2013 Cayuga Lake
Tributary Water Quality: Preliminary Analysis

Anthony R. Prestigiacomo
Results: Comparison of Daily Flow Records

- 2013 study interval
- to be expanded for longer-term records
- support model hindcasting and scenarios
Preliminary Estimates of Epilimnetic Flushing

- first approximation
- assumptions
  - epilimnetic depth of 10 m
  - unaged tributary flow estimates according to watershed area ratios to Fall Creek
  - tributaries enter the epilimnion
- flushes = average \( Q_{TOTAL} \) (m³/d) ÷ lake vol. (0-10m) x time for May – September interval (152 d)
- number of flushes of epilimnion over May – September interval = 0.18
- tributaries impact the lake’s water quality
Sampling Coverage in 2013

- 97 samples
- 41% flow sampled

Fall Creek
- routine samples
- event samples

Daily Flow (m$^3$/s)

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Sampling Coverage in 2013

- 97 samples
- 41% flow sampled
- 92 samples
- 32% flow sampled
Sampling Coverage in 2013

- 97 samples
- 41% flow sampled
- 92 samples
- 32% flow sampled
- 71 samples
- 38% flow sampled
Sampling Coverage in 2013

- Fall Creek
  - 97 samples
  - 41% flow sampled

- Salmon Creek
  - 92 samples
  - 32% flow sampled

- Cayuga Inlet Creek
  - 71 samples
  - 38% flow sampled

- Six Mile Creek
  - 79 samples
  - 37% flow sampled
Results:

Time Series of Selected Constituents

- $\log Q$ (m$^3$/s)
  - Values range from $0.1$ to $100$

- TP (µg/L)
  - Values range from $1$ to $10000$

- SRP (µg/L)
  - Values range from $0.1$ to $10000$

- NO$_X$ (µg/L)
  - Values range from $100$ to $10000$

Seasons:
- Fall
- Salmon
Results:
Time Series of Selected Constituents

- \( \log Q \) (m\(^3\)/s)
- TSS (mg/L)
- Tn (NTU)

Data points indicating 'Fall' and 'Salmon' are highlighted.

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## Results: Basic Statistics

- medians (maximum obs. in parentheses)

<table>
<thead>
<tr>
<th>Tributary</th>
<th>TP (µg/L)</th>
<th>TDP (µg/L)</th>
<th>PP (µg/L)</th>
<th>SRP (µg/L)</th>
<th>t-NH$_3$ (µg/L)</th>
<th>NO$_X$ (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Creek</td>
<td>51.3 (997)</td>
<td>9.2 (69)</td>
<td>40.6 (927)</td>
<td>3.5 (52)</td>
<td>19.5 (659)</td>
<td>0.94 (18?)</td>
</tr>
<tr>
<td>Salmon Creek</td>
<td>43.7 (3,257)</td>
<td>13.7 (134)</td>
<td>25.3 (3,203)</td>
<td>8.3 (133)</td>
<td>21.0 (113)</td>
<td>4.7 (10.4)</td>
</tr>
<tr>
<td>Cayuga Inlet</td>
<td>27.4 (12,674)</td>
<td>5.7 (49)</td>
<td>21.8 (12,640)</td>
<td>1.8 (30)</td>
<td>20.0 (50)</td>
<td>0.41 (1.21)</td>
</tr>
<tr>
<td>6 Mile Creek</td>
<td>37.5 (539)</td>
<td>8.9 (90)</td>
<td>27.8 (510)</td>
<td>5.8 (81)</td>
<td>21.0 (51.0)</td>
<td>0.27 (0.57)</td>
</tr>
<tr>
<td>Taughannock Creek</td>
<td>11.6 (166)</td>
<td>5.3 (43.2)</td>
<td>5.8 (122.9)</td>
<td>1.4 (24.7)</td>
<td>21.5 (44)</td>
<td>0.11 (3.3)</td>
</tr>
</tbody>
</table>

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### Results: Basic Statistics

- medians (maximum obs. in parentheses)

<table>
<thead>
<tr>
<th>Tributary</th>
<th>Tn (NTU)</th>
<th>FSS (mg/L)</th>
<th>FSS:TSS</th>
<th>PP:FSS</th>
<th>PP:TP</th>
<th>SRP:TDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Creek</td>
<td>13.0 (916)</td>
<td>30.4 (2,439)</td>
<td>0.87</td>
<td>0.0021</td>
<td>0.78</td>
<td>0.39</td>
</tr>
<tr>
<td>Salmon Creek</td>
<td>5.7 (3,905)</td>
<td>6.1 (2,720)</td>
<td>0.80</td>
<td>0.0048</td>
<td>0.57</td>
<td>0.58</td>
</tr>
<tr>
<td>Cayuga Inlet</td>
<td>13.7 (12,368)</td>
<td>31.5 (8,712)</td>
<td>0.88</td>
<td>0.0018</td>
<td>0.78</td>
<td>0.39</td>
</tr>
<tr>
<td>6 Mile Creek</td>
<td>19.5 (942)</td>
<td>31.6 (734)</td>
<td>0.85</td>
<td>0.0027</td>
<td>0.74</td>
<td>0.53</td>
</tr>
<tr>
<td>Taughannock Creek</td>
<td>1.1 (34.9)</td>
<td>1.9 (14.1)</td>
<td>0.74</td>
<td>0.0056</td>
<td>0.54</td>
<td>0.31</td>
</tr>
</tbody>
</table>

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Results: Salmon Creek Longitudinal Patterns

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- **April 12, 2013**

- SRP (µg/L) and NOX (µg/L) levels across different locations:
  - Mouth
  - Upstream 1
  - Upstream 2
  - Upstream 3
  - Upstream 4

- The diagram shows the concentration trends of SRP and NOX from the mouth upstream to each of the four upstream locations.

- The data suggests a gradual increase in SRP and a decrease in NOX as one moves upstream.
Results: Fall Creek Flow-Concentration Relationships

- mostly positive dependencies
Results:
Flow-Concentration Relationships

- tributary differences in low-flow concentrations (intercepts) and loading potential (slopes)
Results:
Flow-Concentration Relationships

- tributary differences in low-flow concentrations (intercepts) and loading potential (slopes)
Results:
Turbidity as a Predictor of TP, PP for Fall Creek

- Int = 0.971
- Slope = 0.670
- r² = 0.90

- Int = 0.747
- Slope = 0.756
- r² = 0.92

Turbidity often a much better predictor than flow for particulate constituents:
- r² Q-TP = 0.42
- r² Q-PP = 0.46
Flow-Weighted Concentrations in 2013

\[ Conc_{FW} = \frac{\sum Observed \ Load}{Volume \ Sampled} \]
Results:
Flow-Weighted Concentrations in 2013

- Cayuga Inlet, highest in TP and PP
Results:
Flow-Weighted Concentrations in 2013

- Cayuga Inlet, highest in TP and PP
- Salmon Creek enriched in dissolved forms of P
  - ~ 75 % of TDP is SRP
Results:
Flow-Weighted Concentrations in 2013

- Cayuga Inlet, highest in TSS
- High fraction of TSS is FSS

![Graphs showing flow-weighted concentrations in 2013 for different locations such as Cayuga Inlet and Salmon Six Mile.](image-url)
Results:
Flow-Weighted Concentrations in 2013

- Fall creek highest in t-NH₃
- Salmon Creek extremely high in NOₓ
  - Fall Creek high as well
Results: Cayuga Inlet Mouth v. Channel

- source/sink dynamics of channel deposits?
Results: Evidence of Plunging

- Subsurface turbidity impacts at Site 3 (0.7 km NW Taughannock Cr. mouth)
Future Analysis

- More detailed statistical analysis
- Analyze tributary data sets from other sources
- Evaluate low-flow vs. high flow conditions
- Loading estimates
  - Flux Load Estimation software
    - utilizes flow-concentration relationships to generate daily load estimates
    - investigate event loading estimates from high intensity sampling during runoff events for individual events
- Unmonitored tributaries
  - under deliberation
  - interaction with T. Walters
  - watershed area ratios
  - selection of tributary for constituent pro-rating
Questions?