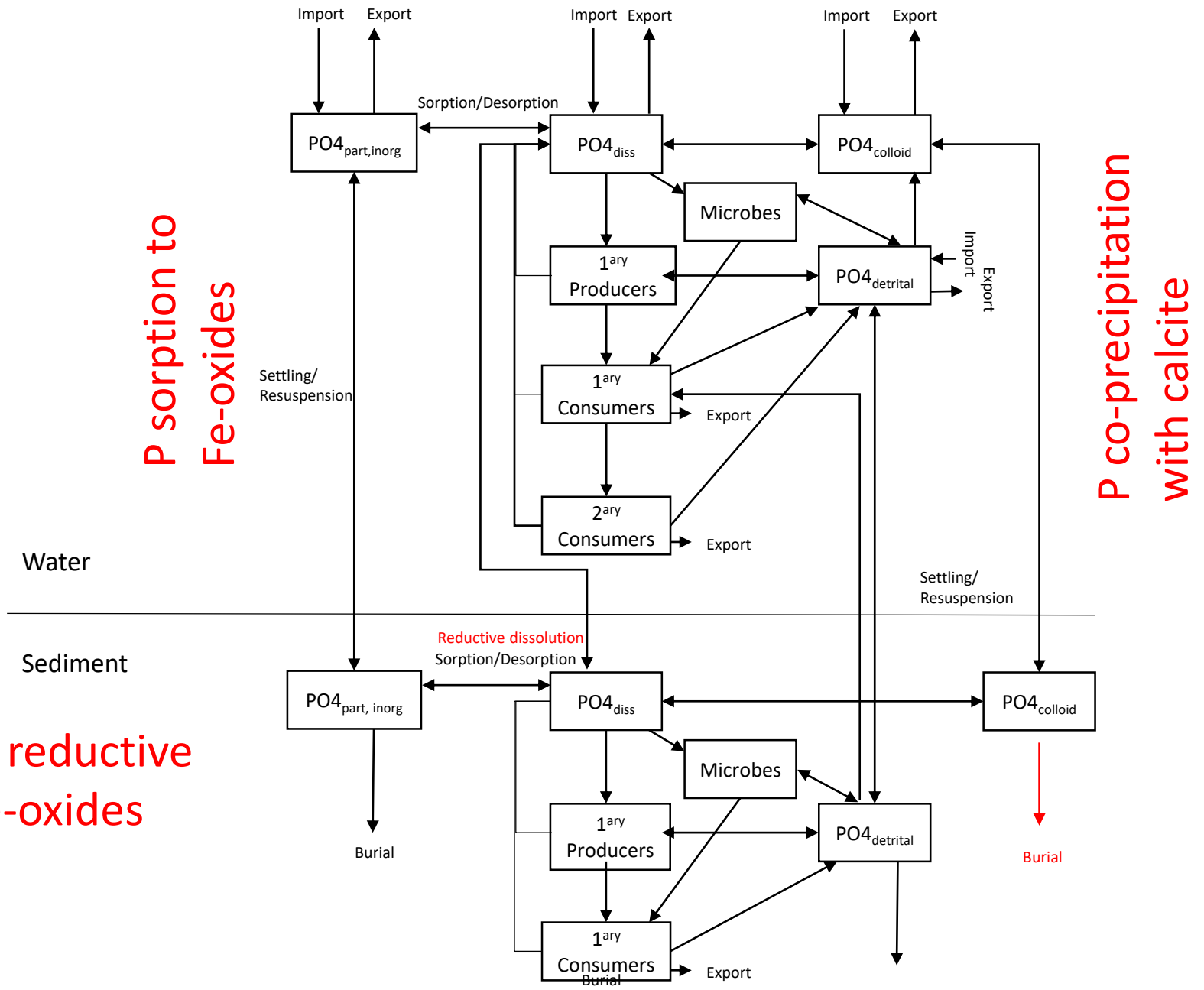
Characterizing the fate and mobility of phosphorus in Utah Lake sediments

Greg Carling[1], Matt Randall[1], Sheena Smithson[1], Steve Nelson[1], Kevin Rey[1], Zach Aanderud[1], Theron Miller[2],

[1] Brigham Young University, Provo, UT
[2] Wasatch Front Water Quality Council, SLC, UT

WASATCH FRONT WATER QUALITY COUNCIL
PROTECTING WASATCH FRONT WATERS THROUGH COLLABORATIVE RESEARCH



P release during reductive dissolution of Fe-oxides

Research Questions

- What is the spatial variability of P concentrations in Utah Lake?
- How mobile is sediment P?
- What are P flux rates from the sediment to the water column?
- What is the role of P scavenging by calcite and Fe-oxides in the water column?

Outline for today's talk

- Recent field work on Utah Lake (2015-2016)
- Current work (2018)
- Proposed projects (starting summer 2019)

PLOS ONE

RESEARCH ARTICLE

Sediment potentially controls in-lake phosphorus cycling and harmful cyanobacteria in shallow, eutrophic Utah Lake

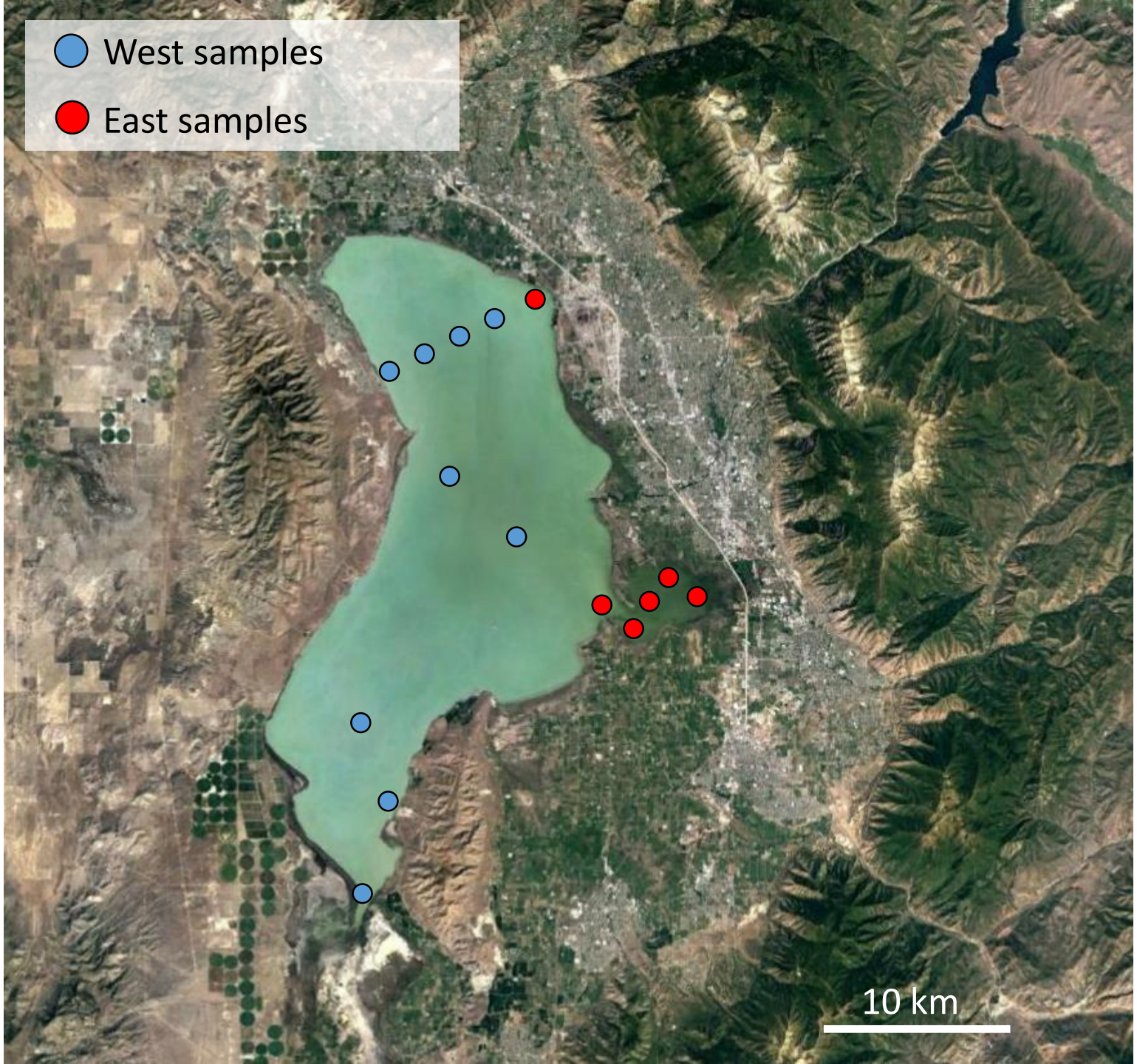
Matthew C. Randall[1], Gregory T. Carling[1]*, Dylan B. Dastrup[2], Theron Miller[3], Stephen T. Nelson[1], Kevin A. Rey[1], Neil C. Hansen[2], Barry R. Bickmore[1], Zachary T. Aanderud[2]

1 Department of Geological Sciences, Brigham Young University, Provo, UT, United States of America, **2** Department of Plant and Wildlife Sciences, Brigham Young University, Provo, UT, United States of America, **3** Wasatch Front Water Quality Council, Salt Lake City, UT, United States of America

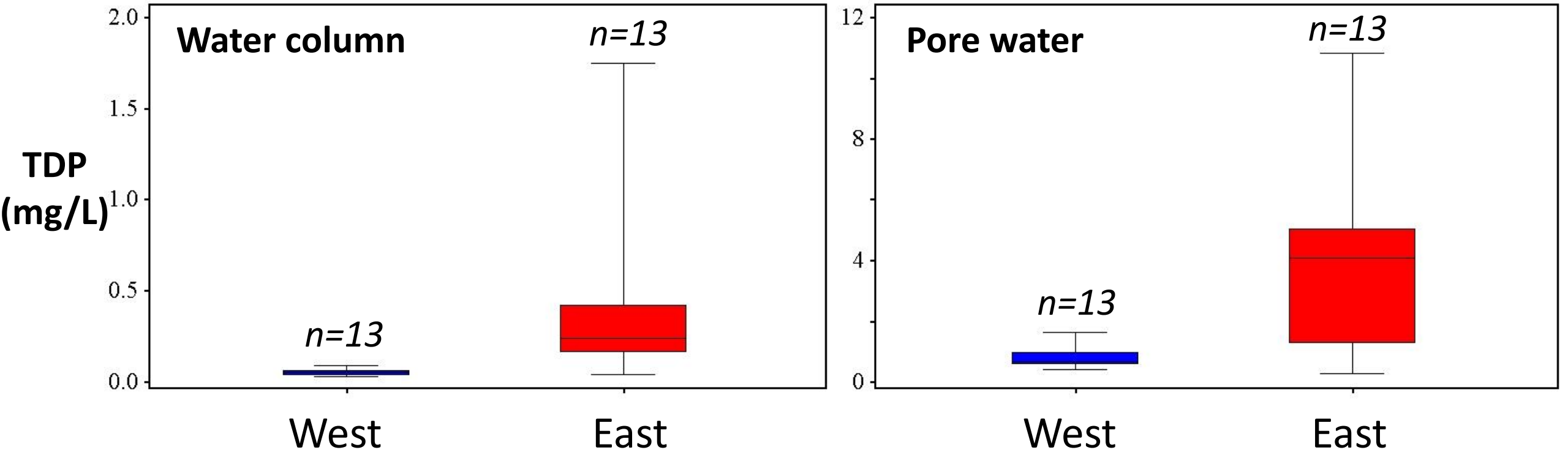
* greg.carling@byu.edu

Water column, pore water, & sediment samples

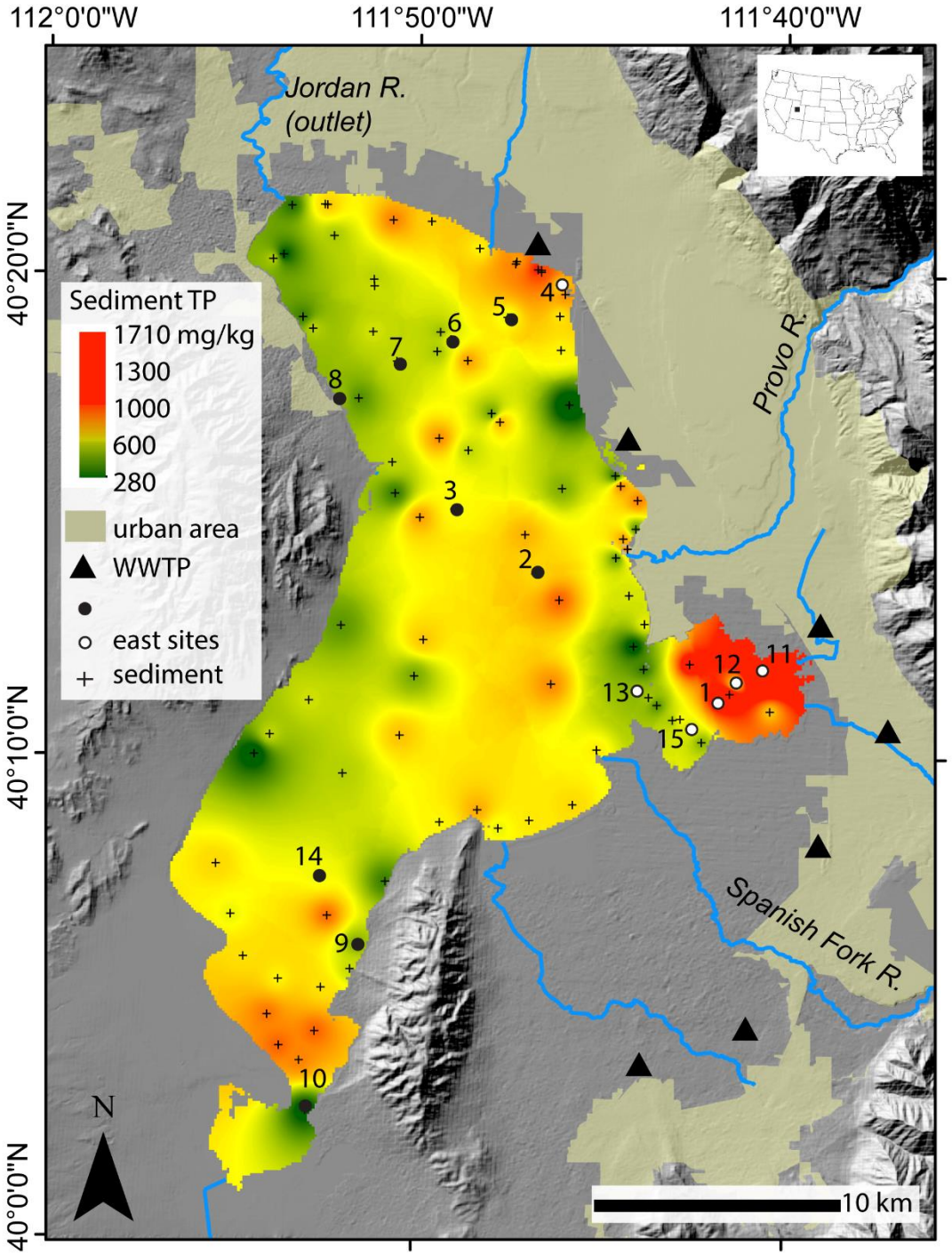
Oct 2015 – Nov 2016



Total dissolved phosphorus (TDP) highest near WWTPs

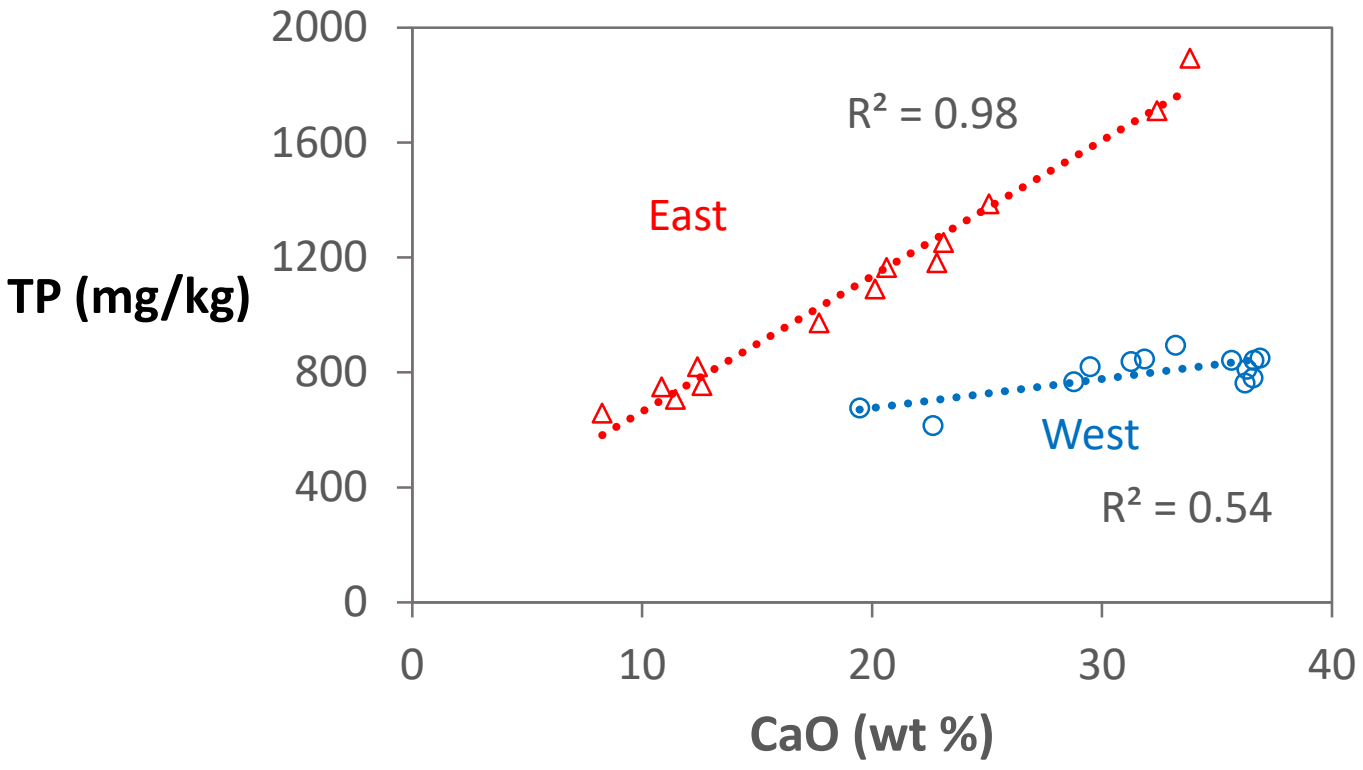


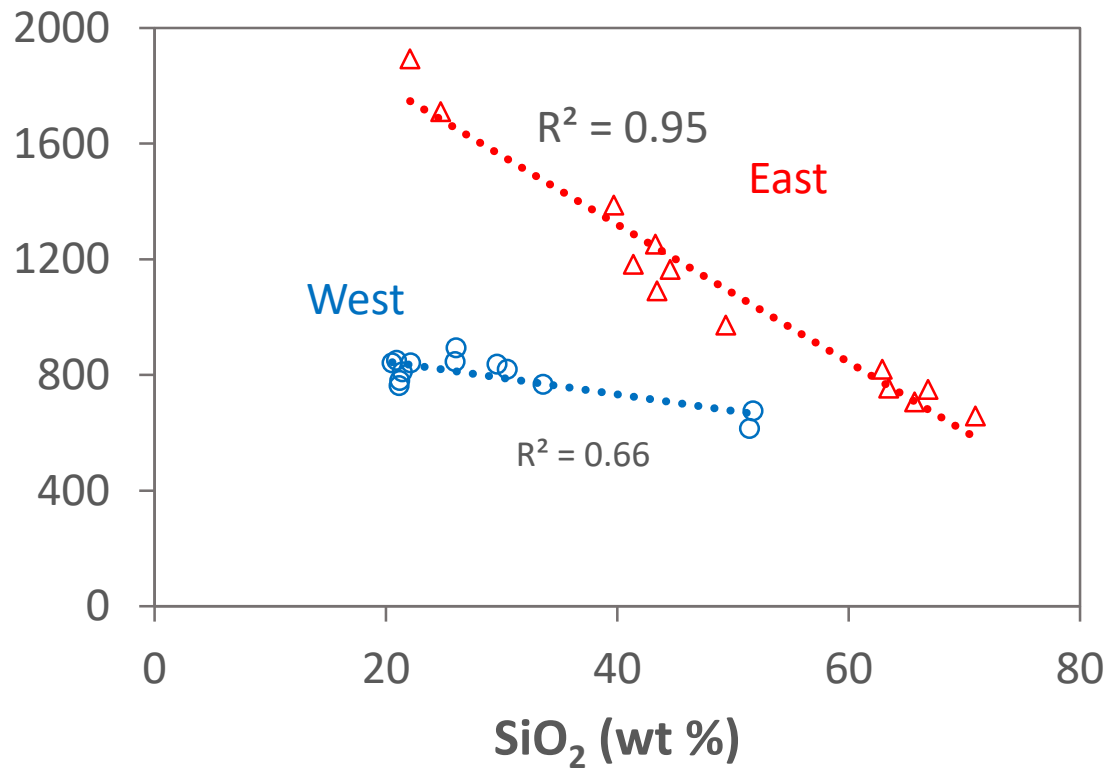
Sediment total phosphorus highest near WWTPs



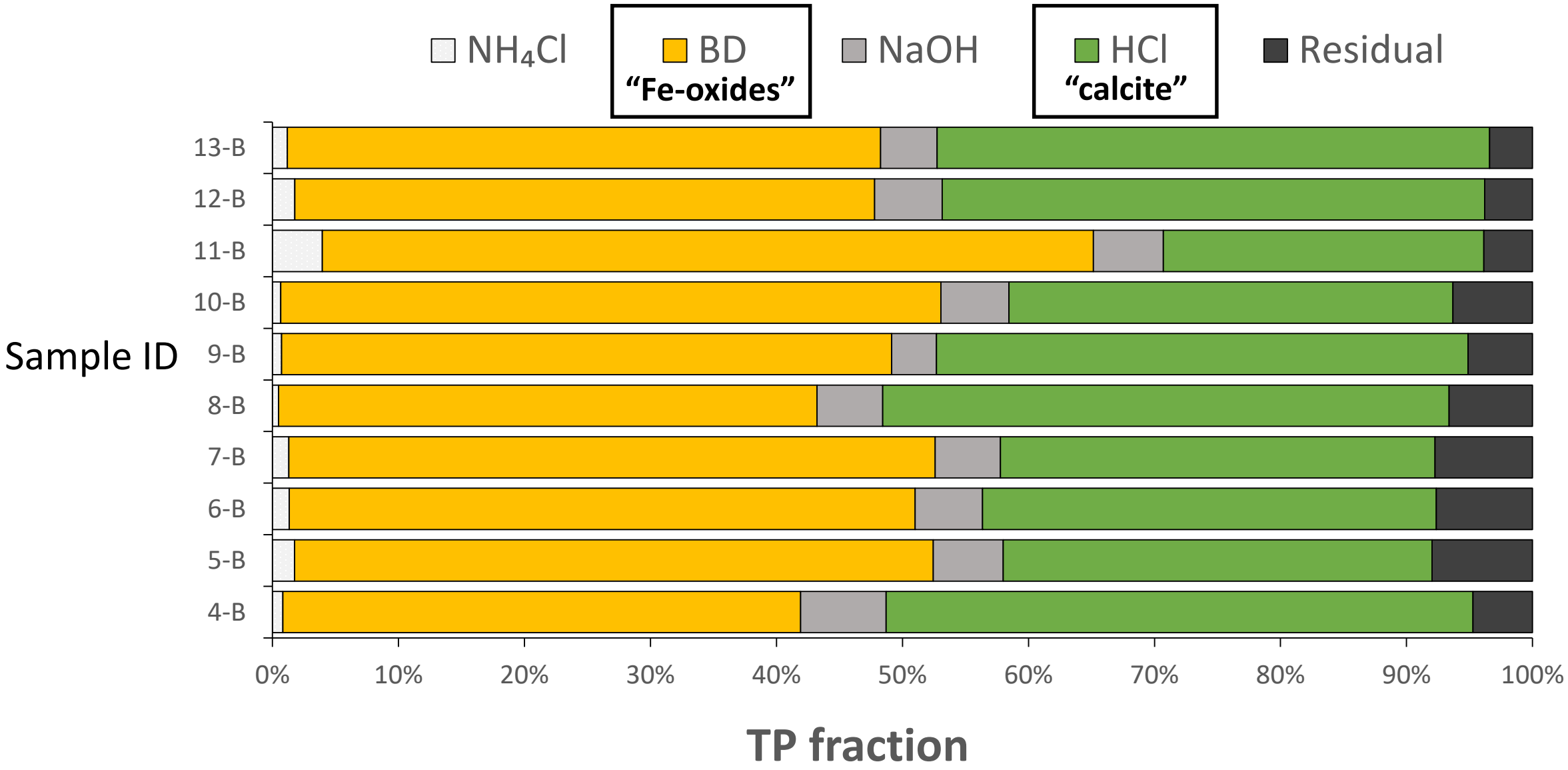
Including data from Abu-Hmeidan et al. (2018)

Location and sediment composition affect P concentrations



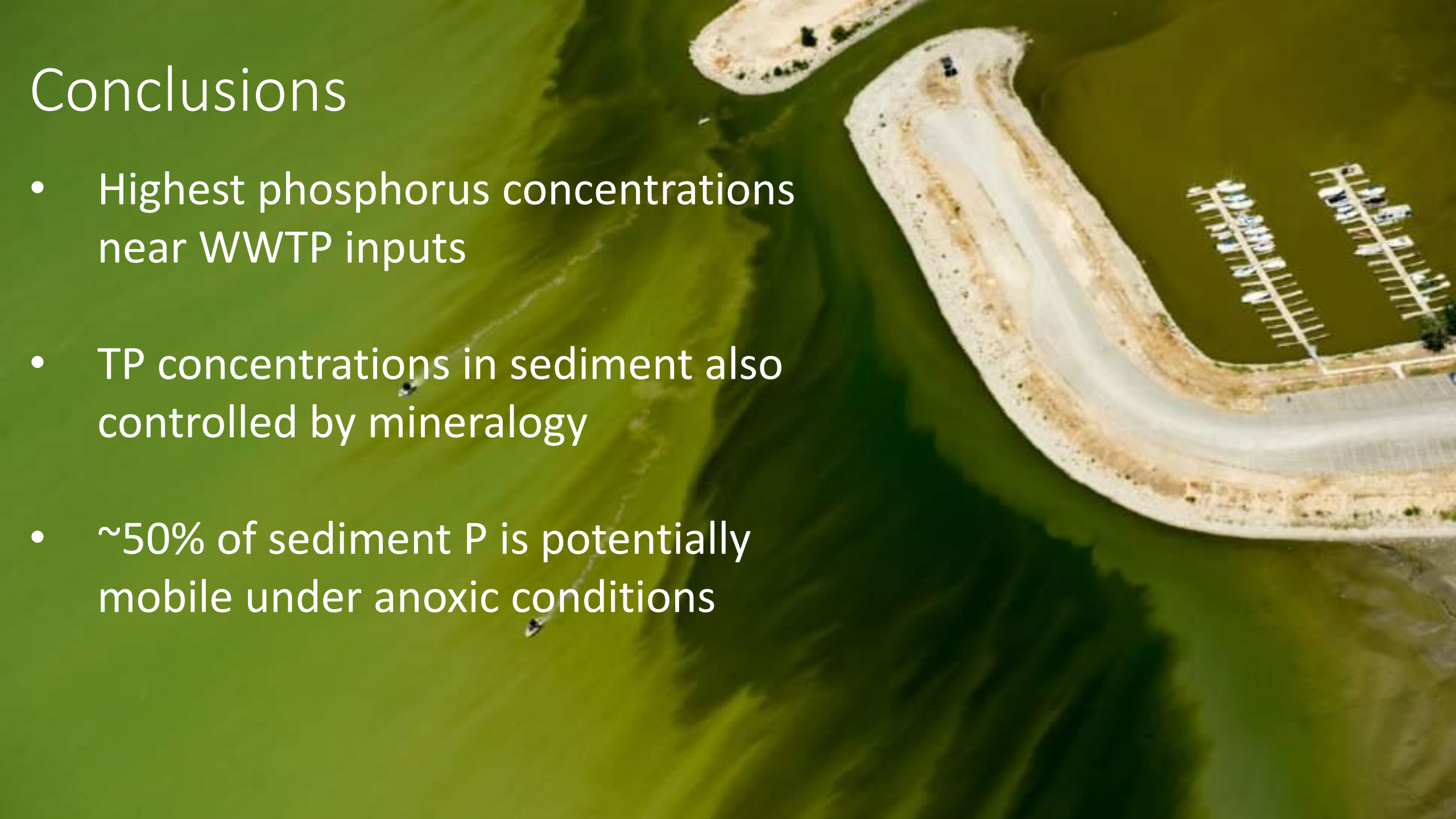


50% of sediment phosphorus is potentially mobile



Conclusions

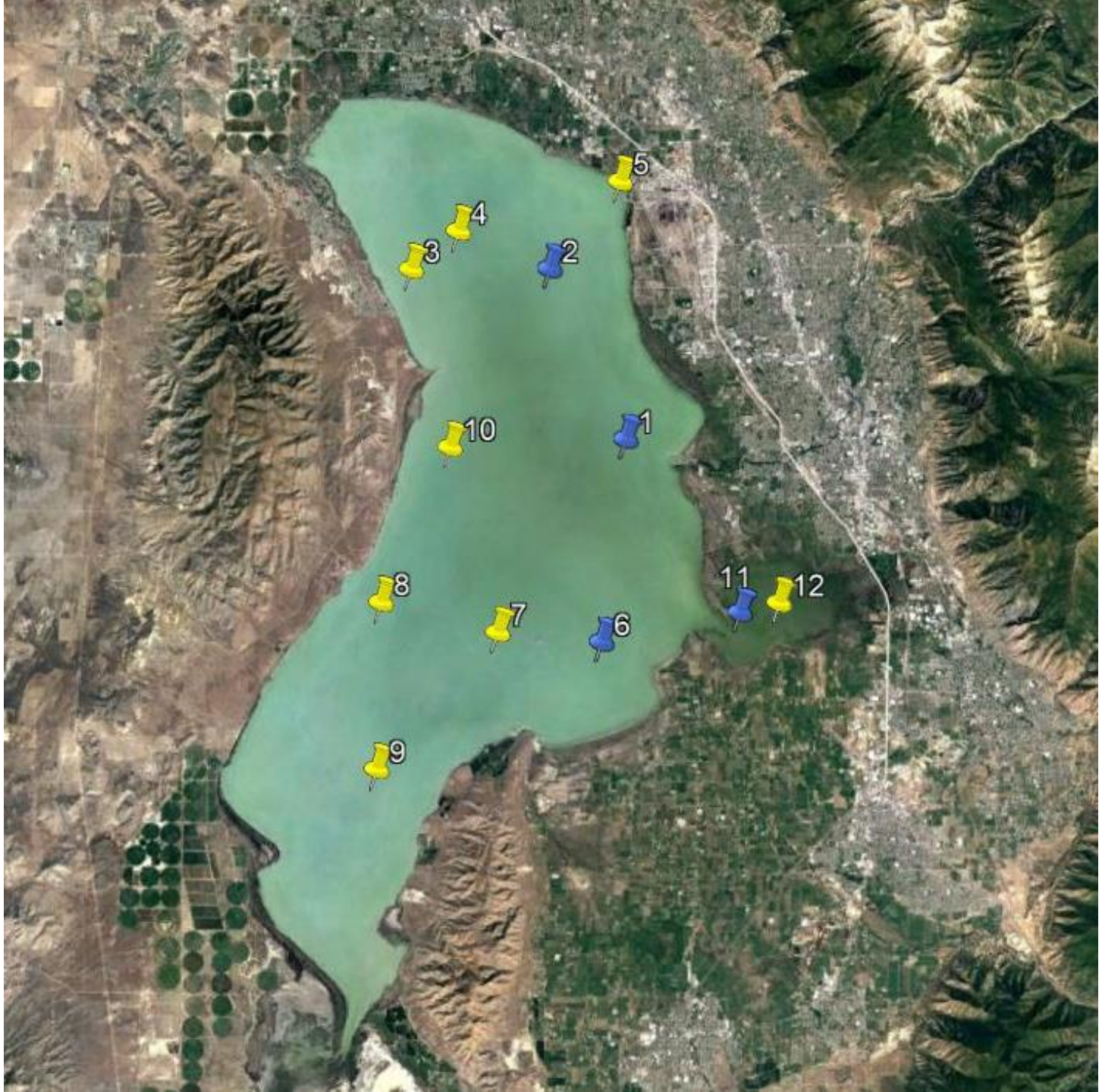
- Highest phosphorus concentrations near WWTP inputs
- TP concentrations in sediment also controlled by mineralogy
- ~50% of sediment P is potentially mobile under anoxic conditions



Current work

12 sites sampled during July, August, and October 2018

Water column, pore water, and sediment chemistry



Ongoing lab work

- Sequential extraction—seasonal variability in Fe-P fraction?

- Batch sorption experiments—how much P can sediment uptake?

Future work

- Nutrient release from Utah Lake sediments
- Sediment equilibrium P concentrations
- P scavenging by calcite and Fe-oxides

Nutrient release from sediments

- Deploy sediment flux chambers at multiple locations on Utah Lake
    - Measure dissolved oxygen, pH, TDP, SRP, orthophosphate, TN, ammonia, nitrate, etc.
    - Build on previous work by Hogsett et al. (2018)
- Measure nutrient concentrations in pore water and redox conditions with depth (0-20 cm) in freeze cores

Sediment equilibrium P concentrations

- Lab experiments on shallow cores collected across Utah Lake
    - Measure TDP, SRP, and orthophosphate in overlying water at multiple time-steps
    - Using multiple cores with replicates, adjust temperature, dissolved oxygen, and pH
- Diel (24-hr) water sampling in Provo Bay near DWQ sonde under changing DO and pH conditions

P scavenging by calcite and Fe-oxides

- Investigate P scavenging and release under different geochemical conditions by linking Lake2K and PHREEQC
  - P removal by calcite precipitation
  - P removal by surface complexation with hydrous ferric oxides (HFO)
  - P release during reductive dissolution of Fe-oxide minerals
- Lab experiments and SEM imaging to investigate calcite precipitation in the presence of phosphorus