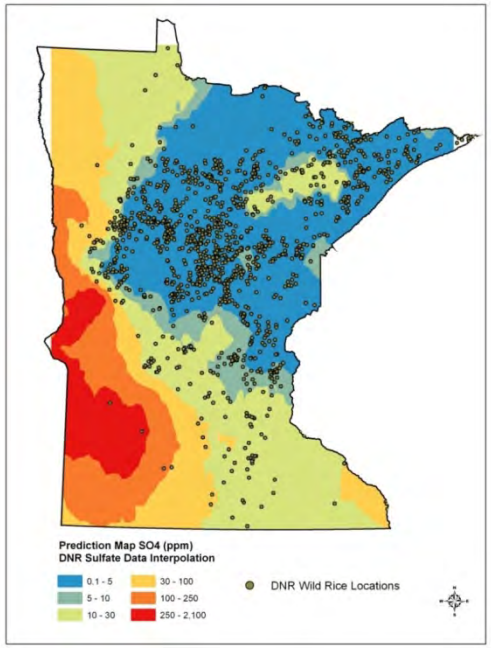
Introduction:
Wild Rice Sulfate Standard Field Survey

Edward Swain

Minnesota Pollution Control Agency

Mid-Project Review

February 28, 2013



Minnesota Pollution Control Agency

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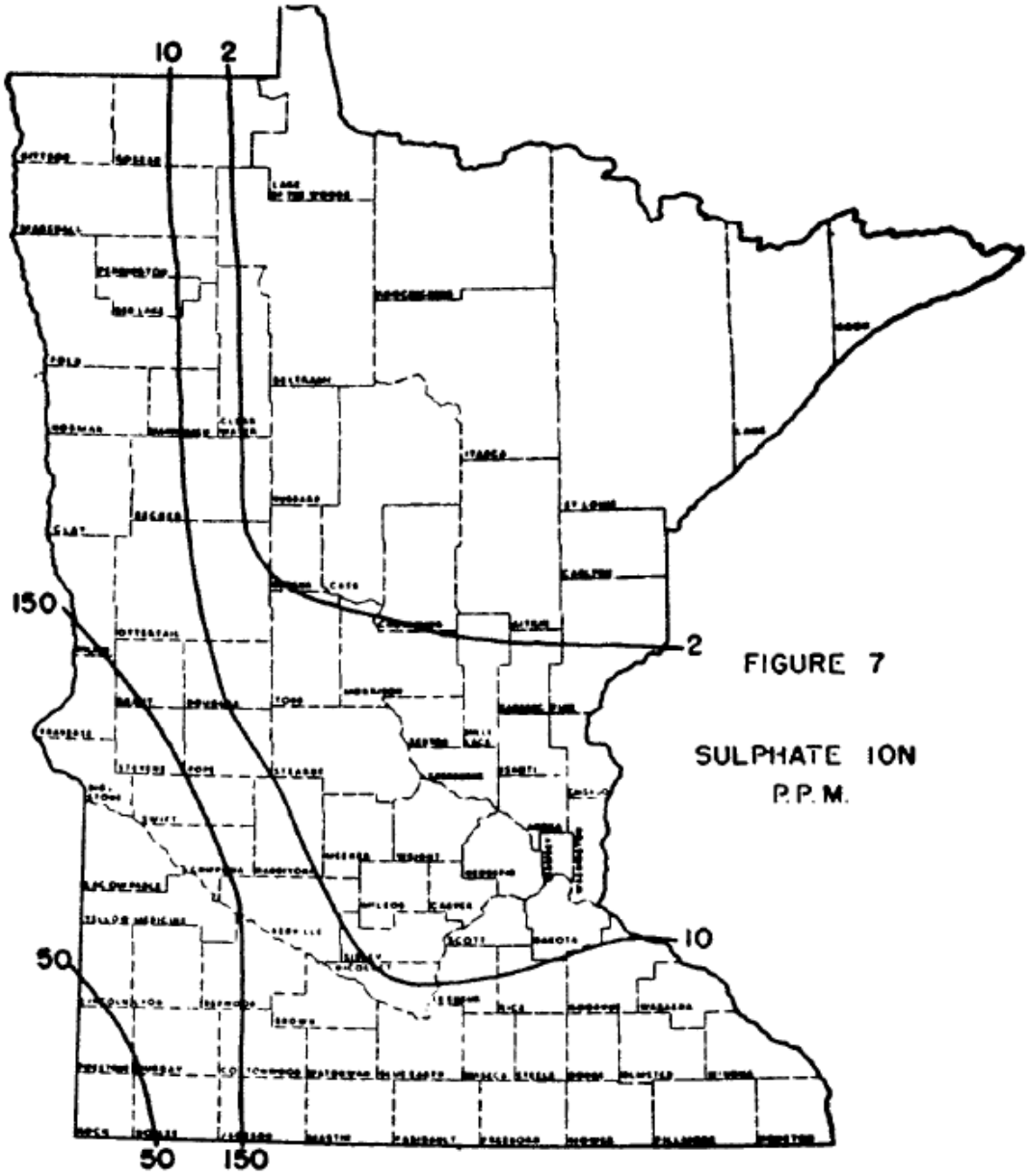

Sulfate pattern in lakes across Minnesota (Moyle 1956)

Moyle (1956) J Wildlife Management

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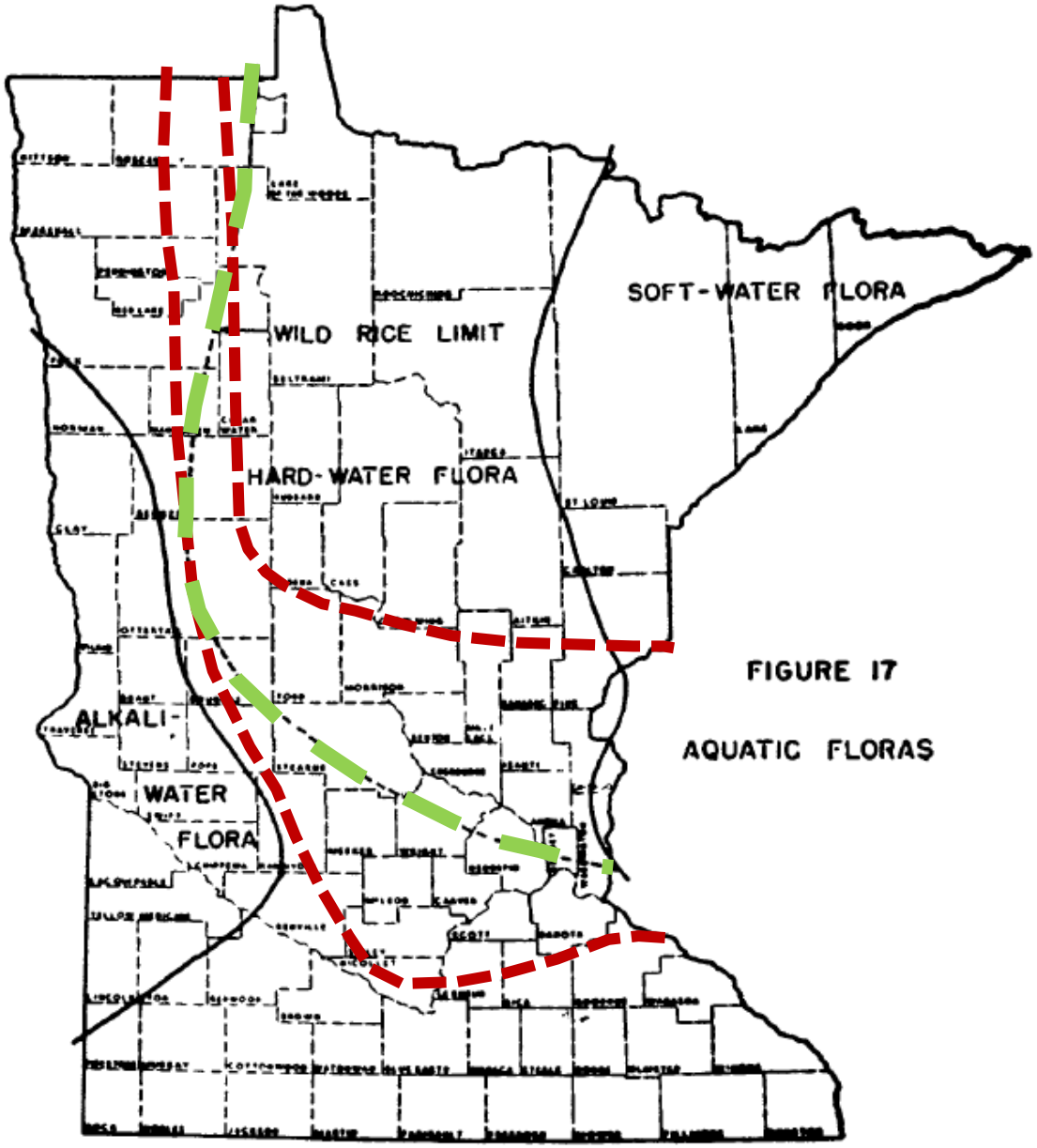

FIGURE 17

AQUATIC FLORAS

Moyle (1956) J Wildlife Management

Moyle's sulfate isopleths (red) superimposed on his western limit of wild rice (green)

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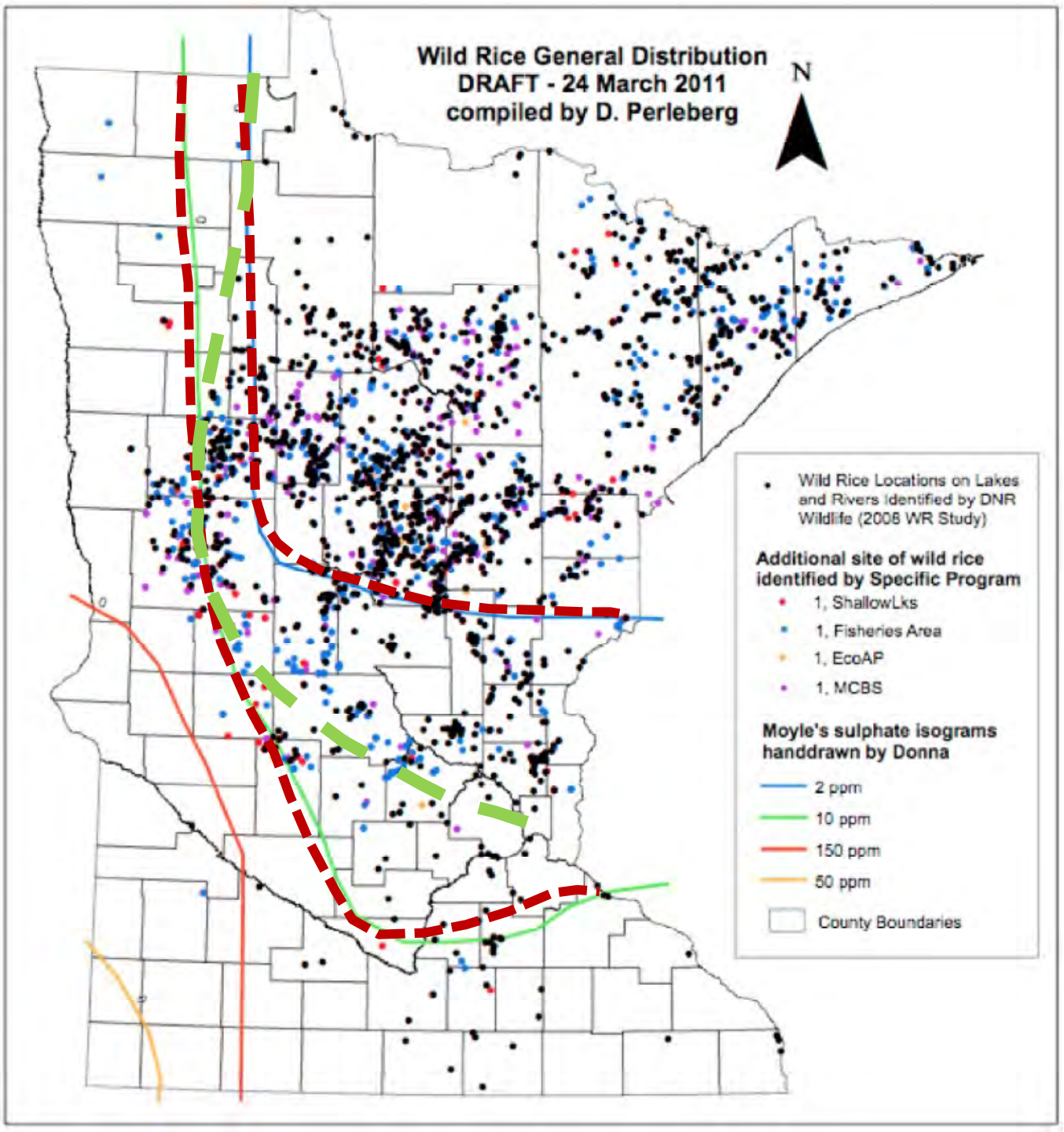

General distribution of wild rice in Minnesota

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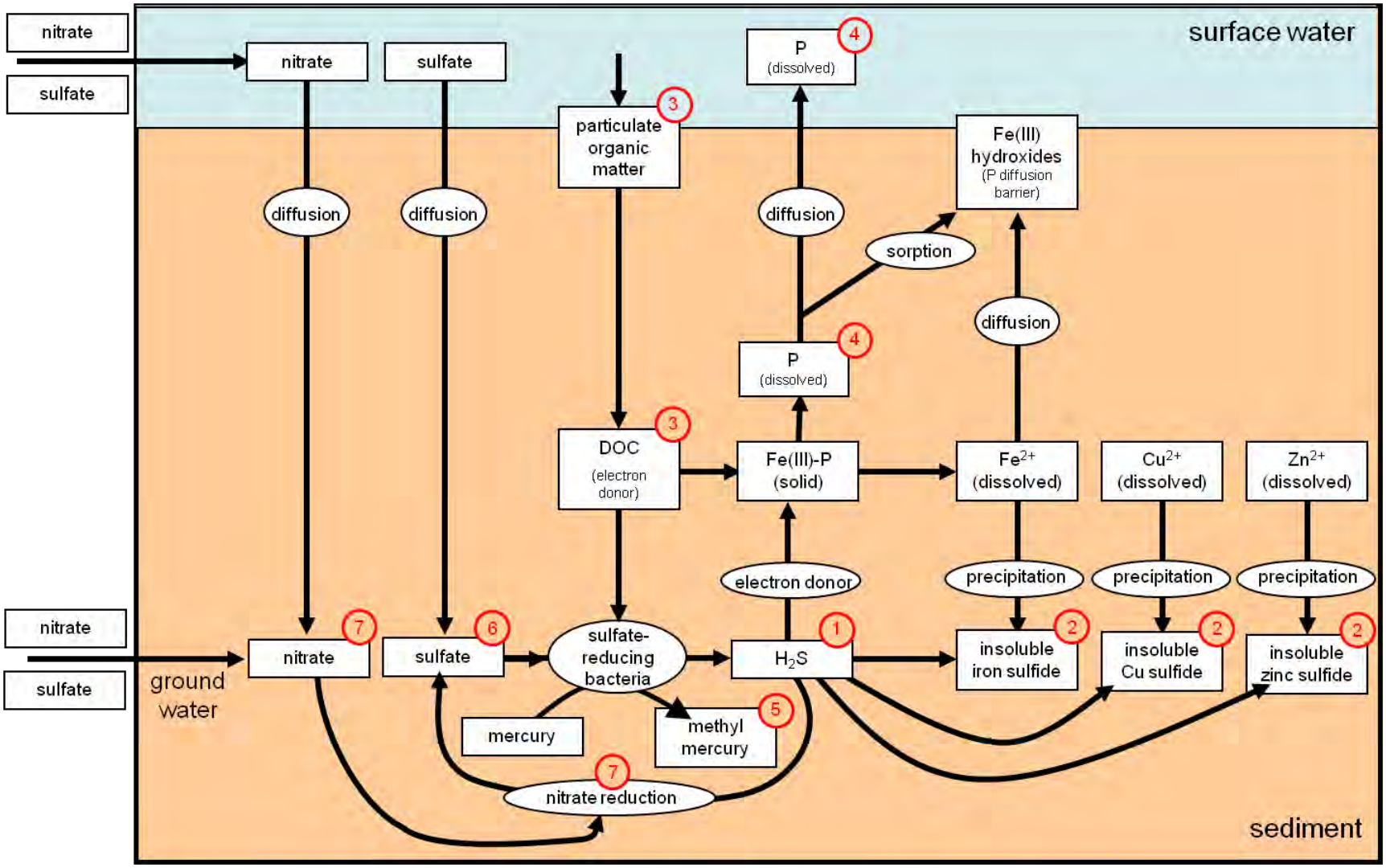
Possible sulfate interactions in wetland sediments that might affect wild rice growth



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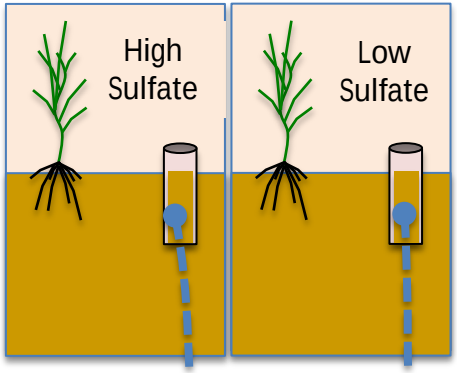
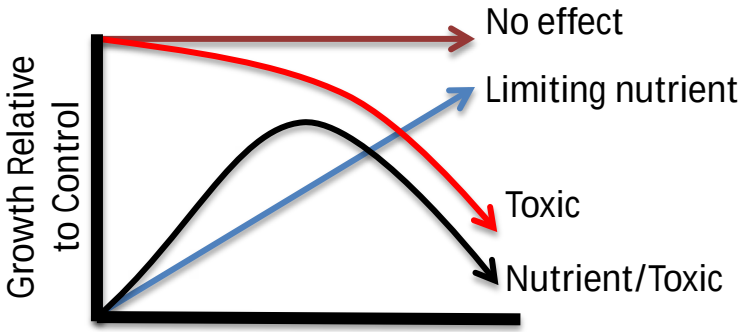
Relationship of Wild Rice Study Tasks

Increased understanding of the effect of elevated sulfate on wild rice growth, to inform re-evaluation of the current sulfate standard.

Exposure Assessment
(Porewater concentrations in the field)



Toxicity Assessment
(Hydroponic Experiments)



Sulfate Additions to Mesocosms
(sulfate gradually penetrates sediment where it can be converted to sulfide)

- Observe time-course of sulfate penetration.
- Measure sulfide concentrations.
- Observe production of metal sulfides.
- Compare effect of different temperatures.
- Effect of elevated sulfate on wild rice growth.

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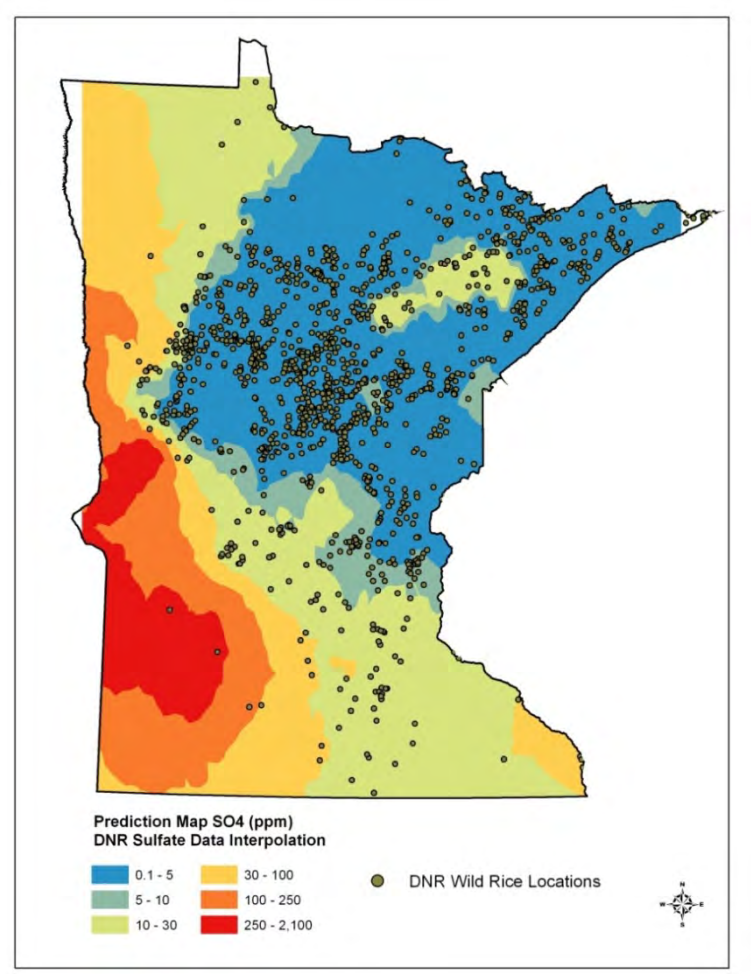
Slide courtesy of Ed Swain

Wild Rice Standards Study Field Survey



Amy Myrbo
Dept. of Earth Sciences
University of Minnesota

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UNIVERSITY OF MINNESOTA
Driven to Discover℠

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2012 Survey

- Two-person teams
- Two field teams operating simultaneously, full time
- Two months (July 22-September 21, 2012)
- 112 sites sampled in 2012

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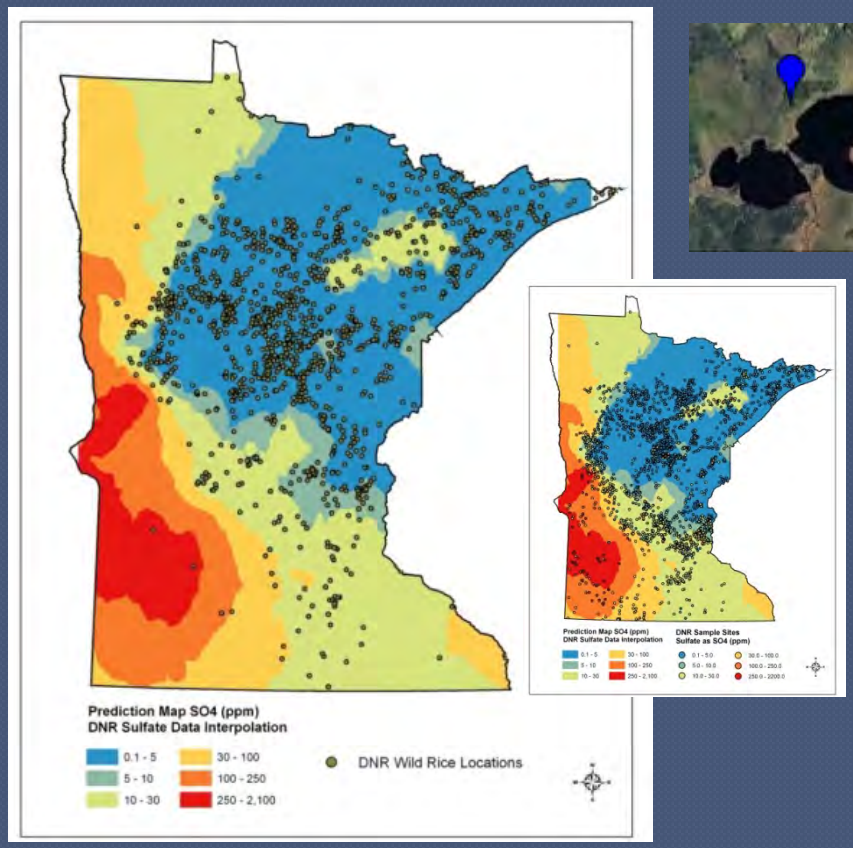
Maps courtesy of Shaun Nelson, MPCA

Site selection



- Based on DNR data:
  - Sulfate
  - Aquatic vegetation
  - Transparency
  - Depth
- Lakes, rivers, paddies with wild rice or suitable wild rice habitat
- Spread across state
- Range of SO_4 values

Wild rice waters (DNR 2008):

Contours are sulfate concentration in surface water (based on data from inset map). Light green and warmer = >10ppm

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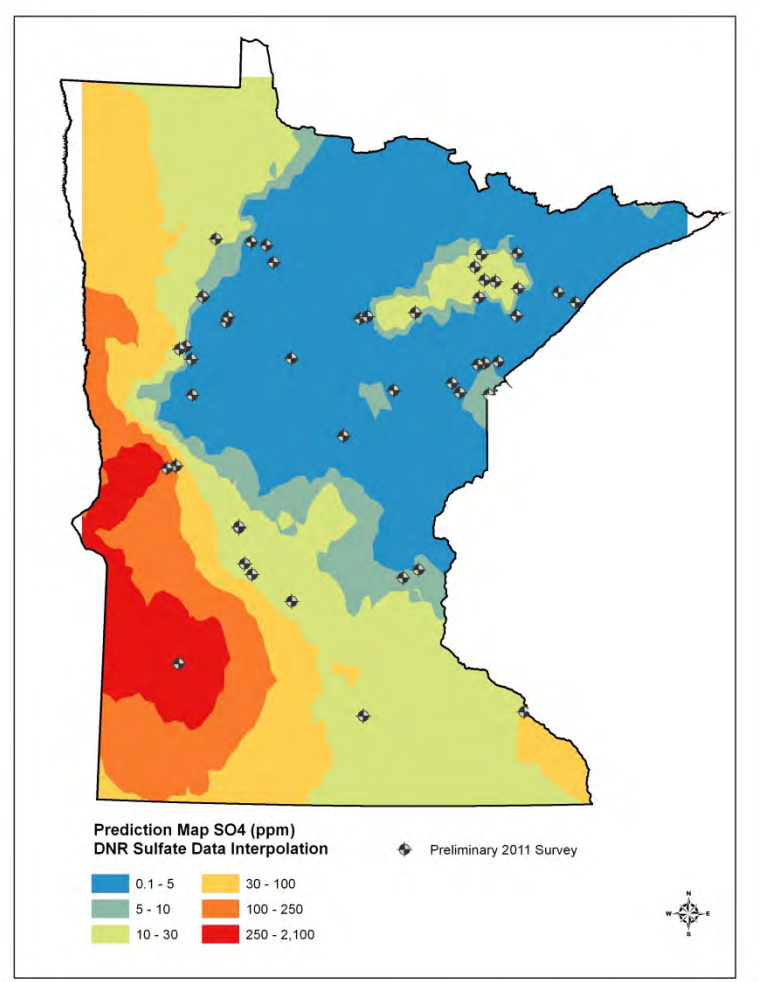
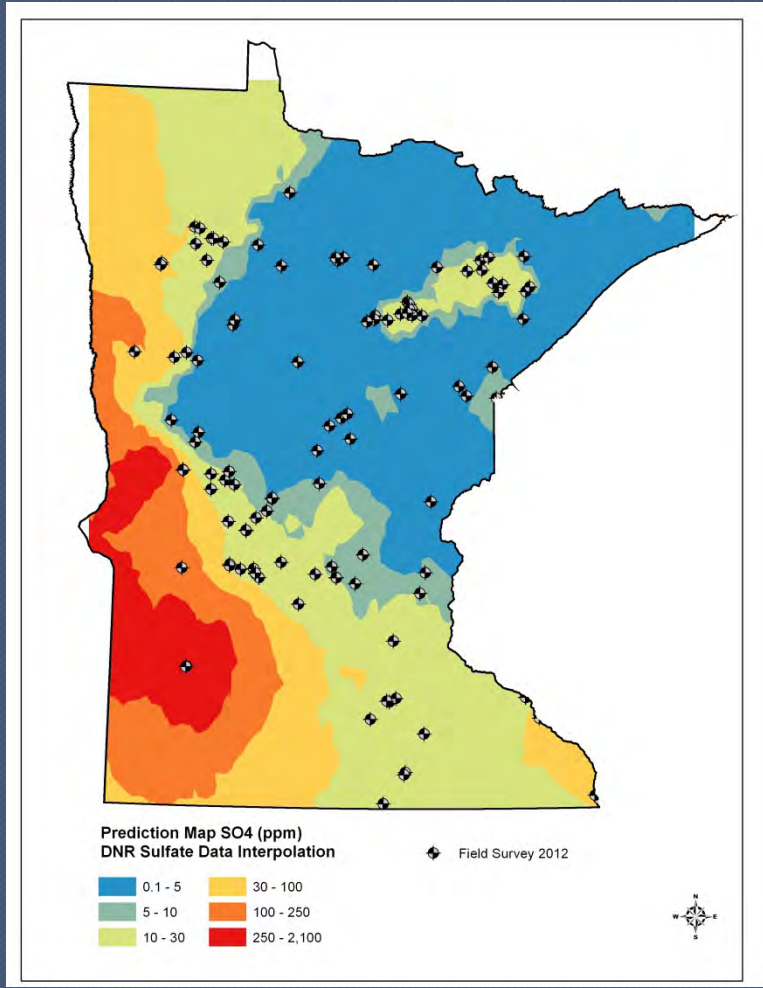
Sites sampled



2011 Preliminary Field Survey



2012 Field Survey

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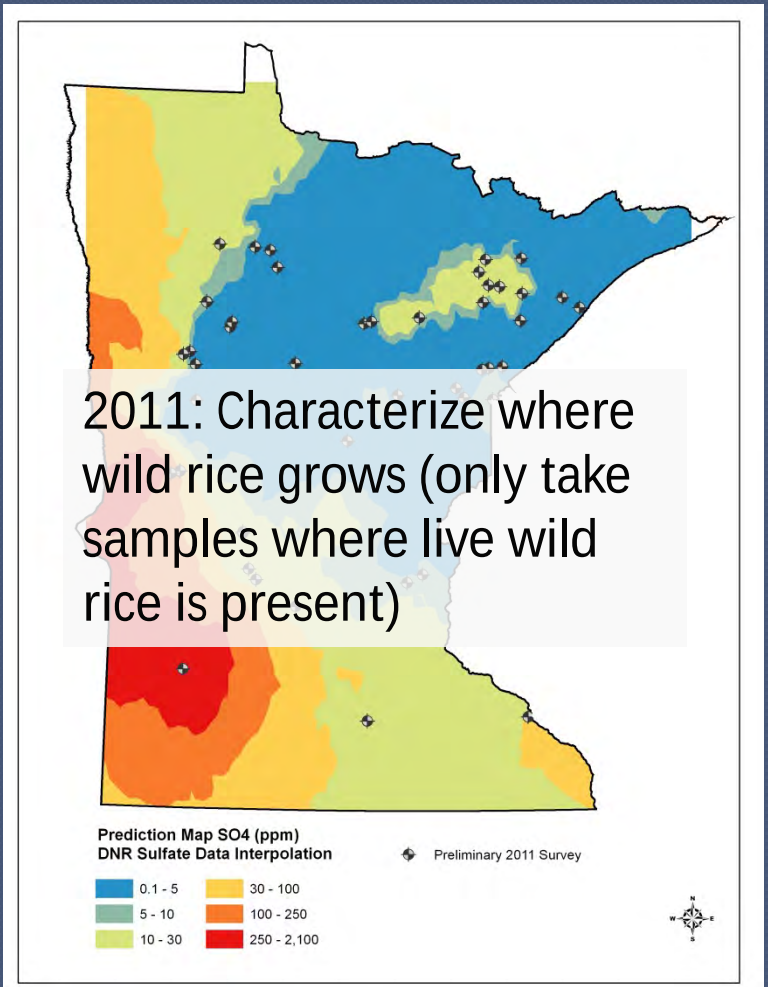
Sites sampled



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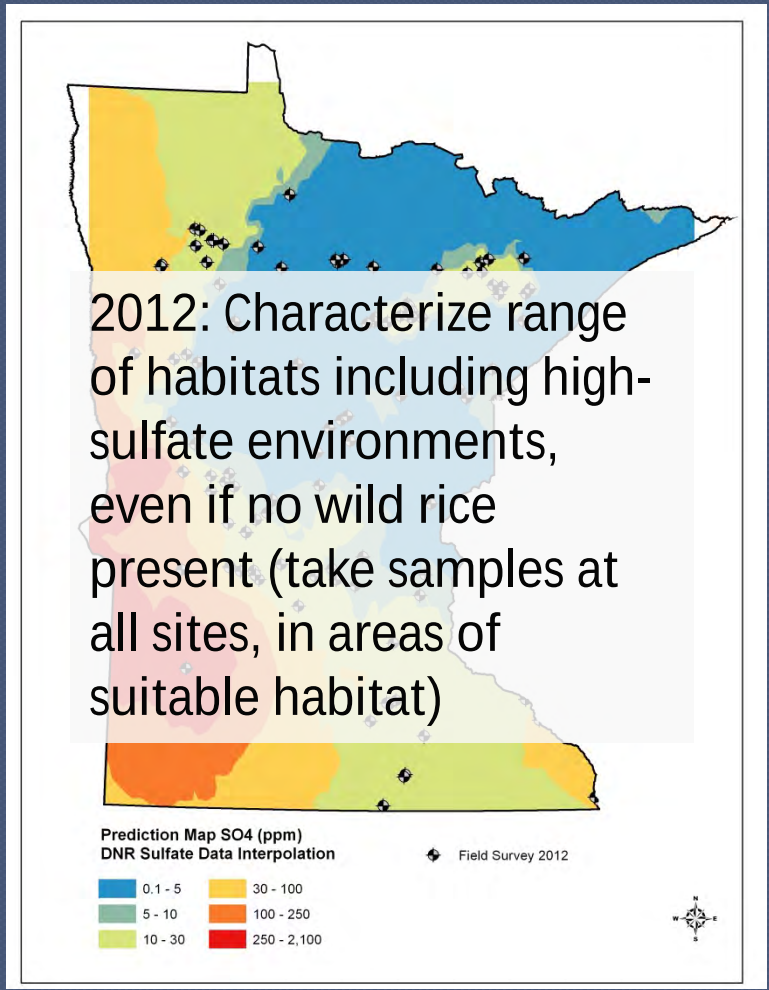

2012 Field Survey

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The right tools for the job

- Lightweight canoes
- Motorboats
- HTH corer
- Rhizons
- Nitrogen glove bag
- iPads

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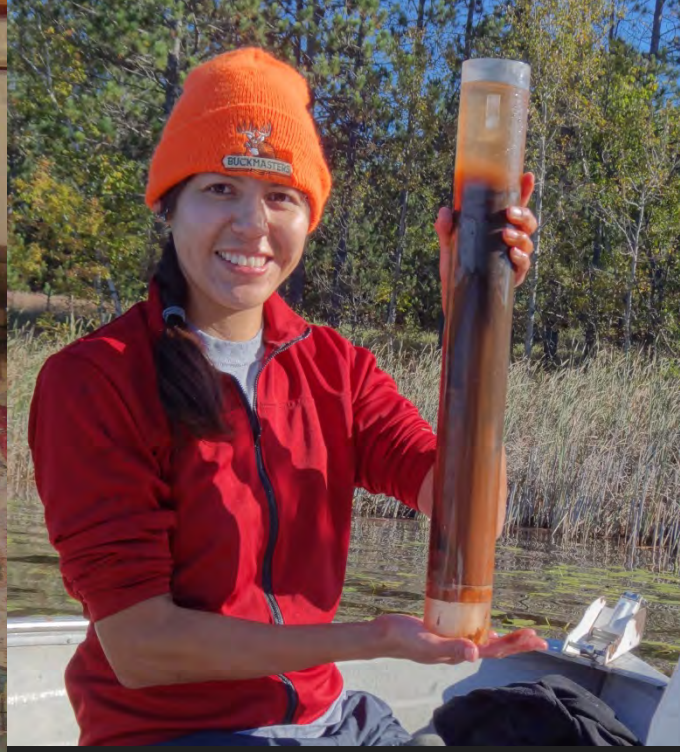
. . . And the right people

Jimmy Marty
BA Biology, Luther College

Cindy Frickle
BS Geology, U of M



June Sayers
Red Lake Band of Ojibwe/Ho-Chunk Nation
Hydrology major, St. Cloud State

Aaron Fish
Earth Sciences major, U of M
US Marine Corps

Sean Rogers
Fisheries biology major,
U of M

Aaron Lingwall
Lab Manager, LLOX-UMD
BS Geology, U of M

Chris Schodt
BA Geology, Macalester College

What we're measuring

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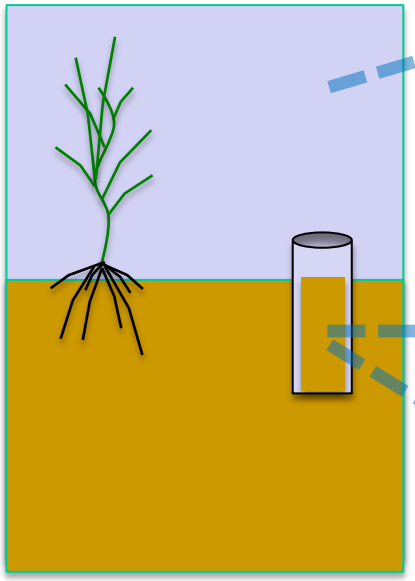
2012 Wild Rice Study Task: Field Data

~~Up to~~ over 100 sites in 2012



Surface water

Na, K, Mg, Ca, Fe

SO_4, Cl

Alkalinity, pH, conductivity, Total P, Total N,

Ammonia, Nitrate + Nitrite, transparency

Bulk Sediment Chemistry

Acid-Volatile Sulfide

Total carbon, nitrogen, sulfur

Simultaneously-Extracted Metals:

Fe, Cu, Zn, Co, Ni, Mn, Mo, Se, As, B

Porewater

Sulfide

Na, K, Mg, Ca,

SO_4, Cl

Total P, Total N, Silica

Ammonia, Nitrate + Nitrite

DOC (dissolved organic carbon)

Fe, Cu, Zn, Co, Ni, Mn, Mo, Se, As, B

Other Sediment Properties

Water, organic matter, carbonate content

Organic grain size

Wild rice phytolith presence/absence

Slide (modified) courtesy of Ed Swain

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Pore water sampling

- Rooting zone
- Redox hotbed
- Anaerobic sampling for sulfide

Rhizon sampler

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Challenges

- Variable site conditions
  - Rice absent in 2012 where it was present in 2011
- Access
  - Low water, mudflats
  - High water, flooded sites
  - Cattail forests
- Distance traveled: 14,893 mi

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Wild Rice Sulfate Standard Field Survey: Preliminary Data

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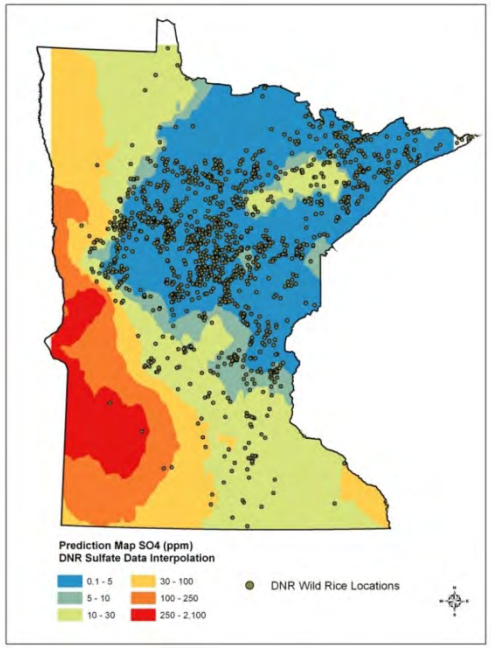

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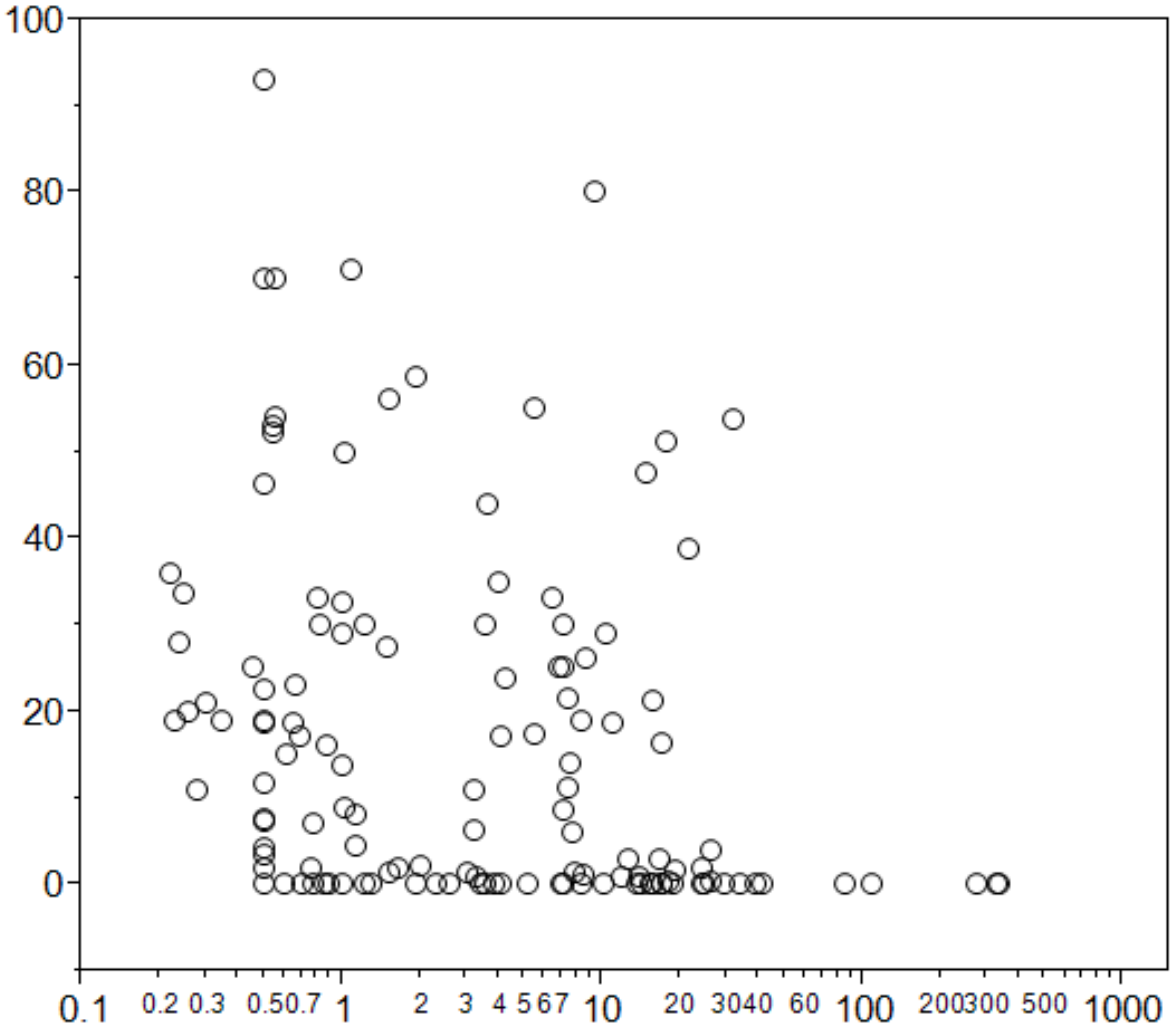
Zizania vs. Sulfate

Wild Rice Cover



Sulfate in surface water (mg/L)

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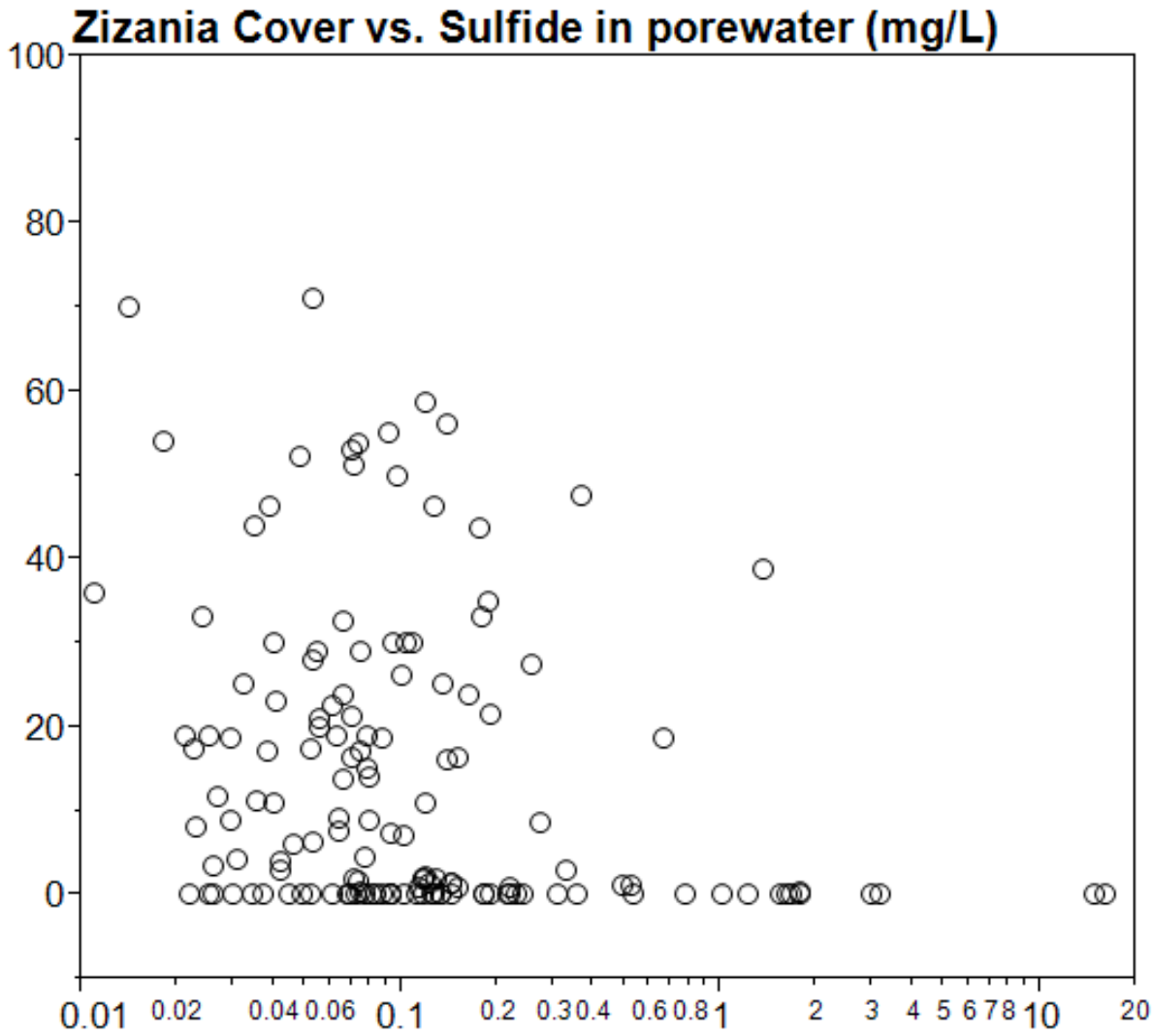
Zizania vs. sulfide in porewater



Wild Rice Cover

Sulfide in porewater (mg/L)

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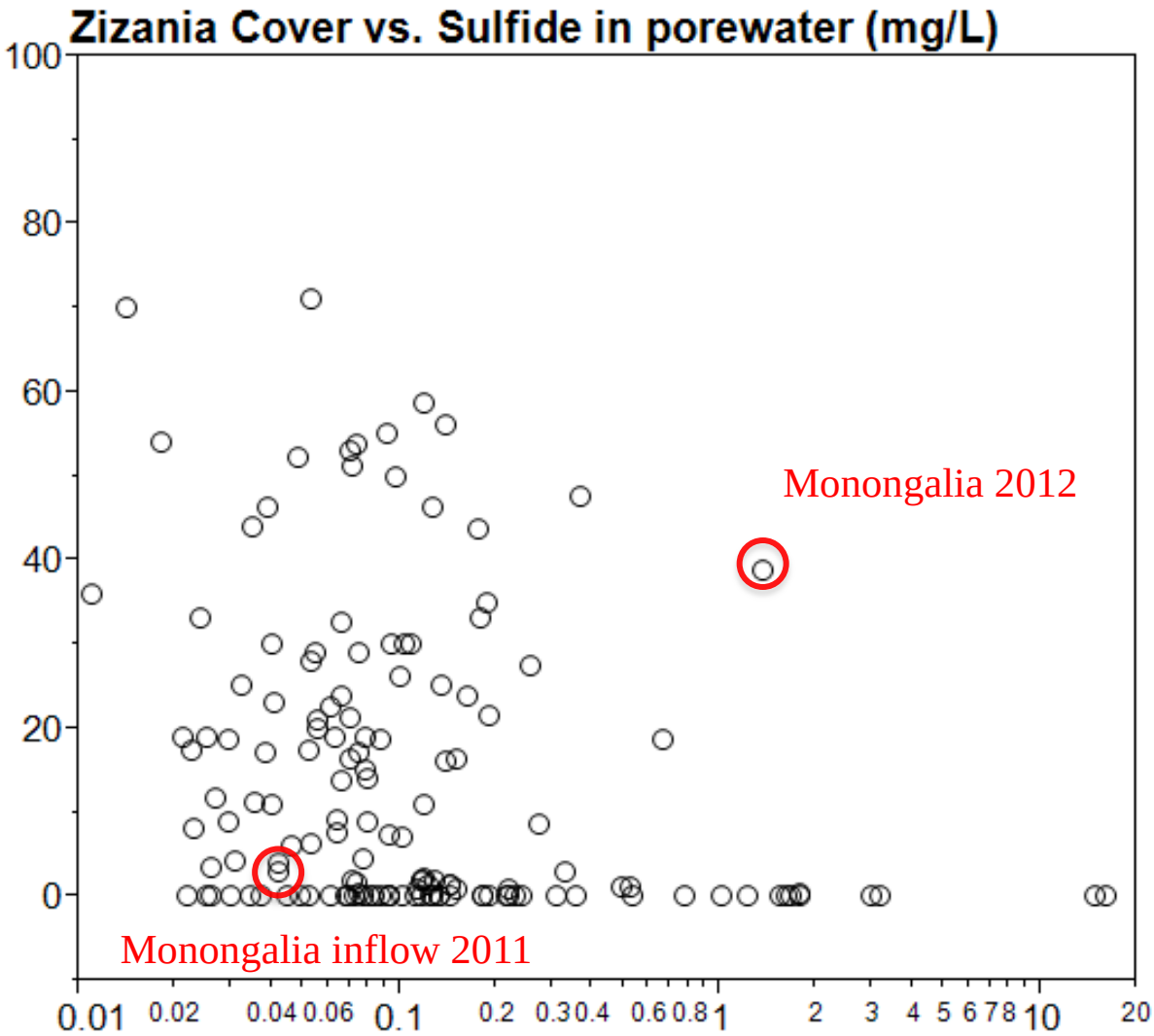

Wild Rice Cover

Sulfide in porewater (mg/L)

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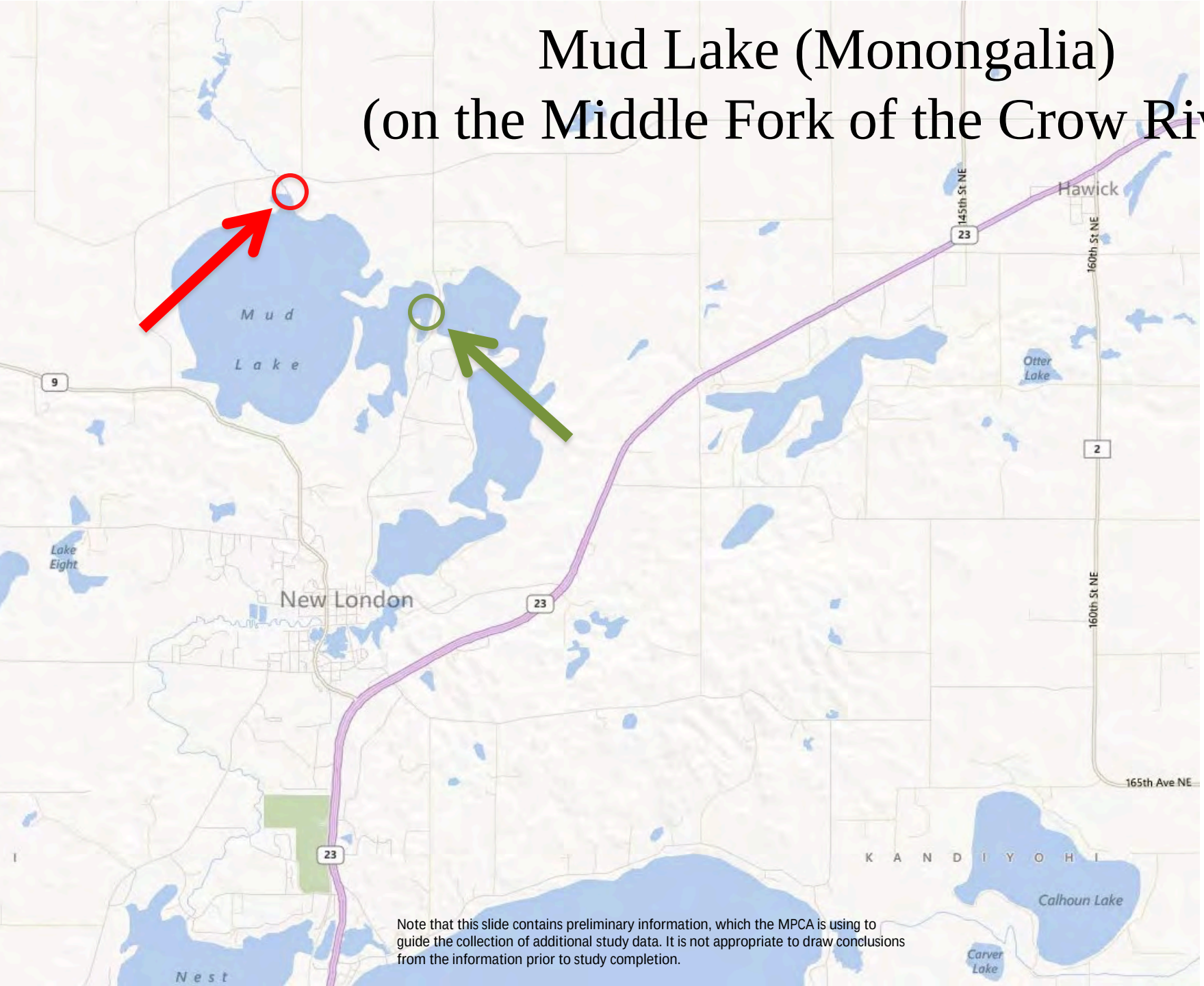
Mud Lake (Monongalia)
(on the Middle Fork of the Crow River)



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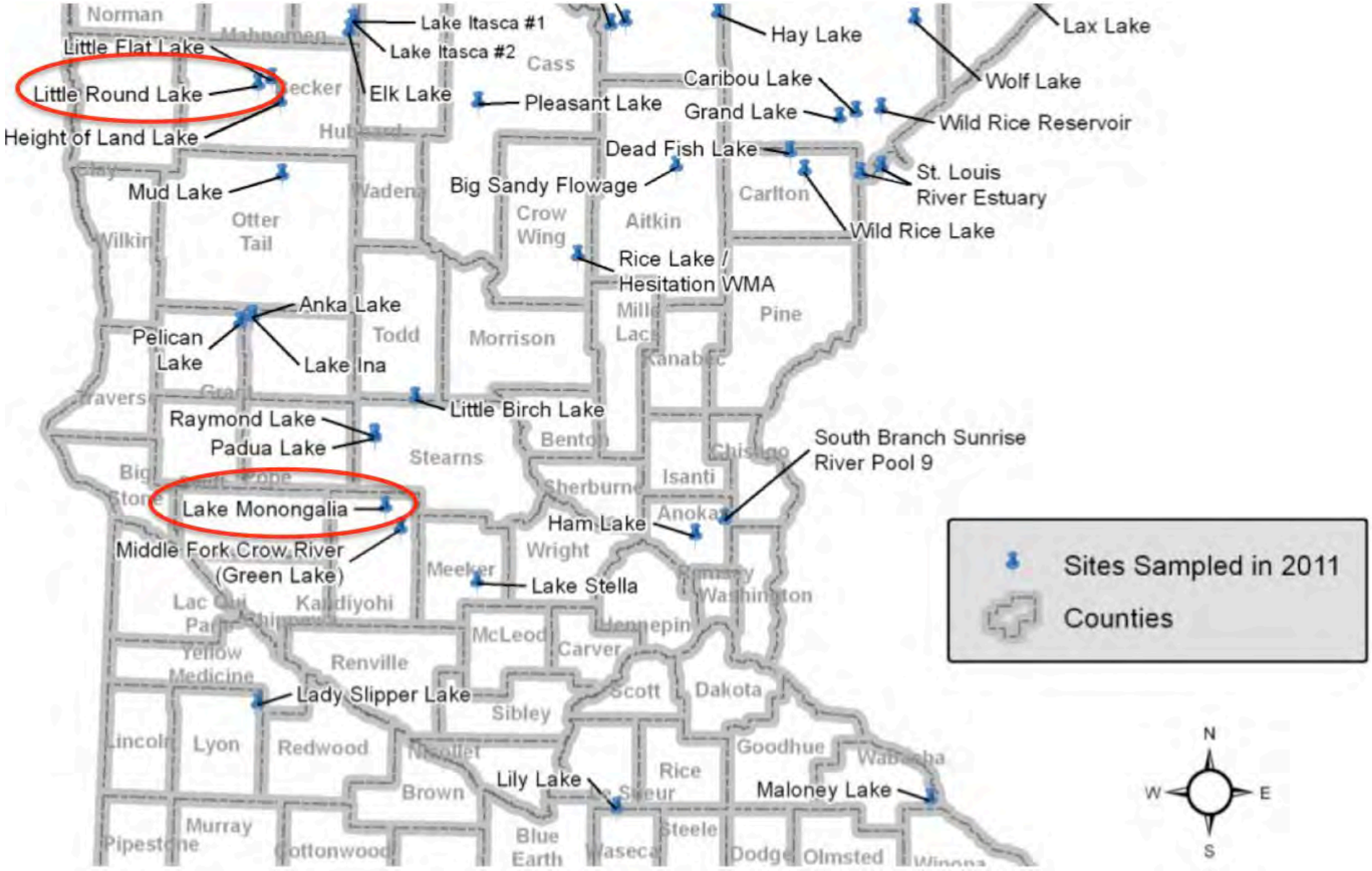
Seed Source Lakes for Hydroponic Experiments



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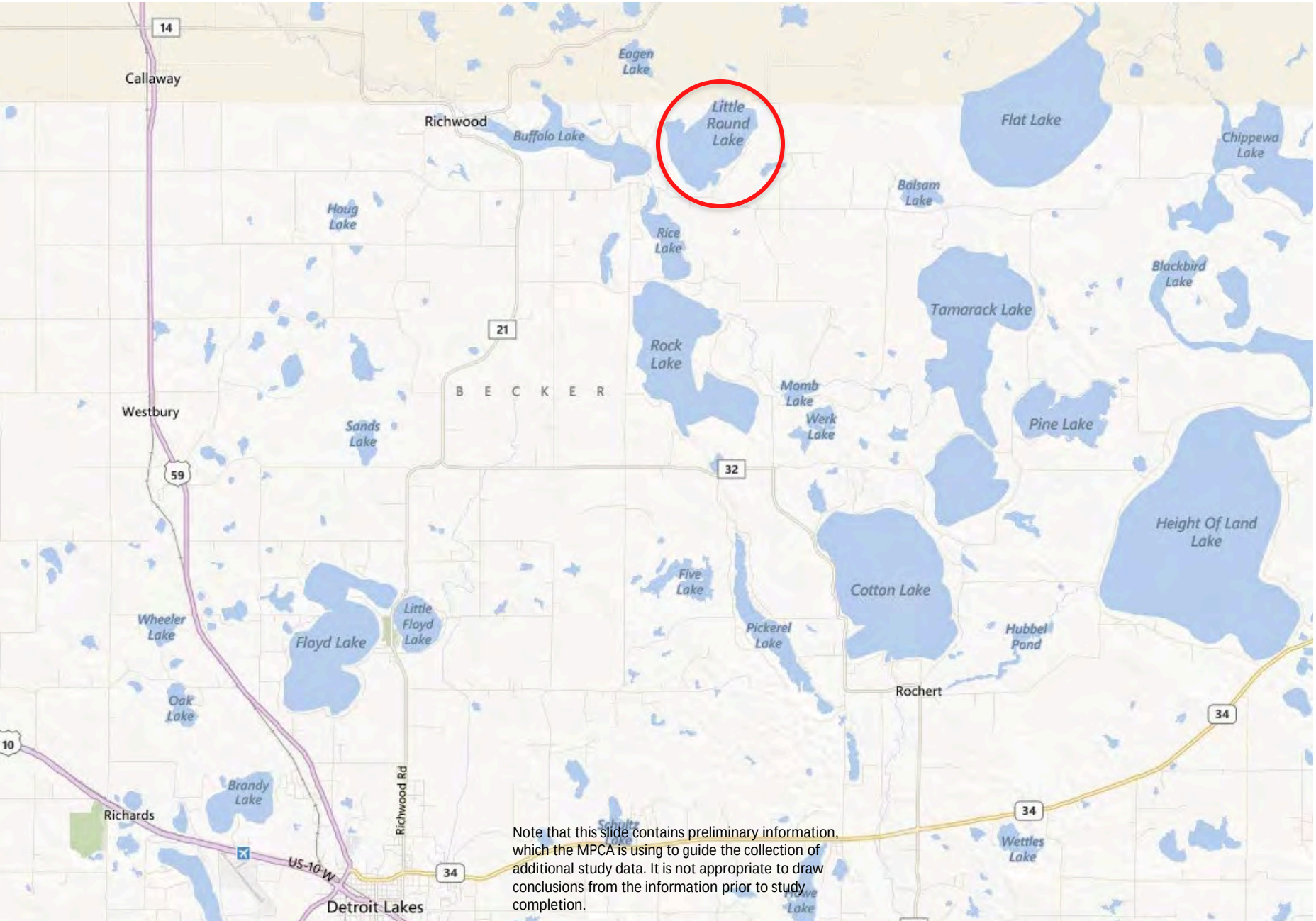
Little Round Lake



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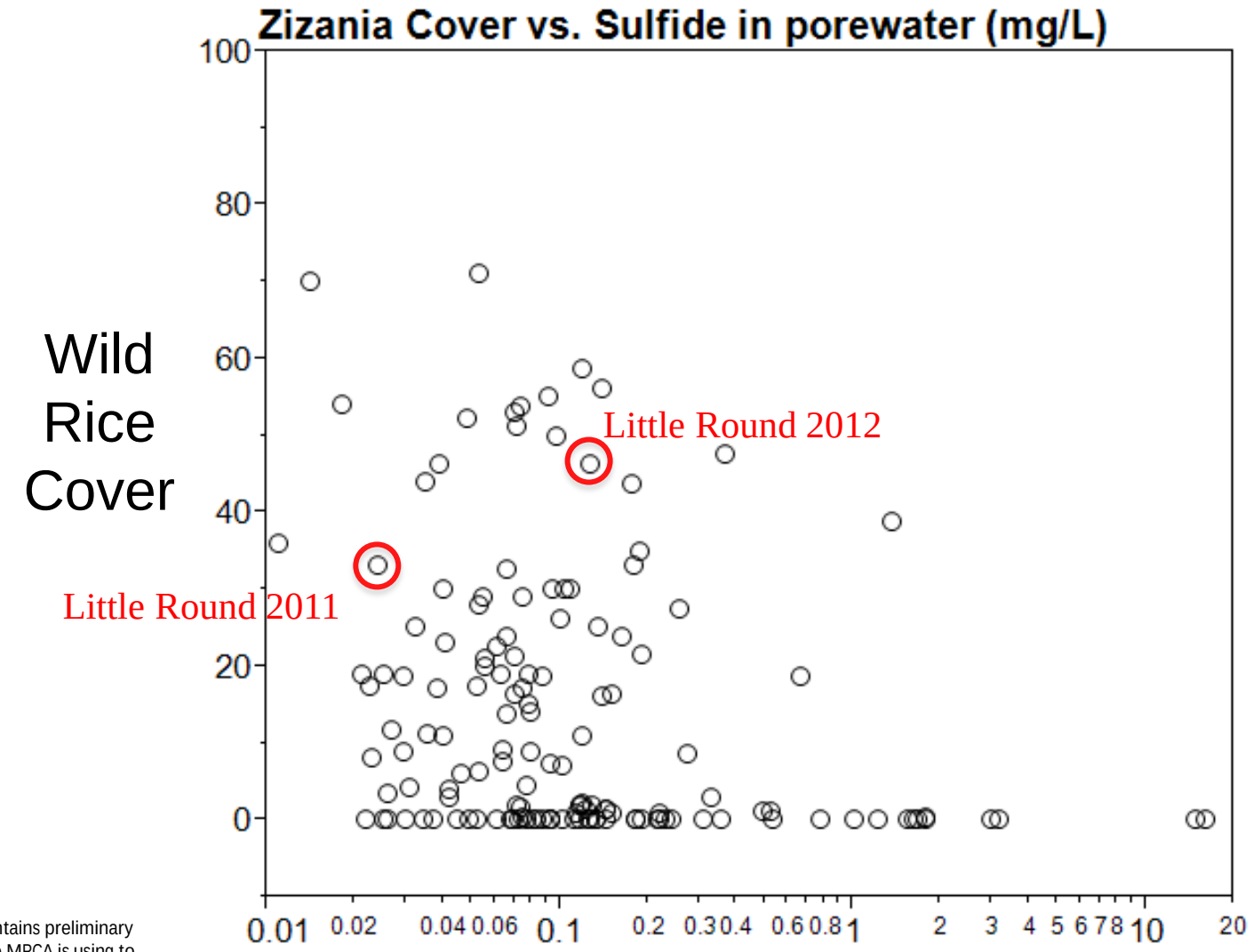
Zizania vs. sulfide in porewater



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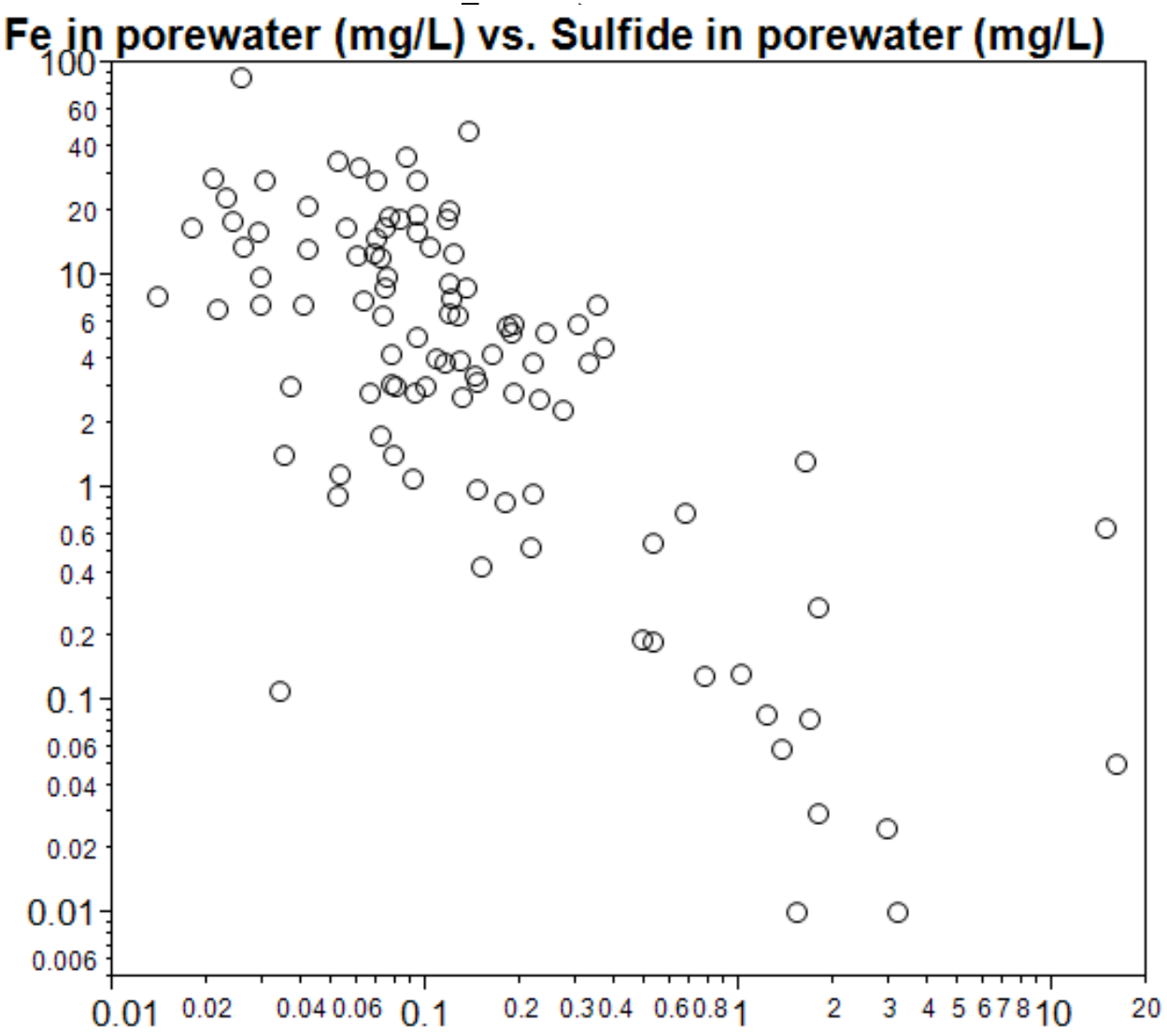
Porewater: Iron vs. Sulfide (log-log)



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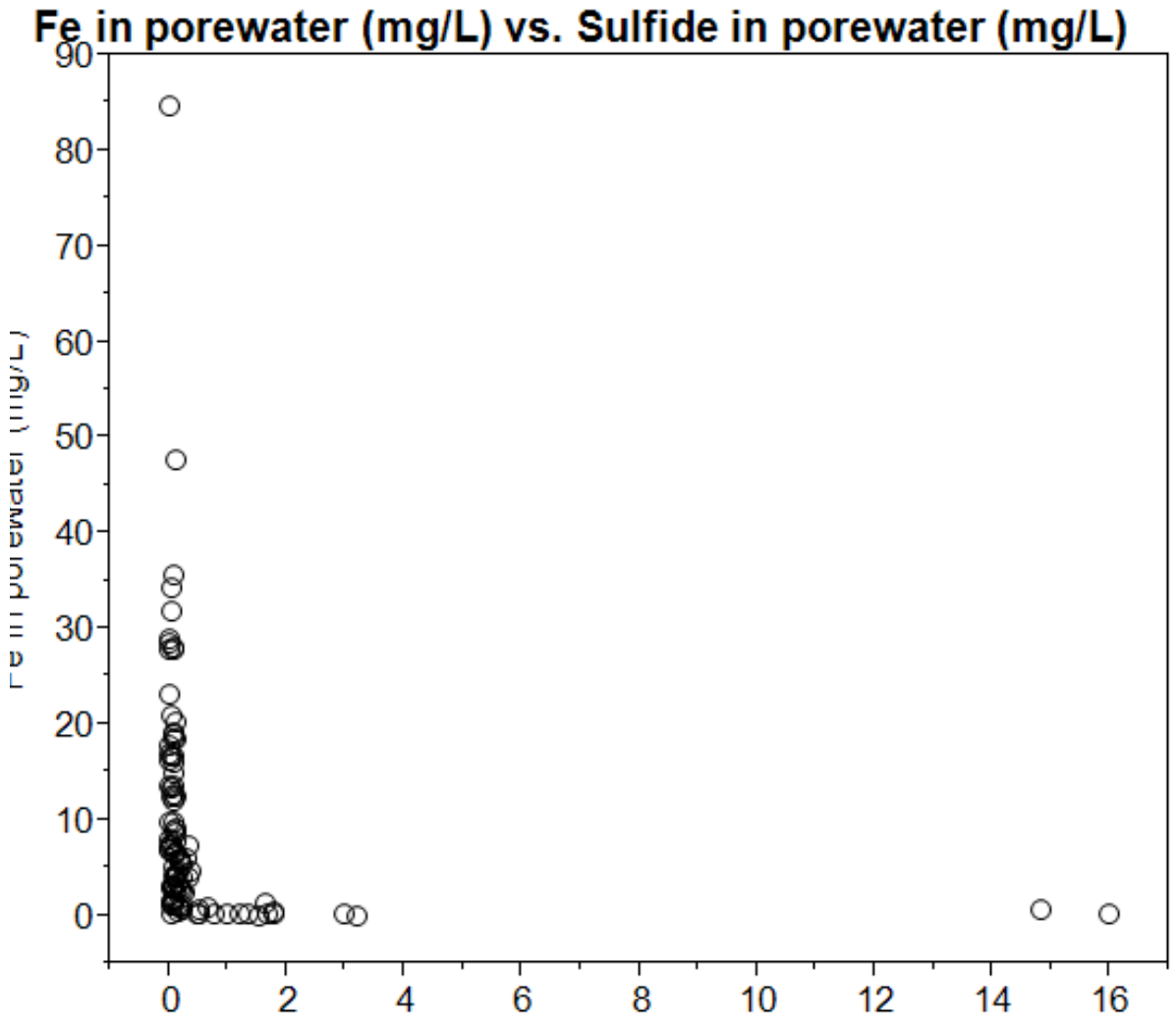
Porewater: Iron vs. Sulfide (linear plot)

Iron in porewater (mg/L)



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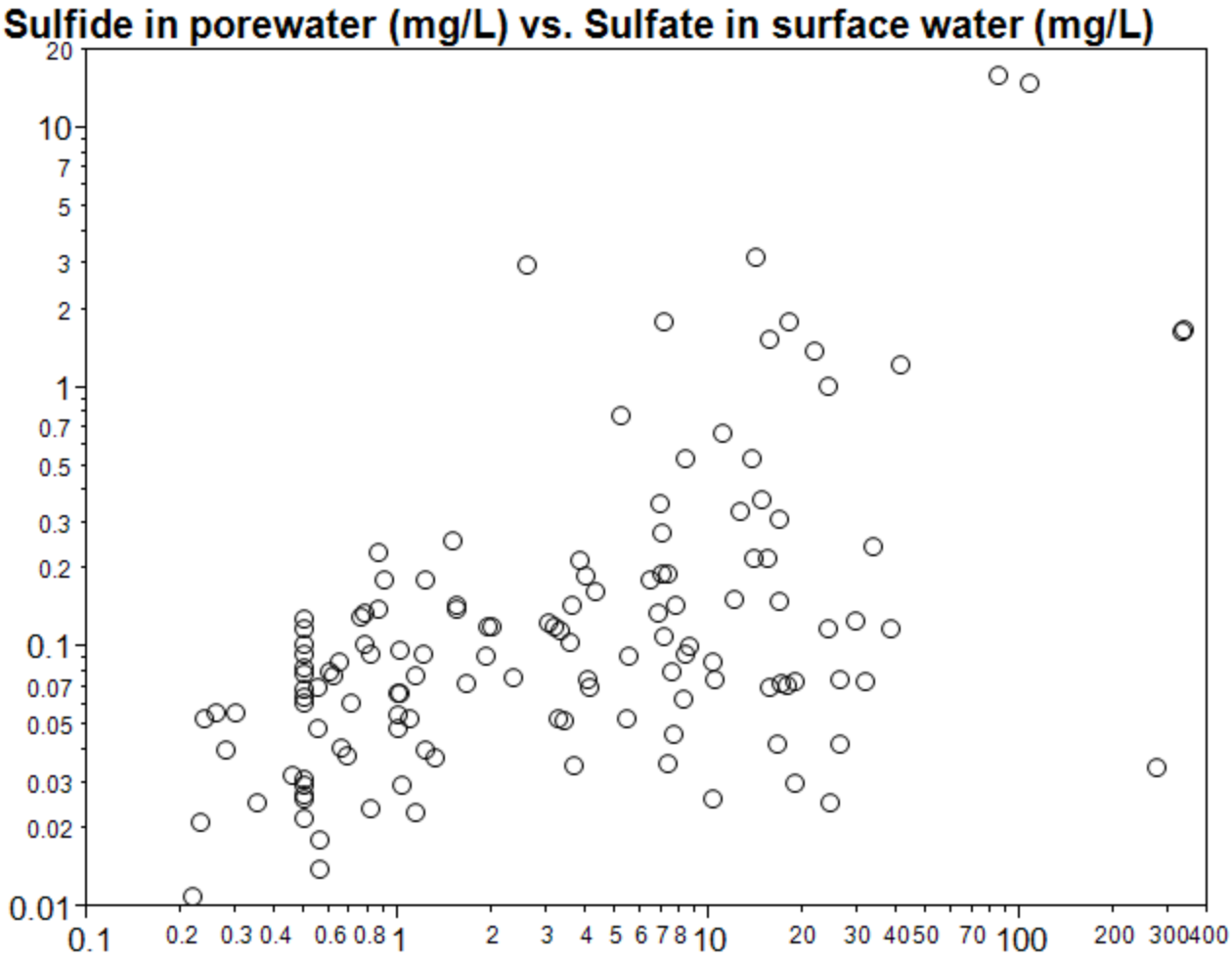
Sulfide vs. Sulfate

Sulfide in porewater (mg/L)



Sulfate in surface water (mg/L)

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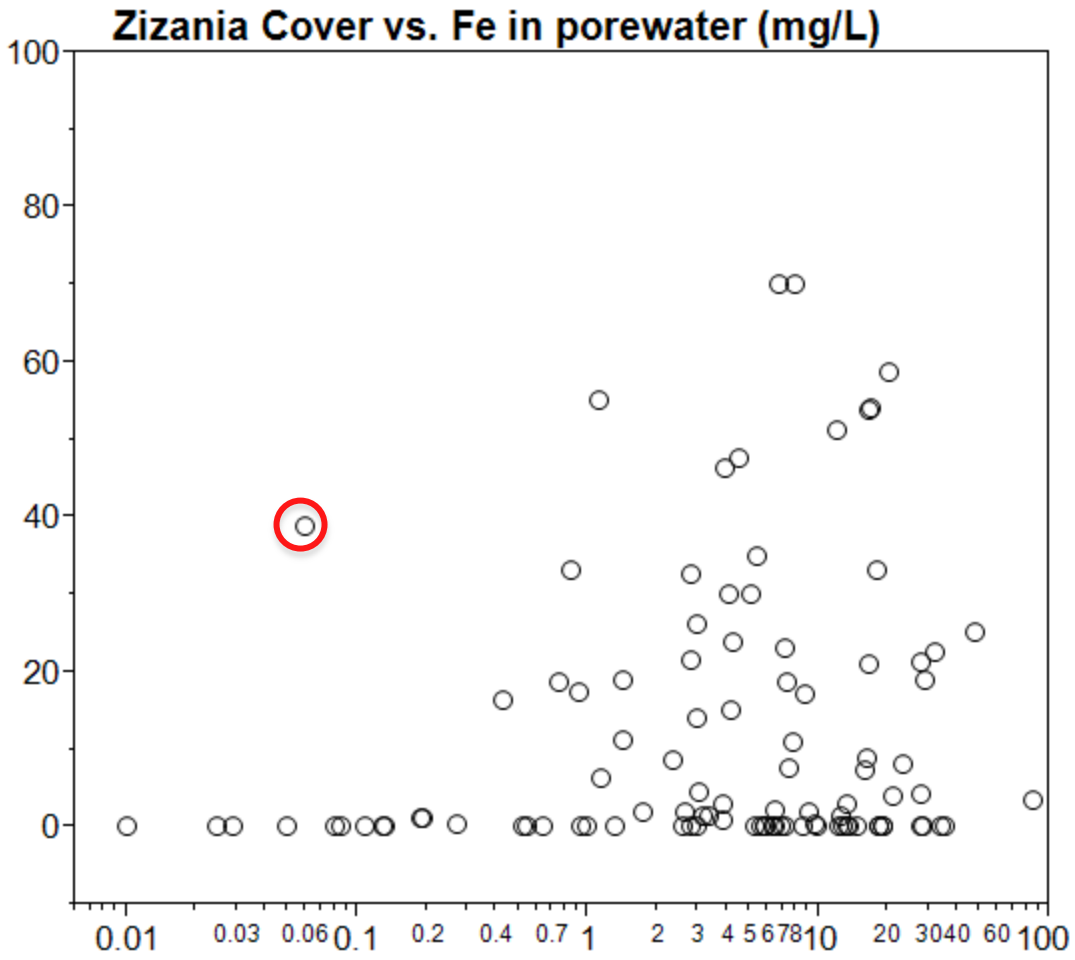
Zizania vs. Iron in porewater



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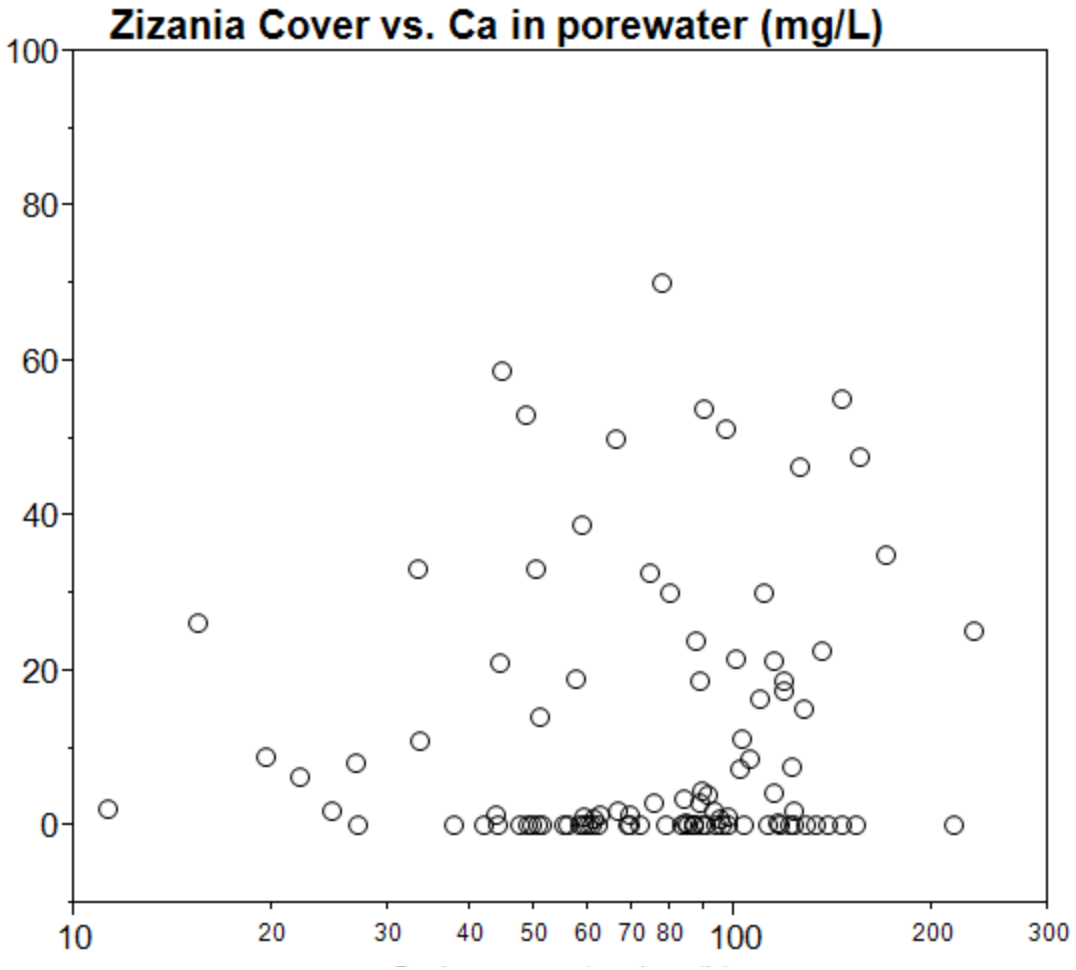
Zizania vs. Calcium in porewater



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