

Prairie Pothole Sedimentation: a Study Looking at Effects on Macroinvertebrate Communities

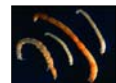


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Sediment Effects on Aquatic Invertebrates

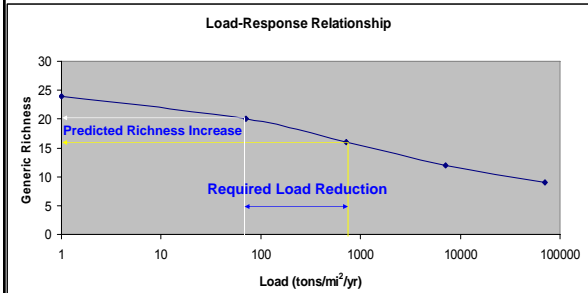
- Smothering
 - Chou et al. 2004; Koel and Stevenson 2002; Wood et al. 2001
- Clogging of respiratory and feeding apparatuses
 - Donohue and Irvine 2004; Shaw and Richardson 2001; Hanson and Butler 1994; Lemly 1982
- Habitat reduction
 - Suren and Jowett 2001; Lenat et al. 1981
- Metal contamination
 - Ali et al. 2002; Courtney and Clements 2002; Borgmann et al. 2001; Moore et al. 1979
- Scouring of exoskeleton
 - Crowe and Hay 2004



Objectives

- Determine habitat-specific effects of sediment on invertebrate communities
 - Macrophyte Beds
 - Rocky Shores
- Generate a load-response relationship for invertebrate biomonitoring metrics versus regional sediment load
 - TMDL Development

Load-Response Relationships

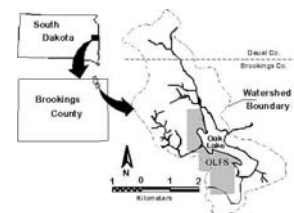


The TMDL Process

- Total Maximum Daily Load
 - Specifies maximum amount of a pollutant that a waterbody can receive and still meet water quality standards (EPA 2006)
 - Under Section 303(d) of the 1972 Clean Water Act, states must develop lists of impaired waters
 - What will be the expected changes in invertebrate or fish communities with load reductions?

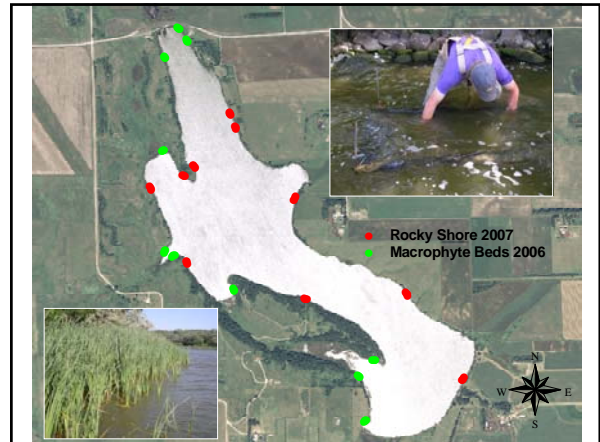
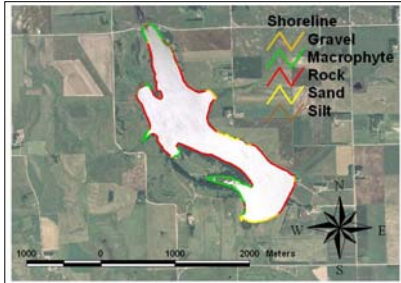
Study Site

- Oak Lake
 - 44° 30.563 N latitude, 96° 31.432 W longitude
 - Intermittently exposed
 - Prairie pothole
 - Hypereutrophic
 - Average depth 1.1 m
 - Max depth 2.0 m
 - 163 ha basin
 - Drains about 1600 ha
 - Mostly agriculture landscapes



Shore Habitats

- Macrophyte beds (Year 1/Green Lines)~30%
- Rocky shores (Year 2/Red Lines)~60%



Field Methodology

- 10 replicate experimental locations
- Five treatment plots (Carroll 2005)
 - One control, four treatment levels
 - Numbers generated using Missouri River loads
 - 0.1 kg
 - 1.0 kg
 - 10 kg
 - 100 kg



Sediment Treatment

- A local clay loam soil
 - 39% sand
 - 35% clay
 - 26% silt
- Located in Oak Lake watershed

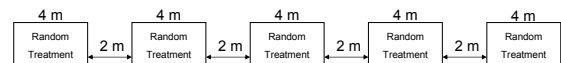


Sediment Treatment

- Treatment Loads
 - Based on drainage area of 100 square miles or less (Dunne and Leopold 1978)
 - Bracket estimated loads from Missouri River drainage
 - 0.1 kg treatment = 71 tons/mi²/yr
 - 1.0 kg treatment = 712 tons/mi²/yr
 - 10 kg treatment = 7,124 tons/mi²/yr
 - 100 kg treatment = 71,243 tons/mi²/yr

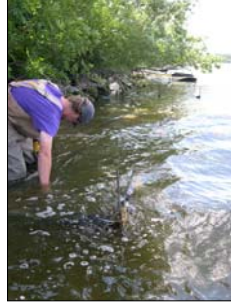
Experimental Design

- Plot Size
 - 1m x 4m plots
 - Placed at 0.5 meter water depth
 - Constructed of silt fence
 - 2 m buffer in between plots
- Treatments were randomly assigned at each location



Sample Collection Dates

- Dates Sampled
 - Pretreatment
 - June 28-July 2, 2006
 - June 25-June 29, 2007
 - 1st Post Treatment
 - July 5-July 9, 2006
 - July 2-July 6, 2007
 - 2nd Post Treatment
 - July 12-July 16, 2006
 - July 9-July 13, 2006



Invertebrate Collection

- Samples were collected from corners of the plot
 - Substrate was disturbed for 30 seconds
 - A 500 μm petite net
 - Samples were combined to make one composite sample for each plot



Invertebrate Sample Processing

- A sub-sampling approach was used to sort and identify invertebrates
 - Samples were placed in gridded sorting trays
 - Random grids were sampled
- Sort invertebrates
 - 300 invertebrates were sorted (EPA 2004)
 - After 300 organisms were collected, large and rare organisms were collected
- Invertebrate Identification
 - Identified to the lowest practical taxonomic level
 - Identifications will aid in the calculations of metric values

Statistical Analysis

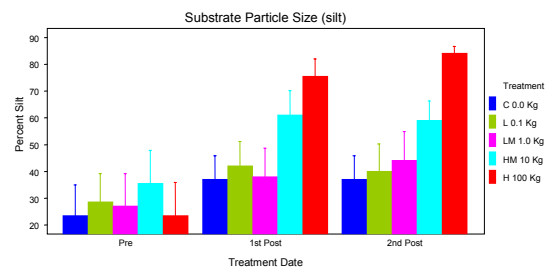
- Split Plot ANOVA
 - Split Plot – habitat type (Macrophyte Beds and Rocky Shore)
 - Blocks – Sampling date (Pre, 1st Post, 2nd Post)
 - Treatments (Change to Loads)
 - Replication – 10 sites per treatment, randomly placed

Metrics

- Metrics are measurable components of biological systems that can be used to predict change
 - Optimized sediment metrics from Braskamp (2002)
 - Diptera Richness, Ephemeroptera Richness, % Dominant Taxa
 - % Gliders, % Swimmers,
 - % Collector-Gatherers, and % Predators
 - % Chironominae, % Insecta
 - Modified Hilsenhoff's Biotic Index

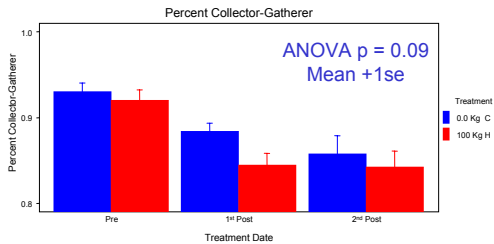


Effect of Treatment on Macrophyte Habitat



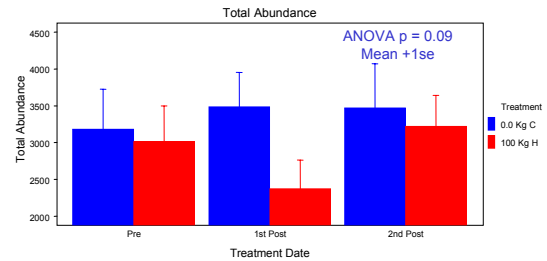
Effect of Treatment on Collector-gatherer taxa

- Percent collector-gatherers were less abundant in high treatment versus control plots

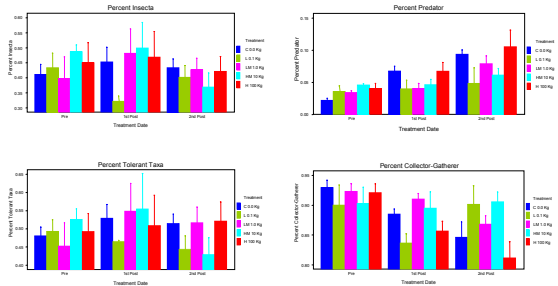


Effect of Treatment on Total Invertebrate Abundance

- Total abundance was lower from high treatment plots within 1 week of treatment compared to control plots



Effect of Treatment on Invertebrate Community

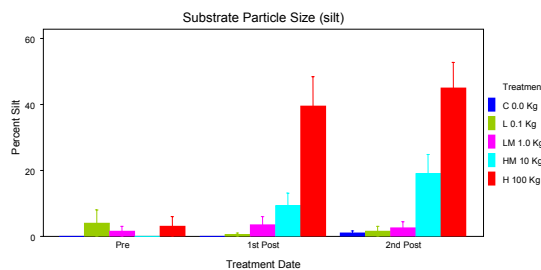


Individual Taxa

- Invertebrate groups not sensitive to treatment in macrophyte beds
 - Annelida, Chironomidae, Caenidae
- Dytiscidae, *Gammarus*, and *Ranatra* were only found in control plots and low treatment plots



Effect of Treatment on Rocky Shore Habitat



Conclusions

- Few associations have been found in macrophyte bed samples
 - Percent collector-gatherer and total abundance declined in high treatment plots only
 - Select invertebrate taxa were absent from high treatment plots
 - Possible explanations
 - Depositional habitat
 - Adaptation to deposition
- Rocky shore samples are in preliminary stages of being sorted and identified
 - Treatment effects from sedimentation may be more prevalent in erosional habitats



Acknowledgements

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