Water Quality Assessment in the Thames River Watershed

Nutrient Trends

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Outline

- Thames River watershed, nutrient issue
- The project: Data, methods
- Nutrient trends: Over time, across watershed
- Export to Lake St. Clair
- Using the information: Implementation
Thames River Watershed

Area: 5,692 km²
Length: 280 km
Land use:
- 82% Agriculture
- 7.8% Urban
- 8.7% Tree cover
Population: 600,000
Thames River Watershed

- 4-10 days from headwaters to Lake St. Clair
- River elevation change: 210 m
- Major dams and flood control structures
- 50% tile drained
The Nutrient Issue – locally in the Thames

- Over time phosphorus concentrations have improved in the river
- Healthy aquatic life – 94 fish species
- Natural river processes important
- Some local effects of excess phosphorus
The Nutrient Issue
Lake St. Clair and Lake Erie West Basin

- Lake Erie findings: March-May runoff determines scale of Lake Erie algae blooms in July
- Tributaries are major source – High flow delivery, spring
- Phosphorus attaches to sediment
Water Quality Assessment Project

- Project started in 2013 through Showcasing Water Innovation
- **Freshwater Research (Gertrud Nürnberg, Ph.D., Bruce LaZerte, Ph.D.)**
- Project team:
  - Ontario Ministry of the Environment & Climate Change
  - Ontario Ministry of Agriculture, Food and Rural Affairs
  - City of London
  - Environment Canada
  - Western University
  - Lower Thames Valley Conservation Authority
  - Upper Thames River Conservation Authority

**Goals: To better understand:**
- What areas and sources contribute nutrients in the Thames watershed
- When are most nutrients getting to the river
- Delivery to Lake St. Clair – effect of reservoirs, flows
- Climate and extreme weather impacts
Monitoring data for the Thames

- 83 water quality stations
- 26 stream gauge stations - Water Survey Canada
- 30 wastewater treatment plants

Time period used: 1986-2012
Annual, Monthly, Seasonal

Variables:
- Total phosphorus
- Dissolved phosphorus
- Suspended solids: Measure of sediment
- Nitrogen, nitrate

Average concentrations (flow weighted)
Loads (three models)
Estimating Nutrient and Sediment Loads

Determined 3 methods for load calculations and used based on data availability for locations:

- **EGRET** (Exploration and Graphics for RivEr Trends – U.S. Geological Survey program)
  - Weighted regressions on time, discharge, season the most reliable model

- **GAM** (General Additive Model)
  - Available for all stations that can be combined with flow data, optimally weighted regression with smoothing

- **LINEAR** (non-flow-weighted loads)
Trends across the Watershed

Phosphorus (FWC)
From the headwaters of the North and South Thames to the Forks in London:
• DRP decreasing, no trend for TP

In lower reach of Thames River:
• TP decreasing, no trend for DRP

Sediment (TSS)
• Decreases in the North Thames River
• Increases in the Thames River (London to Mouth)
• No trend in the South Thames River

Upper Thames – 40,000 tonnes/year
Lower Thames – 74,000 tonnes/year

= 5400 Truck Loads
Findings: Trends over Time (1986-2012)

- Total Phosphorus flow-weighted concentrations decreased significantly with time
  - Sites across the Thames watershed
- No consistent improvement for dissolved phosphorus, sediment, total nitrogen
- Improvement in WWTP effluent phosphorus levels over time
Seasonal Trends

- Phosphorus and sediment loads highest in late winter and spring
- River flows seasonally distinct: High flow (Mar-Apr) decreasing (May-Sept)

**Monthly Average Total Phosphorus Loads (1986-2012)**
Sources of Phosphorus – Point and Non-Point

- Non-point sources dominate loads – runoff from areas across the watershed (e.g., fertilizer, waste, detergents)
Reservoirs and Impoundments

- Decrease load in spring, high flows
- Increase in summer through internal phosphorus load: Release phosphate from bottom sediments during warm, low-oxygen conditions

- Aged impoundments become source of nutrients including legacy nutrients
- Example: Fanshawe Reservoir’s internal load is 4-16 t/summer
Thames River Export into Lake St. Clair

Thames estimated annual export
- 342 t/yr Total Phosphorus
- 187 t/yr Dissolved P
- $113 \times 10^3$ t/yr Suspended Sediment

Lake Huron’s TP load upstream of Lake St. Clair:
- 419 (321-560) t/yr

Detroit River to Lake Erie estimated TP load:
- 3,500 - 4,300 t/yr, or 10 fold

Maumee River TP load
- 3800 t/yr

Water levels between Lake St. Clair and the Thames River are close enough to permit flow exchange. Export was computed from known and modelled contributions from various tributaries with the gauged and monitored Thames River station closest to the mouth.
Considerations for Implementation

Loads in the spring and late winter are highest and most significant to summer algae blooms
- *Target BMPs to minimize phosphorus and sediment runoff in winter-spring*

Phosphorus and sediment loads for the Thames are significant, mainly non-point source, and contributed watershed-wide
- *Enhance urban and rural non-point source implementation across the watershed with BMPs specific to minimizing runoff in high and extreme flow conditions*

Some subwatersheds have proportionally higher phosphorus and sediment loads
- *Target some added implementation to these areas*
Recommendations for Additional Monitoring

• Importance of continued monitoring at key locations to measure future progress in load reductions

• Better monitoring of extreme flow conditions, all seasons, where flow gauges are available; use of continuous samplers
Moving Forward in the Thames Watershed

- Nutrient issue has been a target since PLUARG, and have been implementing programs locally for 30+ years
- Making steady but gradual progress as seen in river trends, despite increases in population, wastewater volumes, row cropped acres and livestock numbers, combined with changing weather patterns
- It takes time with non-point sources to achieve and measure improvement, but it can be done
- Extension (people), knowledge transfer, BMPs with multiple benefits
Thank you

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