# Double Trouble in the Hudson River Estuary: Dominant Abiotic Factors Controlling Harmful Algal Bloom Risk and the Compounding Influence of the Invasive Water Chestnut

Petraccione Ellie[1], Kepner Raymond[1], and Klos P. Zion[1]

[1]Marist College

November 16, 2022

## Abstract

Low-current tributary-estuaries and embayments along the margin of the Hudson River are uniquely at risk for harmful algal blooms of cyanobacteria (cyanoHABs) due to rising temperatures as a result of climate change. An increased prevalence of cyanoHABs in near-shore, low-current sections of the Hudson River could be extremely harmful to nearby communities, aquatic organisms and wildlife. To address this increased risk, it is imperative to understand the current in-stream and upstream abiotic environmental controls (nutrients, water temperature, etc.) on the current background levels of cyanobacteria within the Hudson River. It is also important to understand how these controls and cyanobacterial populations vary spatially with relation to the higher risk, lower-flow sections along the margins of the Hudson River. Locations of tributary-estuaries of special concern within the Hudson Valley include Esopus Creek in Saugerties, Rondout Creek in Kingston, and Wappingers Creek in Wappingers, NY. Other locations of concern are embayments along the Hudson River such as Long Dock Park in Beacon, Port Ewen in Kingston and Norrie Point in Staatsburg, NY. Given the lower-flow nature of these sites, elevated surface water temperatures are likely a result of settled, striated layers from decreased current. These locations are also susceptible to growth of the invasive species Trapa natans or commonly known as the European water chestnut. High concentrations of nutrients like nitrogen and phosphorous within the water chestnut bloom and the captured sunlight from metabolic processes like photosynthesis can create an ideal microhabitat for harmful algae like cyanobacteria. The background levels of cyanobacteria in outflows of tributaries, and their lower-flow estuary extensions were observed alongside the water quality within the water chestnut blooms of these sites at varying depths. By studying the weekly changes in background abundance of cyanobacteria and their drivers occurring at contrasting locations along the Hudson River, it was found that the strongest controls included turbidity, temperature and levels of phosphorous. In locations of low turbidity and high surface water temperatures, the background levels of cyanobacteria were higher in these lower-flow areas than in areas with increased turbidity. Cyanobacteria was found in greater number within water chestnut blooms than in whole water samples outside the area of the bloom. High surface temperature and riverbed temperature also related to higher levels of cyanobacteria. Given the concluded information, it is apparent that invasive water chestnuts within lower-flow extensions of the Hudson River hold a greater threat than originally understood; creating an ideal habitat for potential cyanoHABs in the wake of climate change.

B43J-2612
Hydrological, Chemical, and Biological Connectivity Across Coastal Watersheds and Estuaries

HRF
HUDSON RIVER FOUNDATION

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

Ellie Petraccione[1], Dr. Zion Klos[1]*, Dr. Raymond Kepner [2]    [1]Department of Environmental Science and Policy, Marist College. [2] Department of Biology, Marist College
*corresponding author: zion.klos@marist.edu

## 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

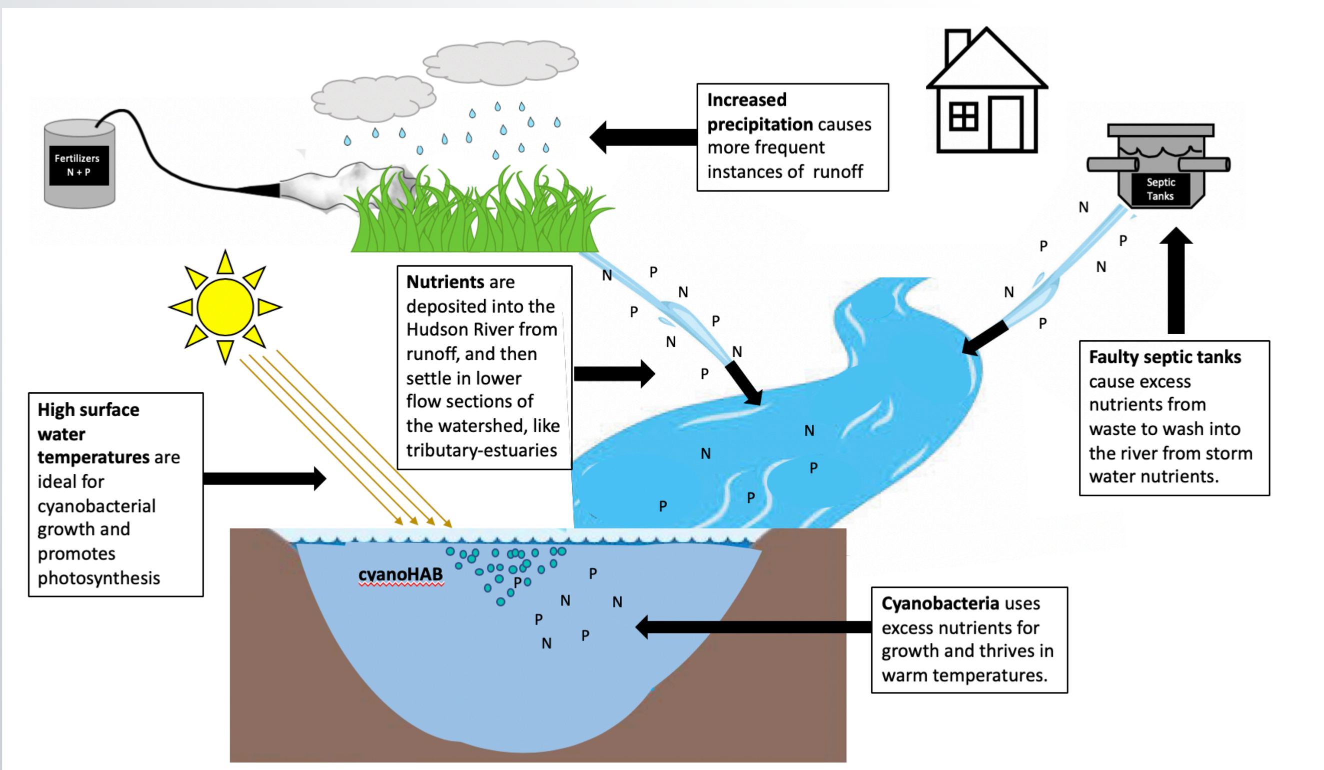


**Figure 1.** Climate change and eutrophication from nutrient-polluted runoff and the effects on cyanoHABs.

## 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

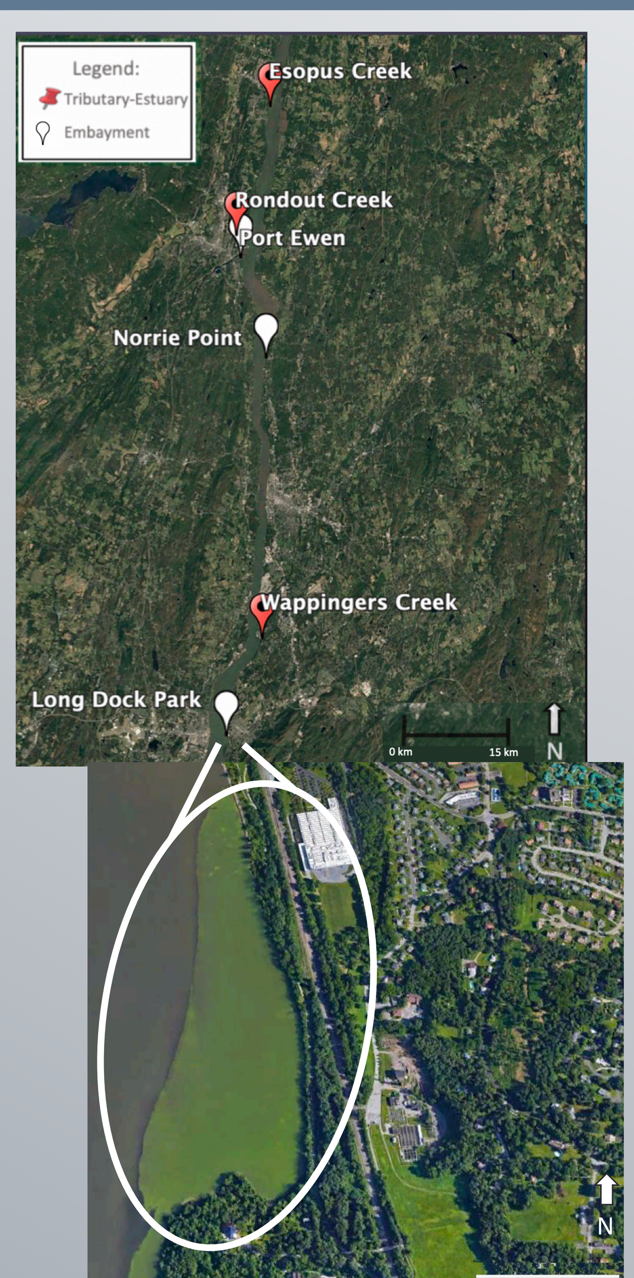


**Figure 2**. Site selection and water chestnut bloom.

## RESULTS

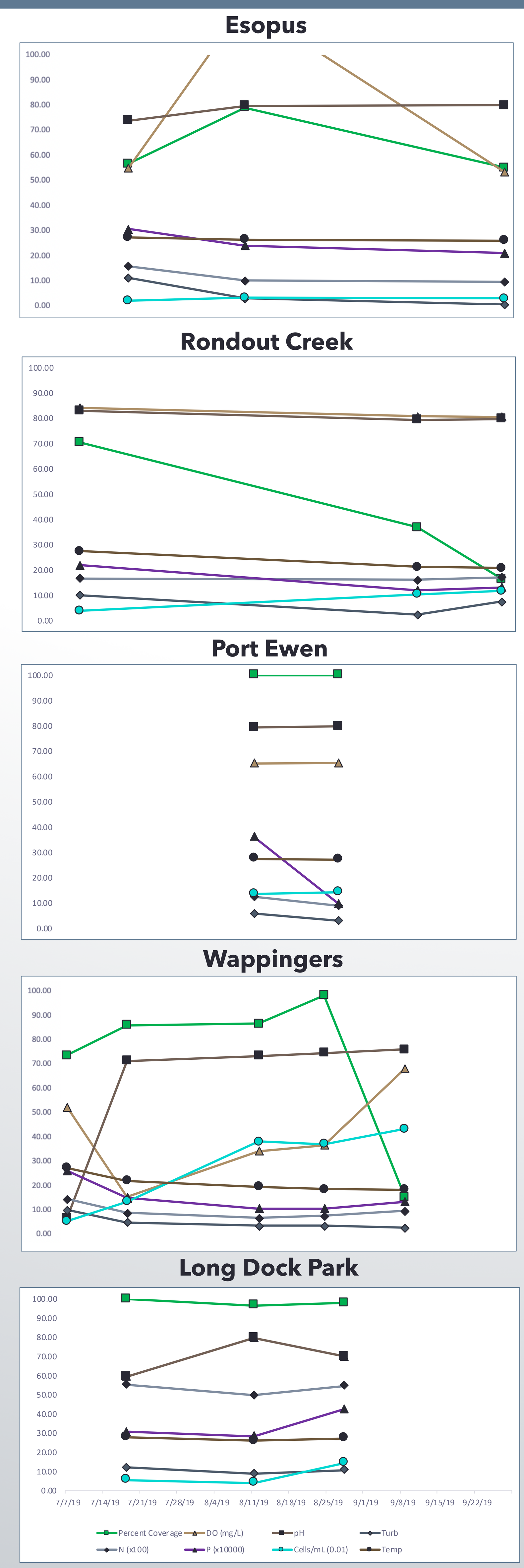


**Figure 3.** Time-series of abiotic factors and cyanobacterial cells/mL between 7/7/19 and 9/28/19.

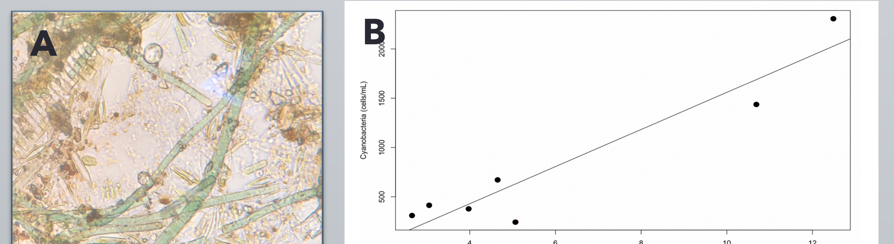


**Figure 4. (A)** Cyanobacteria from PFU sample. **(B)** Cyanobacterial cell counts (cells/mL) and blue-green (BG) Chlorophyll (ppb). Trendline is represented by the equation $y= 0.0048x + 2.1477$ with an $R^2$ value of 0.9016.

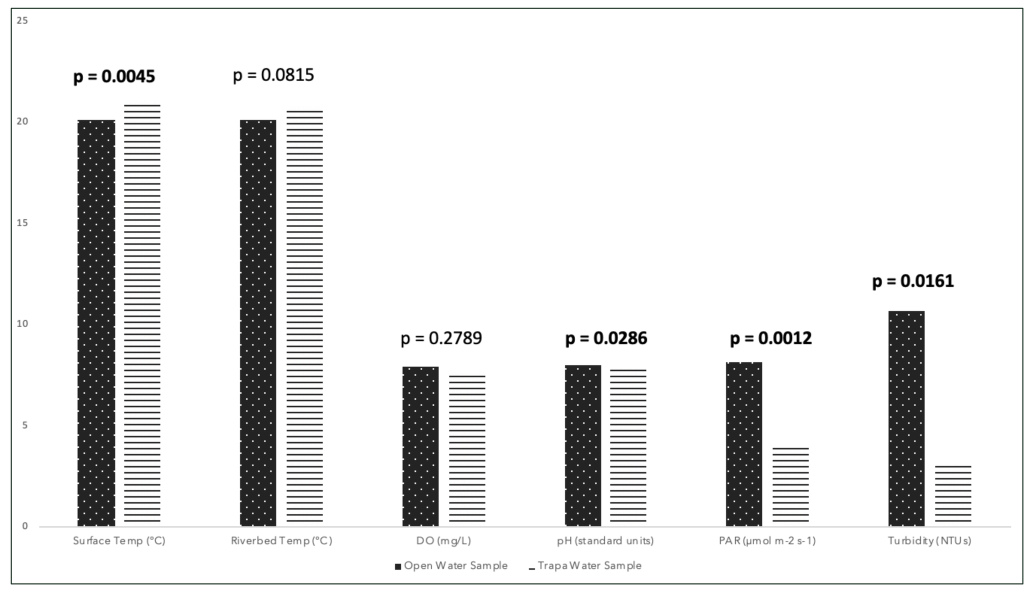


**Figure 5.** The difference of abiotic factors between the open water outside of a *Trapa* bed, and the water within a *Trapa* bed. Three sites were sampled via transect (n=13). Significant p-values are represented in bold.

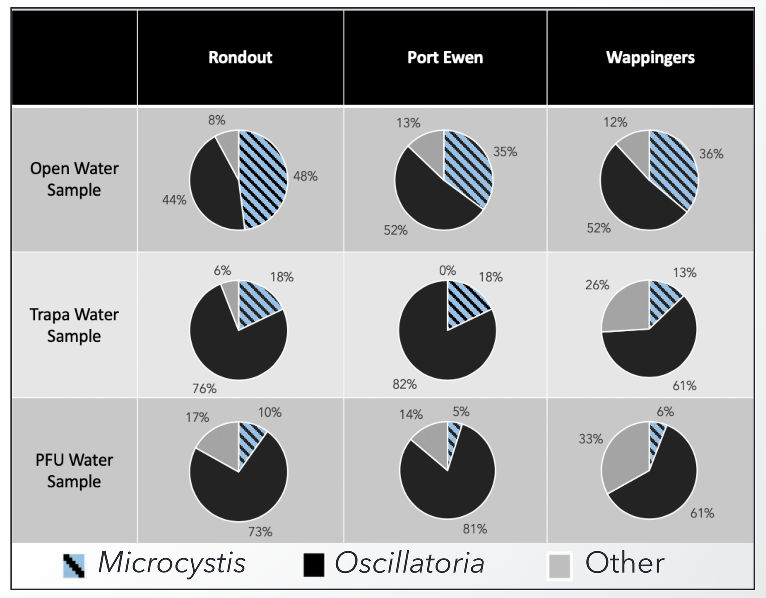


**Figure 6.** Distribution of cyanobacterial species: Toxic (*Microcystis*) and non-toxic (*Oscillatoria* and others) based on sampling location (n = 17 to 36).

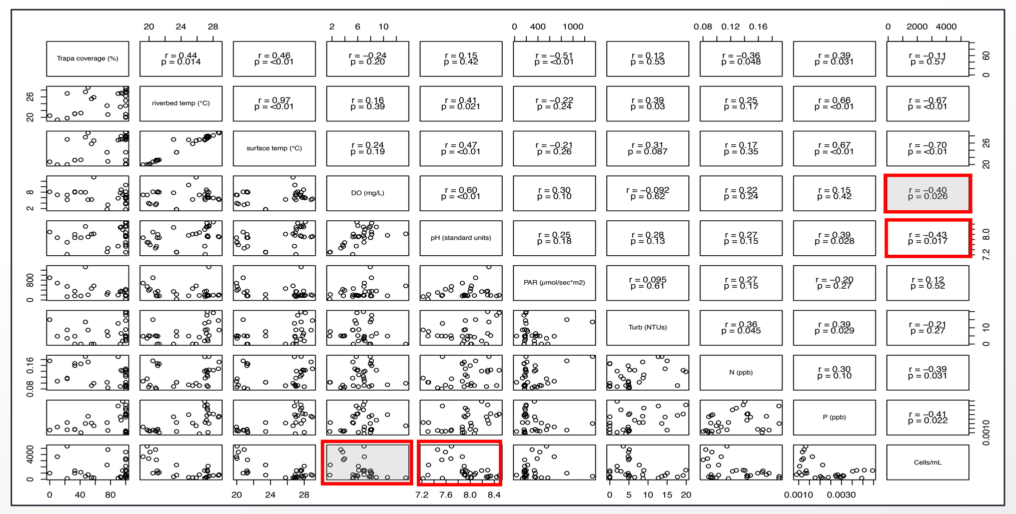

**Figure 7.** Correlation matrix of abiotic factors in relation to cells/mL for all observation (n=32). Relevant p-values and corresponding plots are outlined.

**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

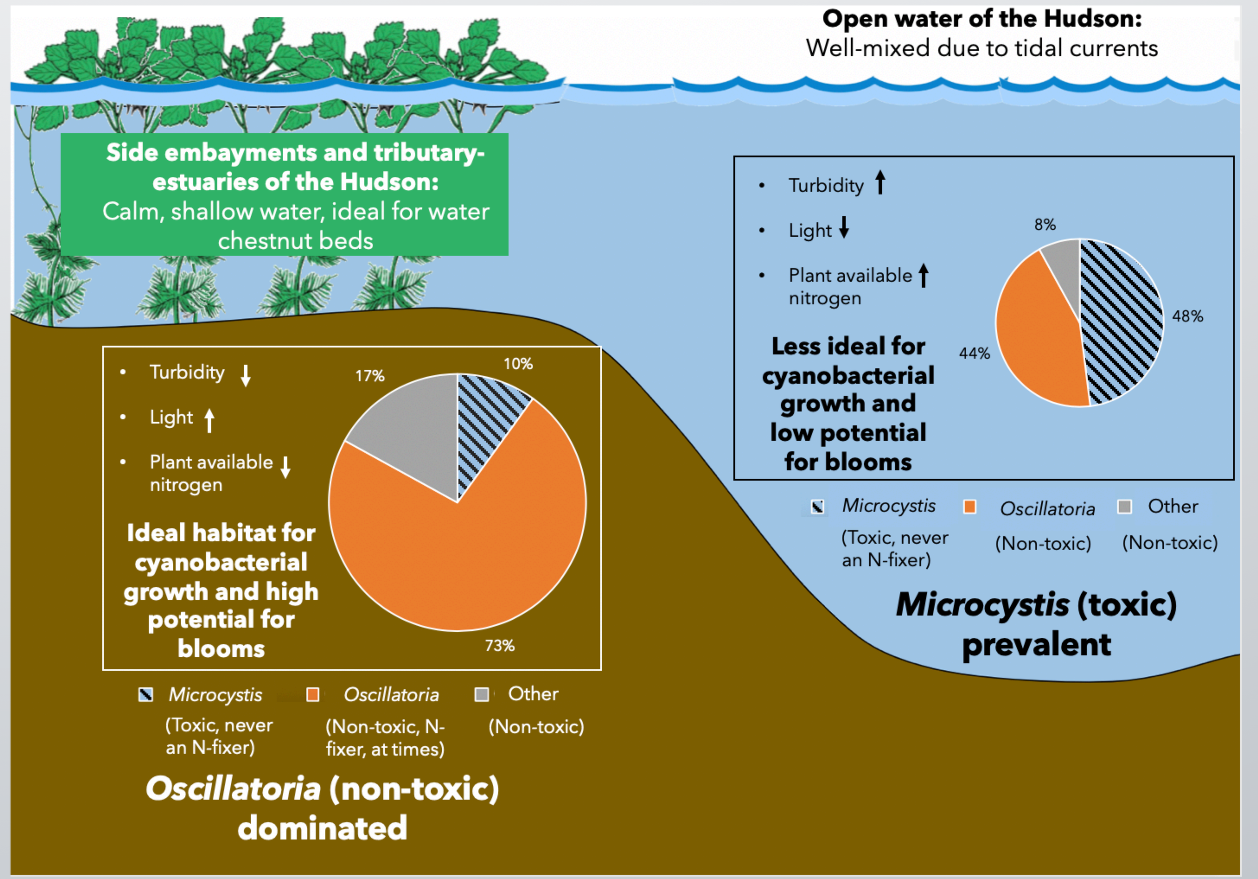


**Figure 9**. Discussion figure.

**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

## ACKNOWLEDGEMENTS

A special thank you to the Tibor T. Polgar Fellowship and the Hudson River Foundation for an unparalleled summer research opportunity. Thank you to Marist College for the VPAA Grant that funded my research materials. Many thanks to my talented advisor, Lucy Holtsnider, for her incredible vision and unwavering positivity. Lastly, thank you to my student volunteers, and friends, who made this possible: Samantha Musso, Lexi Kaminski, Carter Schuh , Colleen Bradley and Gabi DeGennaro.

## REFERENCES

Coffer, M., Schaeffer, B., Darling, J., et al. 2018. Assessing the Impact of Cyanobacterial Harmful Algal Blooms on Drinking Water Intakes Across the United States. *American Geophysical Union Annual Meeting*, Fall 2018.
Eckblad JW. 1978. *Laboratory Manual of Aquatic Biology*. William C. Brown Co.: Dubuque, Iowa.
Falconer, I. 1996. Potential impact on human health of toxic cyanobacteria. *Phycology* 35:6S 6-11.
Havens, K. 2008. Cyanobacteria blooms: effects on aquatic organisms. *Advances in Experimental Medicine and Biology*. 619, 733-747.
Hillebrand, H., C.D. Durselen, T. Kirschtel, U. Pollingher and T. Zohary. 1999. Biovolume calculation for pelagic and benthic microalgae. *Journal of Phycology* 35: 403-424.
Howarth, Bob. 2011. The Hudson River is the Most Heavily Nutrient-Loaded Estuary in the World: Should We Care? Cornell University. College of Agriculture and Life Sciences.
Humpage, A.R., Falconer, I. R. Preliminary evidence for in vivo tumour initiation by oral administration of extracts of the blue-green alga *Cylindrospermopsis reciborskii* containing the toxin cylindrospermopsin. *Environmental Toxicology*. 16:2
Lee, S. S. 2018. Harmful Algal Blooms Get "Hotter" in 2018. *Association for the Sciences of Limnology and Oceanography*.
Lone, Y., Koiri, R., Bhide, M. 2015. An overview of the toxic effect of potential human carcinogen Microcystin-LR on testis. *Toxicology Reports* 2: 289-296.
Pratt, J.R., and R.L. Kepner, Jr. 1992. Collecting *Aufwuchs* on artificial substrata. In J.J. Lee and A.J. Soldo (Eds.), *Protocols in Protozoology*. Lawrence, Kansas: Allen Press, Inc. 12:1–22.