

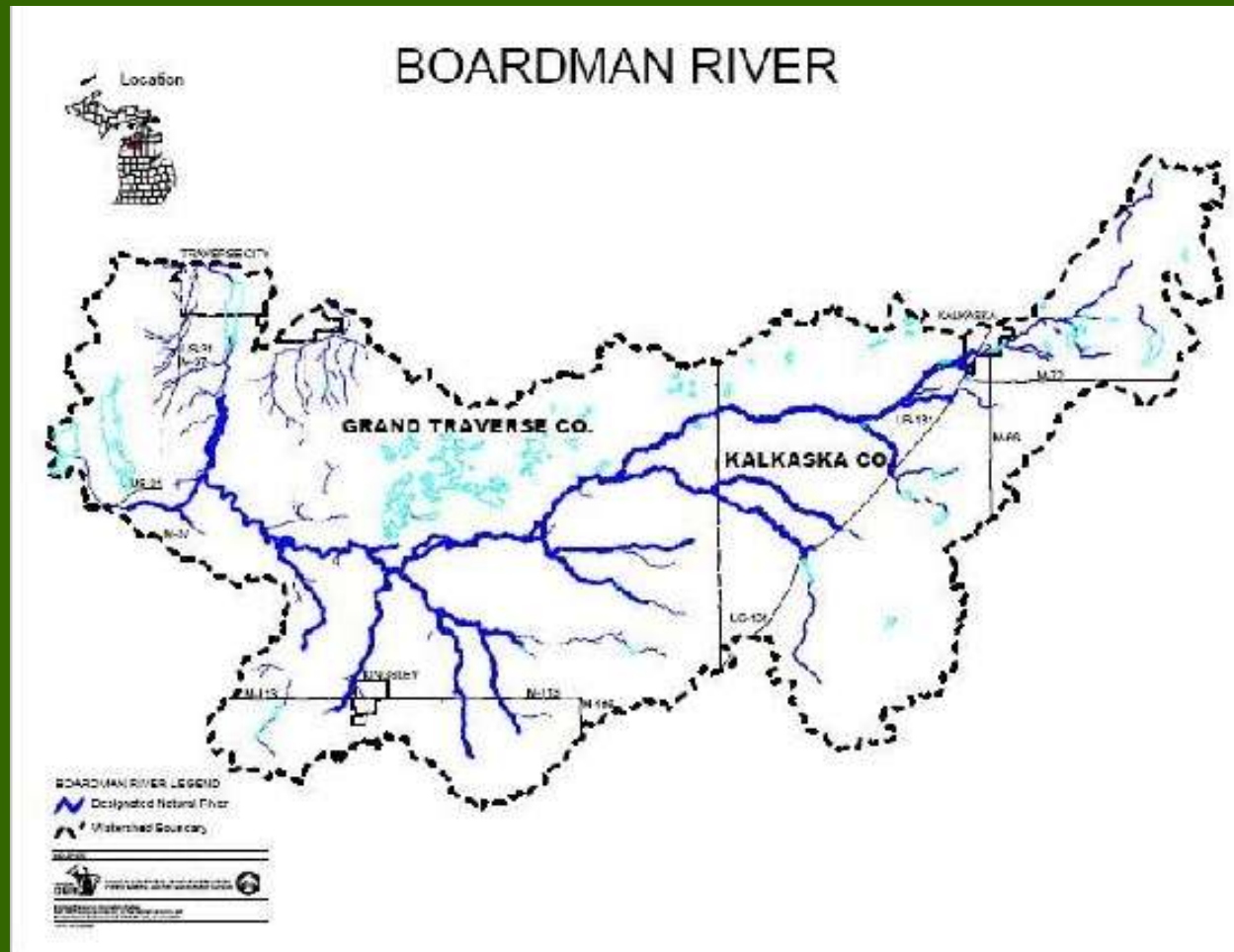
The background image shows an outdoor field research site. In the foreground, there are several clear plastic jars with black lids, some containing a brownish liquid. To the left, a white cloth is draped over a wooden frame. In the background, there is a yellow plastic container, a white jug, and a brown cooler. The setting is outdoors with trees and grass visible.

Recovery of the Riffle Community in the Boardman River Following Reservoir Drawdown

Nathan Sather
Bethel University

Background: The Boardman River

- Located in Northern Michigan
- 287 square mile watershed
- 49 miles of main river channel



Background: Where we were

- In the late 1880's five dams were built
 - Union Street Dam
 - 1867
 - Sabin Dam
 - 1906
 - ~~○ Keystone
 - 1908~~
 - Brown Bridge Dam
 - 1921
 - Boardman Dam
 - 1894

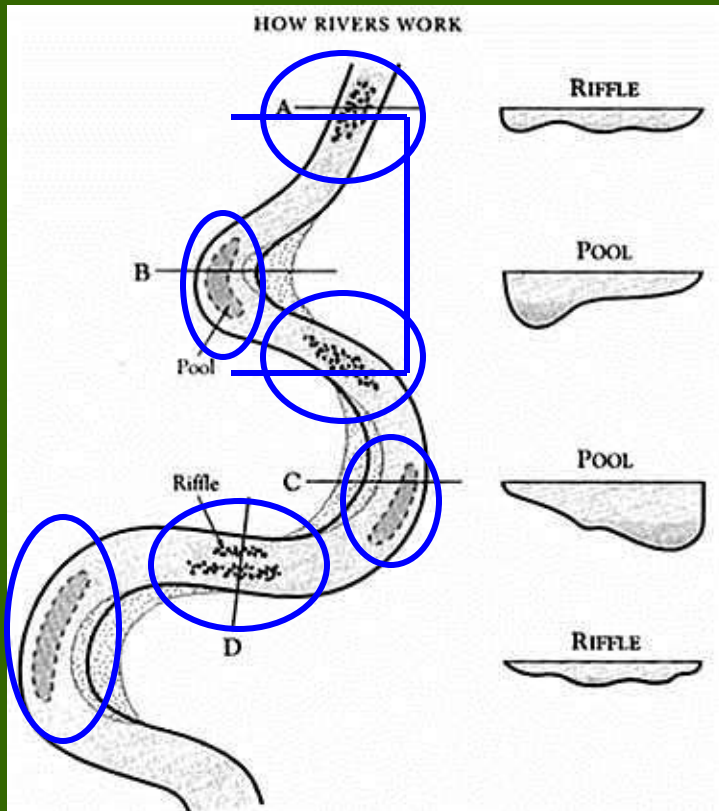


Background: Where we are



- Dams judged not economically viable
 - Structural improvement cost vs. Revenue from power generation
- Dams removal discussed
- Boardman dam reservoir drawn down 17 feet 2007
- April 9, 2009 voted to pursue complete removal of the four remaining dams

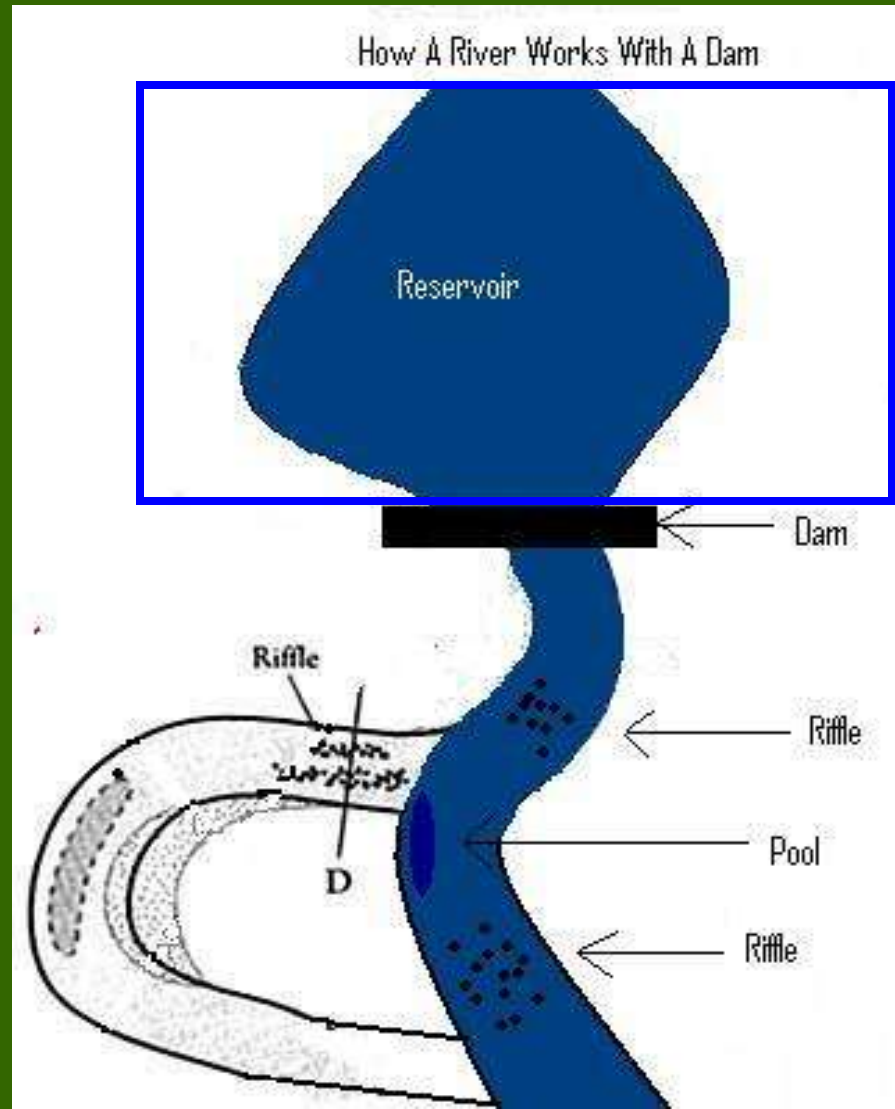
Background: Some Basic Stream Morphology...



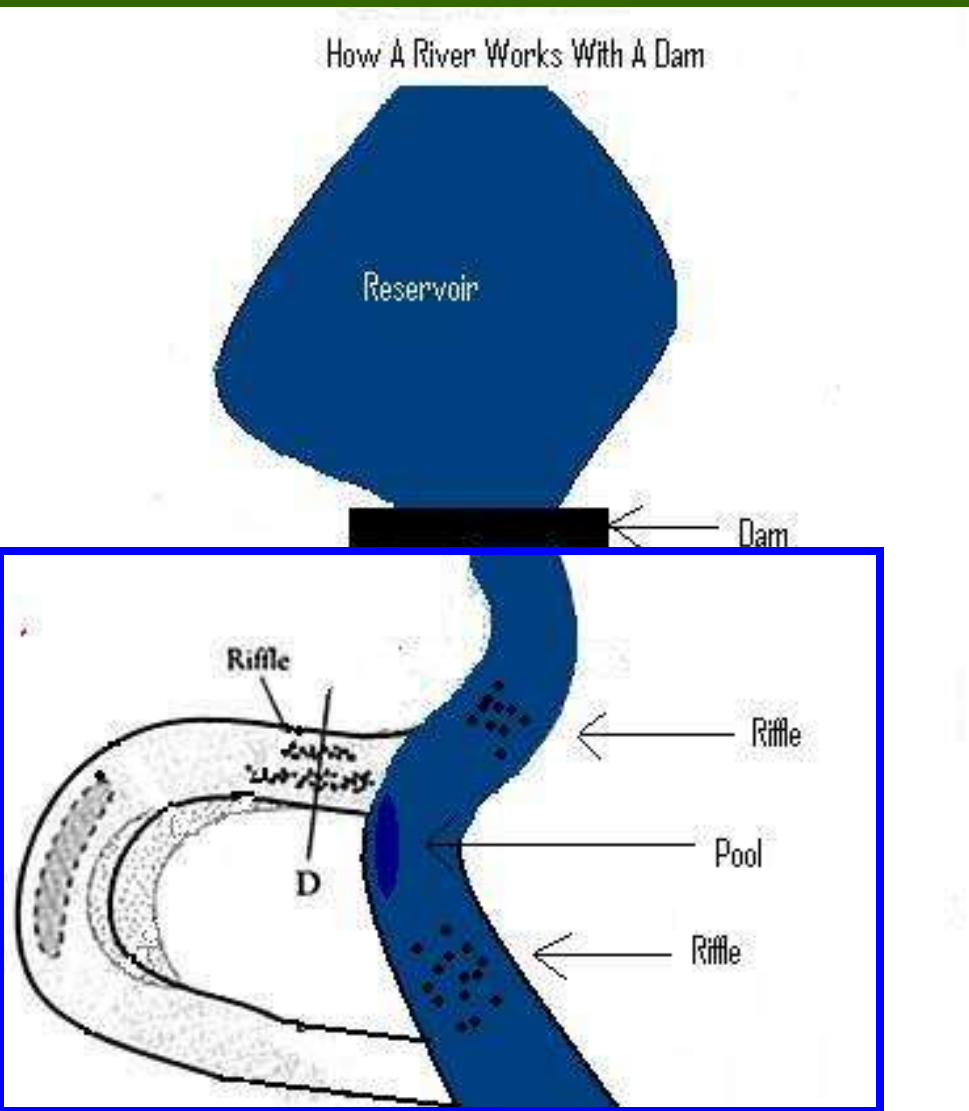
- Meanders
- Riffles
 - Shallow
 - Coarse Substrate
 - More Swift Flowing
- ...and pools
 - Deeper
 - Slower Flow
 - Finer Substrate

Dams Effect on Stream Morphology: Above the Dam

- Decreased current speed
- Change in temperature
- Increase/Settling of FPOM
- Nutrient load changes
- Change in macrophyte and macroinvertebrate composition



Dams Effect on Stream Morphology: Below the Dam



- Change in current speed
- Change water temperature
- Increased nutrient load
- Increased numbers of macroinvertebrates
- Decrease in macroinvertebrate richness

Effects of Dam Removal

- A new stream channel is cut
- Stream channel re-establishment temporarily causes...
 - Changing bottom composition
 - Gravel and cobble re-emerge
 - Loss of food
 - Loss of macroinvertebrates and fish
- Once the new channel is cut and stabilized normal riffle dwelling macroinvertebrate populations begin to return

Previous Research on the Boardman...

- Nelson 2007

- The Effects of a Sediment Trap on Benthic Macroinvertebrate Population in the North Branch of the Boardman River

- Lousma 2008

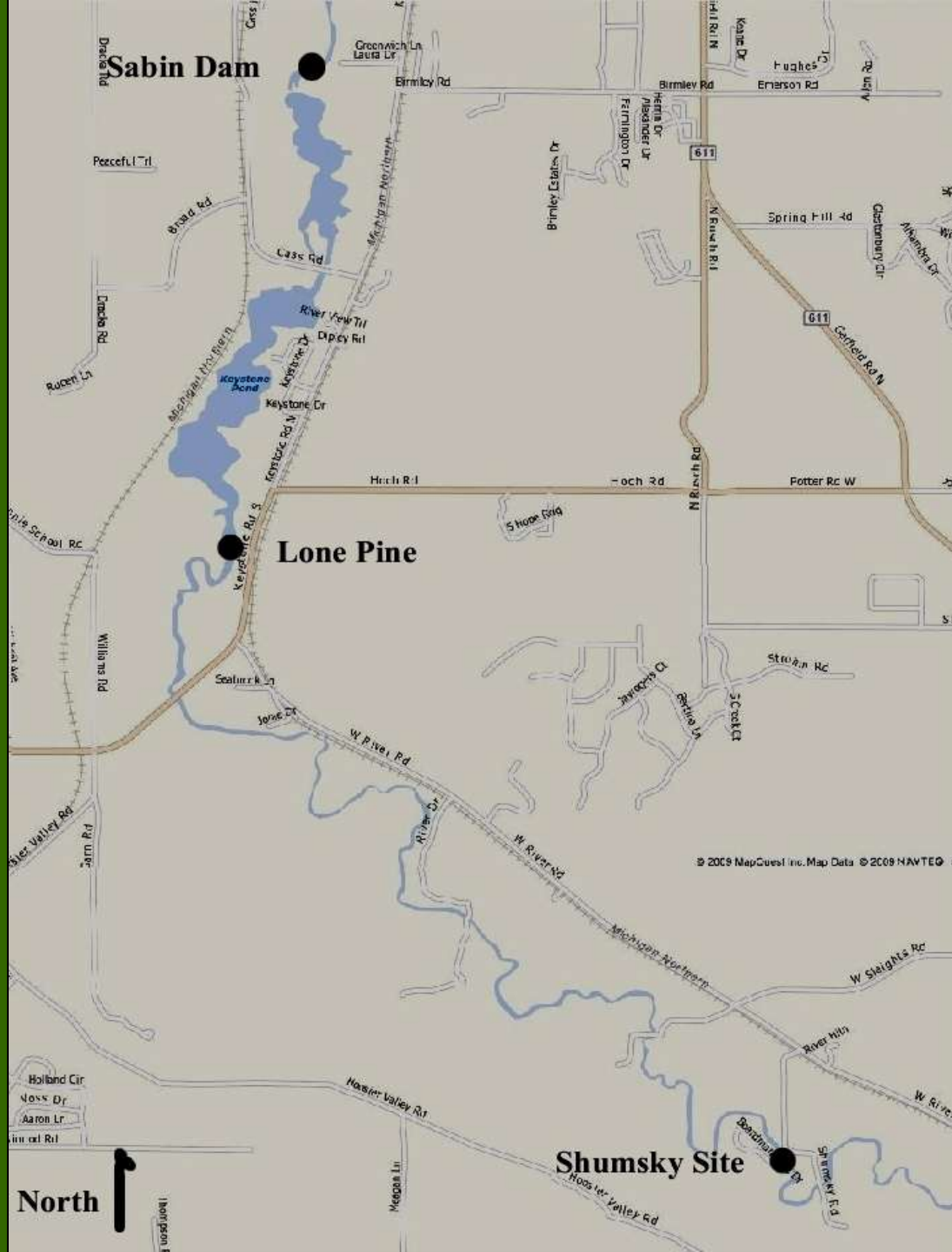
- Response of Macroinvertebrate Community to the Reestablishment of the Channel of the Lower Boardman River, Michigan

Objectives



- Describe riffle dwelling macroinvertebrate communities at three sites on the Boardman
- Compare faunistic similarities between the three sites
- Determine amount of recovery that has been achieved at the recovering site

Location



Shumsky Site

- Control Site
- Undisturbed



Lone Pines Site

- Disturbed/ Recovering Site
- Head of old reservoir
- Stabilizing channel



Sabin Site

- Below dam site
- Disturbed



Field Sampling Method



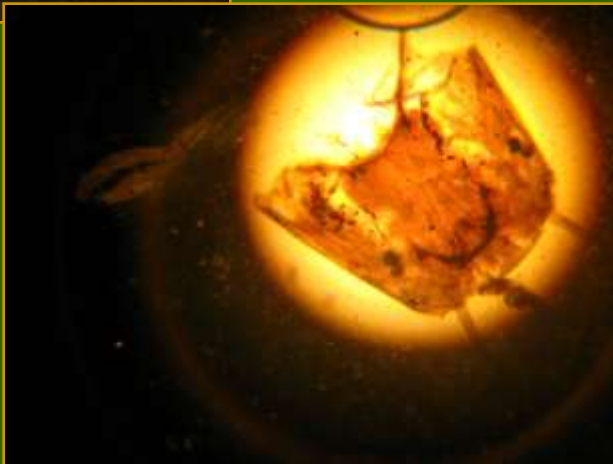
- Samples taken from riffles at three sites
 - Shumsky (Undisturbed)
 - Lone Pine (Recovering)
 - Sabin Dam (Below dam)
- June 12th and 28th 2009
- Three replicates taken at each site

Field Sampling Method

- Standard Surber Sampler
- 3 pronged agitator
 - Substrate agitated for 1 minute
 - Contents of net emptied to bottles
 - Brought back to lab for sorting and identification



Identification



- Lowest possible taxonomic level
- All macroinvertebrates were identified to genus except...
 - Pupae to family
 - Annelids, and Mollusks identified to class
- Unidentifiable individuals were treated as morphospecies

Data Analysis

Chi-Square Contingency Test

$$\chi^2 = \sum \frac{(o - e)^2}{e}$$

- Used Chi-square to compare frequencies between sites or dates

Sørensen's Quotient of Similarity

$$QS = \frac{2 \cdot C}{A + B}$$

- Calculates similarity of two samples

Data Analysis



EPT/ Chironomid Richness

- Number of Ephemeroptera, Plecoptera, and Trichoptera divided by the number of Chironomids
- A useful indicator of water quality

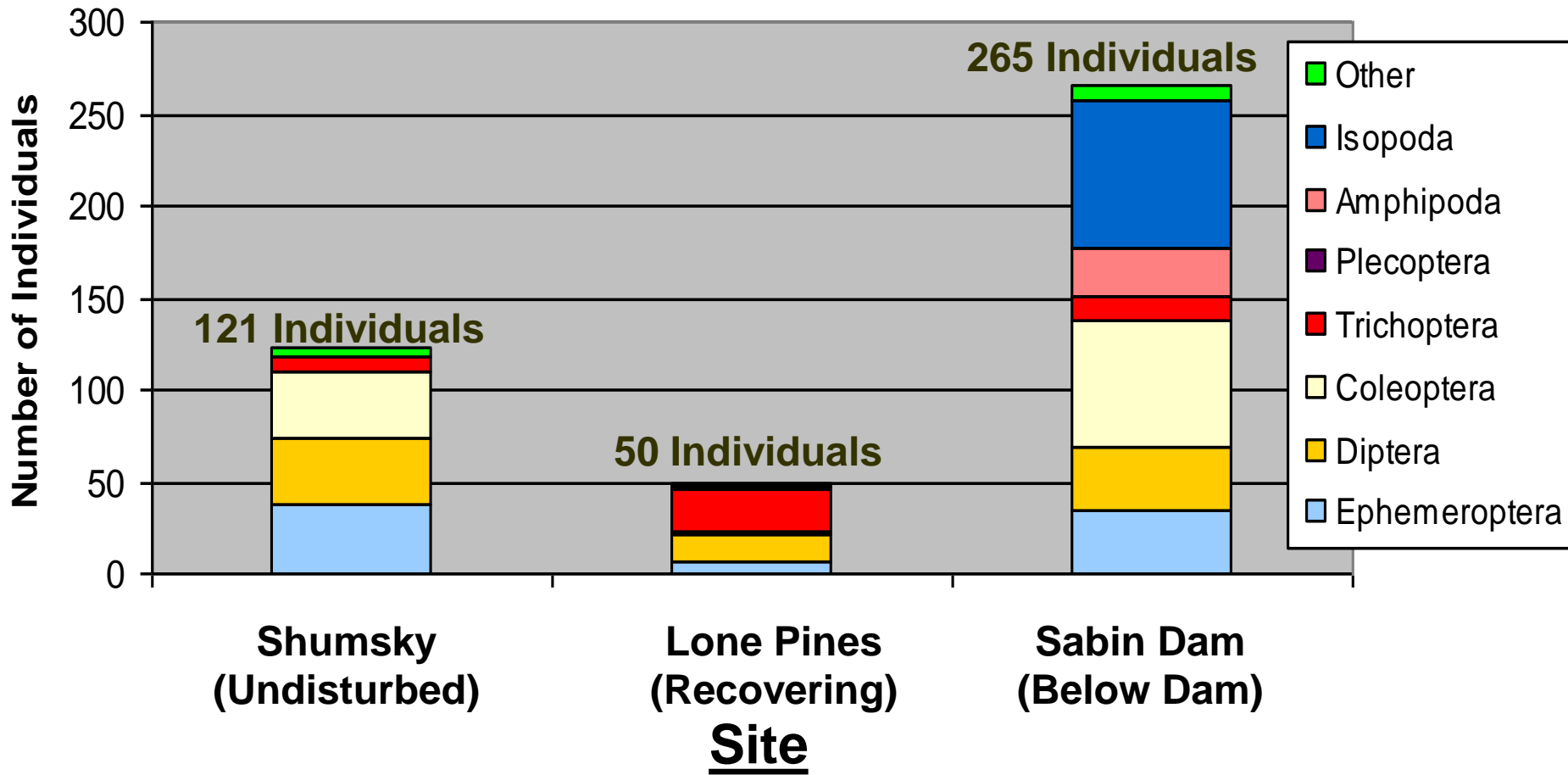
Data Analysis

Rank Abundance Curve

- Graphically represents
 - Relative Abundance
 - Species Richness
 - Species Evenness



Results



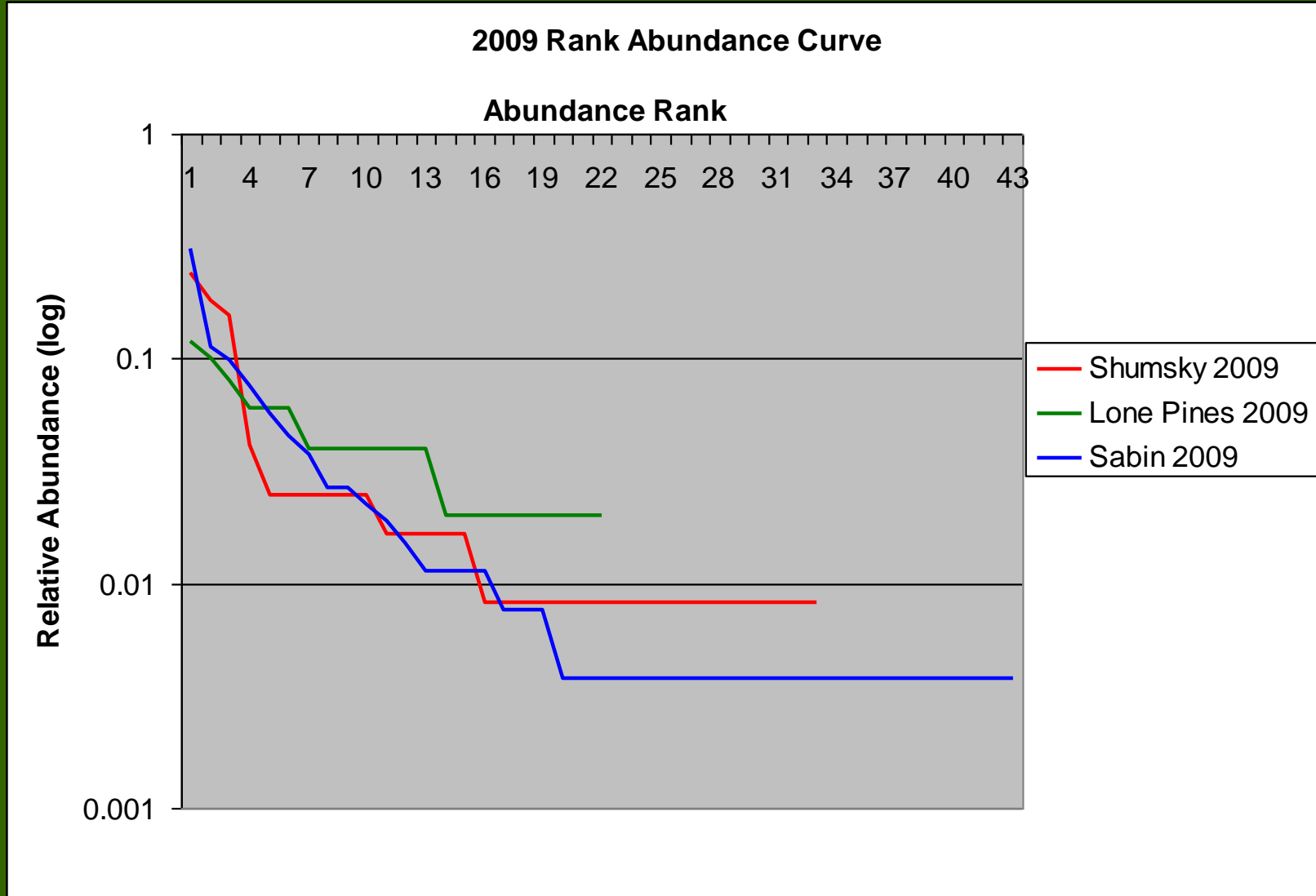
Discussion: 2009 Findings

● Richness:

- Shumsky (Undisturbed) –
35 Morphospecies
- Lone Pine (Recovering) –
25 Morphospecies
- Sabin (Below Dam) –
43 Morphospecies



Discussion: 2009 Findings



Discussion: 2009 Findings

EPT/Chironomid Richness

	Shumsky (Undisturbed)	Lone Pines (Recovering)	Sabin (Below Dam)
EPT/Chironomid Richness Score	6.429	2	2.579

Chi-Square

	χ^2	P-value
All Three Sites	522.36	< 0.01
Shumsky vs. Lone Pines	115.41	< 0.01
Shumsky vs. Sabin	248.23	< 0.01

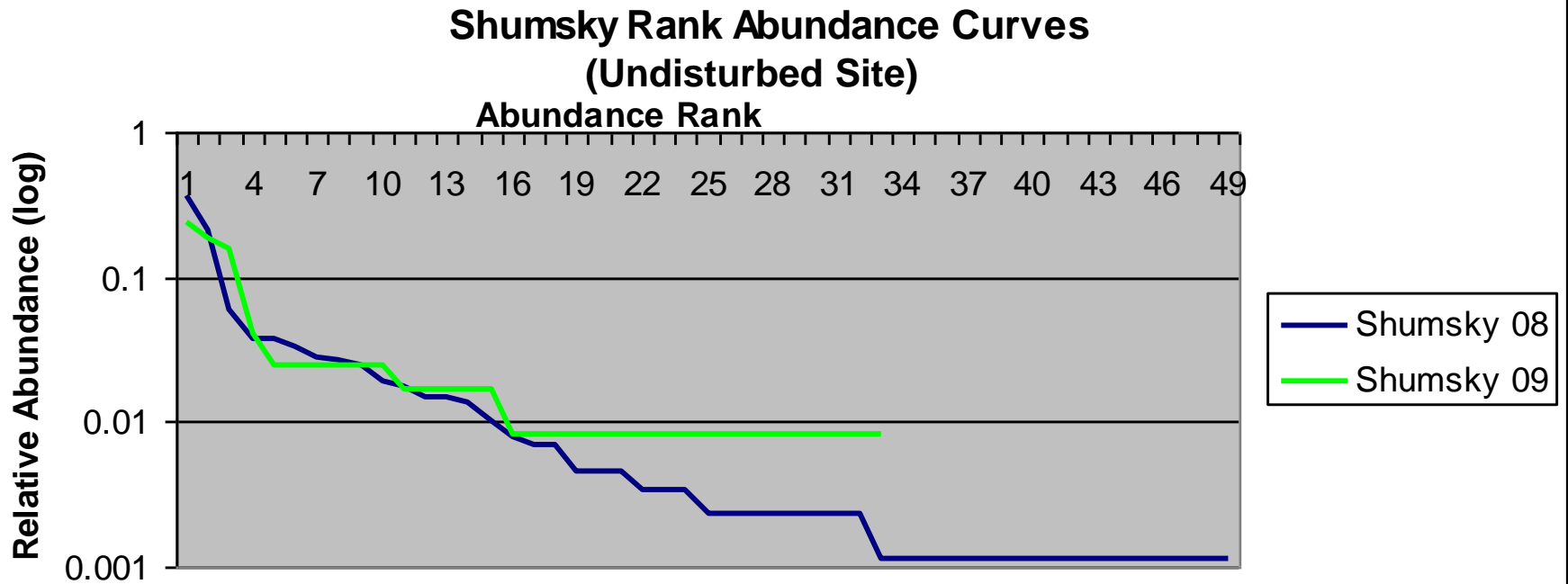
Discussion 2009

Sørensen's Quotient

Shumsky vs. Lone Pine	40%
Shumsky vs. Sabin	37%
Lone Pine vs. Sabin	24%

- All compared sites were dissimilar

Discussion: 2008 to 2009



Discussion: 2008 to 2009



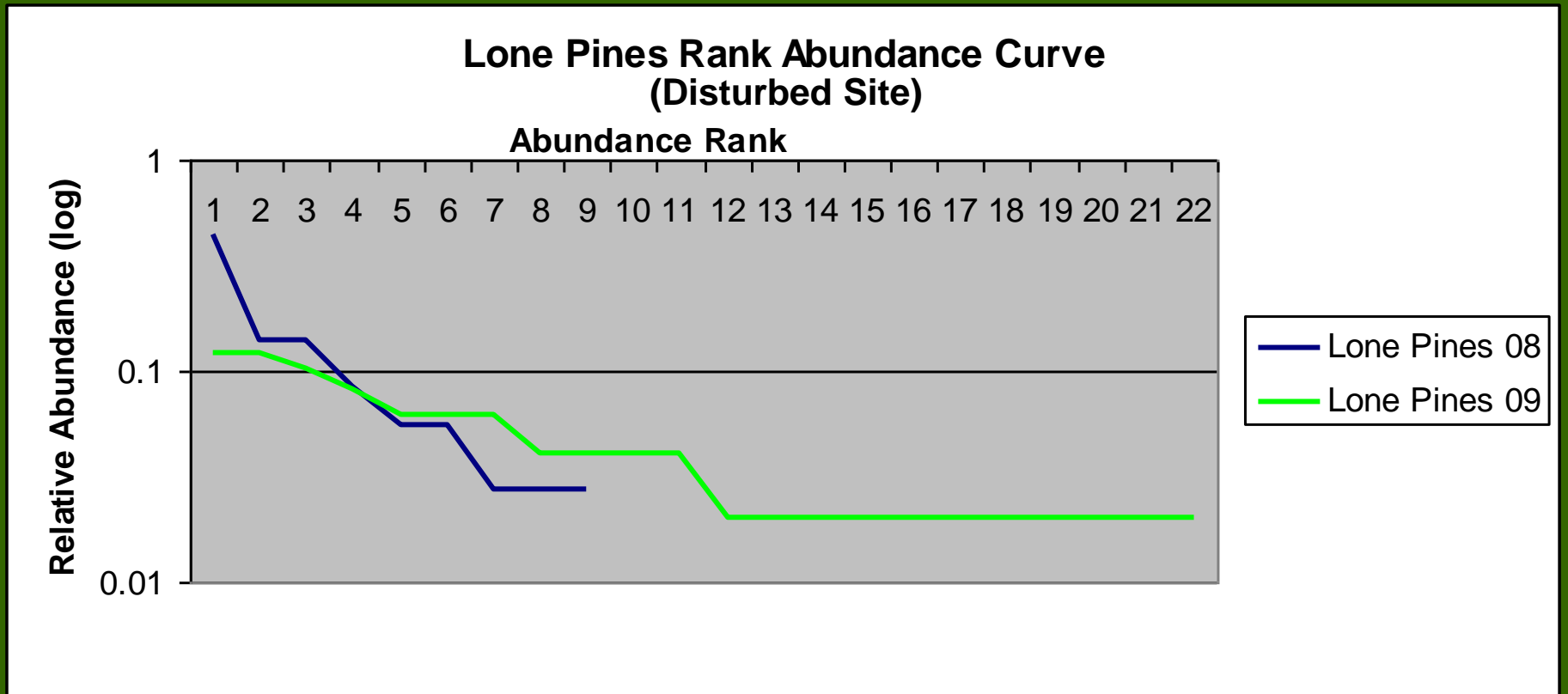
EPT Richness

Shumsky 2008	Shumsky 2009
4.08	6.43

Chi Square

χ^2	P-value
571.08	< 0.01

Discussion: 2008 to 2009



Discussion: 2008 to 2009

EPT/Chironomid
Richness

Lone Pine 2008	Lone Pine 2009
0.3	2

Chi Square

χ^2	P-value
48.26	< 0.01



Discussion 2008 to 2009

- Sørensen's Quotient of Similarity

	2008	2009
Shumsky vs Lone Pine	17.80%	40%

Conclusion

- Three sites are taxonomically different
- There was significant variation between samples taken in 2008 and 2009
- Lone Pine is not fully recovered, but is moving towards recovery



Acknowledgements



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