Dreissenid Mussel Survey of Cayuga Lake, 2013

Objectives, Approach, and Preliminary Findings

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Key Observation:

Increase in hypolimnetic SRP from 2003-2005 from 4 to 10 ug/L
What process could explain this increase in deep water phosphorus during the 2000s?

- Watershed inputs?
- Release from sediments?
- Biological Source?

What changes occurred during this time period in Cayuga Lake?
Introduction and expansion of exotic dreissenid mussels

*Dreissena polymorpha*
(zebra)
1991
(north outlet)

*Dreissena rostriformus bugensis*
(quagga)
1994
(power plant intake)

Limited Benthic Surveys

- 1994: Ed Mills, no mussels reported
- 2000/2001: Ed Mills, mussels not differentiated
- 2007-2010: Jim Watkins, primarily quagga mussels
Objective: Are exotic mussels capable of increasing hypolimnetic SRP on a lakewide scale?

Approach:

1) Quantify mussel density and biomass for both species.

2) Apply phosphorus excretion rates.
Transect Sampling Design Questions

1) How does mussel biomass vary with depth?

2) Are the east and west slopes different?

3) Are there latitudinal differences?
Benthic Survey Fall 2013

Field Summary:
372 Grabs
124 Sites
11 Transects

Transect:
9 (North End, Cayuga)
8 (Union Springs)
7 (Wells College, Aurora)
6 (Long Point)
5 (West-Side Wine Country)
4 (Power Plant, Deepest)
3 (Taughannock)
MP (Myers Point)
LA (Lansing)
2 (CU Sailing Club)
1 (South End)
Field Work

• Benthic Sampling
  – Petite Ponar ® with “lobster pot hauler”
  – Triplicate samples
  – Depth range:
    Shore 0.15 and 1 m
    Boat 2 m to 124 m
  – 500 um sieve

• GoPro Hero3 Video
Video Footage

GoPro Hero 3

19 m, Transect 4
75 m, Myers Pt
115 m, Myers Pt
Mussel Sizing

Sort and Measure

• Total counts:
  – Quaggas and Zebras
  – <0.5 cm and >0.5cm

• Wet weight:
  – All Quaggas and Zebras

• Dry Weight:
  – Calculated from size

Size with ImageJ
Mussel Sizing

Sort and Measure

• Total counts:
  – Quaggas and Zebras
  – <0.5 cm and >0.5 cm

• Wet weight:
  – Quaggas and Zebras
    (shell included)

• Dry Weight:
  – Calculated from length
    (shell not included)

Size with ImageJ

Ellipse major axis is length
Length-Weight Regression for Dreissenids

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>Dry Weight (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>2.0</td>
</tr>
<tr>
<td>20</td>
<td>17.8</td>
</tr>
<tr>
<td>30</td>
<td>63.7</td>
</tr>
</tbody>
</table>

Does not include shell weight

Nalepa et al. 2010

Matches Cayuga LW equation for 2007 Quaggas (unpub)
Preliminary Findings

Cross-Lake Transects
9 (North End, Cayuga)
8 (Union Springs)
7 (Wells College, Aurora)
6 (Long Point)
5 (West-Side Wine Country)
4 (Power Plant, Deepest)
3 (Taughannock)
MP (Myers Point)
LA (Lansing)
2 (CU Sailing Club)
1 (South End)
Transect 4
Transect 7 (Wells College)
Mussel Biomass Trend with Depth
Objective 2: Applying Excretion Rates

**Approaches**

*Lab*  
Increase of SRP in filtered lake water

*Downstream vs. Upstream*  
Effler et al. 1997, 2004

*In situ*  

**Reporting**

“Specific”  
umol gDW$^{-1}$ h$^{-1}$

“Areal”  
umol m$^{-2}$ h$^{-1}$  
(considers biomass)

1 umol P = 31 ug L$^{-1}$ P
1) Start with filtered lake water of low baseline SRP.

2) One no-mussel control, triplicate mussel treatments for each temperature.

3) Add mussels of known size.

4) Collect SRP samples over time.

5) Calculation includes

- SRP change (ug/L or umol)
- volume of water (liters)
- time period (hours)
- total dry weight of mussels (g, not including shells)
Excretion Rates

(Table 35.1 pg. 557 Nalepa 2013 Book)

Ranges for Dreissenids

Phosphorus  0.08 to 3.4 umol P gDW$^{-1}$ h$^{-1}$
Nitrogen  1.4 to 26 umol N gDW$^{-1}$ h$^{-1}$

Average Values for Phosphorus Excretion

Zebra  0.67 +/- 0.56 umol gDW$^{-1}$ h$^{-1}$
Quagga  0.33 +/- 0.18 umol gDW$^{-1}$ h$^{-1}$
Figure 35.2

Excretion rates of soluble reactive P (\(\mu\text{mol P gDW}^{-1} \text{ h}^{-1}\)) by quagga mussels at five different temperatures. Mussels were collected from Lake Michigan in March 2010. Mussels were fed a monoculture of *Scenedesmus quadricauda* (particulate carbon concentration = 25–33 \(\mu\text{mol L}^{-1}\)) and acclimated to experimental temperatures for 3 days prior to measurement of excretion rates. Mussel length was between 16 and 18 mm. Excretion rate was measured as SRP accumulation over 1.5 h after mussels were placed in filtered lake water.

Nalepa (unpub)
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>DW Biomass m⁻²</th>
<th>Specific Rate (T-Dependent)</th>
<th>Areal Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 m</td>
<td>100 g</td>
<td>1.2 umol g⁻¹ hr⁻¹</td>
<td>120 umol m⁻² hr⁻¹</td>
</tr>
<tr>
<td>30 m</td>
<td>50 g</td>
<td>0.8</td>
<td>40</td>
</tr>
<tr>
<td>50 m</td>
<td>10 g</td>
<td>0.8</td>
<td>8</td>
</tr>
<tr>
<td>90 m</td>
<td>5 g</td>
<td>0.4</td>
<td>2</td>
</tr>
</tbody>
</table>
Excretion Rates Decrease with Temperature
Thank you!
Our Measurements, Summer 2013

Nalepa Avg Quaggas

Specific Excretion Rate (umol gDW\(^{-1}\)hr\(^{-1}\))

Temperature C

Based on triplicates