How to improve the functionality and resilience of constructed wetlands

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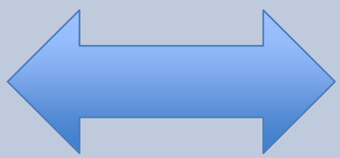
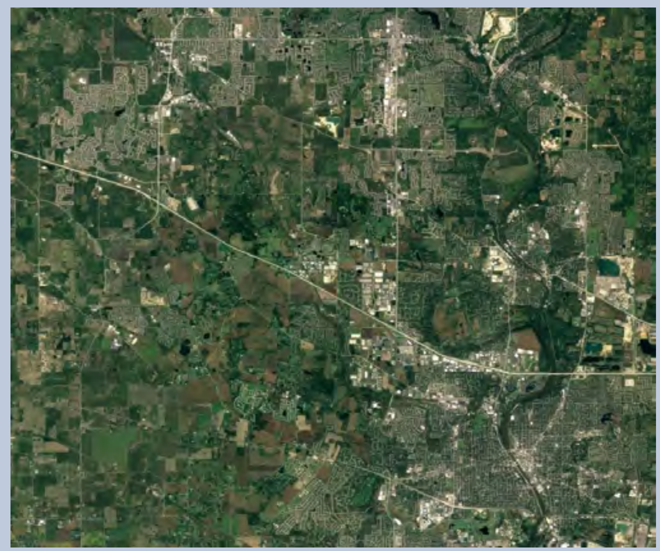
Introduction

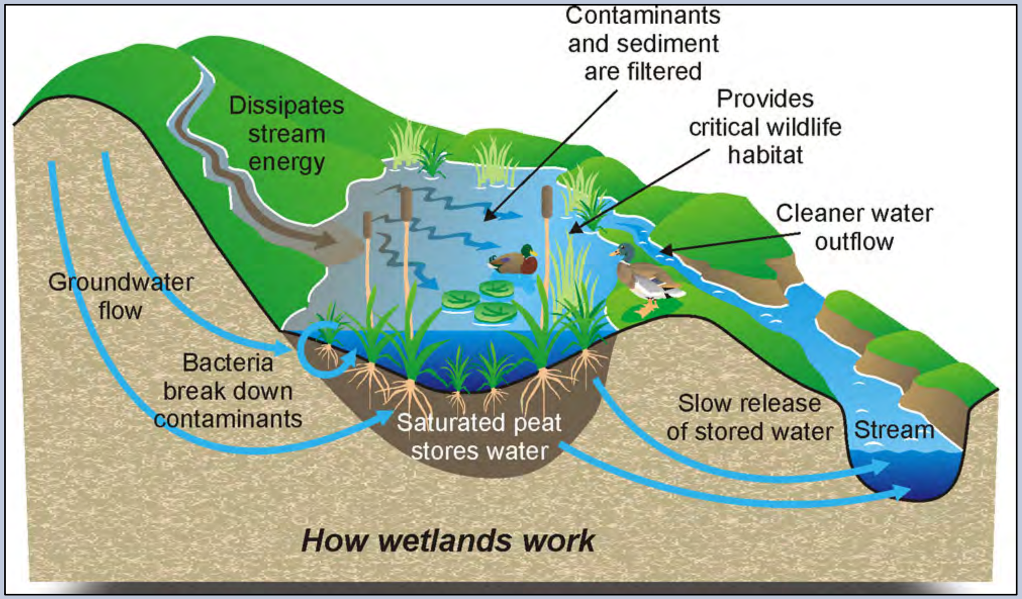
- Background and justification
- Local to landscape multiscale evaluation of wetland integrity
- Conclusions & next steps





What is "compensatory mitigation"?

- Clean Water Act regulates impacts to natural wetland habitat
- Mandates replacement of ***functionality***
- Preference for mitigation located at impacted site; typically in development zone



Background

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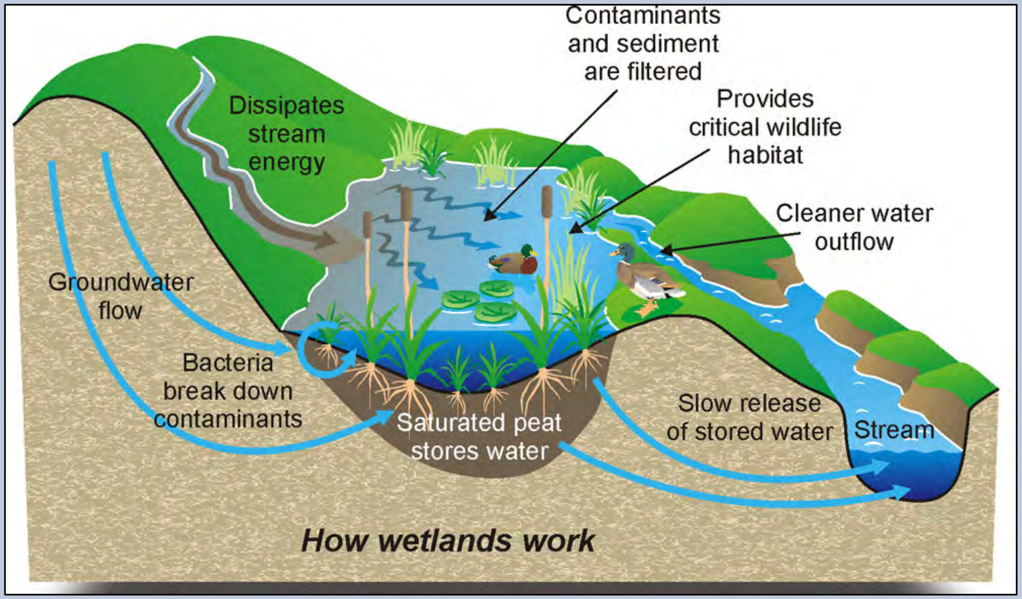
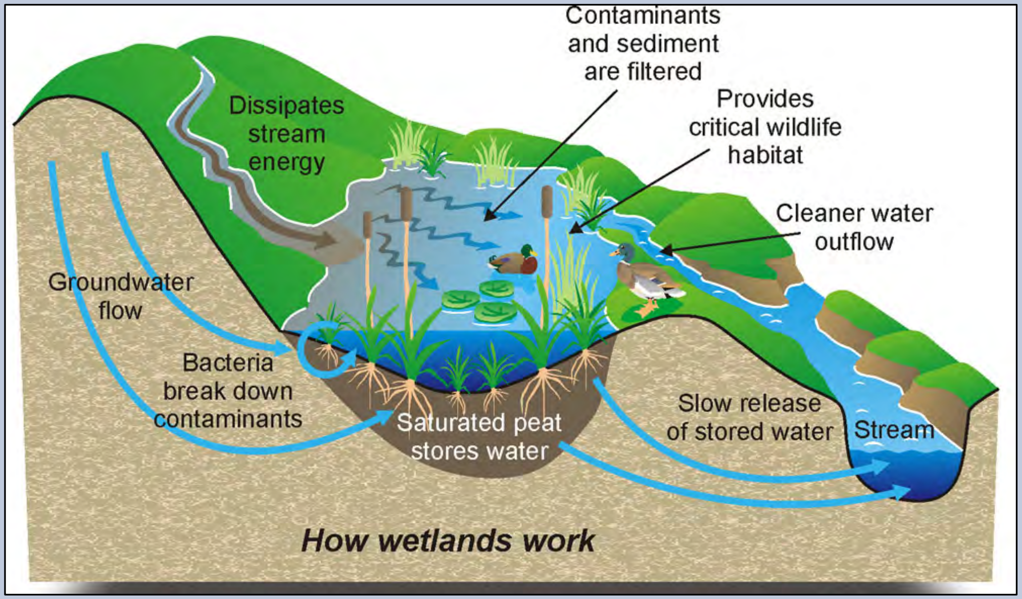
What is "compensatory mitigation"?

- "Success" defined using measurable performance standards:
  - % survivorship of planted species
  - % cover of native and/or invasive plants
  - % cover obligate/facultative wetland plants



What is "compensatory mitigation"?

- "Success" defined using measurable performance standards:
  - % survivorship of planted species
  - % cover of native and/or invasive plants
  - % cover obligate/facultative wetland plants
- Performance standards not tied to replacement of functionality



What is "compensatory mitigation"?

- Structure is not a precursor to wetland functionality
- Functionality gives rise to and maintains structure

Does wetland mitigation work?

- Only 30% of wetlands constructed in IL meet all compliance goals (Matthews & Endress, 2008)
- Up to 87% of wetlands constructed in Indiana fail (IDEM, 2001)
- Planted vegetation doesn’t grow; dominant vegetation weedy exotic species (Matthews & Endress, 2008)

Background

Does wetland mitigation work?

Background

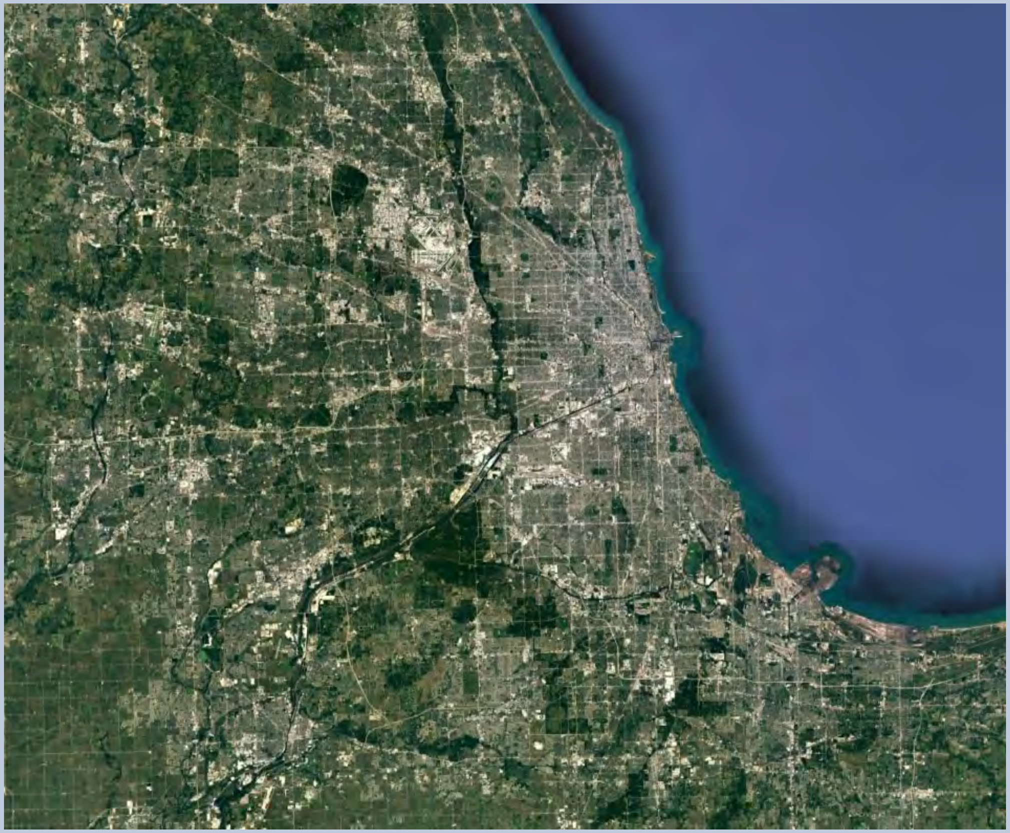
Context is the key to functionality

Background

Context is the key to functionality

Background

What is the role of landscape context?



Hypothesis

Constructed wetlands in natural landscapes have greater ecological functionality than those in urbanized or agricultural landscapes.

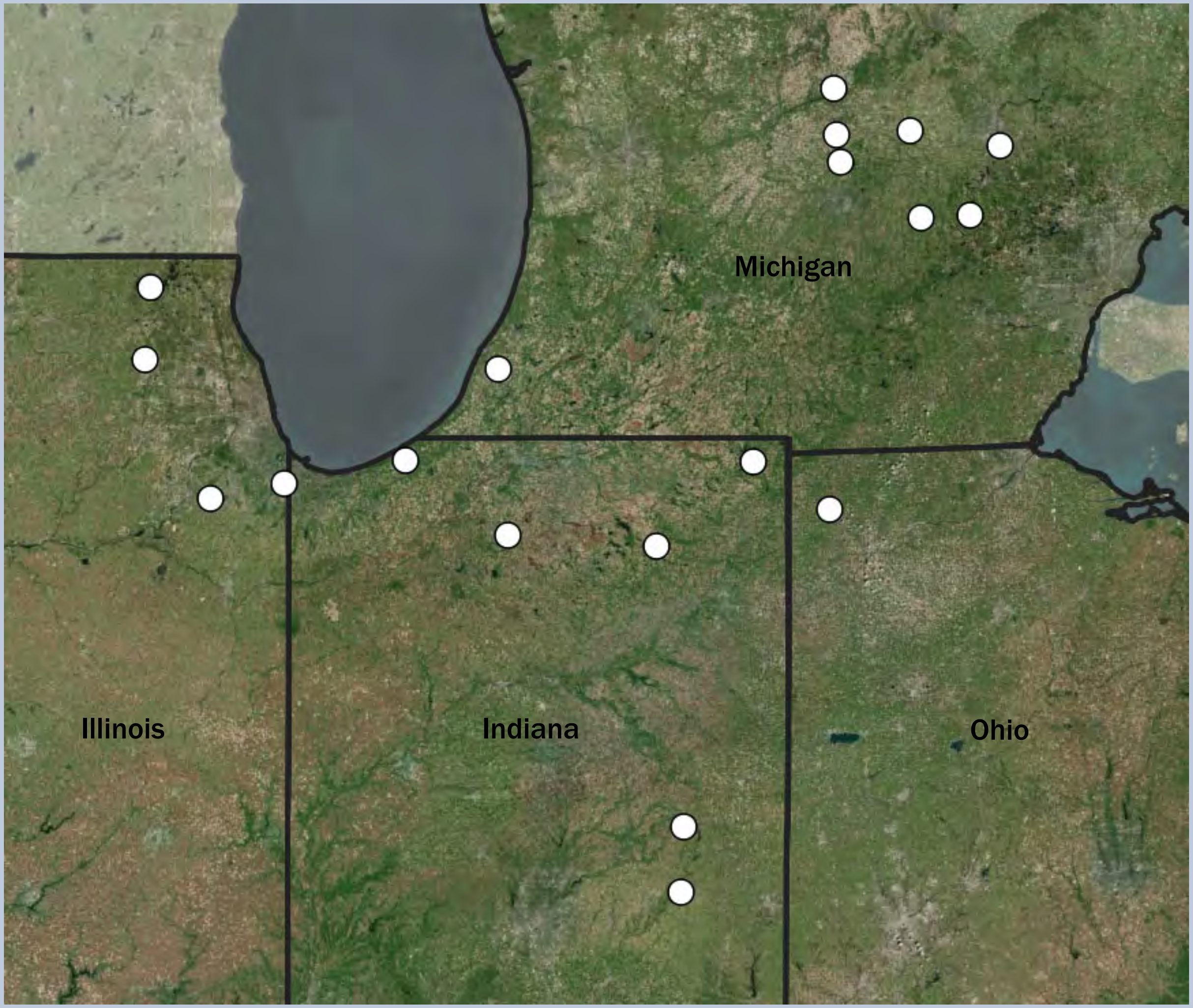
- *Reflected in chemistry, vegetation, and macroinvertebrates*

Ecological functionality = regulatory compliance and long-term maintenance efficiencies

Methods

Study sites

- 19 total sites (12 in 2017, 16 in 2018)
- All > 5 years old
- All "successful"
- Basin sizes: 0.1 – 2.5 ha (avg. = 1 ha)



Methods

Landscape-scale metrics

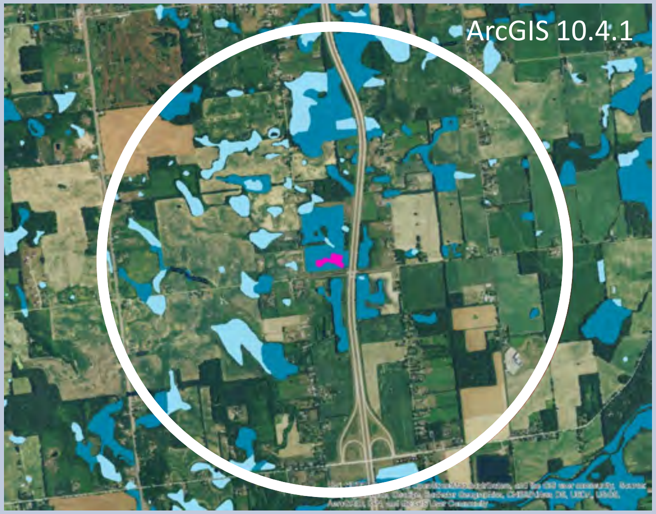
- 2-km buffers around each study wetland

<u>2011 Land Cover & Canopy Closure</u>

- % Forest
- % Agriculture
- % Developed (excluding open space)

<u>National Wetlands Inventory</u>

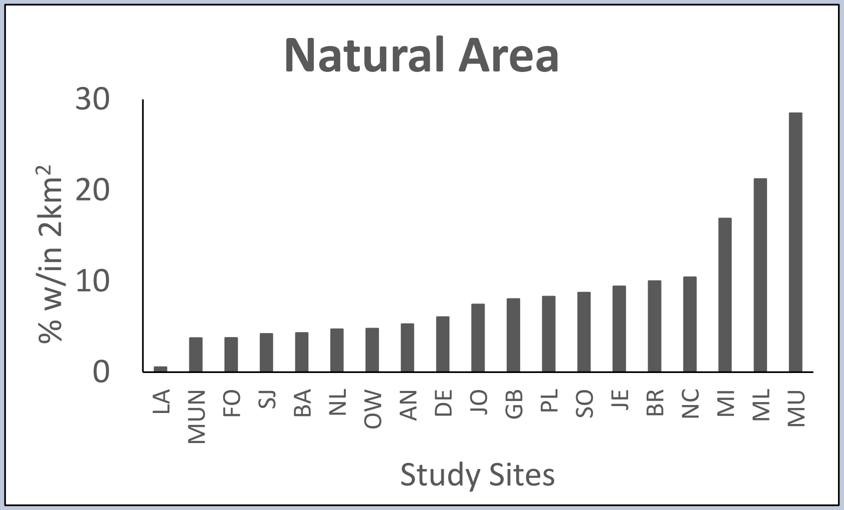
- Total area of wetlands
- Distance to nearest wetland
- Mean and median wetland area
- Total # wetlands

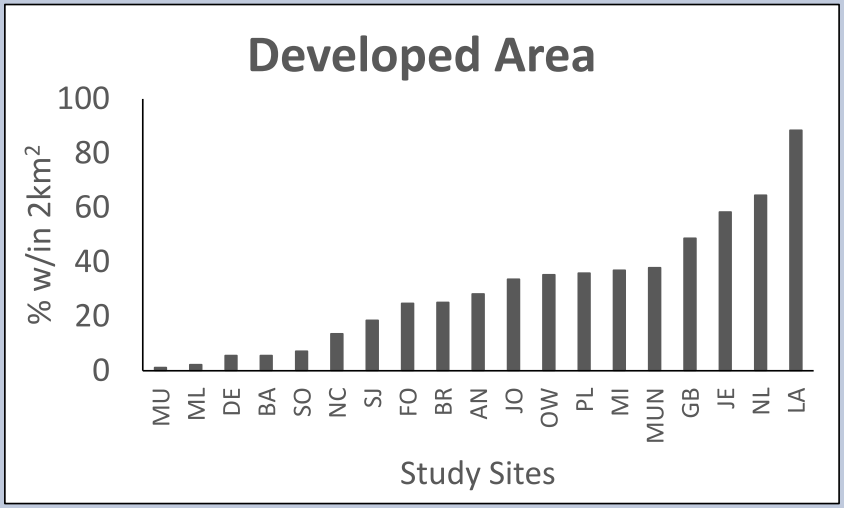


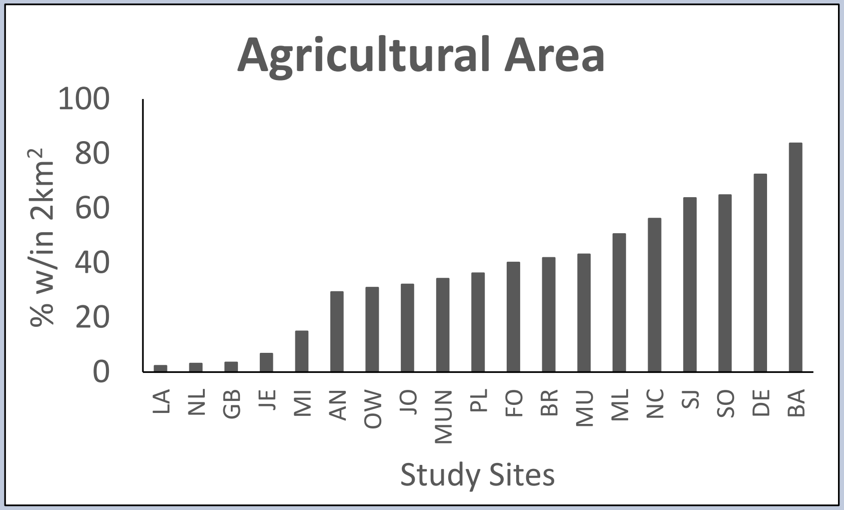
Methods

Study sites

- Selected across gradient of landscape contexts







Methods

Other data

Soil chemistry

- 2018 – 6 cores per wetland; homogenized
- % Organic matter, pH, P, K, Mg, Ca, S, Zn, Mn, Fe, Cu, B, Cl

Water chemistry

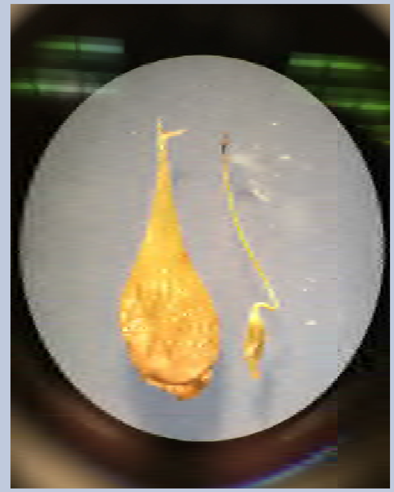
- 2017-2018 – Collected 9 times per wetland per year
- pH, NO_3, PO_4, Cl

Vegetation

- Meander survey & modified Braun-Blanquet method

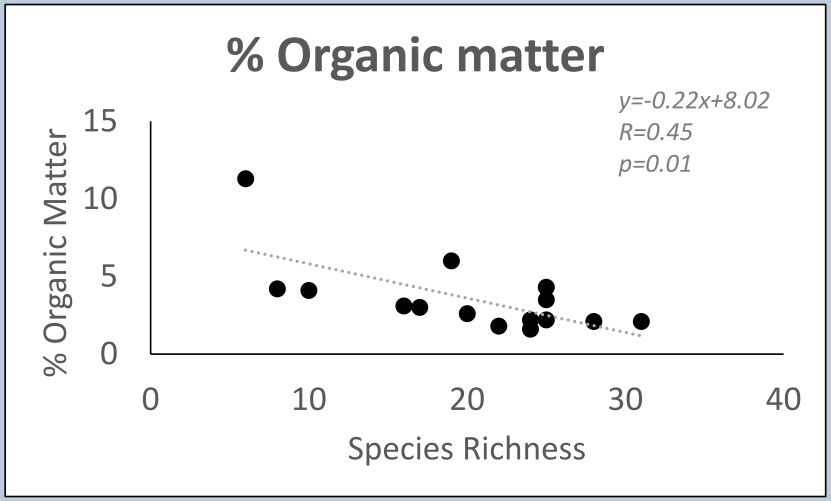
Macroinvertebrates

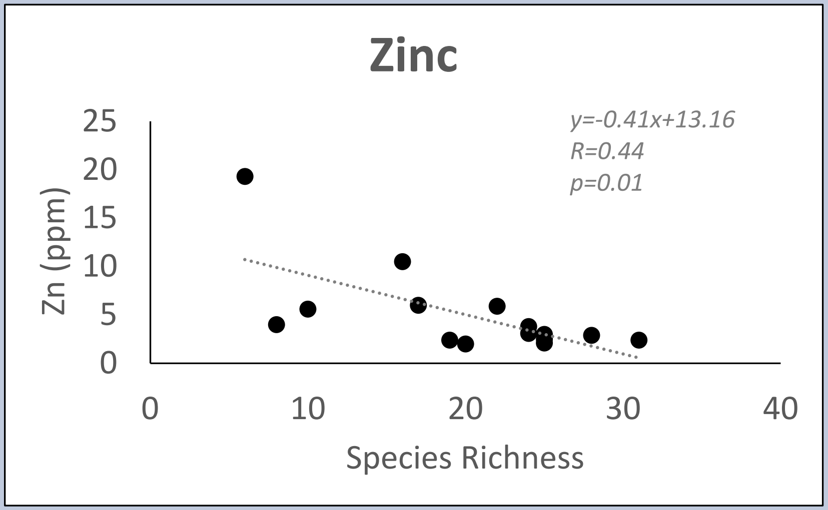
- 2-min sweep net collection in emergent & submerged vegetation zones (standardized sample areas)
- 6 zones per wetland
- Individuals identified to taxonomic Family

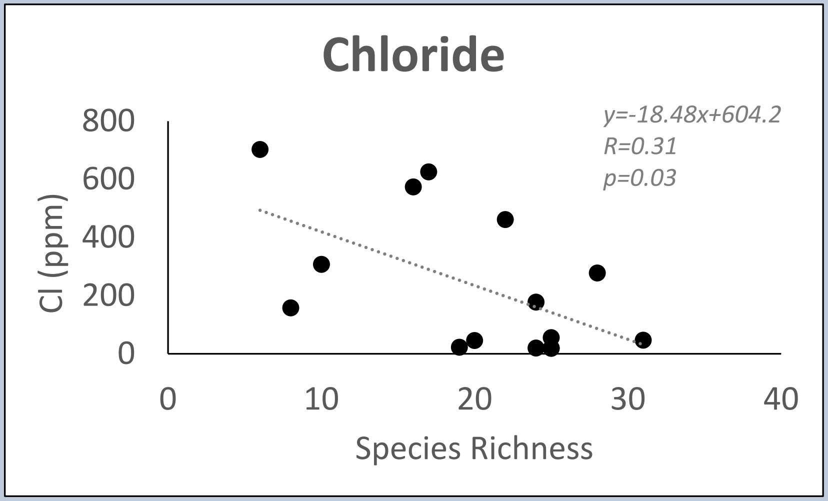


Results

Chemistry effects on wetland vegetation

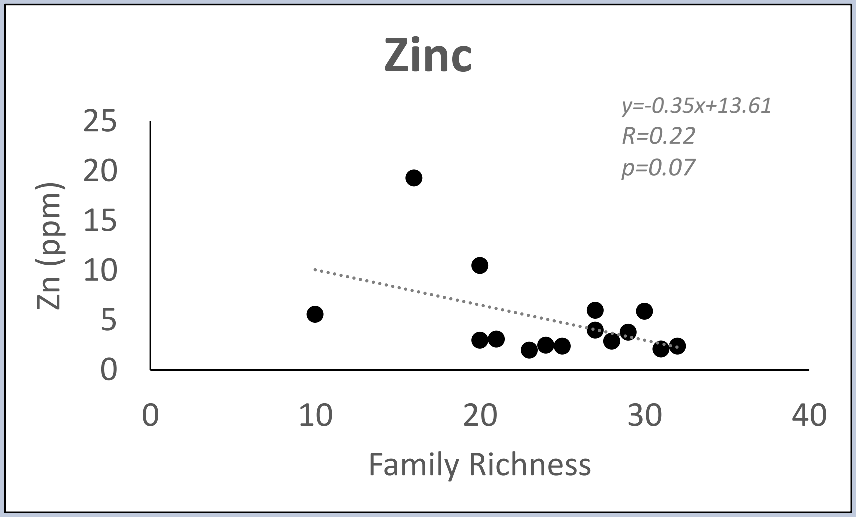


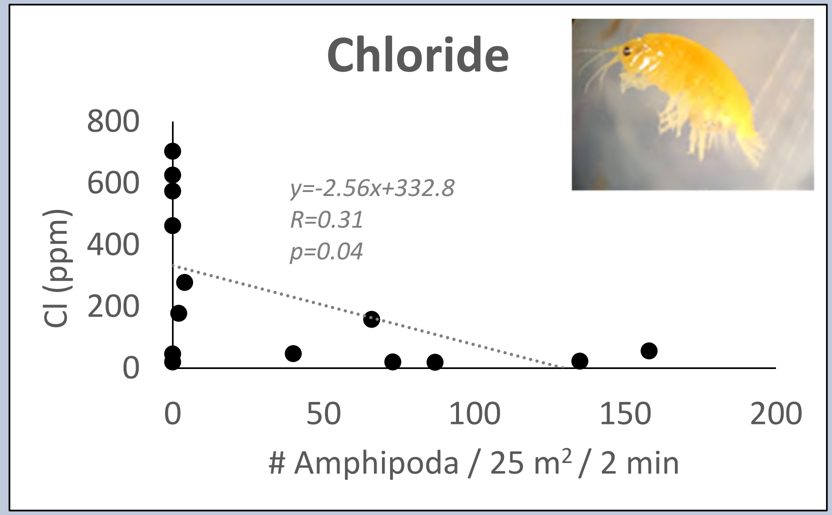


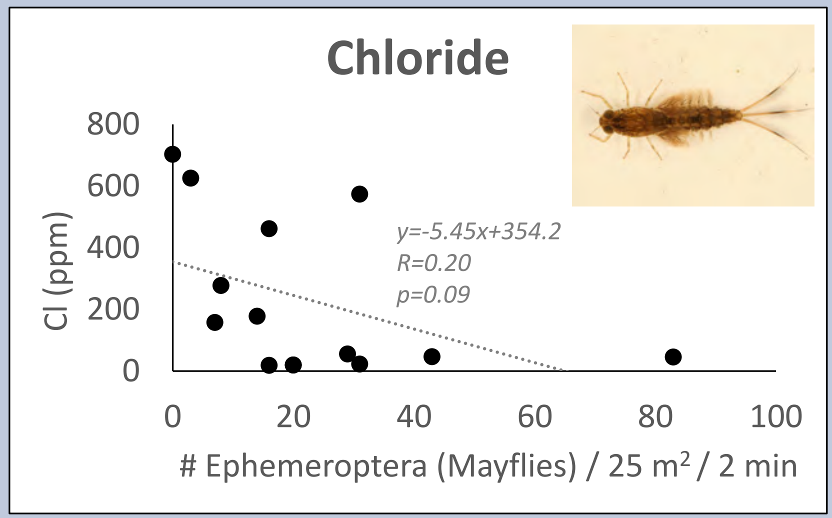


Results

Chemistry effects on macroinvertebrates

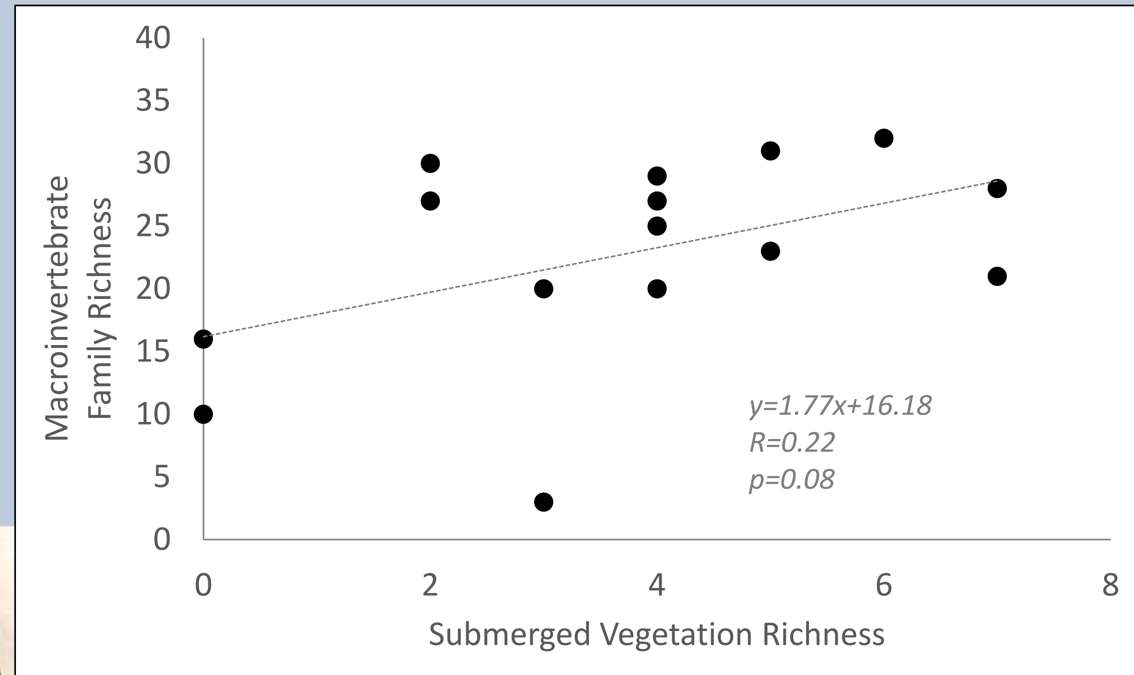






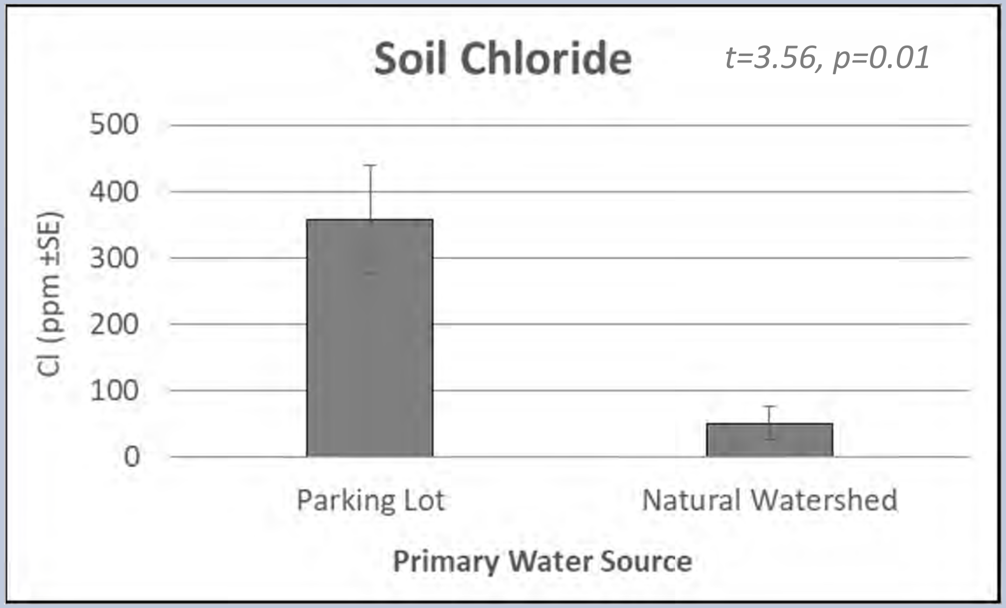
Results

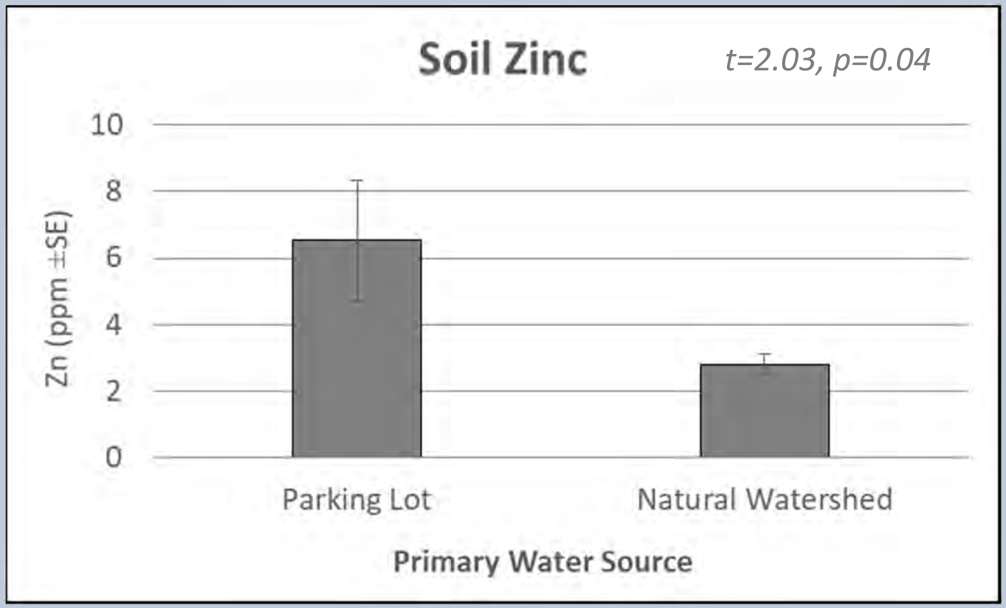
Wetland vegetation effects on macroinvertebrates



Results

Surface runoff effects on chemistry

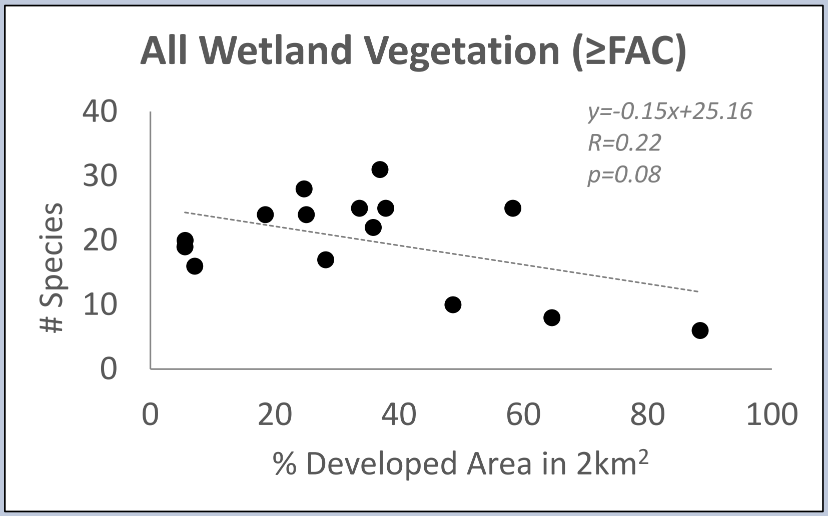


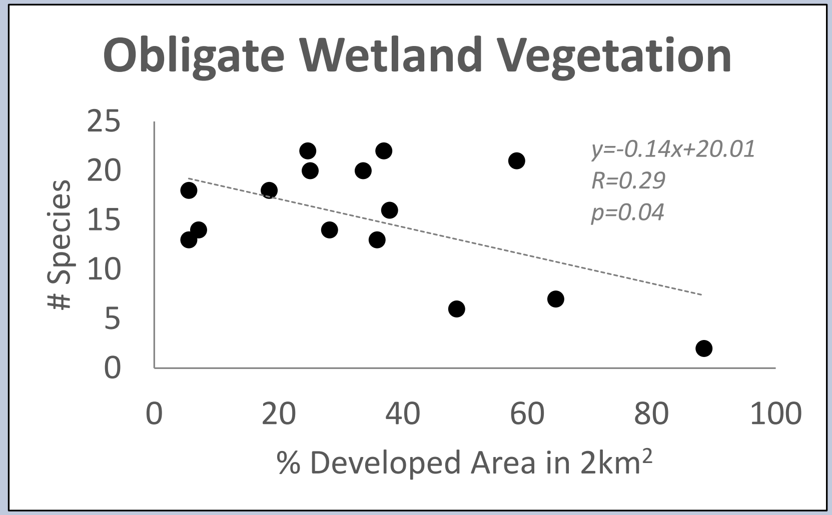


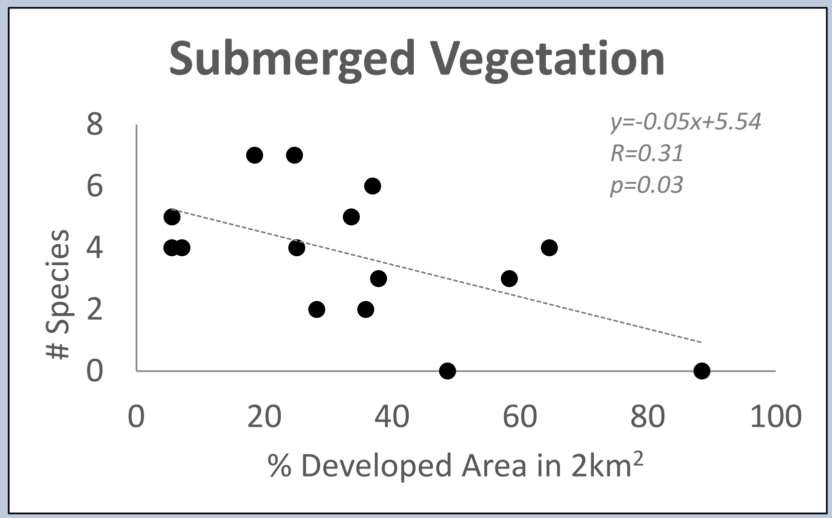
Results

Landscape-scale

Influence on wetland vegetation







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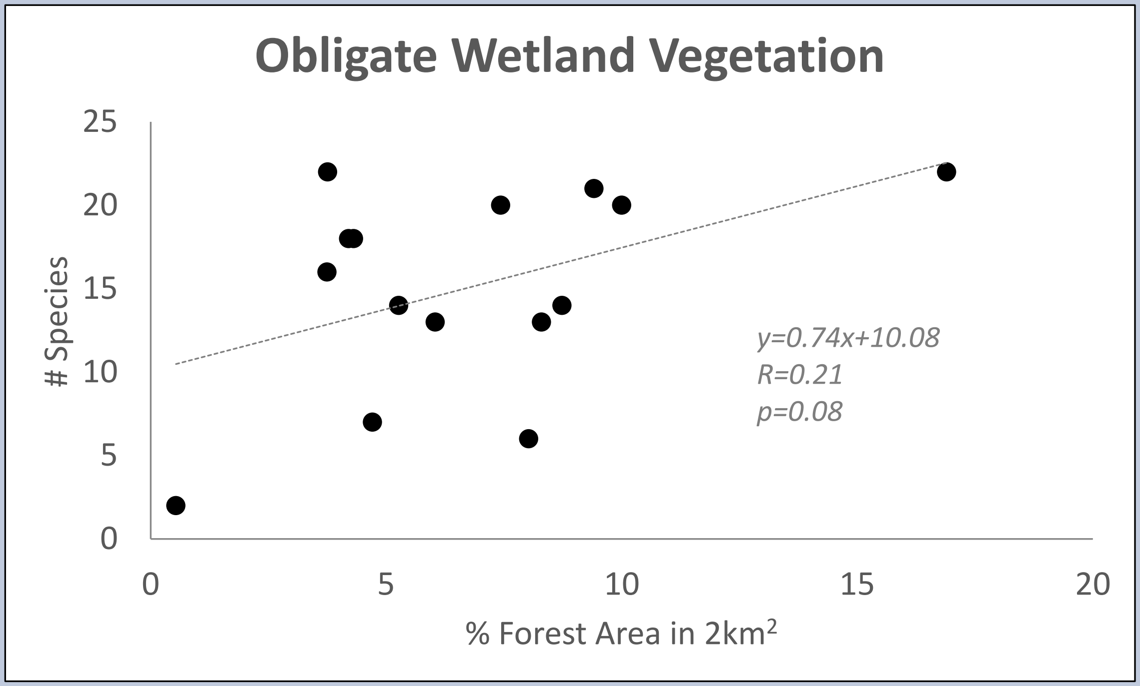

Conclusions & Next Steps

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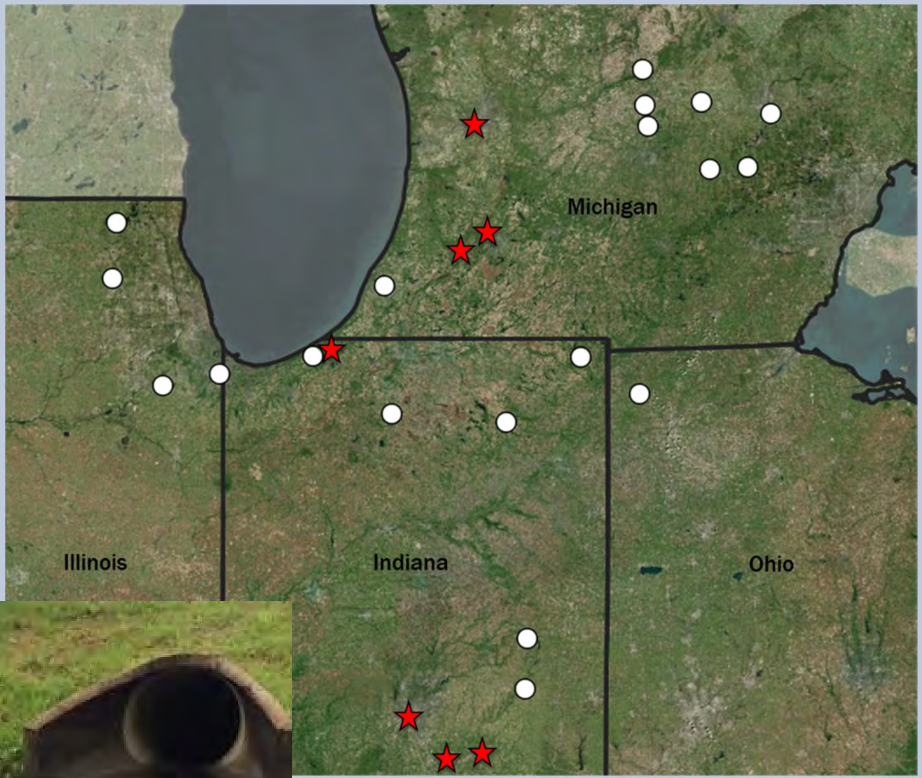
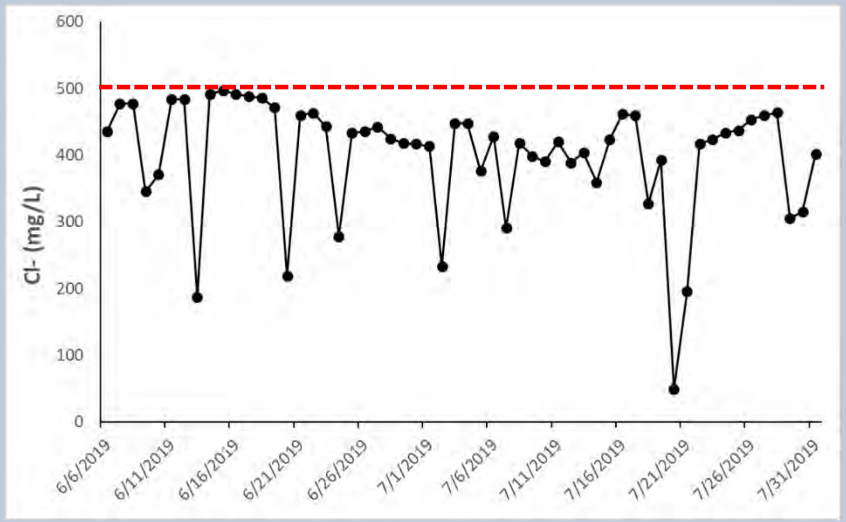
- Urban landscape stressors (e.g., parking lot runoff carrying zinc & chloride) negatively impact functionality of mitigated wetlands
- Constructed wetlands located in more natural landscape contexts seem to support greater biodiversity
- This suggests that landscape context is important when selecting locations of new mitigation sites
- Knowledge of landscape context can also help guide creation of management goals and prioritize management action

Conclusions & Next Steps

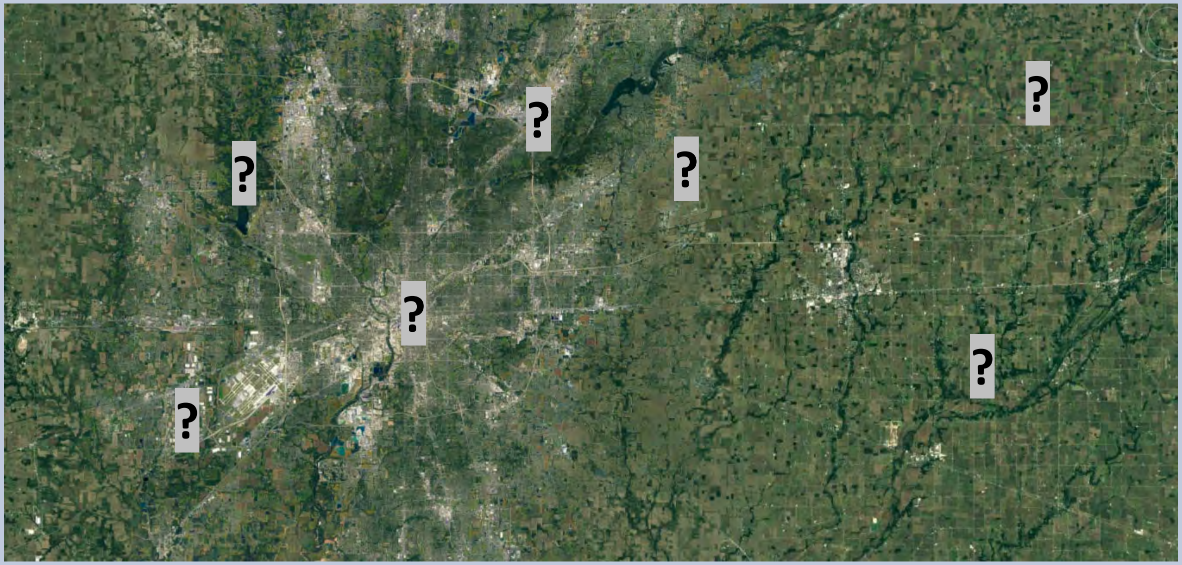
- Continued data collection in 2019 at 7 new sites
- High intensity chloride monitoring in 8 vegetated stormwater ponds (2019-2020)





Conclusions & Next Steps

- Create predictive spatial model for:
  - Selecting locations for wetland mitigation projects that have highest likelihood of achieving regulatory compliance



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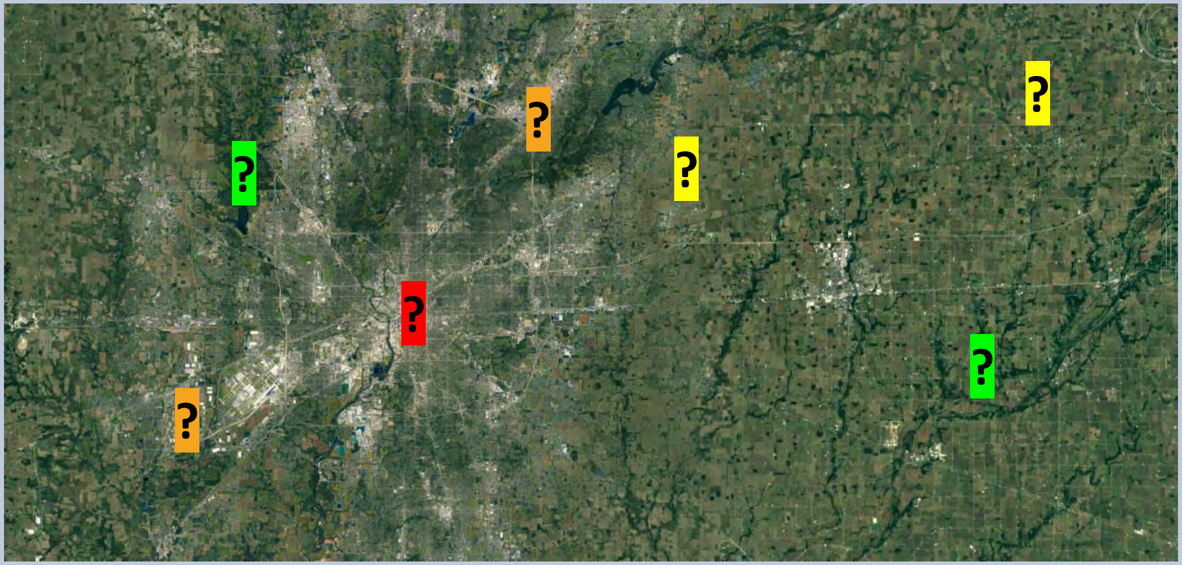

  - Guiding and prioritizing management actions of existing constructed wetlands and allocation of related resources

Acknowledgements & Questions

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