Tracking Toxins: Investigating Organic Contaminants Produced by Harmful Algal Blooms in New Jersey Waters

Elizabeth Macchioni, Kean University

NSF IUSE Program, Mentor: Dr. Shuting Liu

<macchioe@kean.edu>; <liushut@kean.edu>

Methodology

To investigate the presence and distribution of organic toxins produced by harmful algal blooms in New Jersey waters, we employed a combination of field sampling and advanced analytical techniques. Environmental parameters such as temperature, pressure, dissolved oxygen, specific conductivity, salinity, pH, and chlorophyll were measured in situ using a YSI sonde to characterize site conditions. Water samples were filtered and subjected to solid phase extraction (SPE) to isolate dissolved toxins. Toxin analysis was conducted using ultrahigh performance liquid chromatography coupled with triple quadrupole mass spectrometry (LC-MS/MS). Using these methods, we aim to establish a reliable LC-MS/MS protocol for detecting 12 organic toxins (Microcystin (MC)-LR,-RR,-YR, Domoic acid (DA), Azaspiracid (AZA)-1, -2, Dinophysistoxin (DTX)-1, -2, Yessotoxin (YTX), Okadaic acid (OA), Pectenotoxin-2 (PTX2), brevetoxin (PbTx2)), verify their detection limits and extraction efficiency, and survey their concentrations across freshwater and coastal systems to explore potential connections between toxin distribution and environmental factors.

Figure 3. Lab equipment: Liquid chromatography-mass spectrometry (LC-MS) machines.

Figure4. Lab equipment: Nitrogen generator and chromatography system.

Introduction

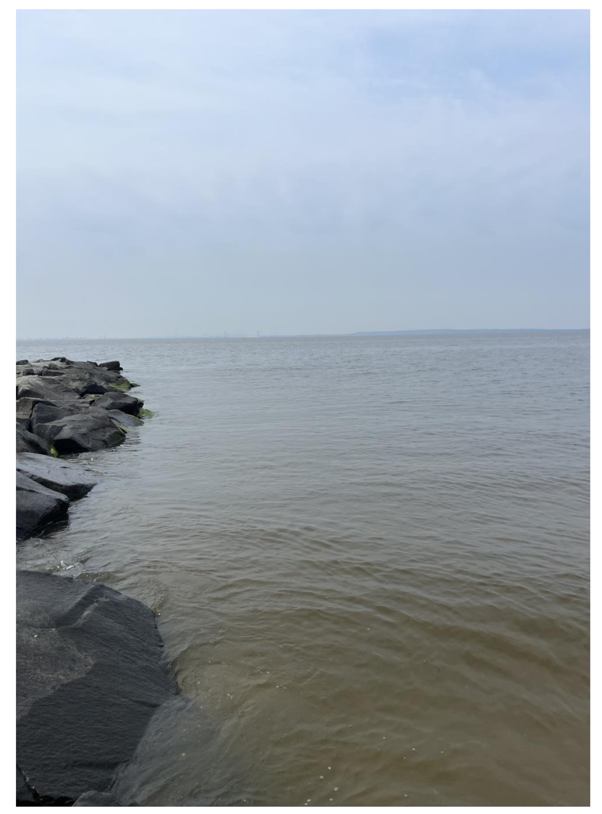

Figure 1. June 13, 2025. Bayshore Waterfront Park sampling site.

Harmful algal blooms (HABs) have become an increasing concern in New Jersey's aquatic environments, where excess nutrient pollution and warming temperatures contribute to their frequency and intensity. These blooms can produce organic toxins that pose serious risks to public health, aquatic life, and local economies. This study investigates the presence and concentration of organic toxins associated with HABs in select freshwater and estuarine sites across New Jersey. We hypothesize that higher nutrient levels and warmer water temperatures will correlate with increased toxin production. Understanding HAB toxin concentrations and the environmental conditions that promote toxin-producing HABs is essential for informing mitigation strategies and protecting water quality in vulnerable ecosystems.

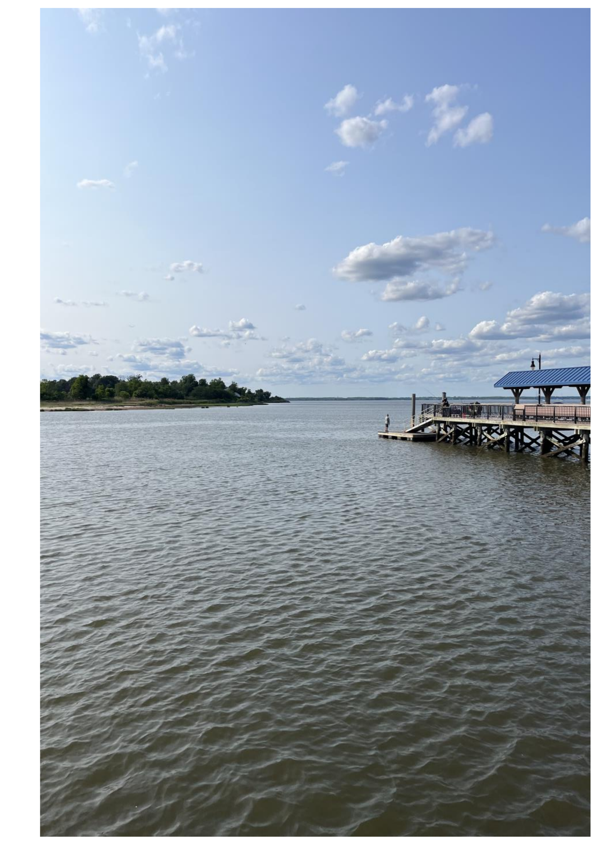

Figure 2. June 02,2025. Matawan Creek sampling site.

Results and Discussion

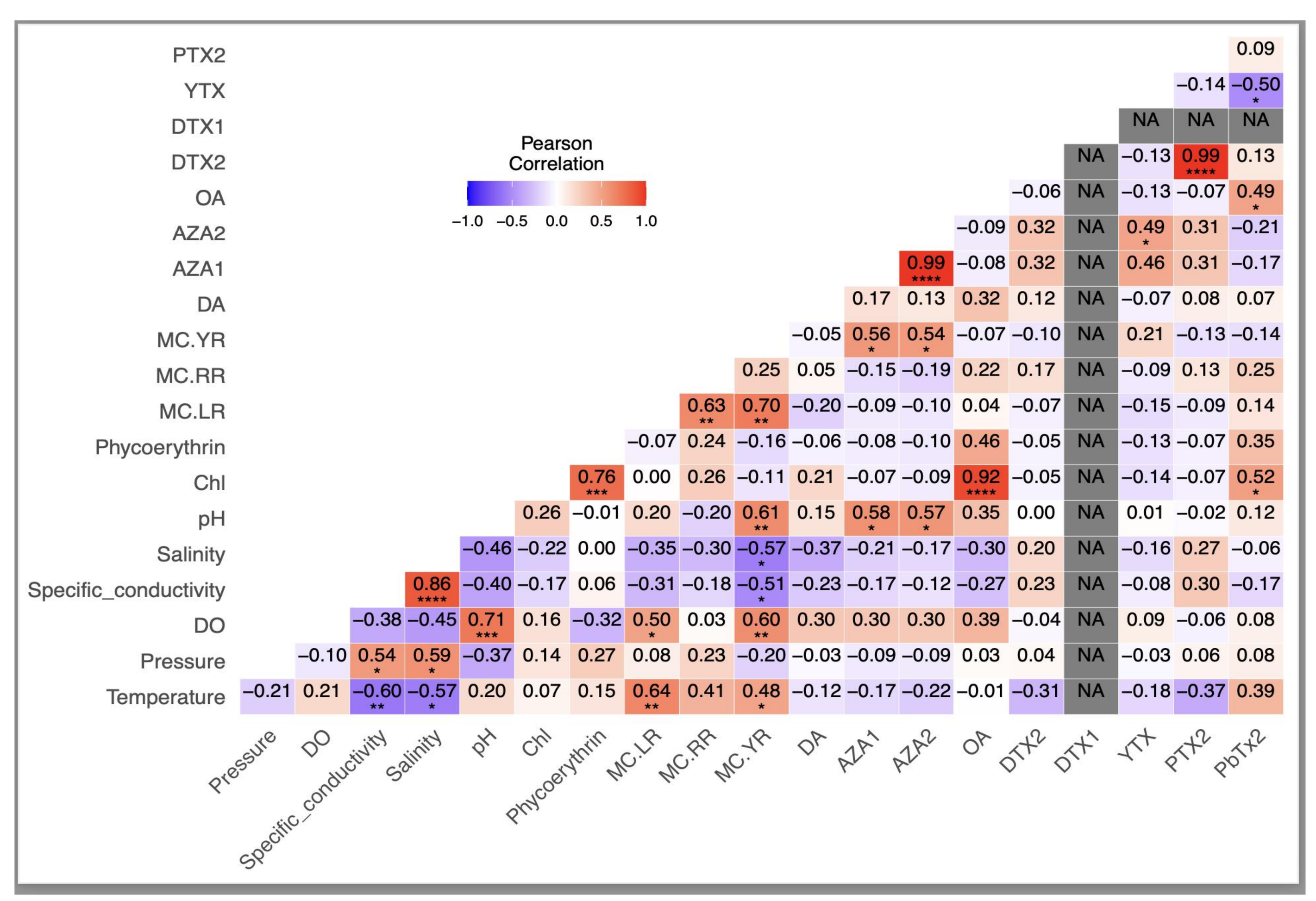

Figure 5. Correlation heatmap. This graph displays the correlation coefficients between multiple variables found in the dataset. PTX2 found to be at higher levels when DTX2 was high. A positive correlation of 0.99 indicates the co-occurrence of these two toxin-producing algae in the water. MC-YR levels were found to be high when salinity levels ran lower, promoting a negative correlation of –0.57.

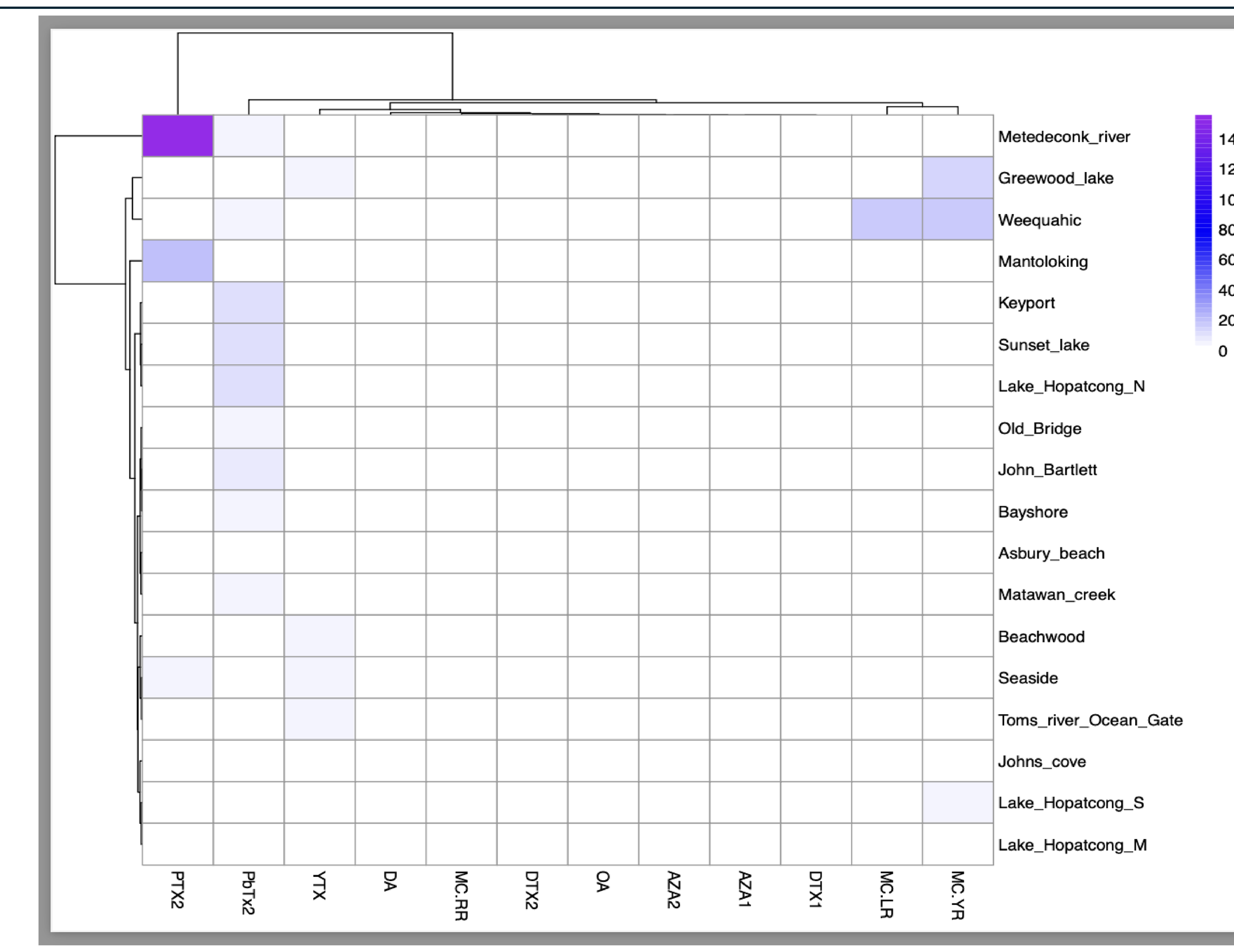

Figure 6. Clustered heatmap of toxin concentrations (ng/L) across study sites. PTX2 values found to be highest at the Metedeconk River site, reaching levels of 140 ng/L. PbTx2 shows consistently lower levels (<20 ng/L) throughout each site. Potential HAB species responsible for the analyzed toxin PTX2 is *Dinophysis* spp.; For PbTx2 are *Chattonella Subsalsa and Chloromorum toxicum.*

Conclusion

This study demonstrates that harmful algal blooms in New Jersey waters produce quantifiable levels of various organic toxins, with clear patterns linked to environmental factors. PTX2 showed a strong positive correlation (0.99) with DTX2, suggesting co-occurrence of toxin-producing algae, while MC-YR was more abundant in lower-salinity environments. The highest PTX2 concentrations (140 ng/L) were observed at the Metedeconk River site, with *Dinophysis* spp. likely responsible for its production.

By establishing and validating an LC-MS/MS method for detecting 12 toxins, these findings provide a foundation for identifying HAB drivers, guiding monitoring efforts, and supporting strategies to protect aquatic ecosystems and public health.

Acknowledgements

It is imperative that I acknowledge and express gratitude for the efforts of the individuals and organizations that have contributed to this research. I would like to thank my mentor, Dr. Shuting Liu, as well as the National Science Foundation for their generous grants. DUE 2247157 and CHE 2409248.

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