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Hydrological, Chemical, and Biological Connectivity Across Coastal Watersheds and Estuaries

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Double Trouble in the Hudson River Estuary: Dominant abiotic factors controlling harmful algal bloom risk and the compounding influence of invasive water chestnut

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OBJECTIVES

- Quantify the **background levels of cyanobacteria** in lower-flow areas of the Hudson River like tributary-estuaries
- Determine the **abiotic drivers** of cyanobacterial growth
- Assess the potential for **cyanobacterial harmful algal blooms (cyanoHABs)** in the Hudson River and the compounding impact of the invasive water chestnut (*Trapa natans*)

BACKGROUND

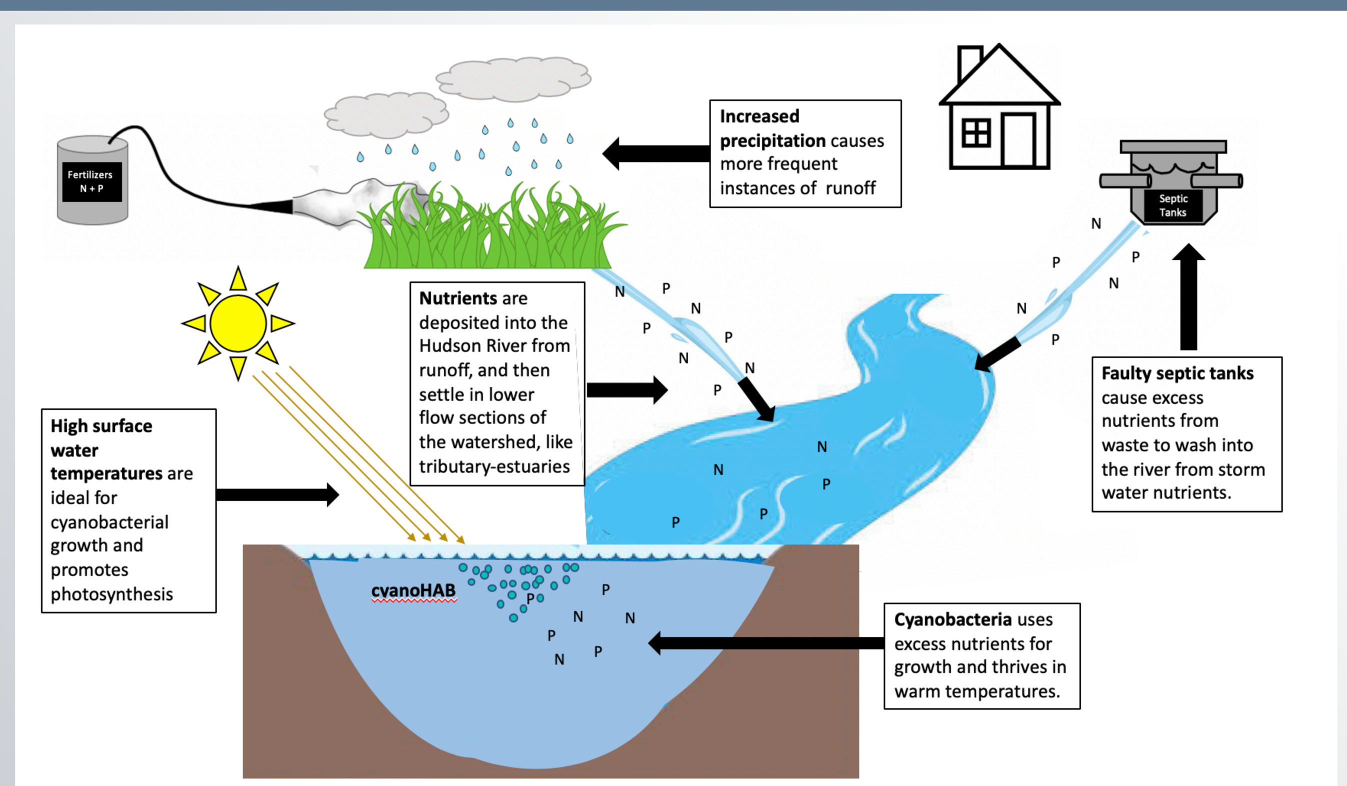

Figure 1. Climate change and eutrophication from nutrient-polluted runoff and the effects on cyanoHABs.

METHODS

1. Accessed sample sites via canoe
   1. Every two weeks
2. Water quality
   1. HydroLab DataSonde
      1. Temperature, salinity, specific conductance, oxygen reduction potential, turbidity, dissolved oxygen, and total dissolved solids
   2. Nutrient Testing
      1. Nitrate and Orthophosphate with spectrophotometry (Eckbald 1978)
3. Cyanobacteria Counts
   1. PFUs: Light microscopy, Palmer-Maloney cell
4. Fluoroprobe III
   1. Blue-green chlorophyll
5. Microbial Transects

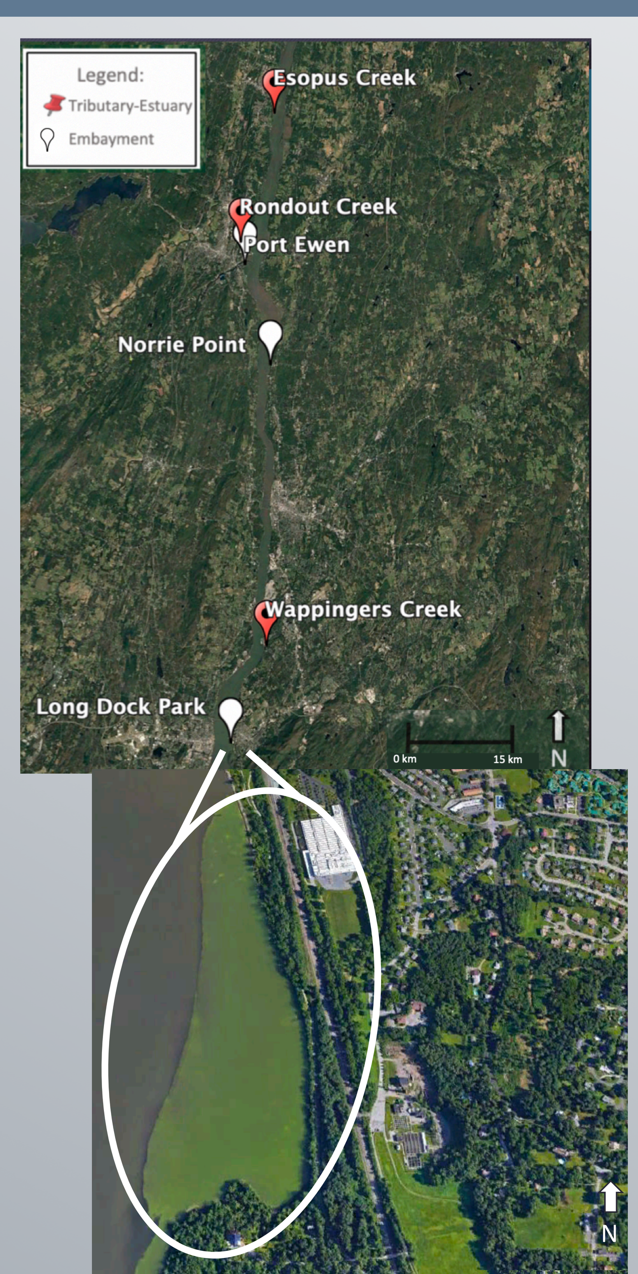

Figure 2. Site selection and water chestnut bloom.

RESULTS

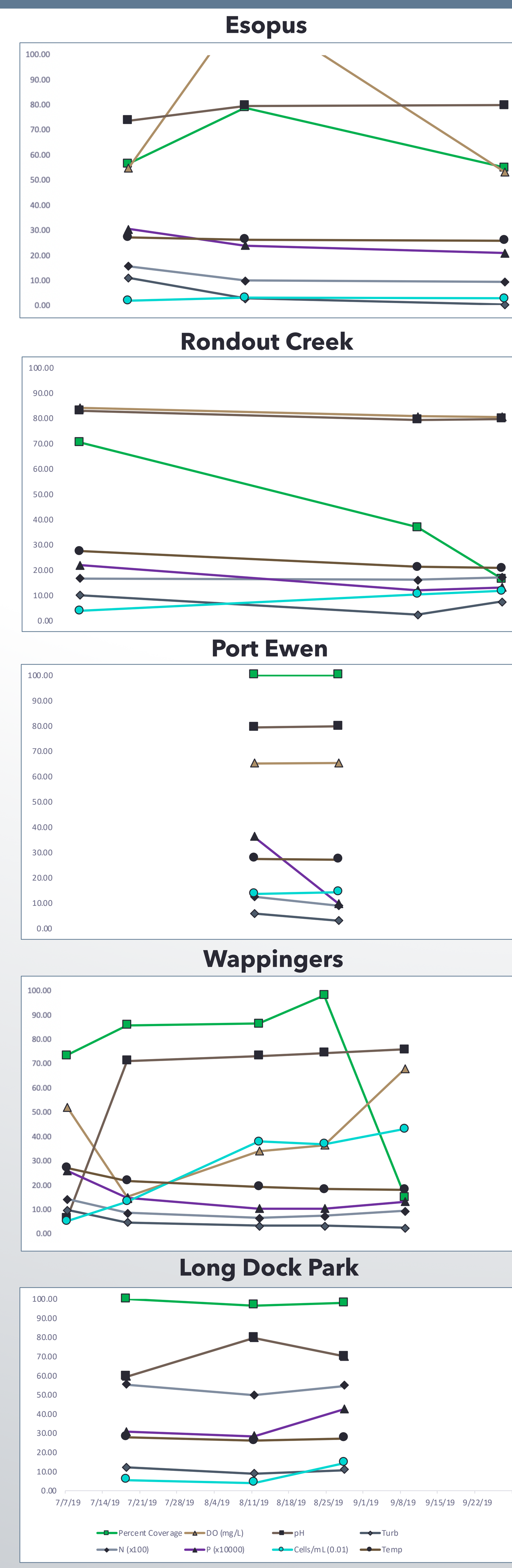

Figure 3. Time-series of abiotic factors and cyanobacterial cells/mL between 7/7/19 and 9/28/19.

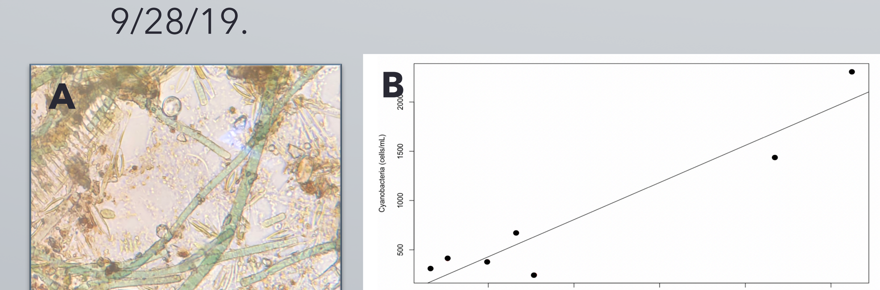

Figure 4. (A) Cyanobacteria from PFU sample. **(B)** Cyanobacterial cell counts (cells/mL) and blue-green (BG) Chlorophyll (ppb). Trendline is represented by the equation $y= 0.0048x + 2.1477$ with an R^2 value of 0.9016.

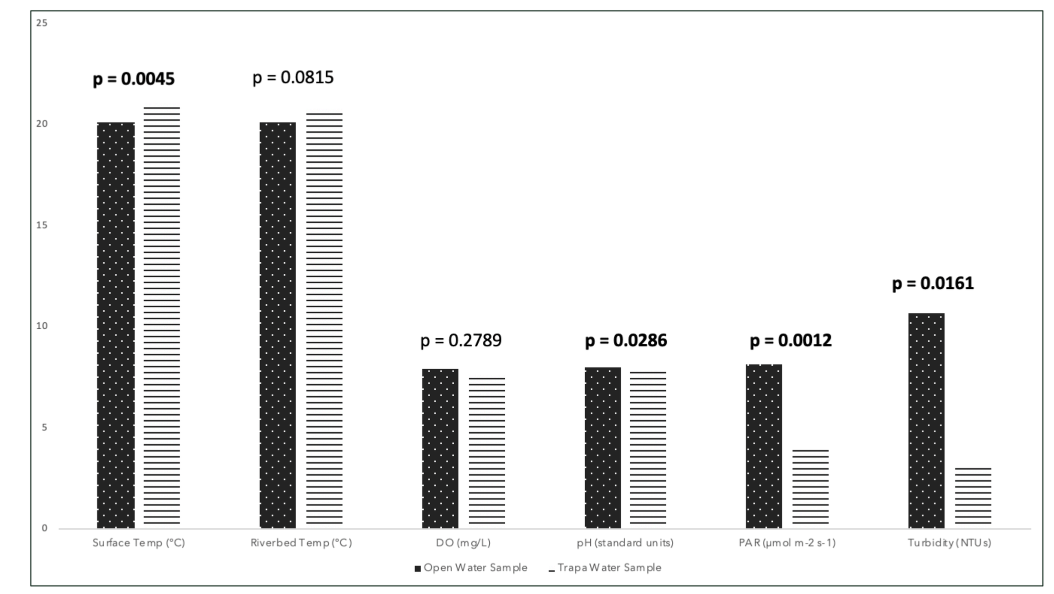

Figure 5. The difference of abiotic factors between the open water outside of a *Trapa* bed, and the water within a *Trapa* bed. Three sites were sampled via transect (n=13). Significant p-values are represented in bold.

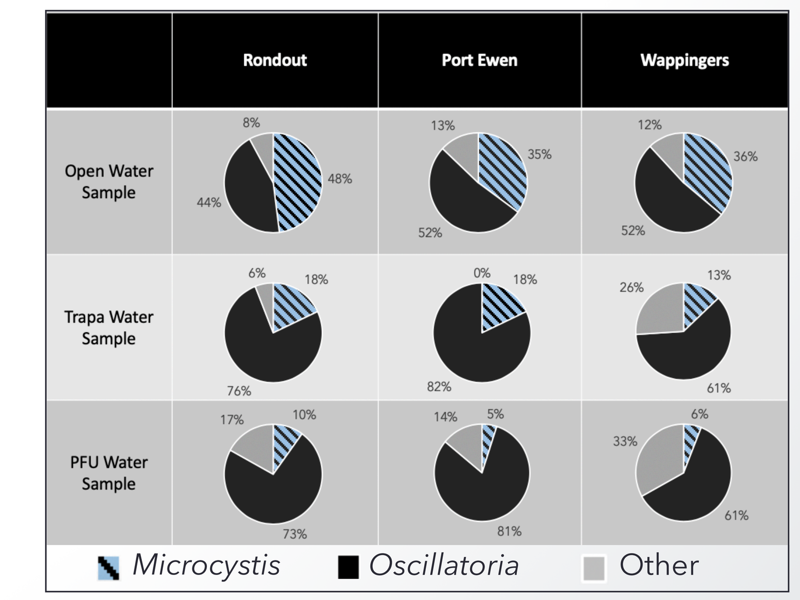

Figure 6. Distribution of cyanobacterial species: Toxic (*Microcystis*) and non-toxic (*Oscillatoria* and others) based on sampling location (n = 17 to 36).

Figure 7. Correlation matrix of abiotic factors in relation to cells/mL for all observation (n=32). Relevant p-values and corresponding plots are outlined.

Figure 8. Correlation matrix of abiotic factors in relation to maximum, minimum, mean and range of cells/mL at each site (n=5). Relevant p-values and corresponding plots are outlined.

DISCUSSION AND FUTURE DIRECTIONS

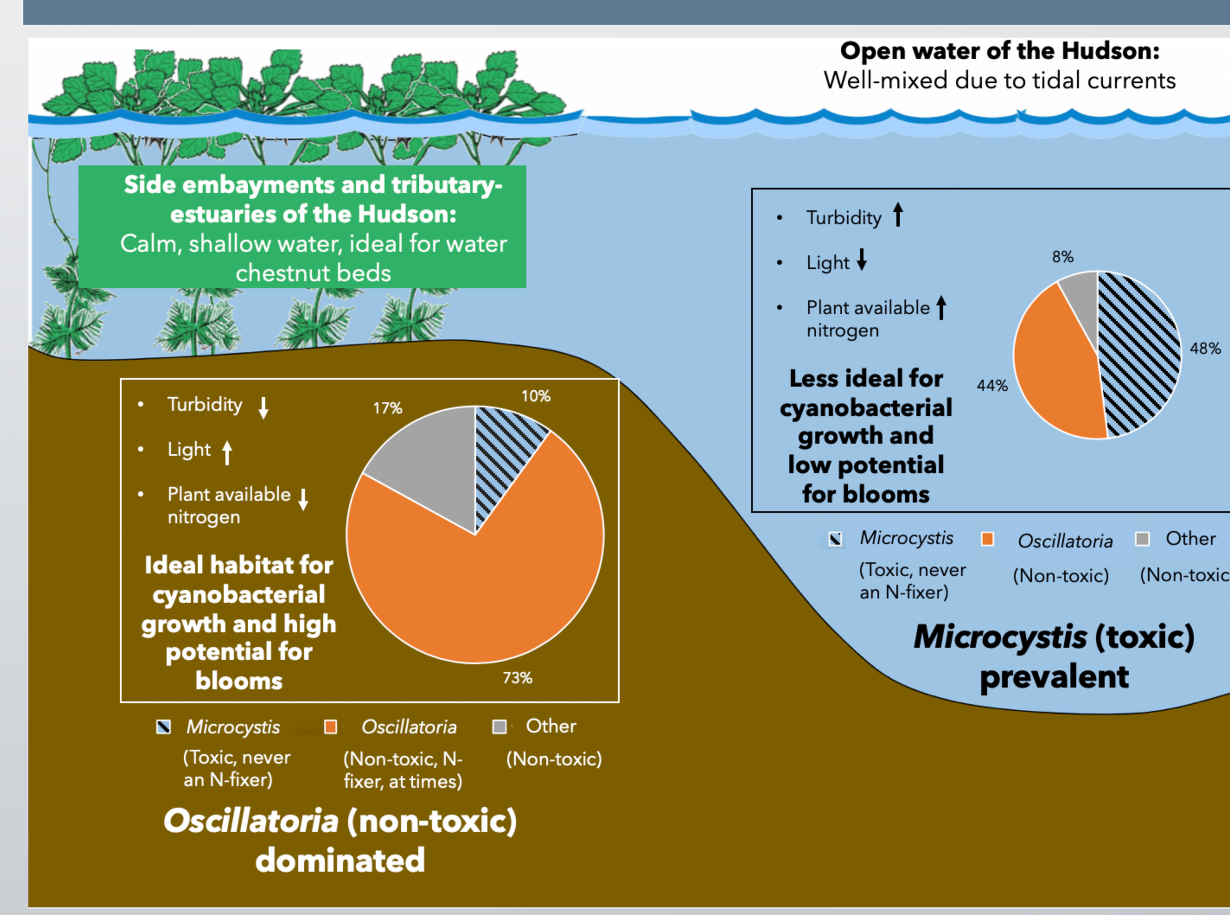

Figure 9. Discussion figure.

Discussion and implications of main findings:

- Toxic *Microcystis* is much more dominant in the main-stem waters of the Hudson where plant-available N is higher, but these locations are not ideal for cyano-bloom formation due to higher turbidity, hence lower light, and lower residence time.
- Ideal cyano-bloom locations are in the slack-water side embayments and tributary-estuaries of the Hudson, but this is where *Trapa* also currently dominates, and cyanobacteria in these areas are dominated by the non-toxic *Oscillatoria*
- *Trapa* beds are previously known to significantly denitrify these slack-water areas, and these lowered nitrogen amounts may favor *Oscillatoria* (a known N-fixer, at times) over *Microcystis* (never an N-fixer)
- These initial findings indicate (pending corroboration with further experimental research) that invasive Trapa beds, common to the Hudson estuary, may currently limit the likelihood of cyanoHABs due to Microcystis even under conditions of climate warming and excess nutrient loading
- For management, increased removal of invasive *Trapa* beds is unadvised until significant mitigation strategies for excess nutrient-loading are completed in municipalities and tributary watersheds of the Hudson estuary system

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