Linking AIS to water quality: A biological aspect to shallow lake TMDLs?

Presented by Tom Langer & Jeff Strom

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DEEP LAKES
Max depth > 3m
Seasonal stratification

SHALLOW LAKES
Max depth < 3m
Daily or weekly stratification
~ 100% Littoral

Epilimnion – mixed layer
Metalimnion – prohibits mixing
Hypolimnion – heavy, non-mixing
Turbid State

Clear State

Nutrient cycling (2x TP, 3x TN)
Biodiversity
Water quality
Driven by:

1. Hydrology
2. **Nutrients**
3. Connectivity

Where do AIS have an impact?

- Area of hysteresis
- High nutrients

Impact, how?

- Habitat alteration
- Excretion
- Bioturbation
- Outcompete natives

Vitense et al. 2018 & 2019
**Clear Water State**

- Piscivores
- Planktivores, Benthivores, Omnivores
- Zooplankton Grazers
- Phytoplankton Biomass
- Macrophyte Biomass
- Sediment Resuspension
- Bioturbation

**Shallow Lake Trophic Cascades**

- Piscivores
- Planktivores, Benthivores, Omnivores
- Zooplankton Grazers
- Phytoplankton Biomass
- Macrophyte Biomass
- Sediment Resuspension
- Bioturbation

**Turbid Water State**
CONNECTING LAKE ECOLOGY TO AIS MANAGEMENT
MN TMDL STANDARDS

Max allowable pollutant load.

Protect H2O resources for aquatic life, recreation, consumption (among others).

Eutrophication typically falls into recreation benefit.

Natural difference in lakes:

1. Ecoregion
2. Lake Type

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Lake Type</th>
<th>TP (ppb)</th>
<th>Chl-a (ppb)</th>
<th>Secchi (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLF</td>
<td></td>
<td>&lt; 30</td>
<td>&lt; 9</td>
<td>&gt; 2.0</td>
</tr>
<tr>
<td>NCHF</td>
<td>Deep</td>
<td>&lt; 40</td>
<td>&lt; 14</td>
<td>&gt; 1.4</td>
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<tr>
<td></td>
<td>Shallow</td>
<td>&lt; 60</td>
<td>&lt; 20</td>
<td>&gt; 1.0</td>
</tr>
<tr>
<td>WCBP &amp; NGP</td>
<td>Deep</td>
<td>&lt; 65</td>
<td>&lt; 22</td>
<td>&gt; 0.9</td>
</tr>
<tr>
<td></td>
<td>Shallow</td>
<td>&lt; 90</td>
<td>&lt; 30</td>
<td>&gt; 0.7</td>
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</table>
Atmospheric deposition
Watershed load modeling
Upstream lakes
Septic systems
Model residual

Watershed = Redwood
County = Lyon
Watershed Area = 1,740 acres
Lake Area = 349 acres
Max Depth = 11 feet
Terrestrial Inputs
(Landuse, upstream sources, etc.)

27%
415 lbs

Atmospheric Inputs

5%
83 lbs

Internal Processes

Residual
68%
1,072 lbs

Output
Terrestrial Inputs (Landuse, upstream sources, etc.)

Atmospheric Inputs

Sediment
- Anoxic Release, Resuspension
- Sequester

Output

Residual
SEDIMENT ASSESSMENTS

Sediment chemistry (release potential)

Area of anoxia (period of release)

TP released during anoxia

Assessment could explain 94% of residual.
Terrestrial Inputs (Landuse, upstream sources, etc.)

27% 415 lbs

Atmospheric Inputs

5% 83 lbs

Residual
5%
65 lbs

Output

Anoxic Release, Resuspension

Sediment
Sequester

63%
1007 lbs

Wenck
COMMON CARP

Uproot/displace SAV
Bioturbation – burrow/forage 10+ cm
Excretion into water column

Leads to WQ and biodiversity decline in lakes

Bajer et al. 2009
1. Is there an issue?
   • Population assessment

2. Yes, where are the areas of concern?
   • Population tracking

3. How can the problem be resolved?
   • Removals

4. How can we prevent from reoccurring?
   • Implement controls
Carp Densities

- Persist at densities resulting in no submerged vegetation.
- Bioturbation issues
- Directly and indirectly contributing to algal and nutrient loading issues.

![Graphs showing carp densities and vegetation cover.](image)
CURLYLEAF PONDWEEED

Grows under ice
Senesce early summer
Mono dominant prone
Areas left void of vegetation
HARVESTING ASSESSMENT

Point intercept
Rake correction
Extrapolate coverage
Quantify possible loading resulting from senesces

<table>
<thead>
<tr>
<th>Ratio of CLP’s TP effect on IL</th>
<th>Reduction of TP from Lk Augusta’s internal load (lbs.)</th>
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</thead>
<tbody>
<tr>
<td>1:1</td>
<td>58.71</td>
</tr>
<tr>
<td>1:1/2</td>
<td>29.36</td>
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<tr>
<td>1:1/5</td>
<td>11.74</td>
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<td>1:1/10</td>
<td>5.87</td>
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</table>
CHEMICAL TREATMENT

Weaver Lake study

• Began chemical treatment of CLP in 2004

• Significant reduction in nutrient observed

• Increased plant diversity, water clarity

• Other SAV concerns
Terrestrial Inputs (Landuse, upstream sources, etc.)

Atmospheric Inputs

Sediment
- Anoxic Release, Resuspension
- Sequester

Fisheries
- Excretion, Bioturbation, Immigration
- Ingestion, Piscivorery, Emigration

Vegetation
- Senesce, Release
- Uptake, Burial

Output
TAKE HOMES

• Standard TMDL and source assessments fail to include internal and AIS discussion.

• AIS management can have a direct benefit to water quality.

• Direct mechanism research is limited but growing.

• Many lakes need to address AIS to make significant progress in becoming de-listed.
THANK YOU!

Responsive partner.
Exceptional outcomes.