

Mesocosm Studies on Effects of Sulfate on Wild Rice Growth and Development



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Experimental Design

- Wild rice grown in 100 gal Rubbermaid stock tanks buried into ground
- 10 cm of washed sand followed by 12 cm of sediment from Rice Portage Lake
- Seeds from Swamp Lake
- Populations thinned to 30 plants per tank
- Water levels maintained at 23 cm depth with PVC pipe draining into PVC bucket
- Target sulfate concentrations of background (no addition), 50, 100, 150, and 300 ppm SO_4
- 6 replicates per sulfate level

Measurements

- Total aboveground biomass in each tank
- Six plants harvested with seeds, stems and roots
- Sulfate concentrations in water column checked weekly and adjusted accordingly
- Rainfall and drainage amounts and chemistry measured weekly
- Sediment nitrogen and phosphorus availability
- Litter decomposition rates
- Sediment profiles of sulfate, sulfide, and iron, pH



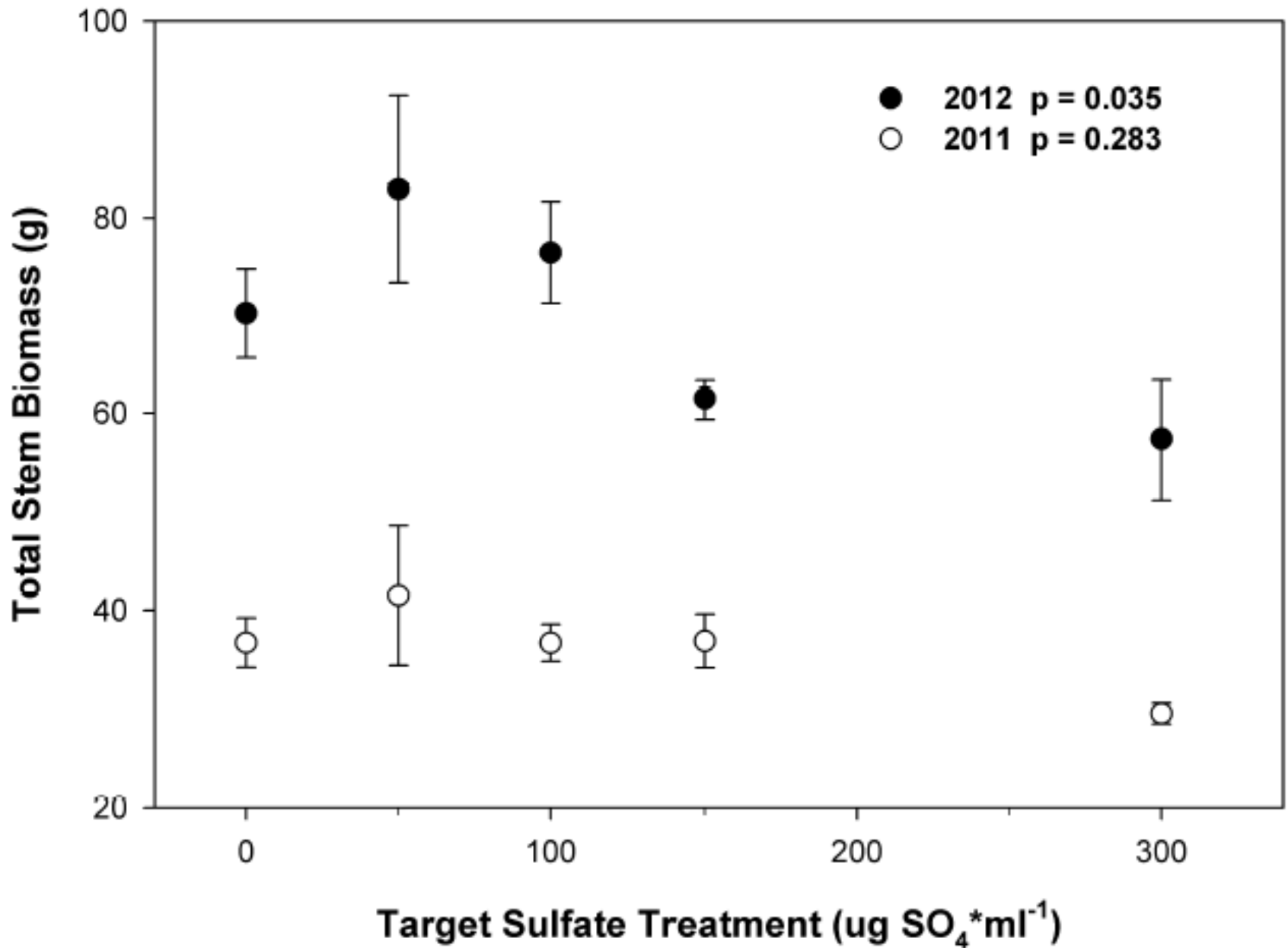
Note that this slide contains preliminary information, which the MPCA is using to guide the collection of additional study data. It is not appropriate to draw conclusions from the information prior to study completion.



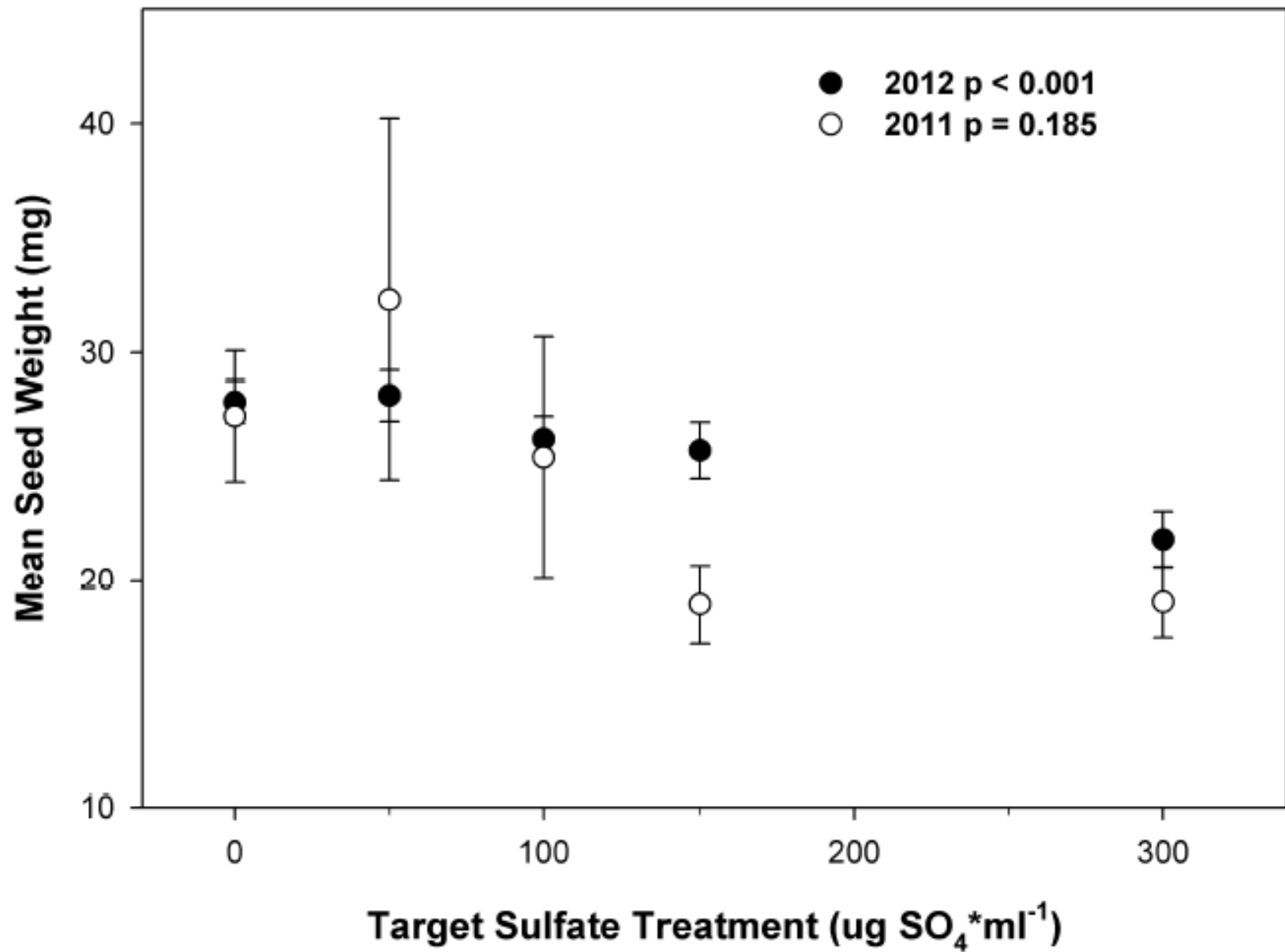
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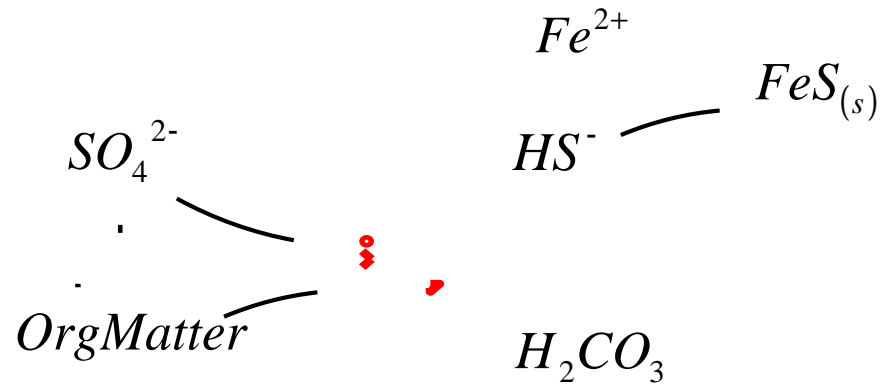
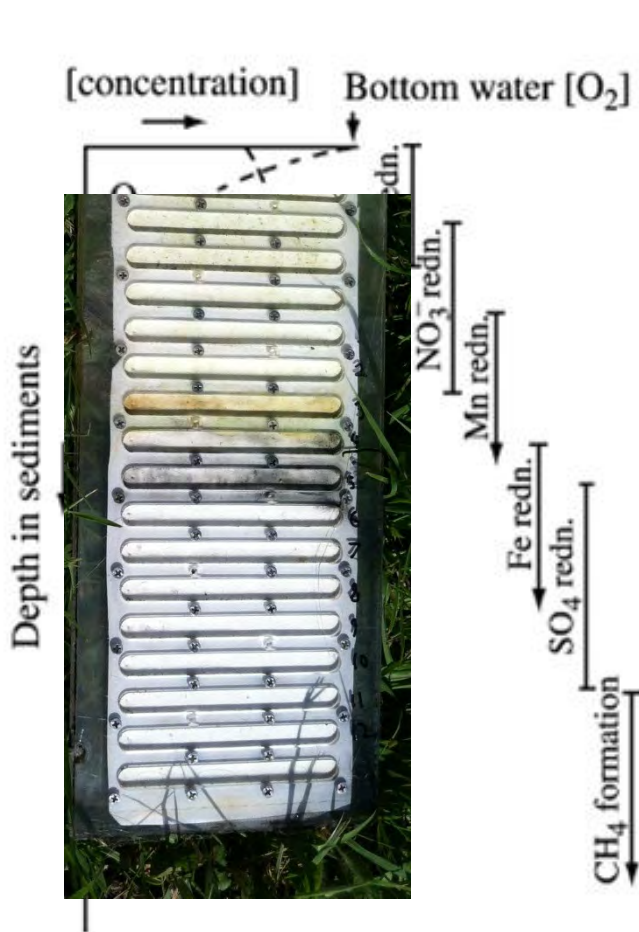


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Porewater Geochemistry

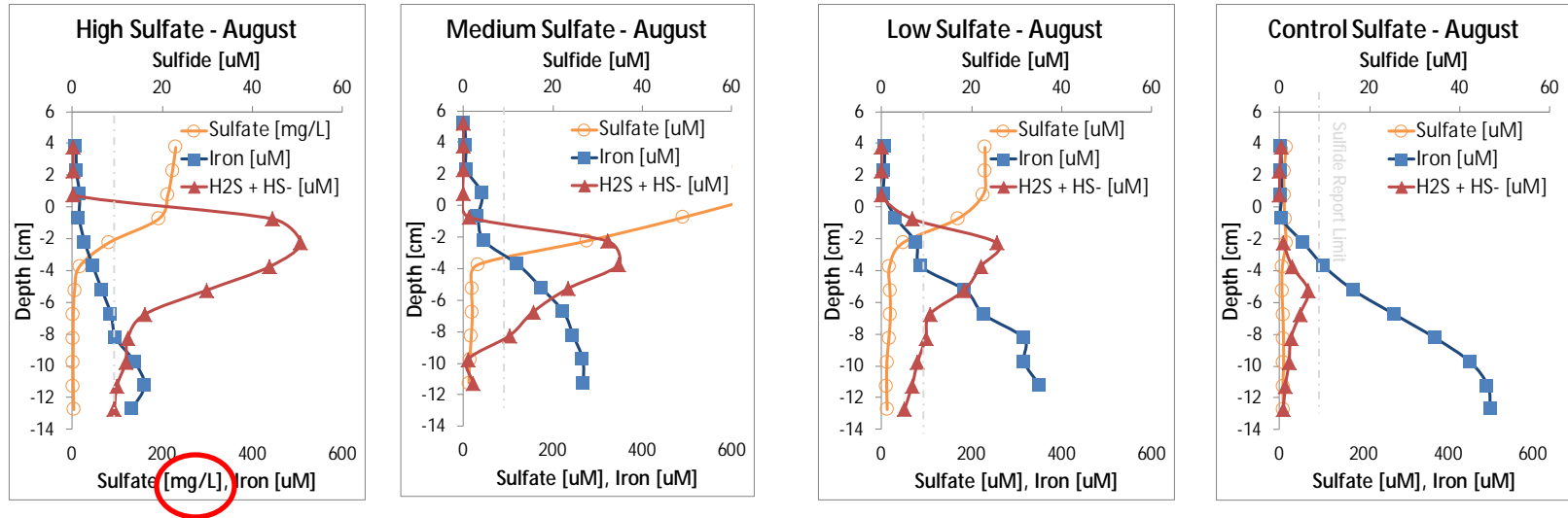


- Is sulfate reduced to sulfide in surficial wild rice sediment?
- Is iron present in sufficient quantities to reduce the buildup of H_2S ?

Measurements

- Small volume samples non-destructively collected from wild rice microcosms amended with varying amounts of sulfate
- High resolution (1.5 cm) equilibrium samplers (peepers) provided measurements of depth-dependent pore water geochemistry
- Samplers were deployed (2-3 wks) in June, August, and October 2012; samples analyzed for dissolved sulfate, sulfide, iron, and pH

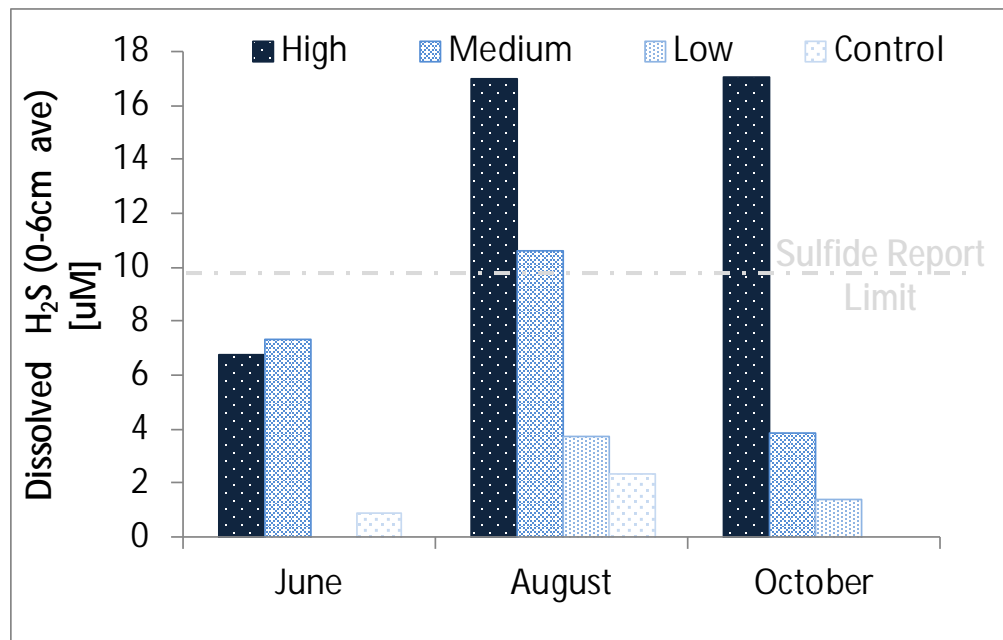
Preliminary Results



- Sulfate depleted in the top 3-8 cm of porewaters regardless of overlying water sulfate amendment concentration
- Sulfide above reporting limit of 10 μM observed in the porewaters of high, medium, and low sulfate amendments between 0-8 cm sediment depth during August 2012
- Lower dissolved iron in porewaters of sulfate amended sediment suggests consumption via iron sulfide precipitation

Note: After this was presented on March 1, 2013, Dr. Nate Johnson alerted the MPCA that the pH adjustments to the dissolved H₂S concentrations in this slide may be erroneous if the water samples had significantly degassed carbon dioxide prior to measurement, which would have raised the pH above the true *in situ* value. Dr. Johnson is investigating this issue. Therefore, please do not rely on these preliminary results in any discussion.

Preliminary Results

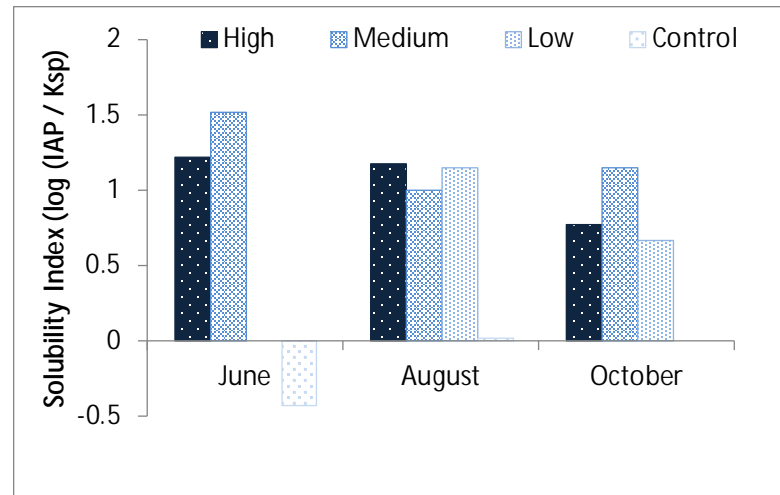


- Total sulfide measurements adjusted for pH to quantify dissolved H₂S
- Some seasonal differences observed in dissolved hydrogen sulfide

Note: After this was presented on March 1, 2013, Dr. Nate Johnson alerted the MPCA that the values of the Solubility Index in this slide may be erroneous: the calculation of the Solubility Index relies on the pH, which may have been misleadingly high (see previous slide). Dr. Johnson is investigating this issue. Therefore, please do not rely on these preliminary results in any discussion.

Preliminary Results

- Solubility Index greater than zero indicates “oversaturation” of iron sulfide minerals
- Likely indicative of active iron sulfide precipitation



- Total sulfide measurements adjusted for pH to quantify dissolved H₂S
- Some seasonal differences observed in dissolved hydrogen sulfide

Preliminary Results

- In the absence of bulk fluid advective flow, diffusion carries sulfide away from the location where it is produced
- Location of maximum observed sulfide concentration is location of maximum net sulfide production
- Observed porewater sulfide is the result of two reactions (at least):
 1. Sulfate reduction
 2. Iron-sulfide precipitation

