RISE RESEARCH INNOVATION SCHOLARSHIP ENTREPRENEURSHIP

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# Wetlands' Effect on Nutrients in the Charles River Watershed

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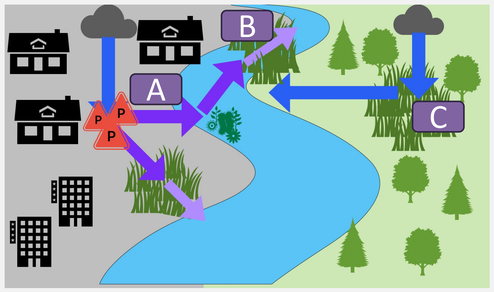
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## Question

Do wetlands affect phosphorus concentrations in the surface waters of the Charles River Watershed?

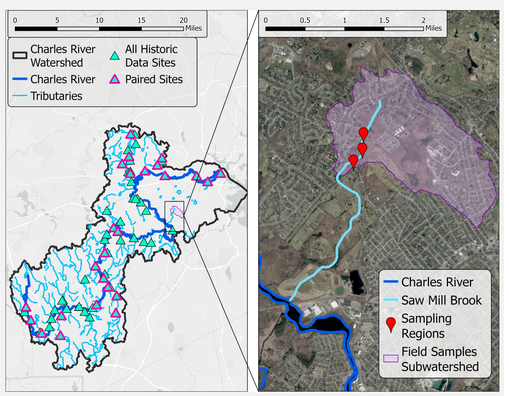
## Background

- MassDEP and EPA classify the Charles River Watershed as impaired by phosphorus and harmful algae[1]
- (A) Runoff from impervious surfaces carries phosphorus to rivers and streams, leading to eutrophication and harmful algae blooms[2]
- Wetlands can remove phosphorus through settling of sediments, uptake by plants, or chemical reactions in soil[3]
- Impacts on water quality could come from (B) riparian wetlands along streams[4] or (C) wetlands in the drainage area[5]



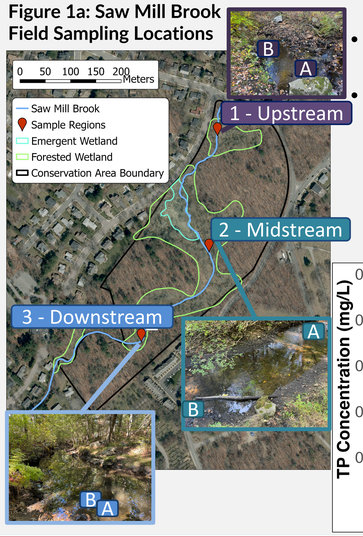

## Methods and Study Area

- Acquired and analyzed historic water quality data from MassDEP, USGS, and Charles River Watershed Association
- Identified 30 sites on Charles River and 37 on tributaries with 5 or more Total Phosphorus (TP) records since 2005
- Field sampling in Saw Mill Brook, a phosphorus-impaired urban stream running through forested and emergent wetlands



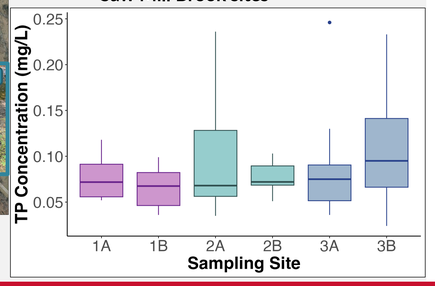

## Saw Mill Brook Field Sampling

**Figure 1a: Saw Mill Brook Field Sampling Locations**




- 3 **regions** with 2 **sites** (A and B) at each (Figure 1a)
- 6 samples x 7 weeks analyzed for **Total Phosphorus (TP)** by digestion and spectrophotometry (Figure 1b)

**Figure 1b. TP concentrations of Saw Mill Brook sites**




## Paired Sites and Riparian Wetlands

- 16 pairs of sites adjacent on the same stream (ranged from 2-5 stream miles apart) with 5+ common sampling dates
- Calculated wetland area % within a 100-meter riparian buffer around the stream between each site pair (example: Figure 3a) and the mean difference in Total Phosphorus from the upstream to downstream site

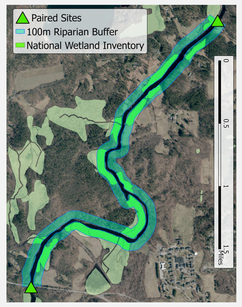



**Figure 3a. Example of paired sites with 100m riparian area along stream between sites**

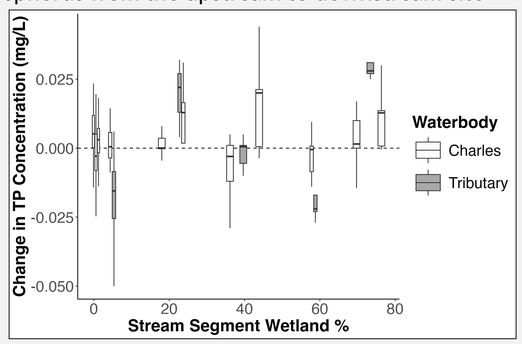



**Figure 3b. Total Phosphorus concentration difference versus riparian wetland percentage between paired sites**

## Results

- No evidence of wetland phosphorus removal in Saw Mill Brook (Fig. 1b)
- Sites with more wetlands in their drainage areas had higher measured TP (Fig. 2b) but lower modeled P Load per acre (Fig. 2c)
- Riparian wetland cover between paired sites did not influence difference in TP concentrations (Fig. 3b)
- Drainage area P Load is positively correlated with measured TP (Fig 4a)
- Sites with lower measured TP than predicted by P Loading had less wetland area in their drainage areas (Fig. 4a)
- Tributary sites drive the relationships between drainage area wetlands and measured TP (Fig 2b, Fig. 4b)

## Drainage Area Analysis

- Used USGS StreamStats to delineate the areas draining to each historical sample site (example: Figure 2A)
- Calculated wetland area as a percentage of each drainage area using the FWS National Wetland Inventory
- Estimated **phosphorus loading (P Load)** for each drainage area, using EPA methodology to translate land use/land cover data to pounds per year of phosphorus in runoff to sample site

**Figure 2a. Example drainage area with wetlands and land use/land cover data**

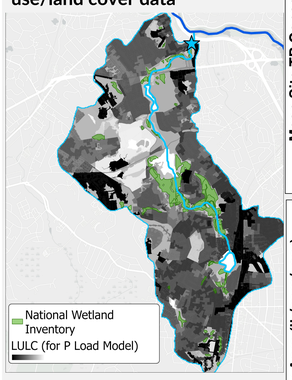



**Figure 2b. Total Phosphorus concentrations versus drainage area wetland percentages**

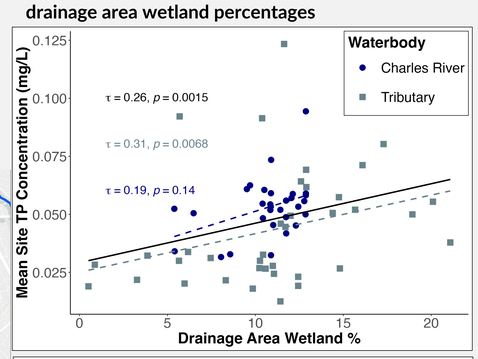
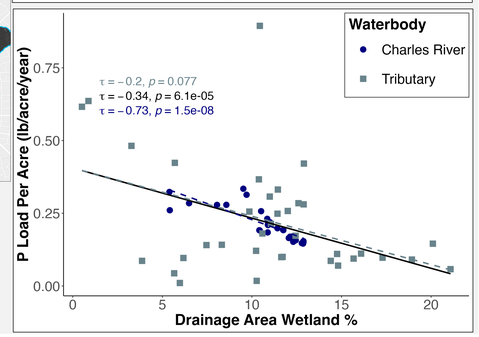
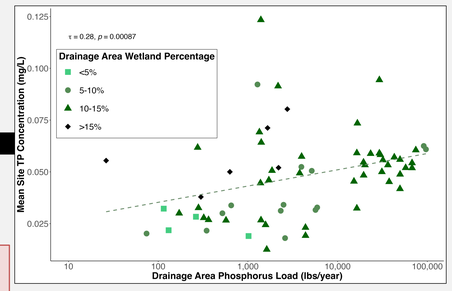



**Figure 2c. Area-normalized phosphorus load (pounds per acre per year) versus drainage area wetland percentages**



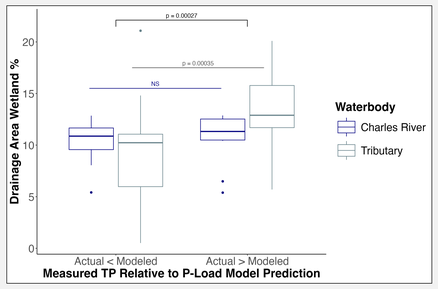

## Concentrations Relative to Loading

**Figure 4a. TP concentrations versus total drainage area phosphorus load (not area-normalized)**




**Linear regression to predict site TP based on drainage area P Load**

**Figure 4b. Drainage area wetland percentages of sites with actual concentrations above versus below predicted**




## Conclusions and Next Steps

- ➢ **More drainage area wetlands correlate with higher measured phosphorus, especially in tributary sites**
- ❑ Use specific sites and other water quality parameters to determine if wetlands are acting as a source of phosphorus (some literature supports this possibility) or if there is a confounding factor
- ➢ **There is a lot of site-to-site variability, including some extreme outliers and some sites that may have wetland removal of phosphorus**
- ❑ Investigate influences like wastewater treatment facilities, and assess sites with signs of P removal to pinpoint possible mechanisms
- ➢ **Overall, the data do not support the idea that wetlands have a strong influence on phosphorus concentrations in the Charles River Watershed**
- ❑ Use similar analyses to evaluate wetland influence on nitrogen concentrations because nitrogen interacts with wetlands in different ways

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