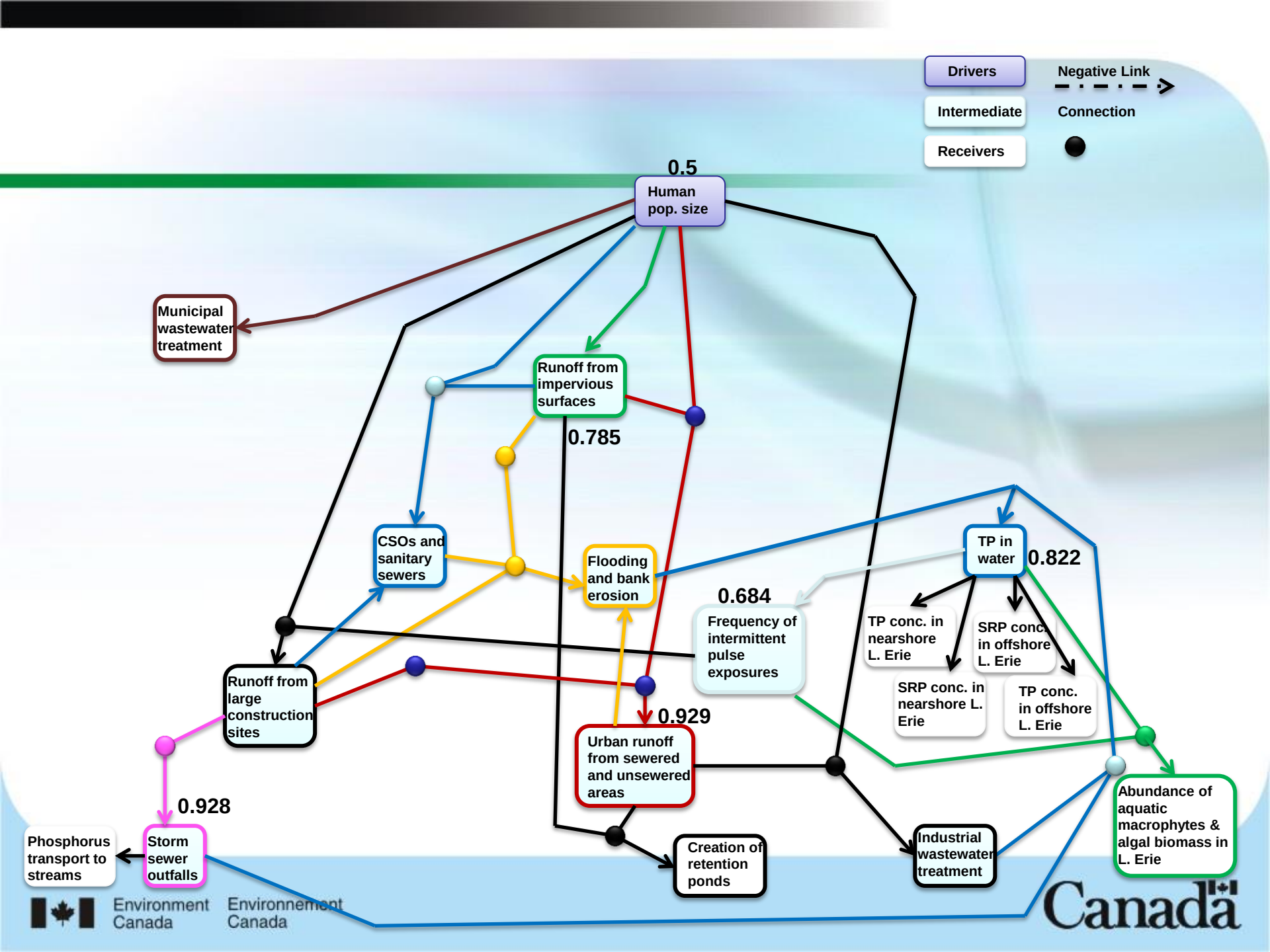
Review of Agricultural Phosphorus BMPs

✓ BMP Component Functions

BMP	Farm Set-ting	Primary Functional Component[1]	Primary Form of Phosphorus (P) Affected[1]	Effect of Tile on BMP Effectiveness
Livestock fencing	Stream	Source	Dissolved & particulate	n/a
Tile water treatment	Stream bank	Source	Dissolved & particulate	Complementary
Streambank Stabilization	Stream bank	Transport	Particulate	Variable
Tile outlet control structures	Stream bank	Transport	Dissolved & particulate	Complementary
Tile outlet stabilization	Stream bank	Transport	Particulate	Complementary

- 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.


Filtration of water through soil to recharge ground aquifers
Frequency of winter warming
Frequency and intensity of storms
Human pop. size
Amount of precipitation
Winter road maintenance
Municipal wastewater treatment
Early Spring
Runoff from impervious surfaces
Shoreline development
Maintenance of vegetated riparian buffer zones
Septic leachate and runoff from failed septic systems
Lawn size
CSOs and sanitary sewers
Flooding and bank erosion
TP in water
Water T in L. Erie
Frequency of intermittent pulse exposures
TP conc. in nearshore L. Erie
SRP conc. in offshore L. Erie
SRP conc. in nearshore L. Erie
TP conc. in offshore L. Erie
Runoff from large construction sites
Urban runoff from sewered and unsewered areas
Abundance of aquatic macrophytes & algal biomass in L. Erie
Phosphorus transport to streams
Storm sewer outfalls
Retrofitting existing infrastructure to green infrastructure
Creation of retention ponds
Industrial wastewater treatment
Drivers
Intermediate
Receivers
Negative Link
Connection
Environment Canada
Environnement Canada
Canada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Intermediate
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0.5
Human pop. size
Municipal wastewater treatment
Runoff from impervious surfaces
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CSOs and sanitary sewers
Flooding and bank erosion
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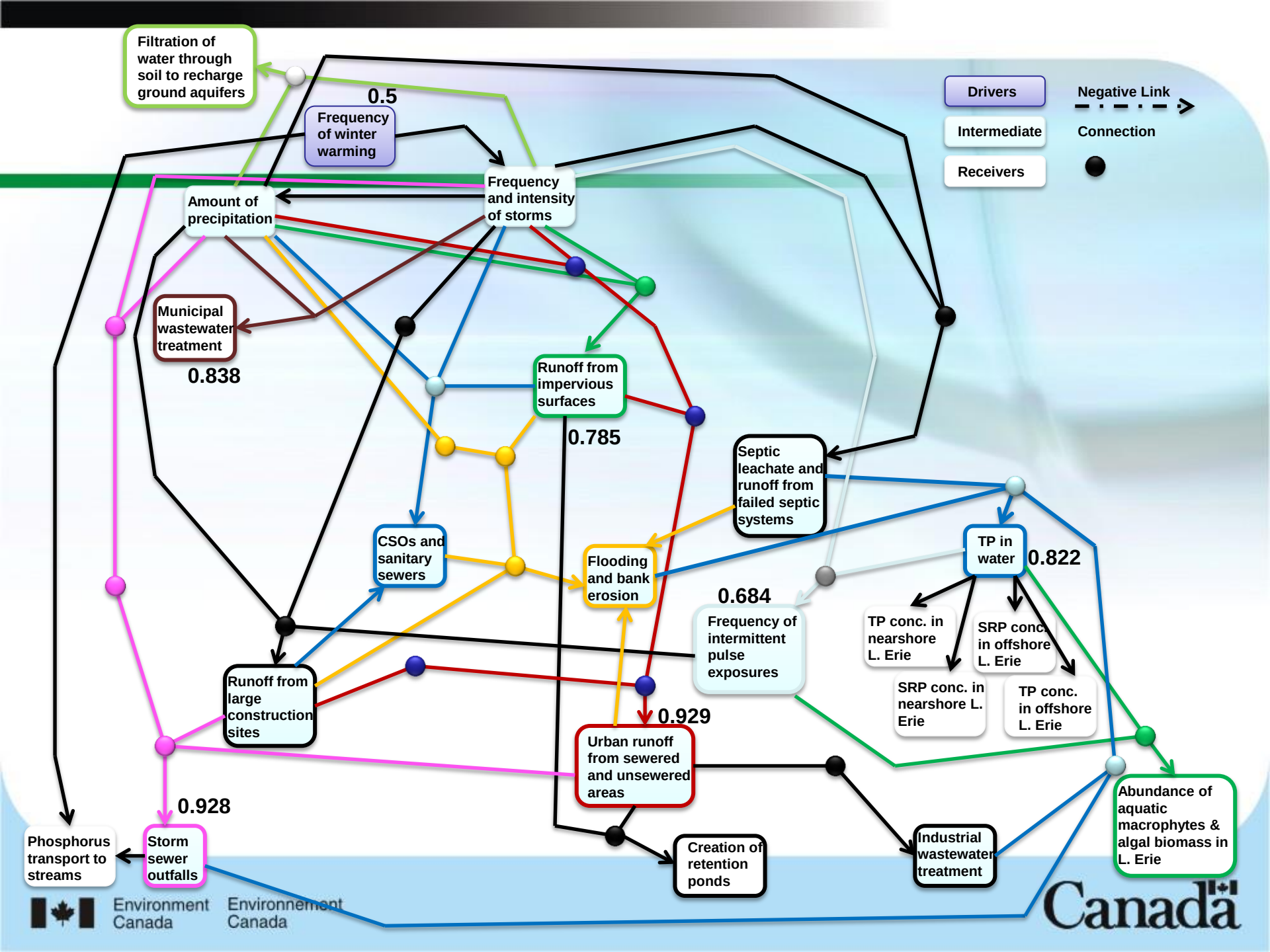
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Environment Canada
Environnement Canada
Canada

Wastewater Treatment

Common Practices in Lakes Erie, Simcoe	Achievable Conc. (mg/L)
• Bio. treatment + chem. precipitation	0.5
• Tertiary treatment + fixed film	0.33
• Activated sludge + cloth disk filter	0.25
• Lagoons + intermittent sand filter	0.3-0.04
• Tertiary sand filtration + chem. prec.	0.1
• Sequencing batch reactor	0.1
•Solids contact clarifier + chem. prec.	0.03

Urban Policy, Program and Legislation (PPL) Summary

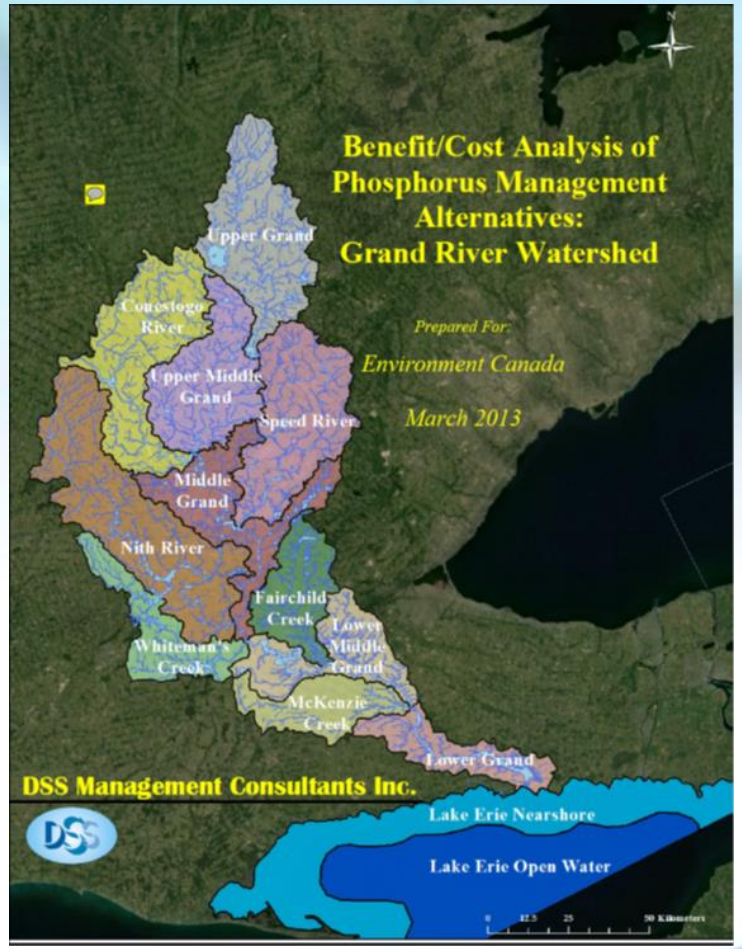
PPL Category	Overview
Urban Sanitary	Aging STPs and CSO issues. Current limits may be too high
Stormwater	Lack of monitoring to assess effectiveness
Residential Unsewered	Addressed in Building Codes and Bylaws
Urban NPS	Very few PPLs address P loads; distance decay effect from Lake

PPL Category	Overview
Watershed NPS	Many organizations with water quality PPLs, but only monitoring is of trends in L. Erie
CSO	Addressed at through LID & other BMPs. Province starting to monitor
Urban Fertilizers and Detritus	No fertilizer bans
LID	Insufficient monitoring

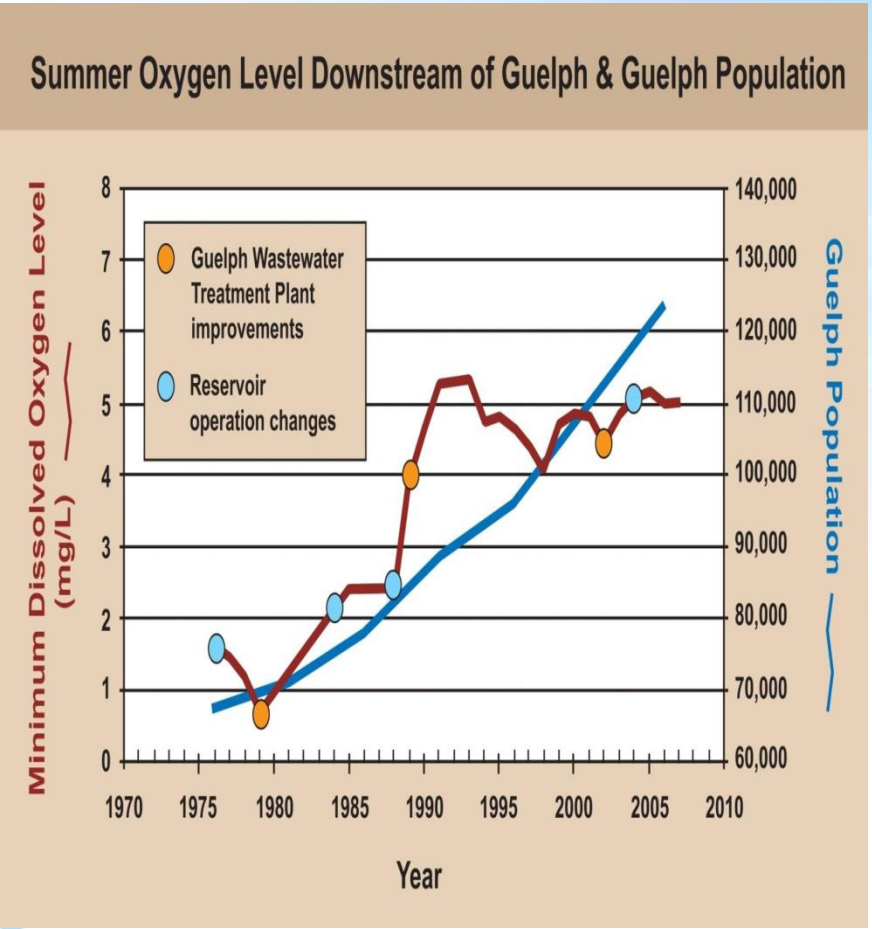
Grand River Cost-Benefit Analysis

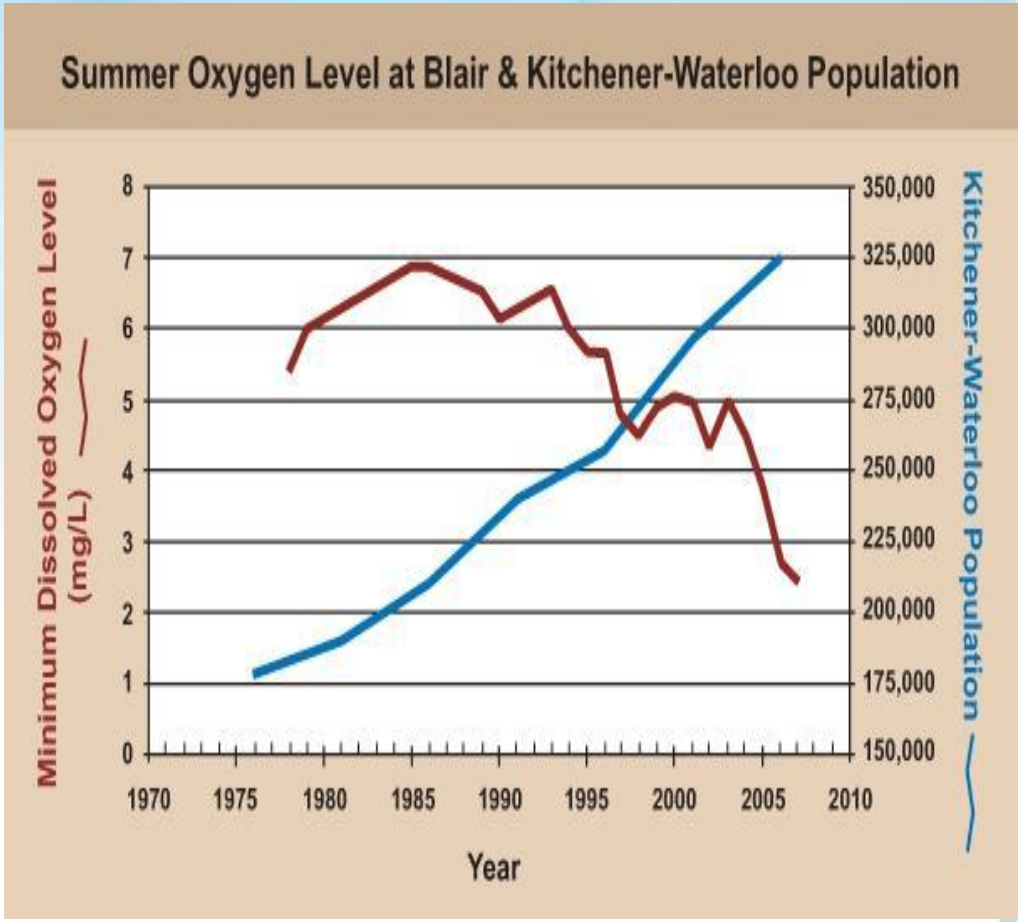
- **Ecological Services:**
  1. Agricultural production
  2. Provision of raw water for drinking water supplies
  3. Water-based recreation (boating and swimming)
  4. Fisheries productivity/angling.

- **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

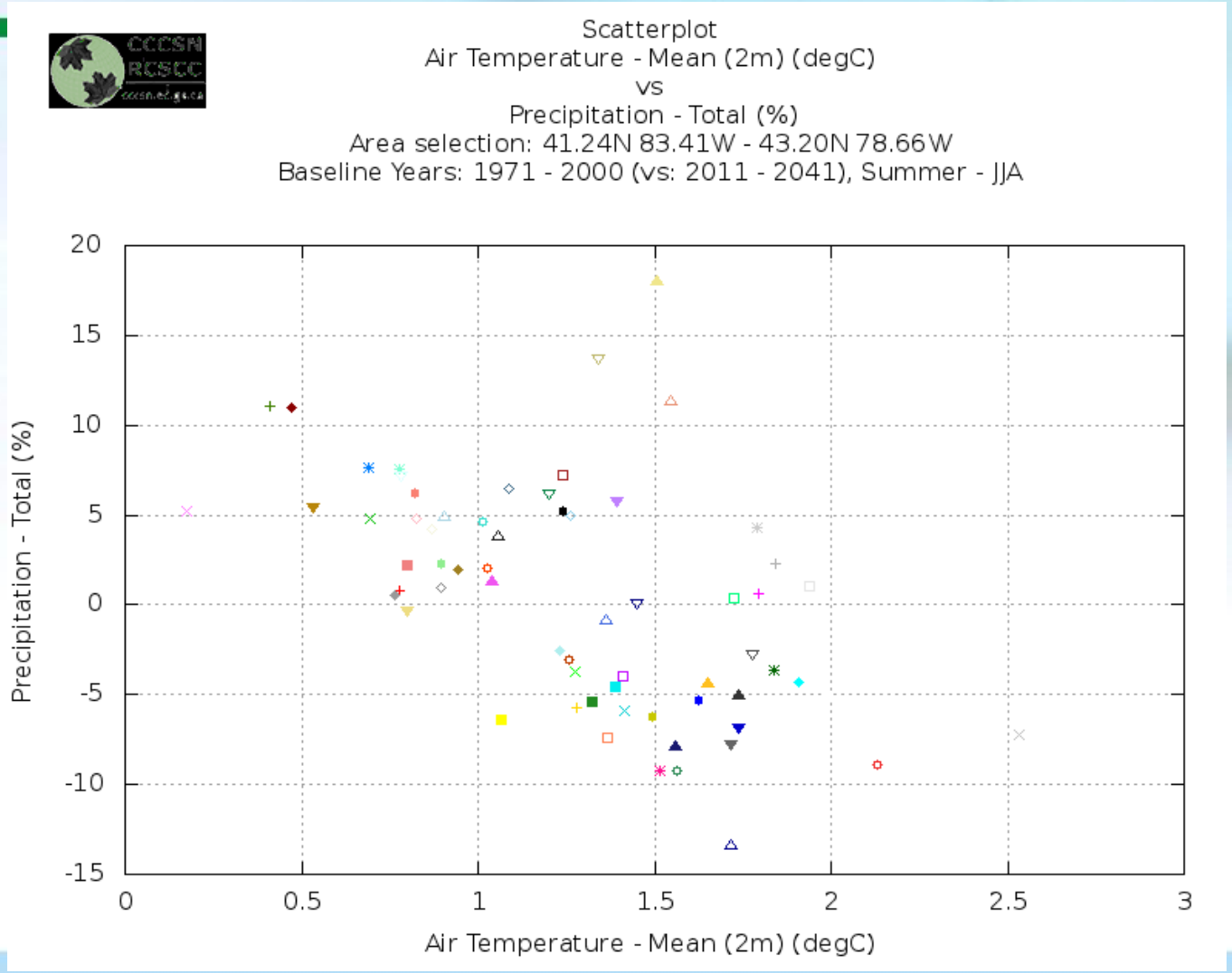


Future Concerns – Urban Growth





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
Precipitation - Total (%)
20
15
10
5
0
-5
-10
-15
0
0.5
1
1.5
2
2.5
3
Air Temperature - Mean (2m) (degC)

Future Concerns – Climate Change

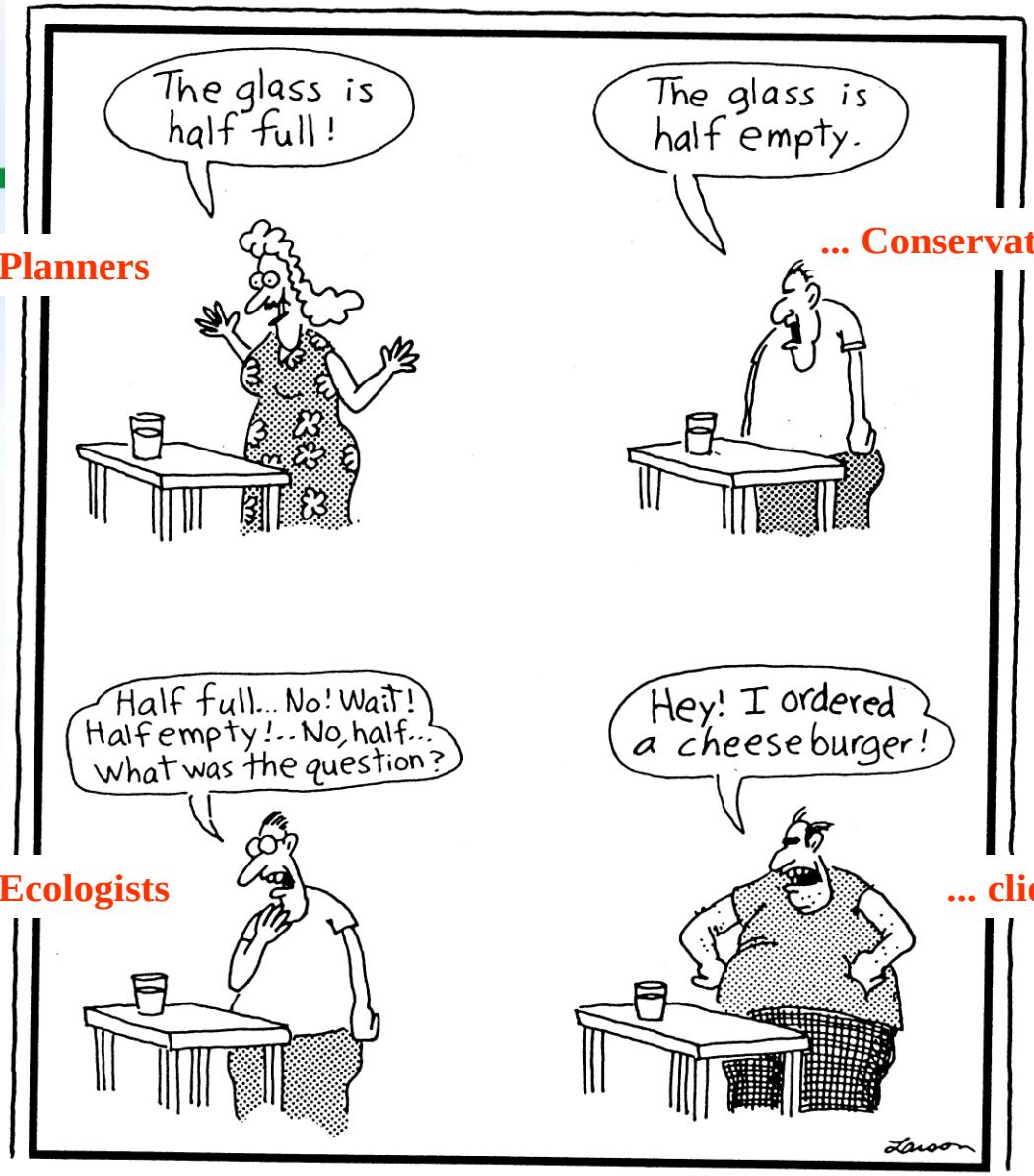
- Decreasing Snow:Rain ratio in Winter
- Rain on frozen or not-frozen, bare soils
- Drier Summer with more severe storms
- Stable late Summer / Fall lake temperatures delay overturning
- Impacts on BMPs

CONVINCING PEOPLE

Multiple Perspectives

... Planners

... Conservationist



... Ecologists

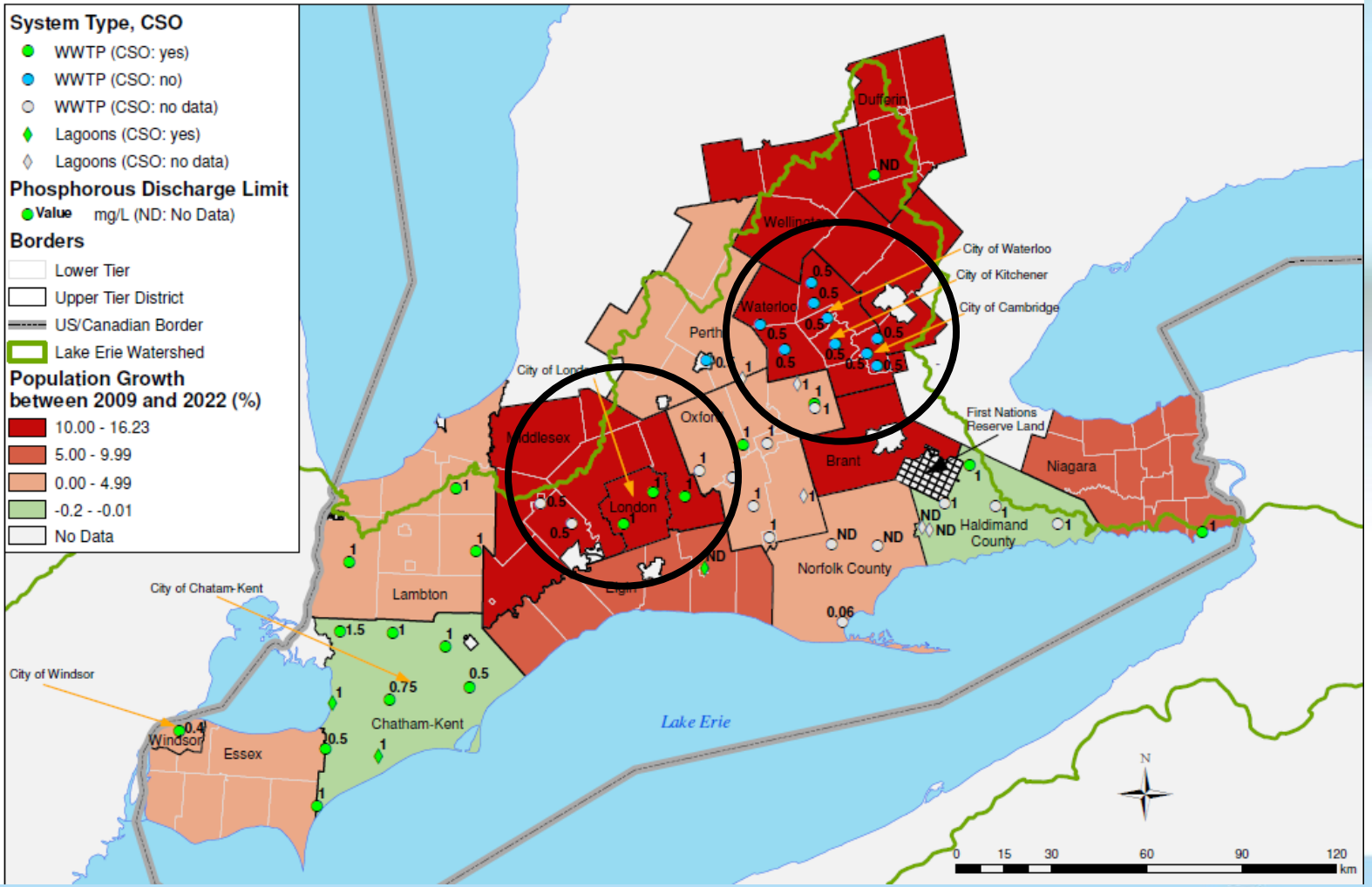
... clients

The four basic personality types

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



Thank you!