Long-Term Nitrate Trends For Several Lake Erie Tributaries

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- Monitor water quality at 23 stations across Ohio and southern Michigan
- Samples are collected 3x a day*, year-round and retrieved weekly for analysis in the laboratory
Heidelberg Tributary Loading Program

Colorimetry for TP, DRP, TKN, NH$_4$, Si

Ion chromatography for NO$_3$, NO$_2$, Cl, F, SO$_4$

Suspended Sediments
Why Should We Care About Nitrogen?

- Typically one of the limiting nutrients in aquatic systems and a major component of nutrient pollution to Lake Erie

- While most Lake Erie HABs research has focused on the role of Phosphorus, seasonal co-limitation with Nitrogen may control bloom progression

- Most bloom forming cyanobacteria are unable to fix nitrogen, thus require dissolved nitrogen, and have been shown to be superior N scavengers

- Additionally, recent studies have linked seasonal N availability to the development of toxic compounds in HABs

- Has links to the formation of “deadzones” in Lake Erie Central basin
Concentration vs. Load
Why both are important to consider
Load
\( \text{Mass/time} \)
\( \text{Metric tons/spring} \)

= 

Concentration
\( \text{Mass/H}_2\text{O volume} \)
\( \text{mg/L} \)

Flow or Discharge
\( \text{H}_2\text{O volume/time} \)
\( \text{ft}^3/\text{s (CFS)} \)
Flow / Concentration Relationship

Can we tell if Nitrate is from Point Sources or Non-point sources?
Map showing locations such as Raisin, Maumee, Sandusky, Portage, Tiffin, Lost, Blanchard, Rock, Honey, Cuyahoga, Old Woman Creek, and Chickasaw.
Agricultural/ Non-Point Sources
Urban/ Point Sources
Seasonality

The timing of loading/ high concentrations has big implications for Lake Erie HABs
Spring Load as a % of Total

<table>
<thead>
<tr>
<th>River</th>
<th>% in 2020</th>
<th>% Change over POR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raisin</td>
<td>41%</td>
<td>+12%</td>
</tr>
<tr>
<td>Maumee</td>
<td>39%</td>
<td>+9%</td>
</tr>
<tr>
<td>Portage</td>
<td>35%</td>
<td>+7%</td>
</tr>
<tr>
<td>Sandusky</td>
<td>38%</td>
<td>+18%</td>
</tr>
<tr>
<td>Cuyahoga</td>
<td>31%</td>
<td>+1%</td>
</tr>
</tbody>
</table>
Long-term Trends in Loading and Concentrations
POR trends and the relationship with discharge
➢ Hump-shaped for both loads and concentration

➢ U-shaped response in the last decade

➢ Current loads/concentrations similar to levels seen in early 1980s
- 5000 mt increase in loads over POR (peaked in late 80s/early 90s)
- Concentration has steadily declined over last 20 years
- Significant inter-annual variation driven by changes in discharge
➢ Steady increase in loading and concentration (need more years to fill out trends)

➢ Fewer years in the POR, but patterns are consistent with Maumee/Sandusky over same period
➢ Similar pattern to Maumee- Load increasing, concentration decreasing over last 20 years
Load and concentration both decreasing over the POR

Much less inter-annual variation

Much less sensitive to changes in discharge
Concentration/ Discharge/ Season Relationships

10th, 50th and 90th percentile flows over the POR
Output from WRTDS
Raisin

- Hump shape seen in long-term trends driven by spring high flow events
- Base flow largely unchanged over the POR
Maumee

- Largest conc. increases seen in Spring Low-flow
- Summer/Fall decreases across flow levels
- Increases in total load likely driven by increases in high flow events
Portage

- Largest conc. increases seen in Summer High flow
- Summer/Fall increases across flow levels
- Decreasing concentration across flow/season
- Small increase in winter low flow conc.
- Increasing loads being driven by storm events
Cuyahoga

- Increasing Winter low flow conc.
- High and mid flows decreasing/steady (note high/low flow flipped from other rivers)
- Largely unaffected by storm frequency/intensity
What about TKN?

Organic components of Total Nitrogen (Maumee, Portage, Sandusky)
Seasonal/flow changes and % of TN
TKN Maumee

- Decreases in conc. across flow/seasons though mainly driven by summer high flow decreases.
TKN Portage

- Very little change, maybe a slight increase?
- Note - concentrations drop with increasing flow, then rise (i.e. colors on concentration v. year plot flipped)
TKN Sandusky

- Flat to slightly negative across season/flow
- High flow conc. really only thing changing
Nitrate to TKN ratio

- Inter-annual variance
- Land use a major predictor
Conclusions

- Loads are generally increasing from agriculturally dominated watersheds
  - Mean concentrations are flat/decreasing in many systems
Conclusions

- Load increases are tied to increased discharge, and increases in high flow storm events—particularly spring storm/high flow events.
Conclusions

- Spring load as a % of total load is increasing across ag watersheds
  - Has implications for the control of HABs and deadzones in Lake Erie
Conclusions

- Nitrate comprises ~75% of TN Load in Ag dominated watersheds
  - ~60% in Urban watersheds
  - Annual variation likely driven by precipitation events
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Thank You

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Visit our data portal:
https://ncwqr-data.org/
WRTDS

- Weighted Regression on Time, Discharge and Season

- Allows for the analysis and visualization of concentration changes over time