WATER QUALITY, TROPHIC STATUS AND POTENTIAL LOADING SOURCES FOR CLEARWATER LAKES

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• The Clearwater River Basin lakes are key to the local economy, lifestyle and sense of place.
• Increasing population and urbanization have focused discussions on land use planning, wastewater treatment, and collaborative restoration.
• Recent concerns about lake water quality have been voiced in the community and local TMDLs.
• Despite periodic studies of area lakes in the past 40 years, available data have never been analyzed as a whole.
Objectives

• Summarize existing information on past and present condition of Seeley and Salmon lakes and determine whether conditions are getting better or worse.
• Consider potential sources of nutrients that may influence the lakes and how they may have changed since the 1970s.
• Use scientific models to determine whether the lakes are at risk of worsening condition in the future.
• Recommend future monitoring, studies, and actions to minimize degradation of the lakes.
Approach—Past & Present Conditions

- Summarized in a database past studies of lake clarity (SD) & levels of nutrients, chlorophyll a & DO. (UM, EPA 1970’s & 80’s; DEQ 2003-8)
- Measured current (2009-2011) lake clarity & levels of nutrients & DO – added to database
- Calculated AHOD from DO levels
- Converted above to Trophic State Indexes
TSI’s used

- Carlson’s TSIs:
  - TSI SD = 60 - 14.41 (ln Secchi depth (meters))
  - TSI TP = 14.42 (ln TP (ug/L)) + 4.15
  - TSI Chl a = (9.81) (ln Chl a (ug/L)) + 30.6

- Walker’s TSI:
  - TSI AHOD = 175 + 49(log_{10} AHOD) - 223(log_{10} mean depth) + 100(log_{10} mean depth)^2
Approach:
Seeley Lake Loadings Past & Present

• Used EPA’s Lake Loading estimates for 1970’s

• For present lake loadings, increased loads from septic systems 8 fold

  (because domestic wells near Seeley have increased 8 fold since 1970’s)
Modeling Seeley Lake Response to Past, Present, Future Loads

- Used Classic Lake Loading Response Models (Vollenweider, and Dillon & Rigler) to predict lake water quality response to past & present loads.
- Compared predictions to observed water quality (validation)
- Used models to determine loading level that would push lake into eutrophic zone
RESULTS

• Condition over time – summarized as TSI’s

• Also note N:P ratios in lakes

• Loading Estimates – Past, Present

• Modeled Lake Response – Past, Present, Hypothetical Future
Salmon Lake
Trophic Status Index

Year

TSI
0 10 20 30 40 50 60

Eutrophic

Secchi Disk Depth
Chlorophyll a
Total Phosphorus
AHOD

Mesotrophic

Oligotrophic
Salmon Lake
TN:TP Ratio

North Basin
Mid-South Basin

P-Limited
Co-Limited
N-Limited
## Modeled Lake Response

<table>
<thead>
<tr>
<th></th>
<th>1970s</th>
<th>2010</th>
<th>Hypothetical Scenarios^d</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Load P (kg/yr)</strong></td>
<td>3,320^a</td>
<td>3,600^b</td>
<td>4,500</td>
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<tr>
<td><strong>Total P at spring turnover (µg/L)^c</strong></td>
<td></td>
<td></td>
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<tr>
<td>Vollenweider 1975 model</td>
<td>15</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>Dillon and Rigler 1974 model</td>
<td>11</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td><strong>Observed TP</strong></td>
<td>BD to 20</td>
<td>15-19</td>
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</tr>
<tr>
<td><strong>Lake Conditions</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Predicted Summer Chl a (µg/L)</td>
<td>3 - 4</td>
<td>4 - 4.5</td>
<td>4 - 5</td>
</tr>
<tr>
<td><strong>(Observed Summer Chl a)</strong></td>
<td>(1 - 10)</td>
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<tr>
<td>Predicted Summer SD (m)</td>
<td>3.5 – 3.2</td>
<td>3.4 – 3.1</td>
<td>3.2 – 2.9</td>
</tr>
<tr>
<td><strong>(Observed Summer SD (m))</strong></td>
<td>(2-5)</td>
<td>(3 – 6)</td>
<td>--</td>
</tr>
<tr>
<td>Predicted AHOD (g O2/sq m/day)</td>
<td>0.26-0.3</td>
<td>0.27-0.31</td>
<td>0.30-0.34</td>
</tr>
<tr>
<td><strong>(Observed AHOD)</strong></td>
<td>(0.49)</td>
<td>(0.3-0.43)</td>
<td>--</td>
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</tbody>
</table>
Trophic State of Lakes Mendota & Seeley – Vollenweider Model
• B Rieman observed blue green blooms in Seeley & Placid in 2011. Other volunteers observed what was thought to be a Blue green bloom in Placid in 2012 (this picture from internet for illustrative purposes)
Conclusions

• No apparent trends in water quality data since the 1970’s. Conditions vary from year to year.
• Inconsistency in sampling methods, timing and sites may have obscured trends.
• Most indicators of lake condition put both lakes in the middle range of trophic condition (mesotrophic).
• Recent observations of algae blooms, low oxygen in deep water, and high nutrient levels in the lakes, groundwater and some streams, are worrying.
• Modest increases or even the continuing input of nutrients from human sources could push the lakes past a tipping point, making restoration of better conditions very difficult.
• The lack of evidence of much change in these lakes is not a guarantee that they are not changing. Their response may be hidden or delayed as it has been in other lakes.
Thanks to:

- Dan Hatley for field work and first draft of database.
- Mike Suplee for providing MT DEQ’s lake data;
- Randy Dahlgren for analysis of water quality samples. Brian Sugden for assistance with AHOD analysis.
- Clearwater Resource Council for funding, sharing results, and taking action on behalf of the lakes.
- Volunteers in the Clearwater Basin for collecting 4 years of new data