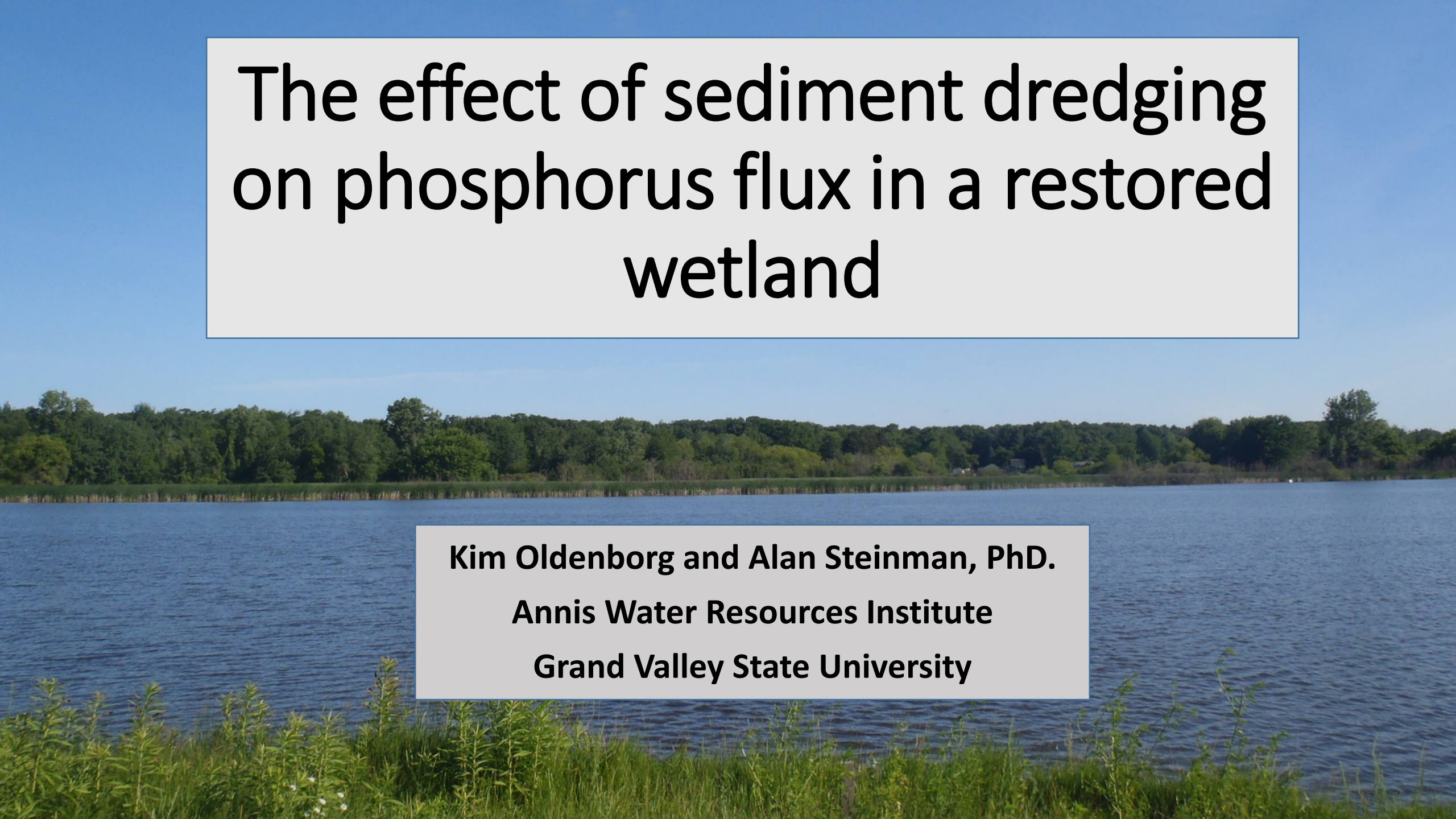
The effect of sediment dredging on phosphorus flux in a restored wetland



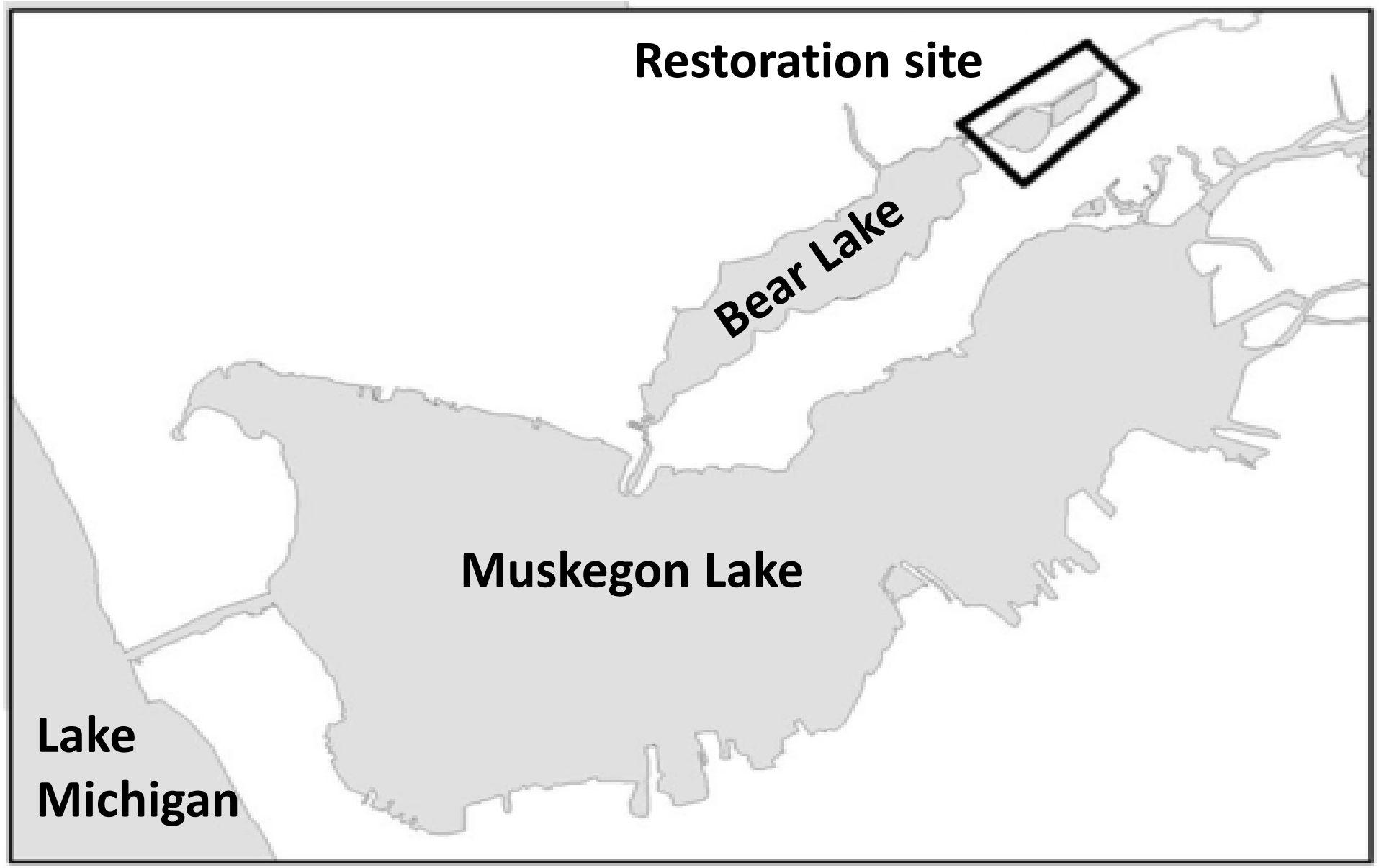
Kim Oldenborg and Alan Steinman, PhD.

Annis Water Resources Institute

Grand Valley State University


Muskegon, Michigan
MI

Study Location: Muskegon Lake Area of Concern

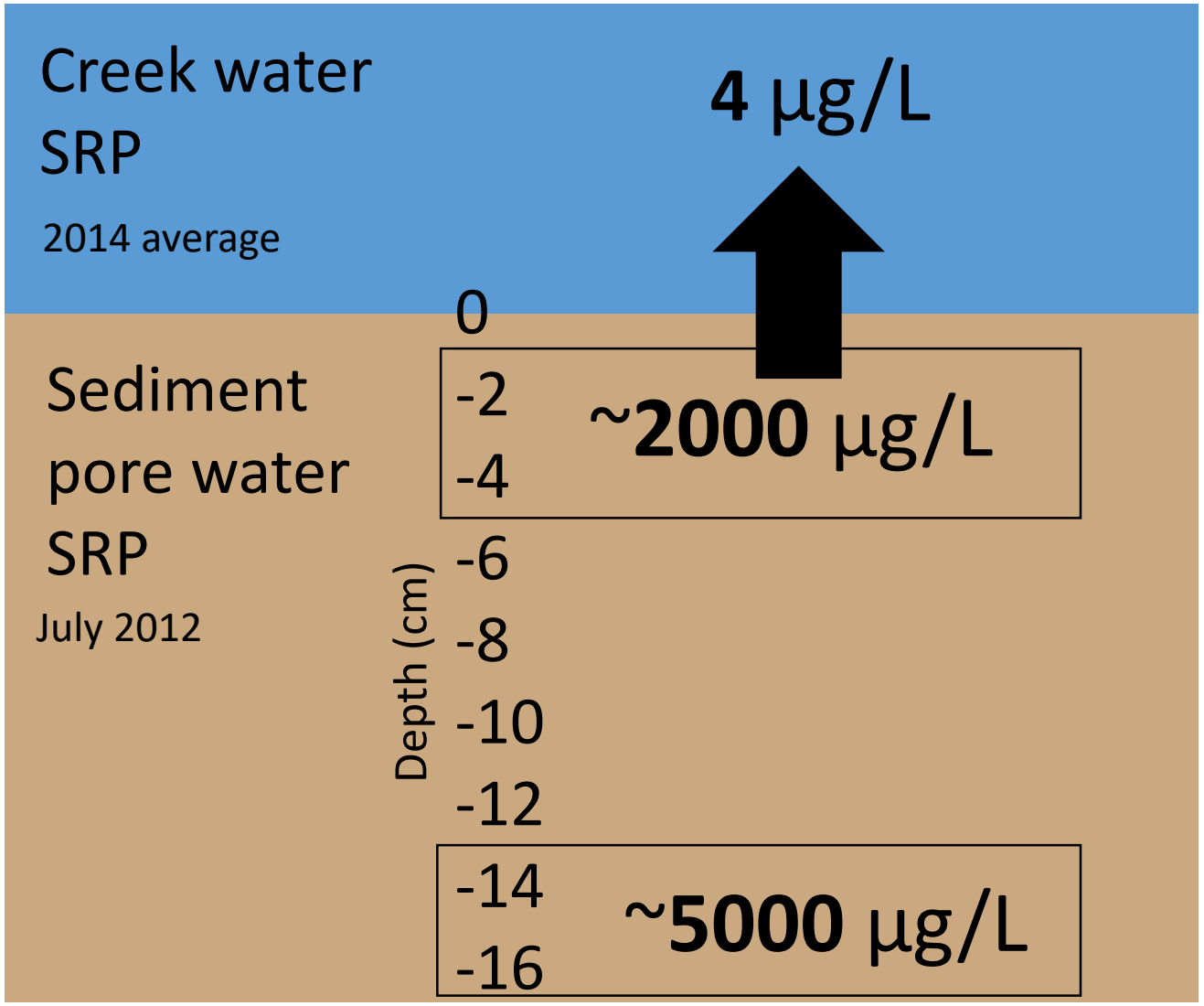



Bear Creek
East Pond
Partial dredging
flow
Bear Creek
West Pond
Never dredged
Witham Drive
Bear Lake

Legacy P in the water column: TP concentrations (March 2016)

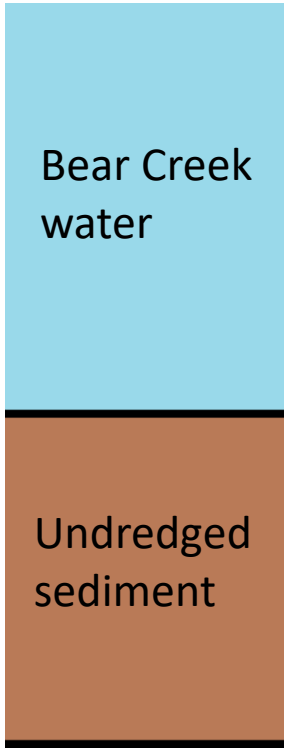
Legacy P in the sediment

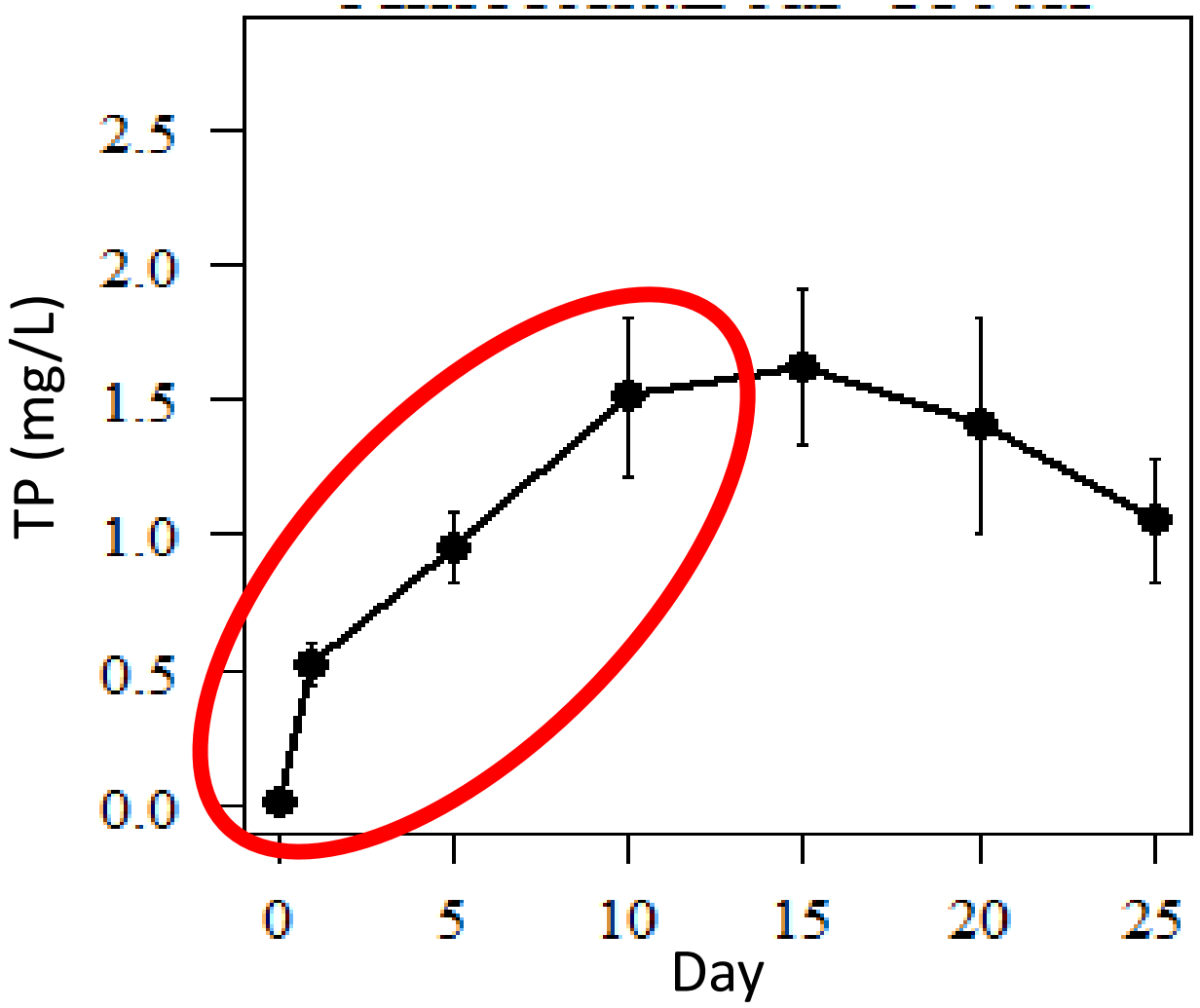
Steinman & Ogdahl, 2016



Simulated hydrologic reconnection

Smit & Steinman, 2015





High risk of sediment P release to downstream waters

Drained: summer 2016

Photo: Mike Hassett, AWRI

Dredged: summer 2016 – fall 2016

Over 100,000 cubic meters of sediment was removed

Photo: Brian Majka, GEI Consultants

Refilled: winter 2016

Berm removal: spring 2017

Photo: Brian Majka, GEI Consultants

Photo: Brian Majka, GEI Consultants

Research Questions

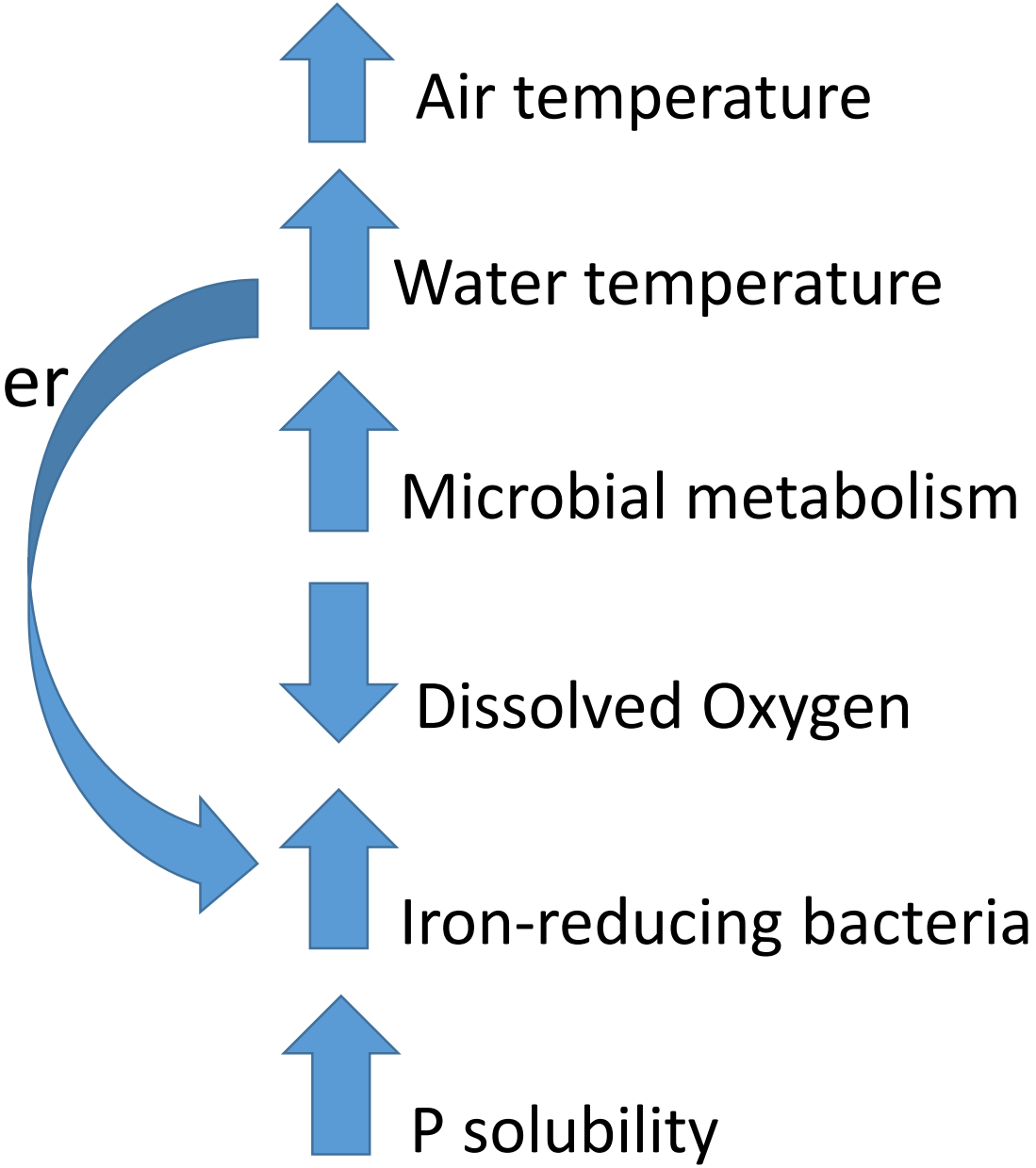
1) Is sediment dredging successful at reducing sediment P release?

Hypothesis: yes

Research Questions

2) Could climate warming stimulate P release even after dredging?

Hypothesis: Yes



More Sediment P release

Sediment Core Incubations

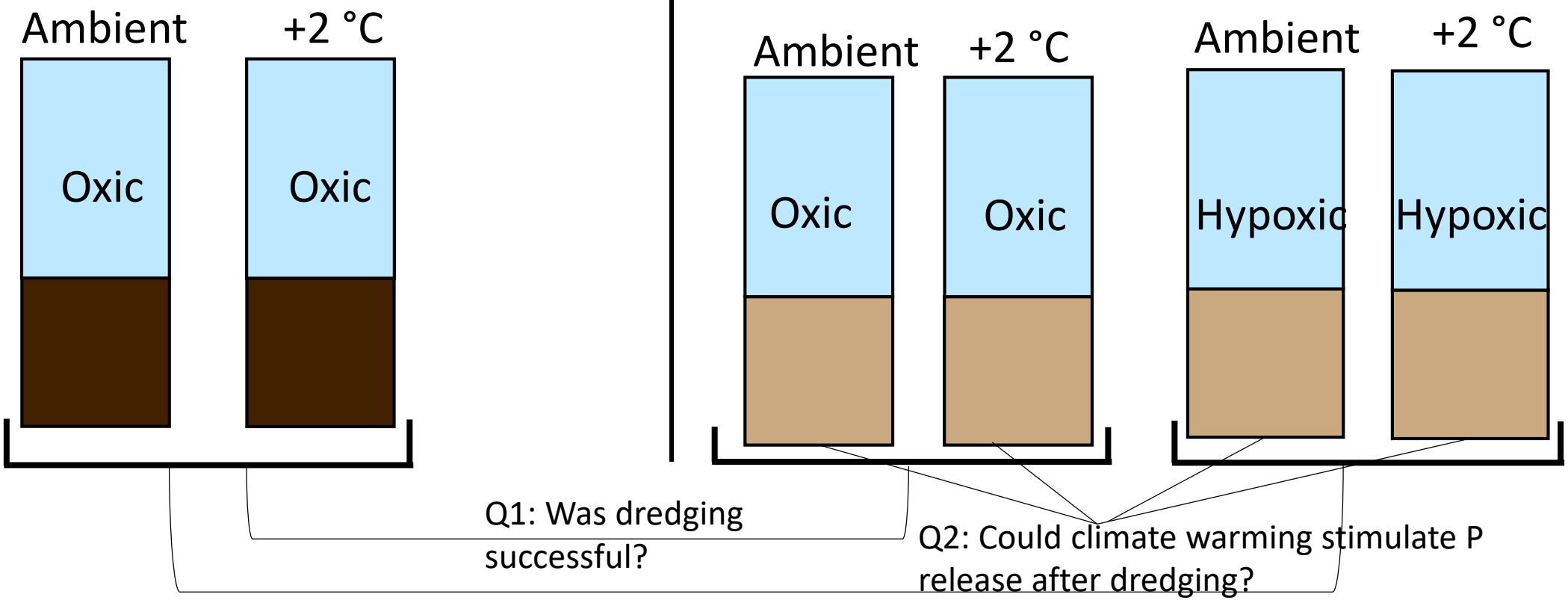
Pre-dredging & Simulated hydrologic reconnection

Summer and Fall 2013

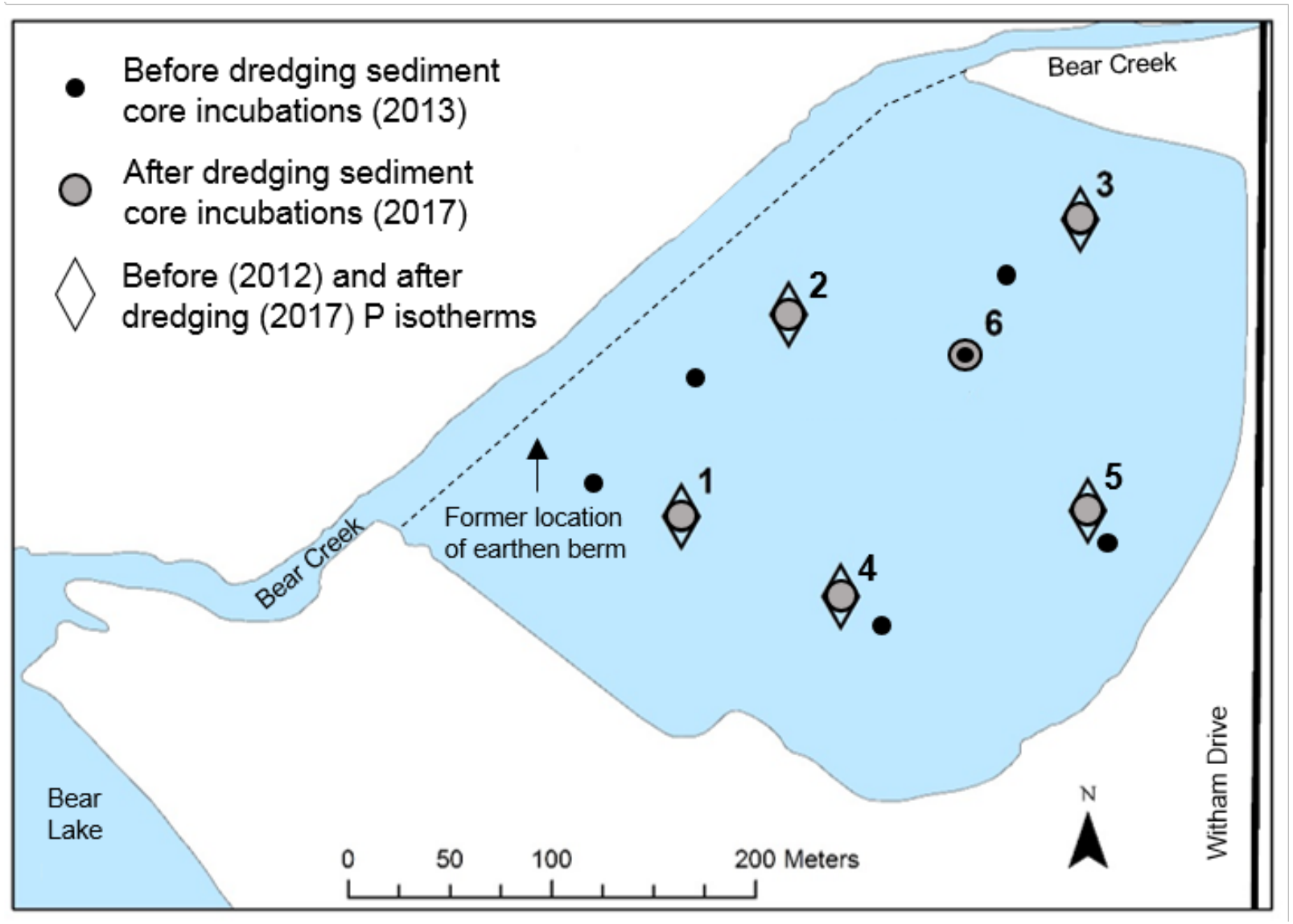
Smit & Steinman, 2015

Post-dredging & Hydrologic reconnection

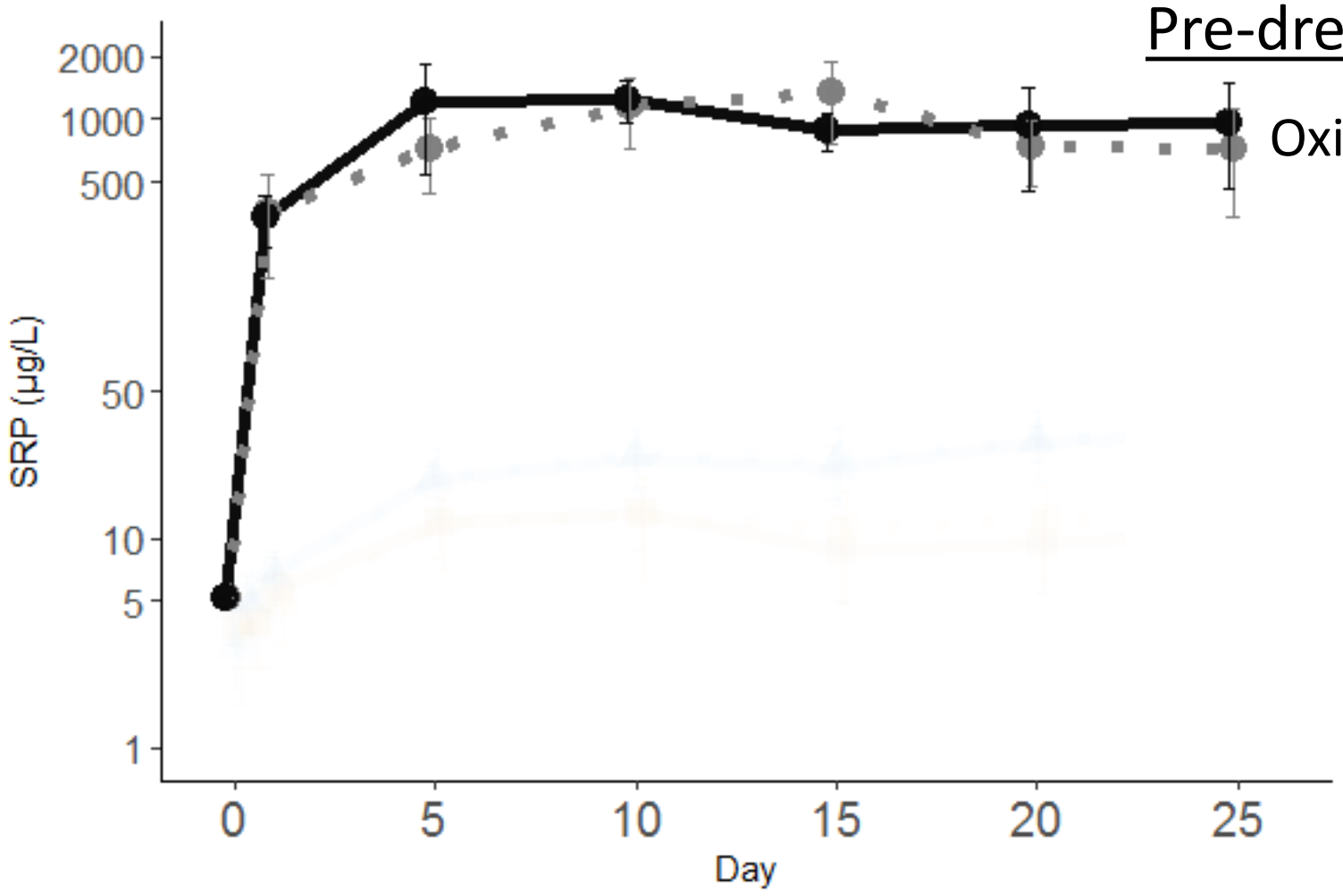
Summer and Fall 2017



Coring locations

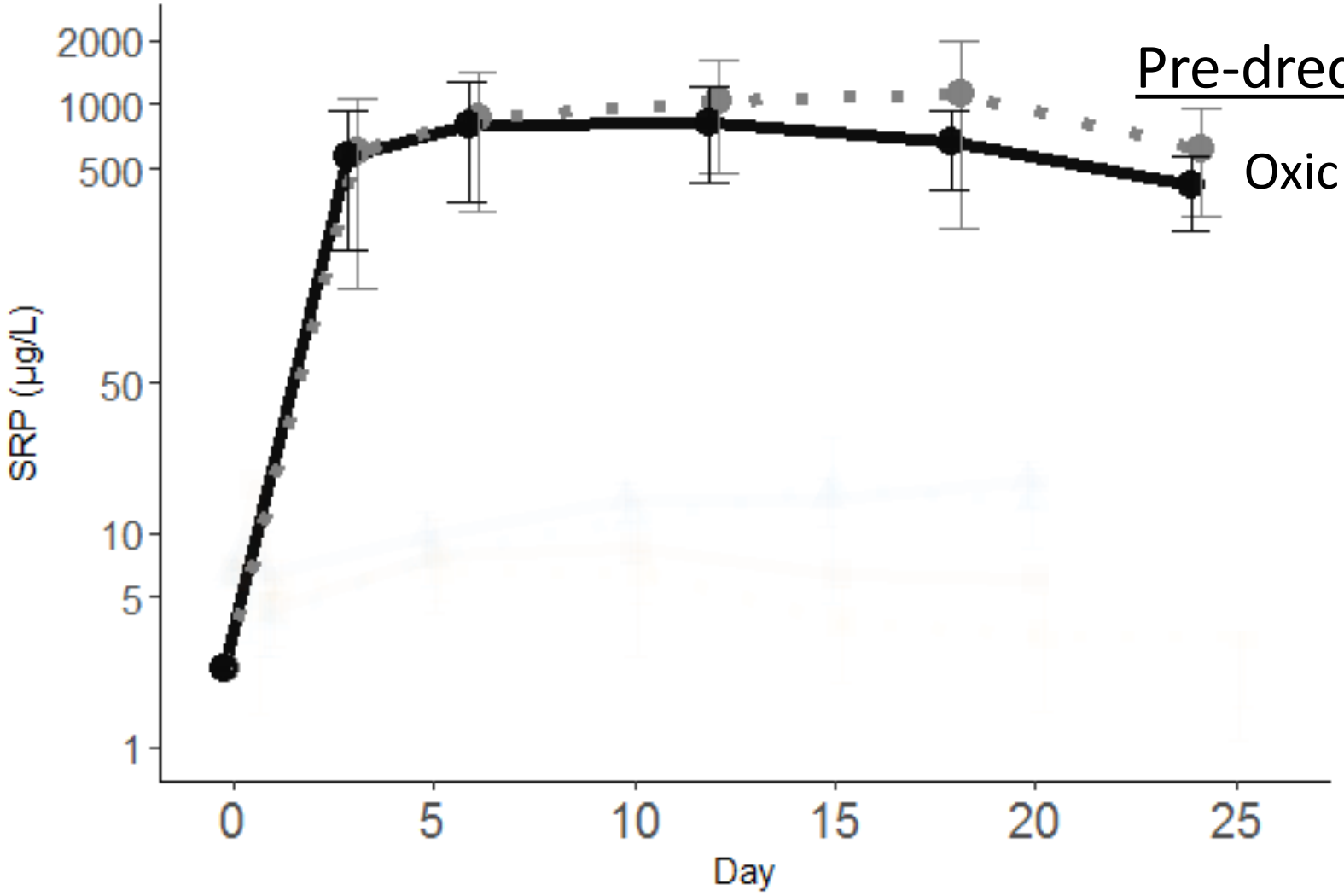


SRP Release: summer experiments



Dotted= ambient (21 °C)
Solid = ambient +2 (23 °C)

SRP release: fall experiments



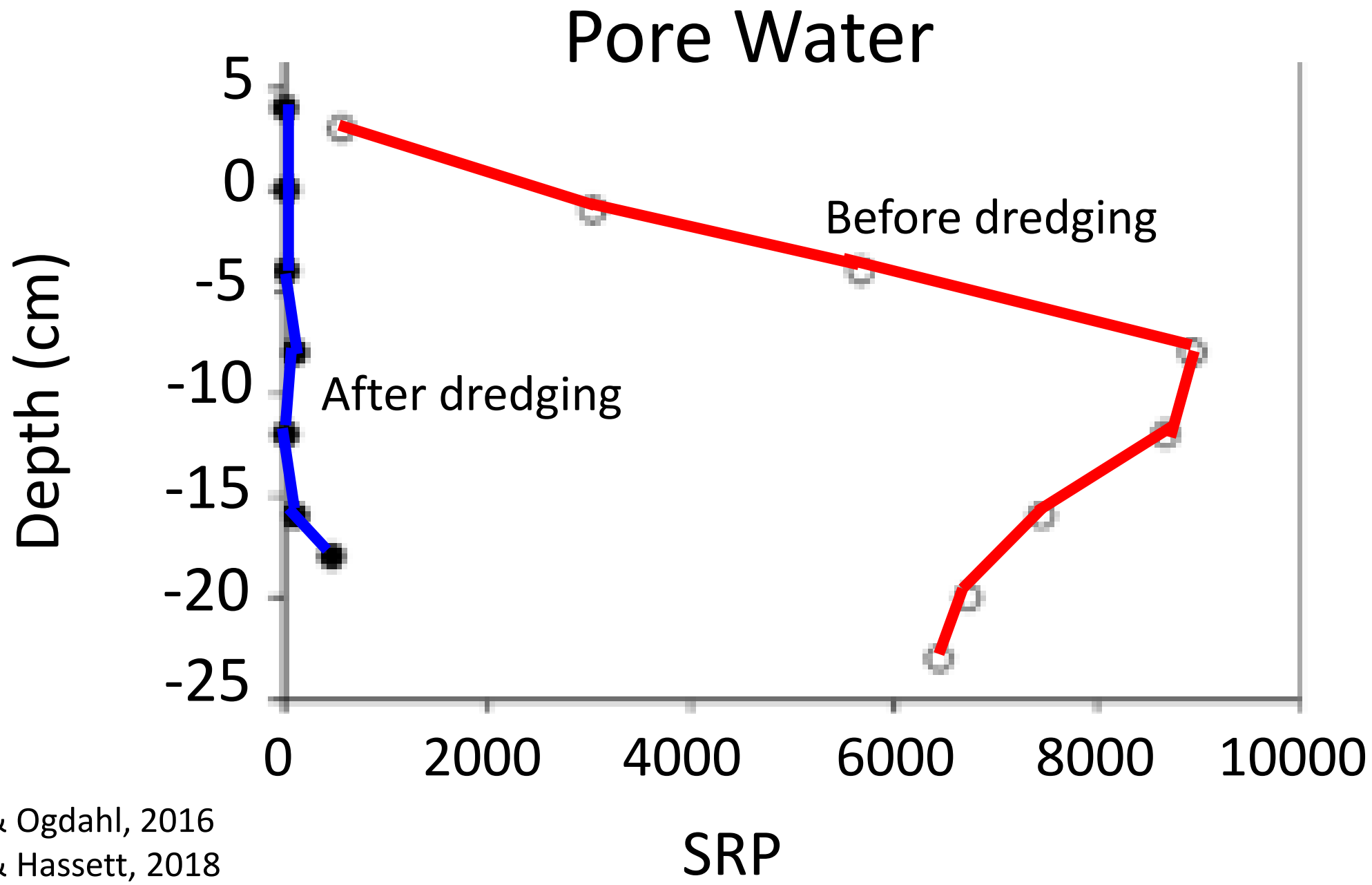
Pre-dredging

Oxic

Dotted= ambient (17 °C)
Solid = ambient +2 (19 °C)

Conclusions: dredging success

- Dredging reduced sediment P release regardless of treatment
  - Likely due to removal of labile P



Steinman & Ogdahl, 2016
Steinman & Hassett, 2018

Conclusions: dredging success

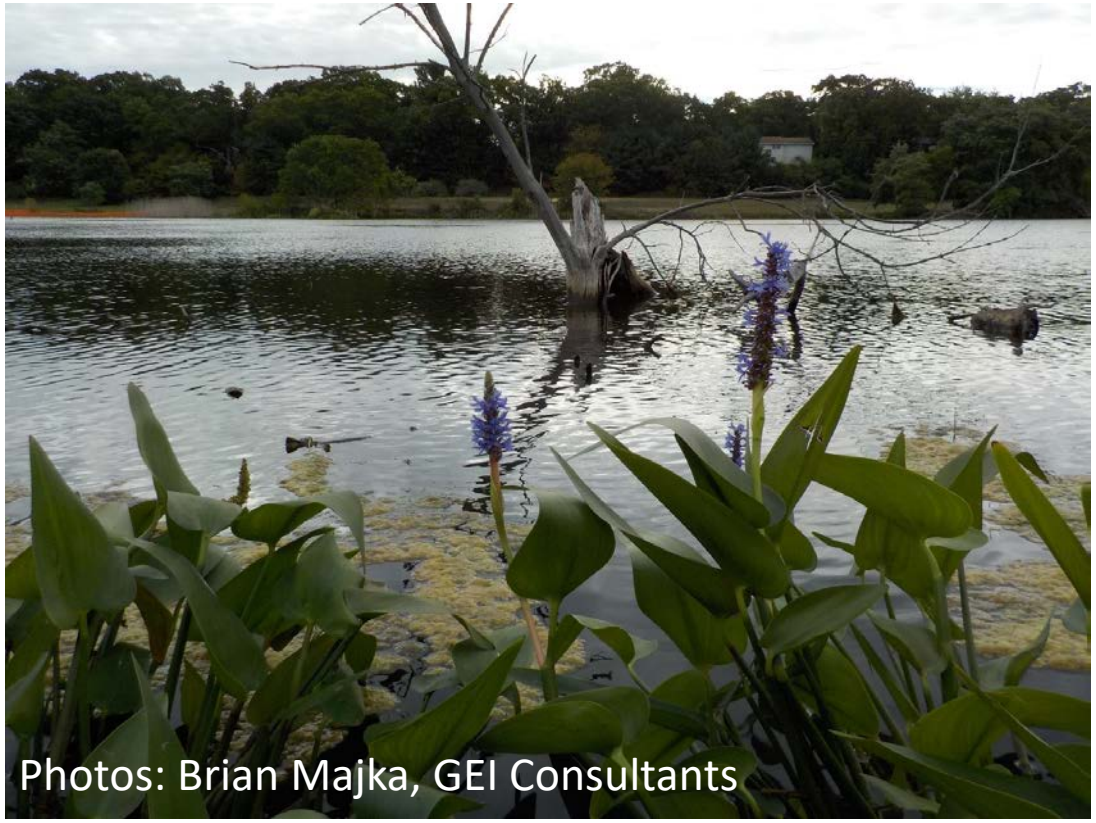
- Dredged sediments are still a minor source of dissolved P
  - EPC_0 > Water column SRP
  - Sediment TP ≈ Sorption maximum

Conclusions: affect of climate warming

- No significant effect of temperature
  - Removal of labile P
  - Small differences in incubation temperature
  - Slow recolonization of microbes

Overall Implications

- Dredging is expensive but can be effective for reducing sediment P release in wetlands restored on agricultural land



Photos: Brian Majka, GEI Consultants

Acknowledgments

- Steinman lab
  - Mike Hassett
  - Maggie Oudsema
- Annis Water Resources Institute
- GEI Consultants
- West Michigan Regional Shoreline Development Commission
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