



New Insights into Pollutant Fate and Transport in Lakes: The Roles of Cyanobacterial Harmful Algal Blooms, Surface Microlayers, and Foam

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Drs. Nandini Kar and Mark Noll (SUNY Brockport)
Lindsey Ayers, Emily Debolt, Cody Perez (CLWA)
Lindsay McMillan (CLWC, FLLT)

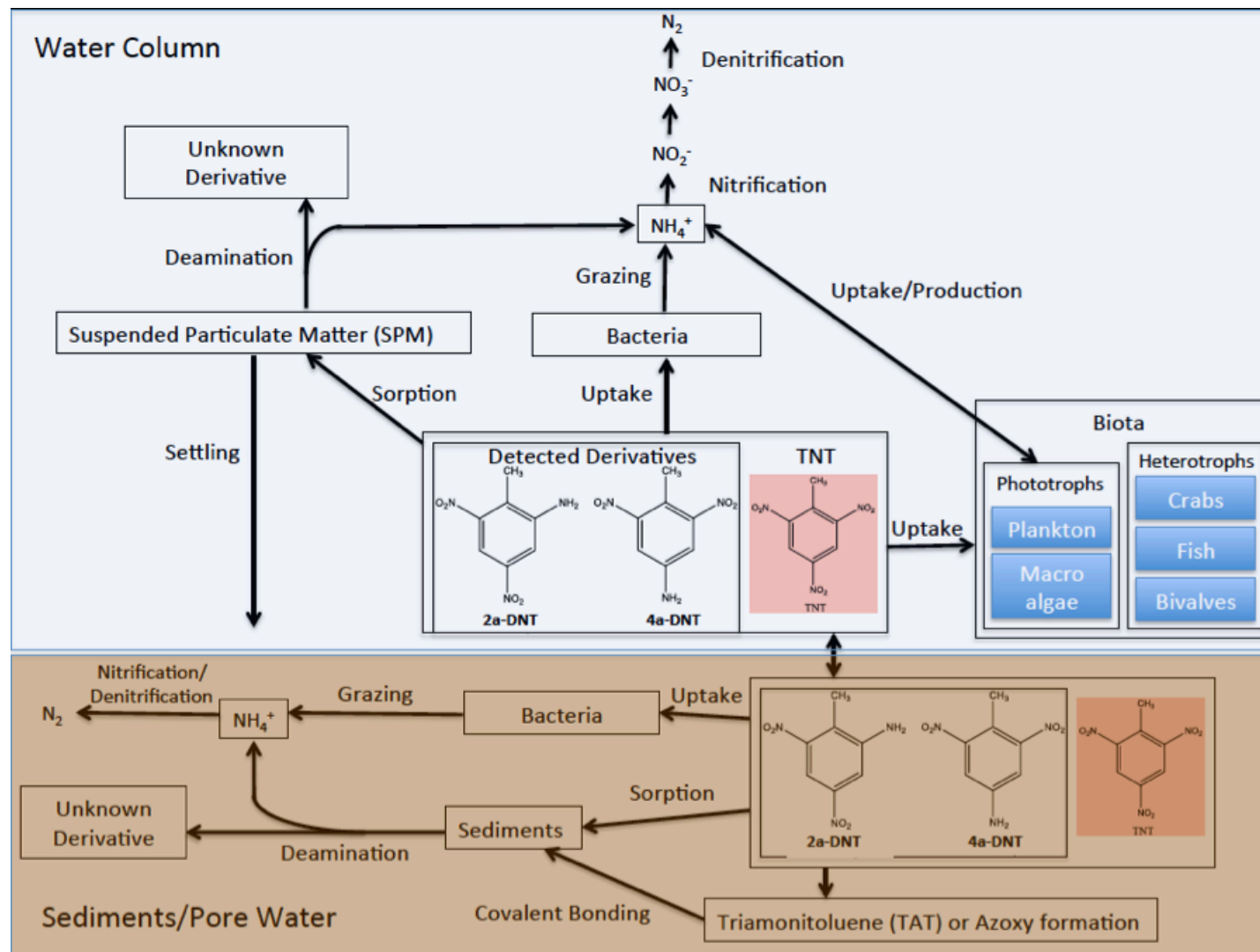


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INSTITUTE



Tracing the Cycling and Fate of the Explosive 2,4,6-Trinitrotoluene in Coastal Marine Systems with a Stable Isotopic Tracer, ^{15}N -[TNT]

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Cyanobacterial Harmful Algal Blooms (cyanoHABs) – *Microcystis Aeruginosa*



Map: NYHABs, New York Department of Environmental Conservation (NYDEC). Inset: Clinkhammer et al., 2018



Canandaigua Lake, 2019

Photo: Lindsay McMillan

Finger Lakes Foam Reporting Tool

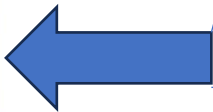
- *Funded by Water Resources Institute (Cornell, NYSDEC)*
- *GAR, Binghamton, CLWA collaboration*

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REQUEST A QUOTE



Finger Lakes Foam Survey

Select Lake*

[Click here](#) for directions to complete the survey

-Please select-

Conesus Lake

Hemlock Lake

Canadice Lake

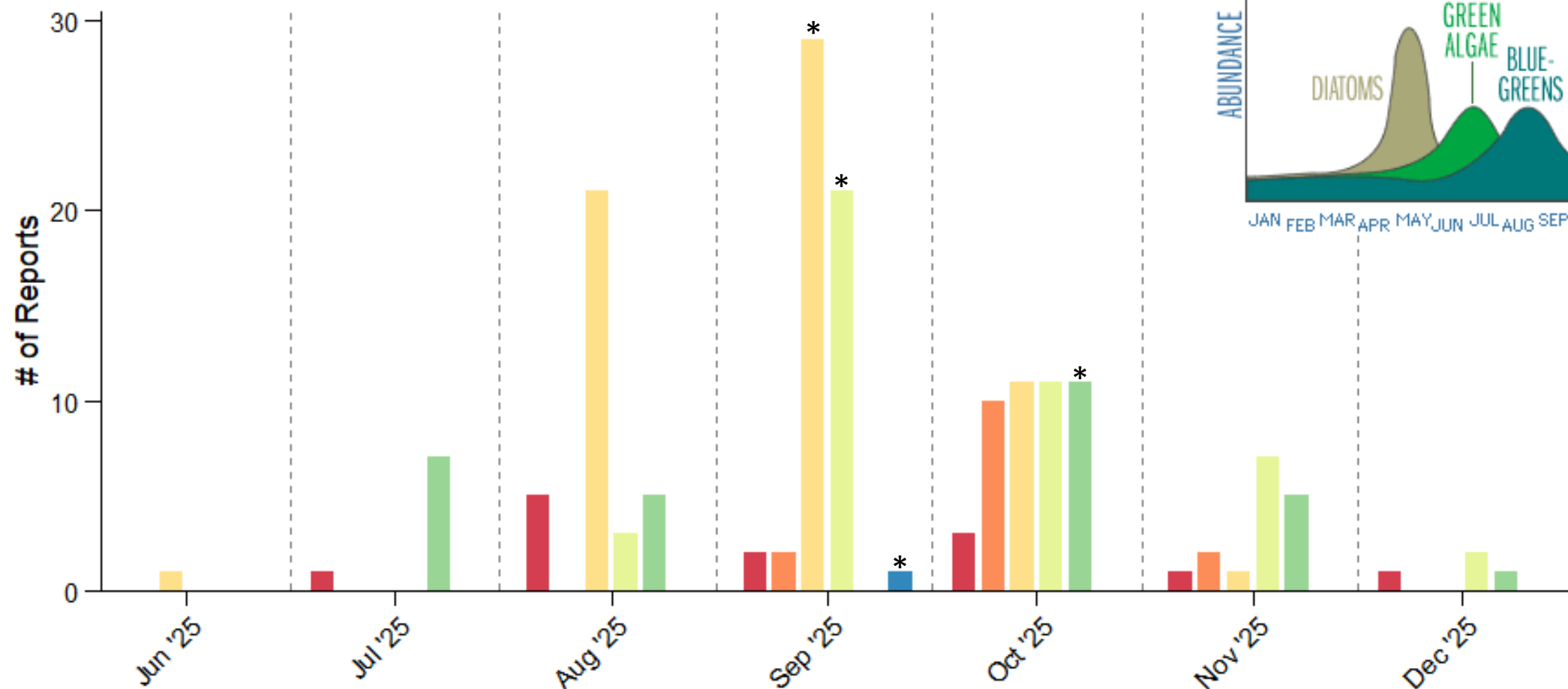
Honeoye Lake

Email*

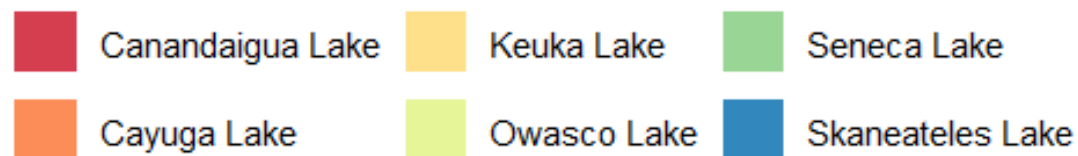
Phone Number*

Finger Lakes Foam Reporting Tool, June 2025 - February 2026

Total Monthly Reports for Each Lake

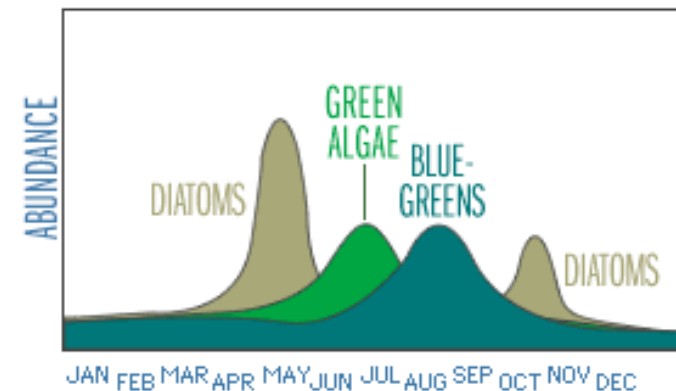


Total reports: 164



*Samples taken

www.waterontheweb.org



Foam Formation – Lake Chemistry Connection

Terrestrial Sources:

- Plants
- Soils
- Bedrock
- Pollution

1.) Aquatic and **terrestrial** sources contribute organic matter (OM) to the lake

Aquatic Sources:

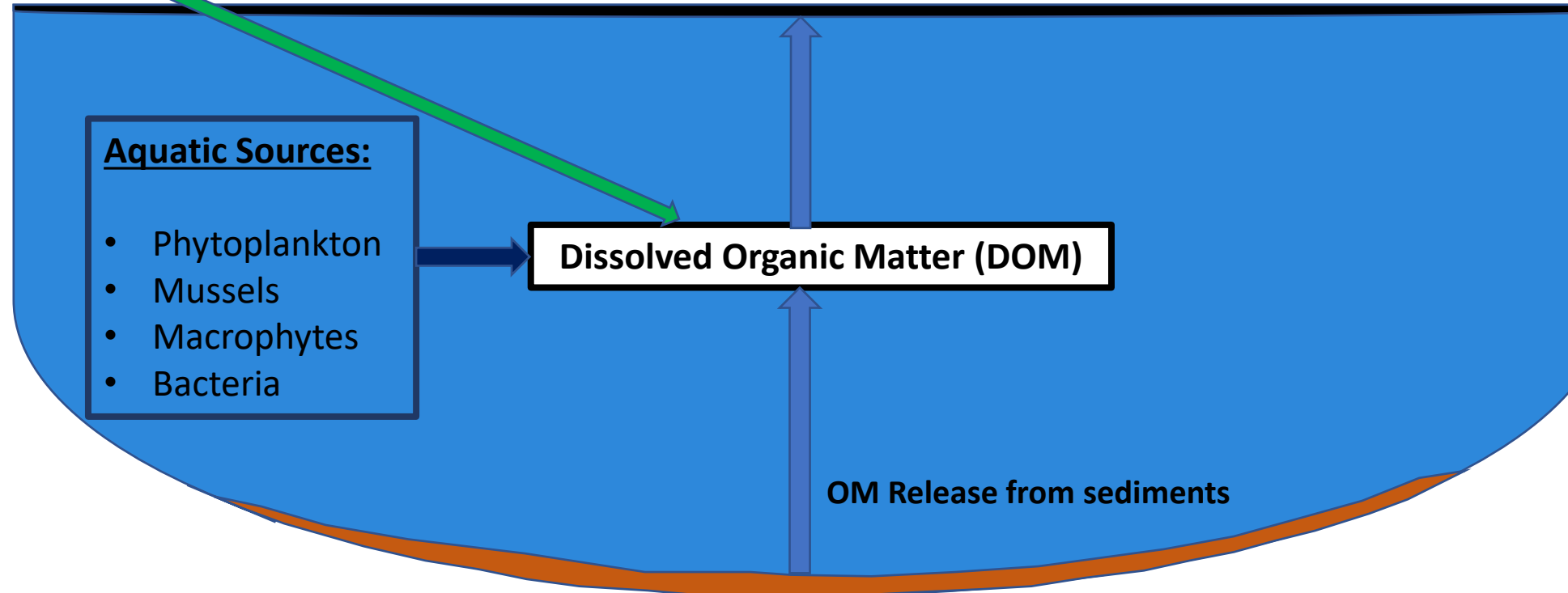
- Phytoplankton
- Mussels
- Macrophytes
- Bacteria

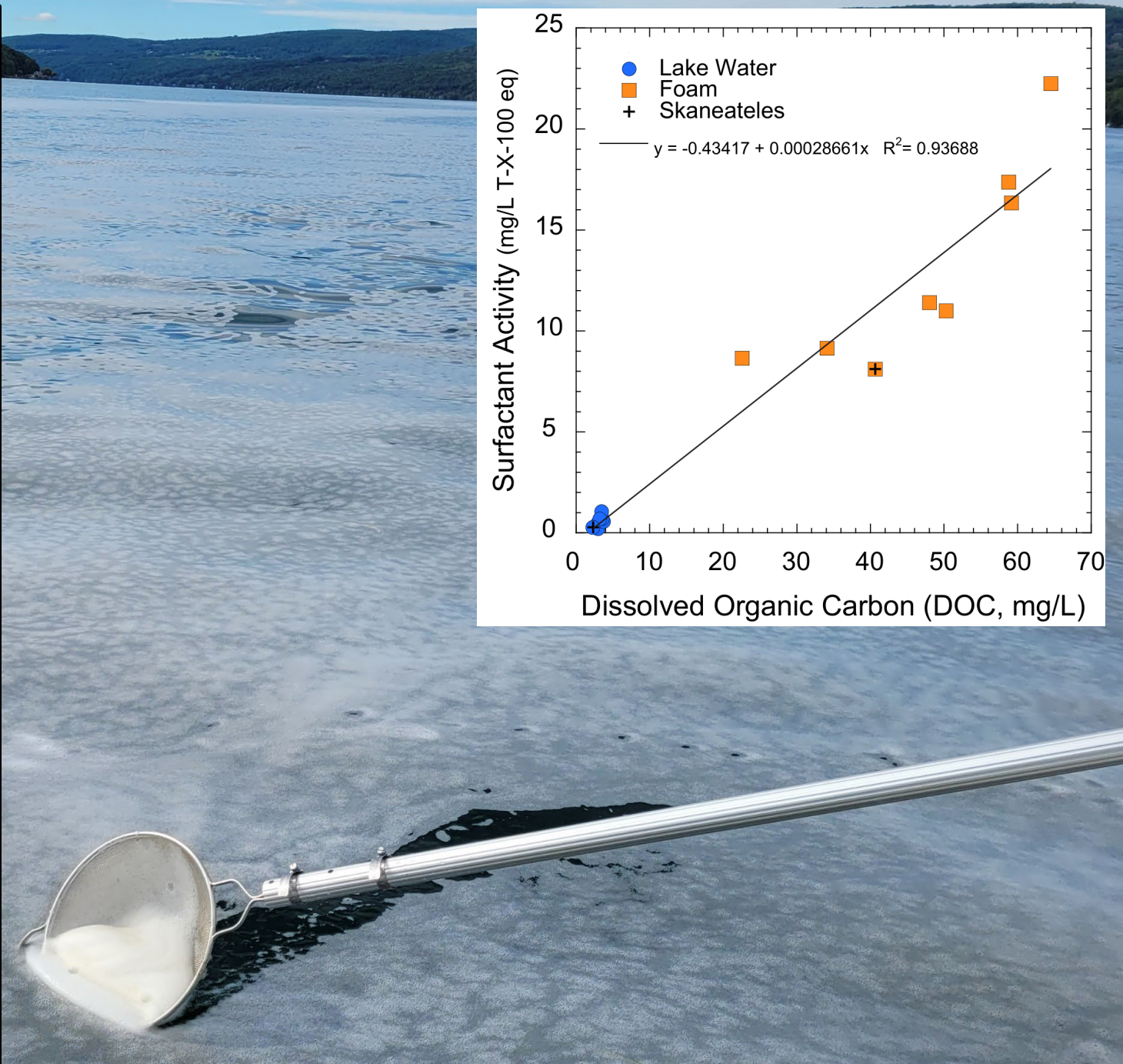
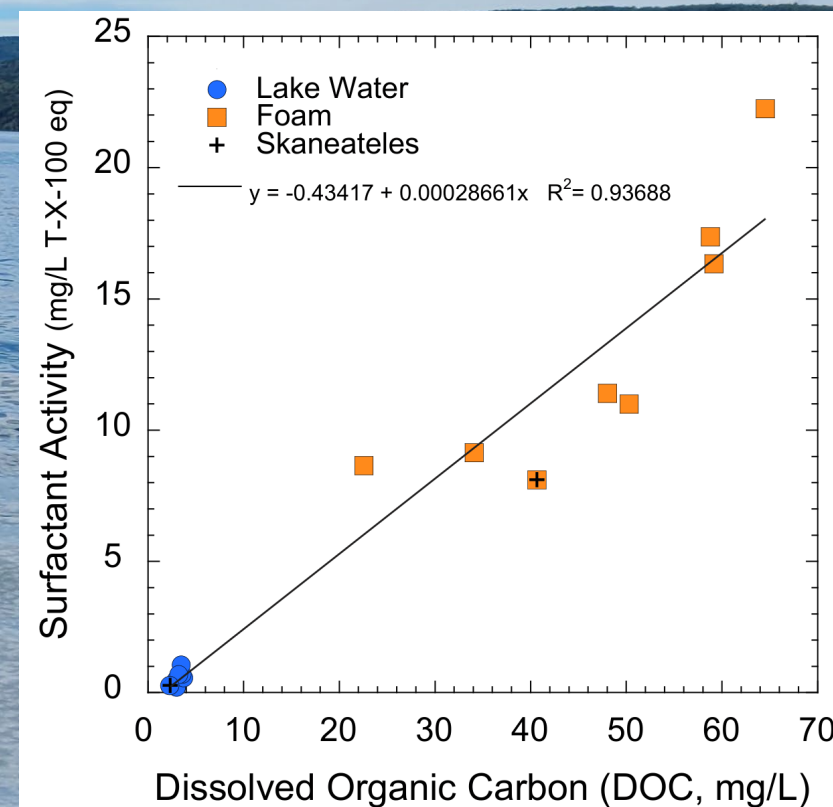
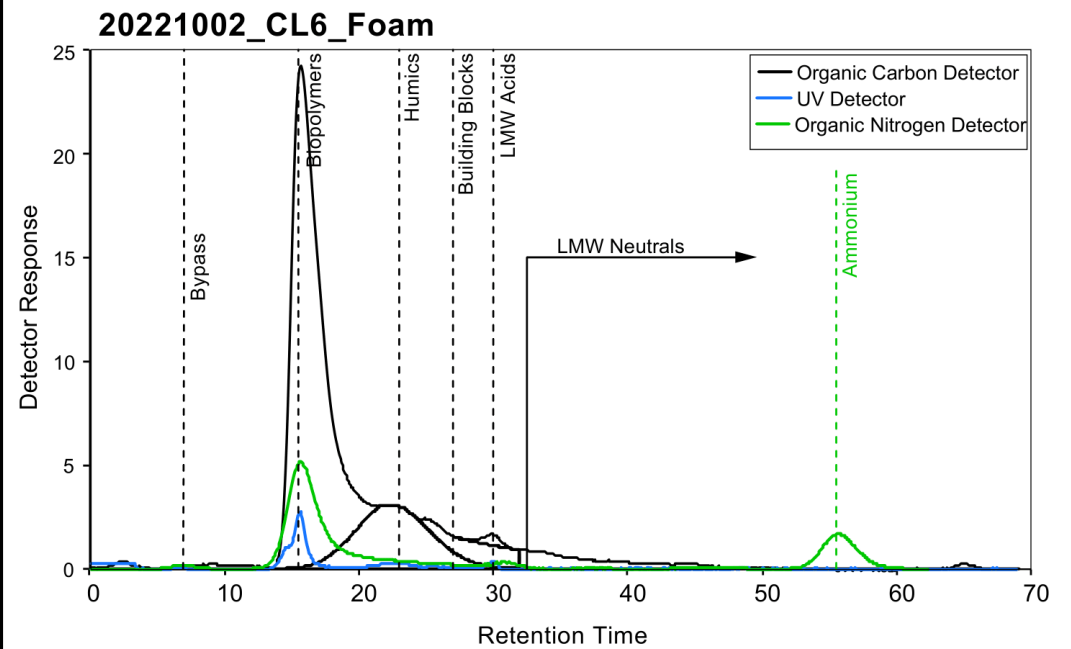
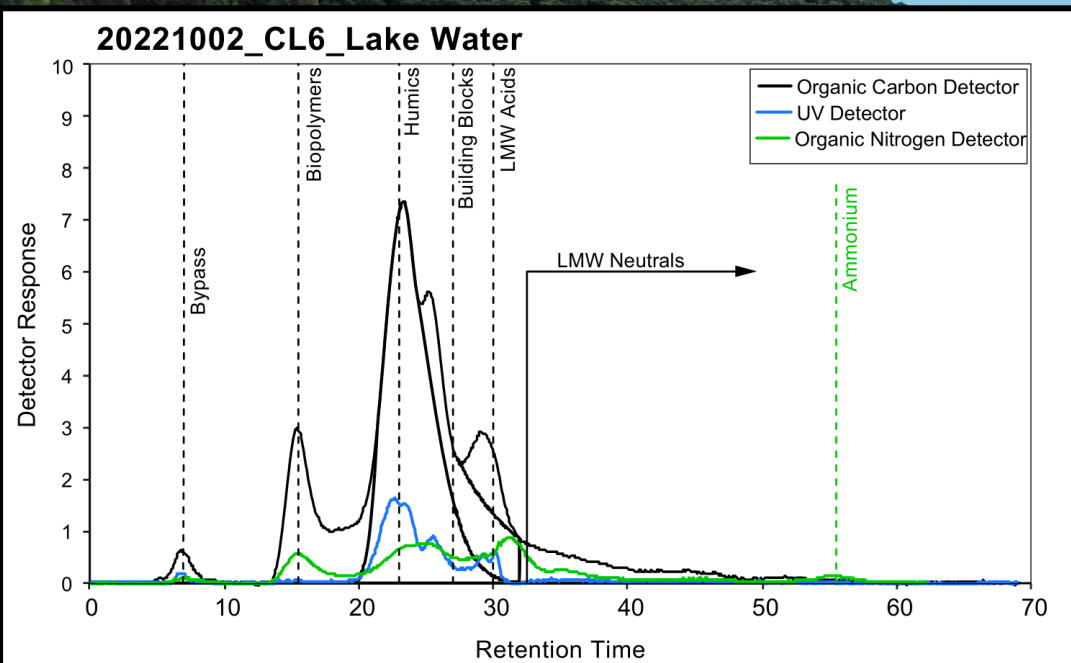
Dissolved Organic Matter (DOM)

2.) Compounds with low water solubility preferentially accumulate at the surface microlayer (SML)

3.) If surface tension is reduced, wind, waves and currents can create foam by entraining air bubbles

OM Release from sediments





FTIR

Fourier Transform Infrared Spectroscopy

Lipids

Proteins

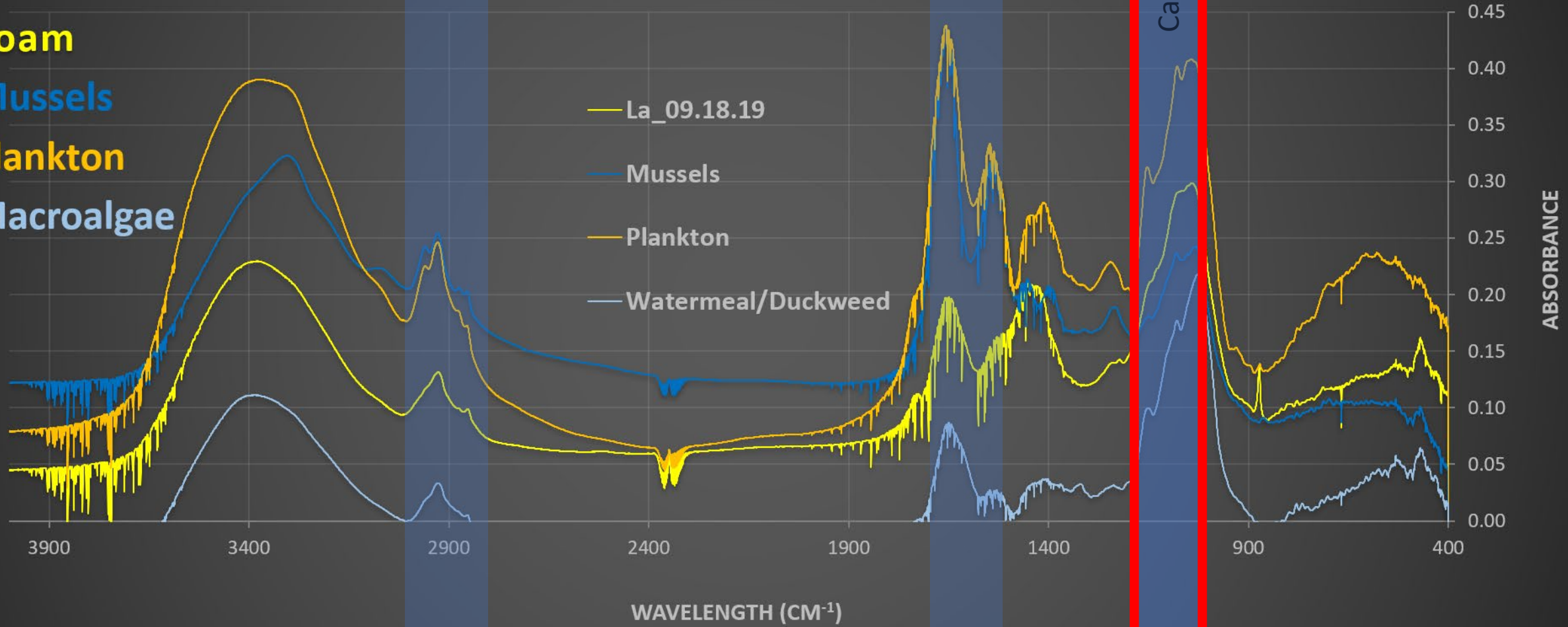
Carbohydrates

Foam

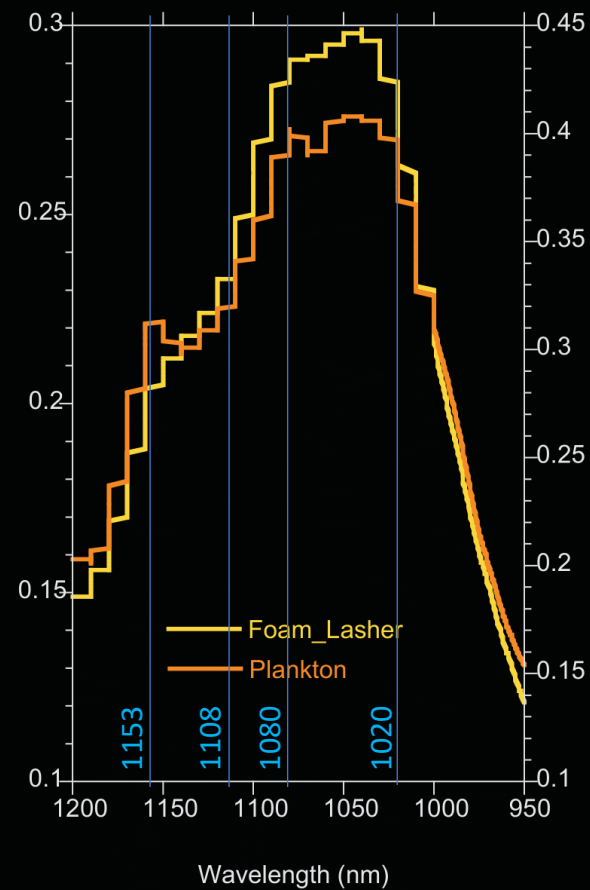
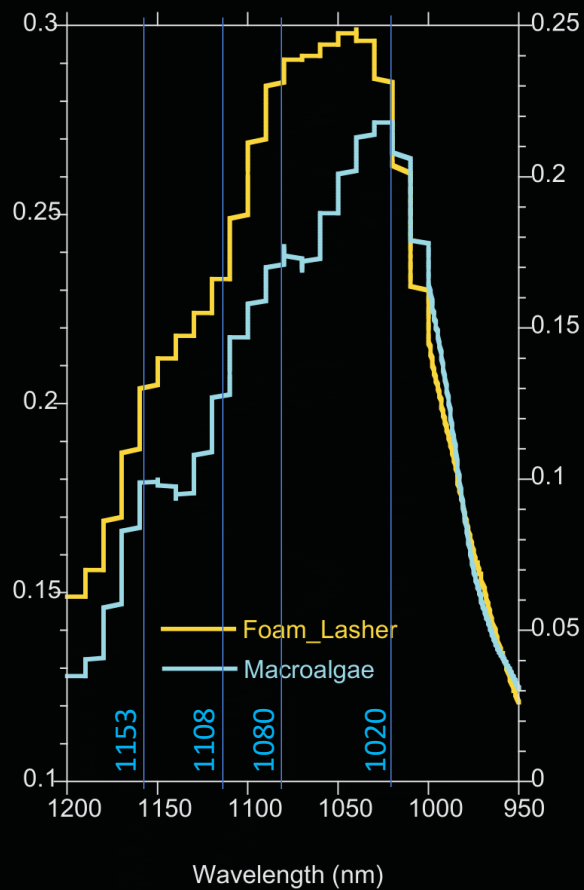
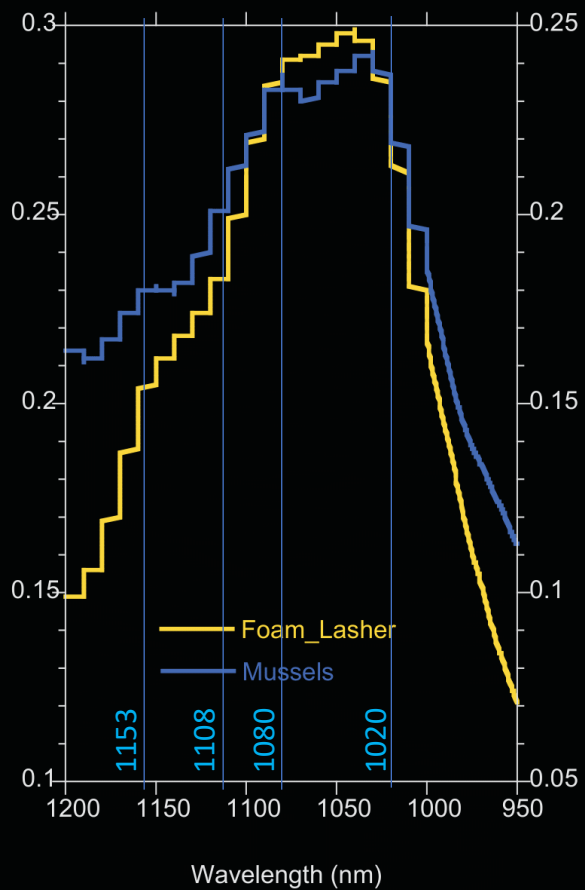
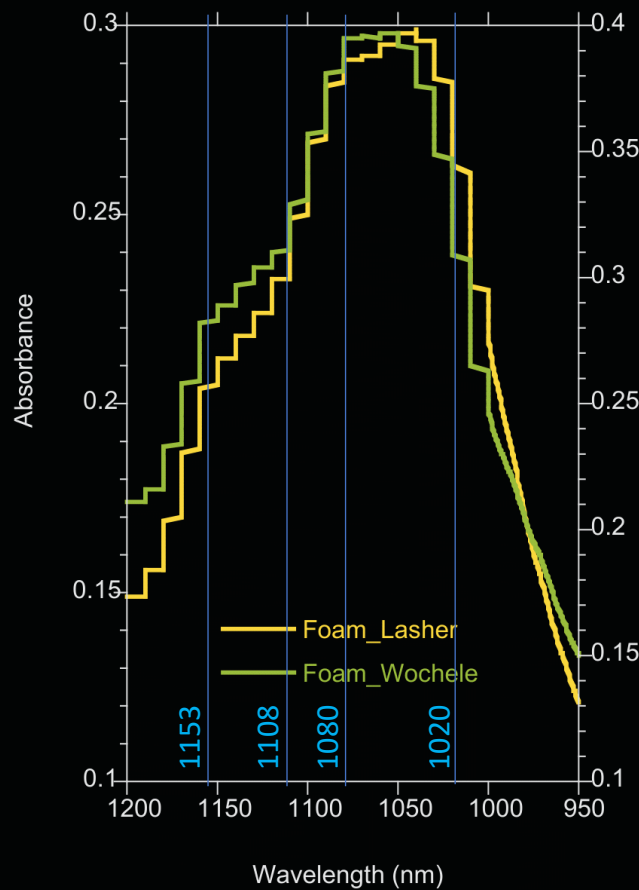
Mussels

Plankton

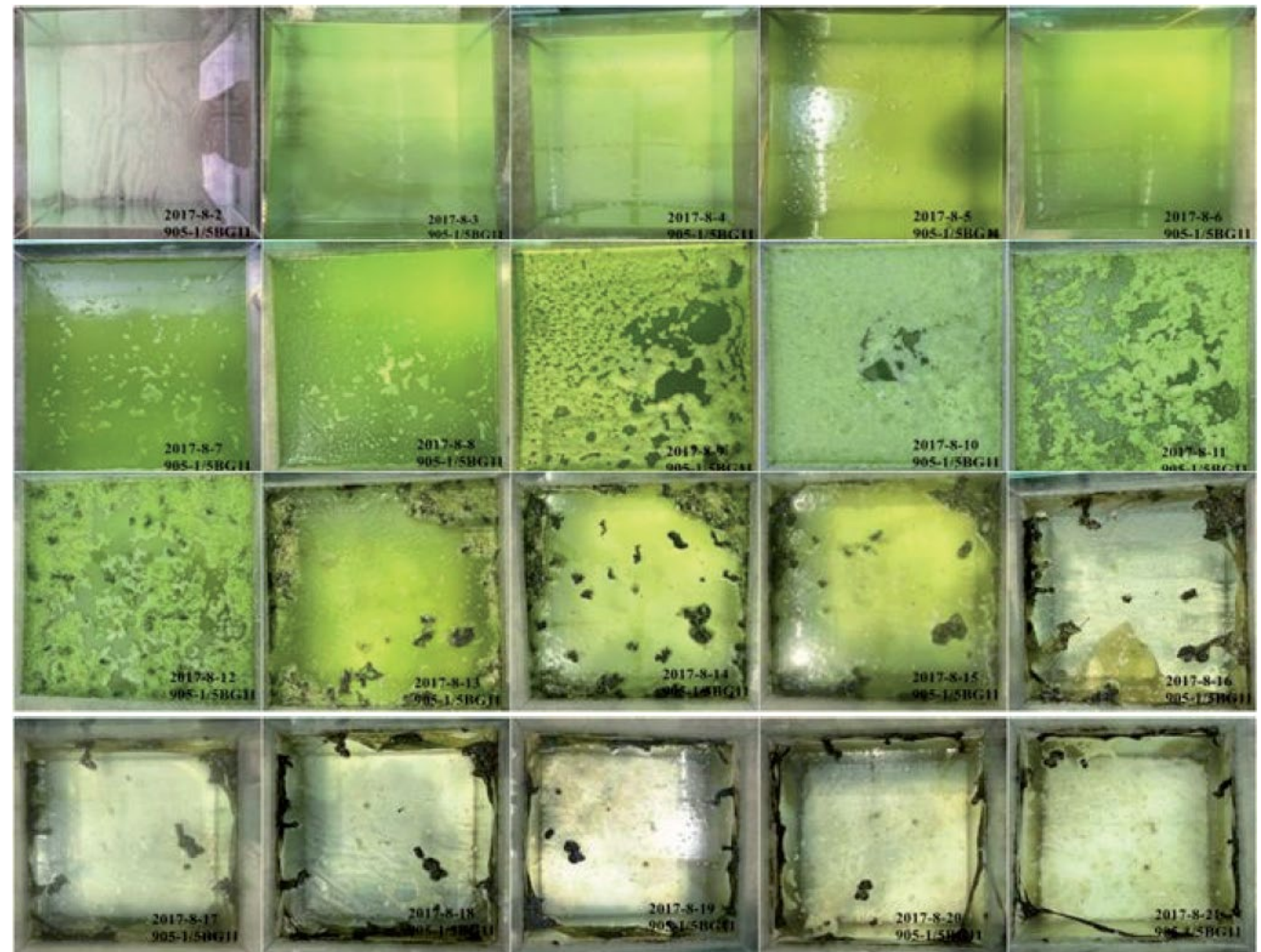
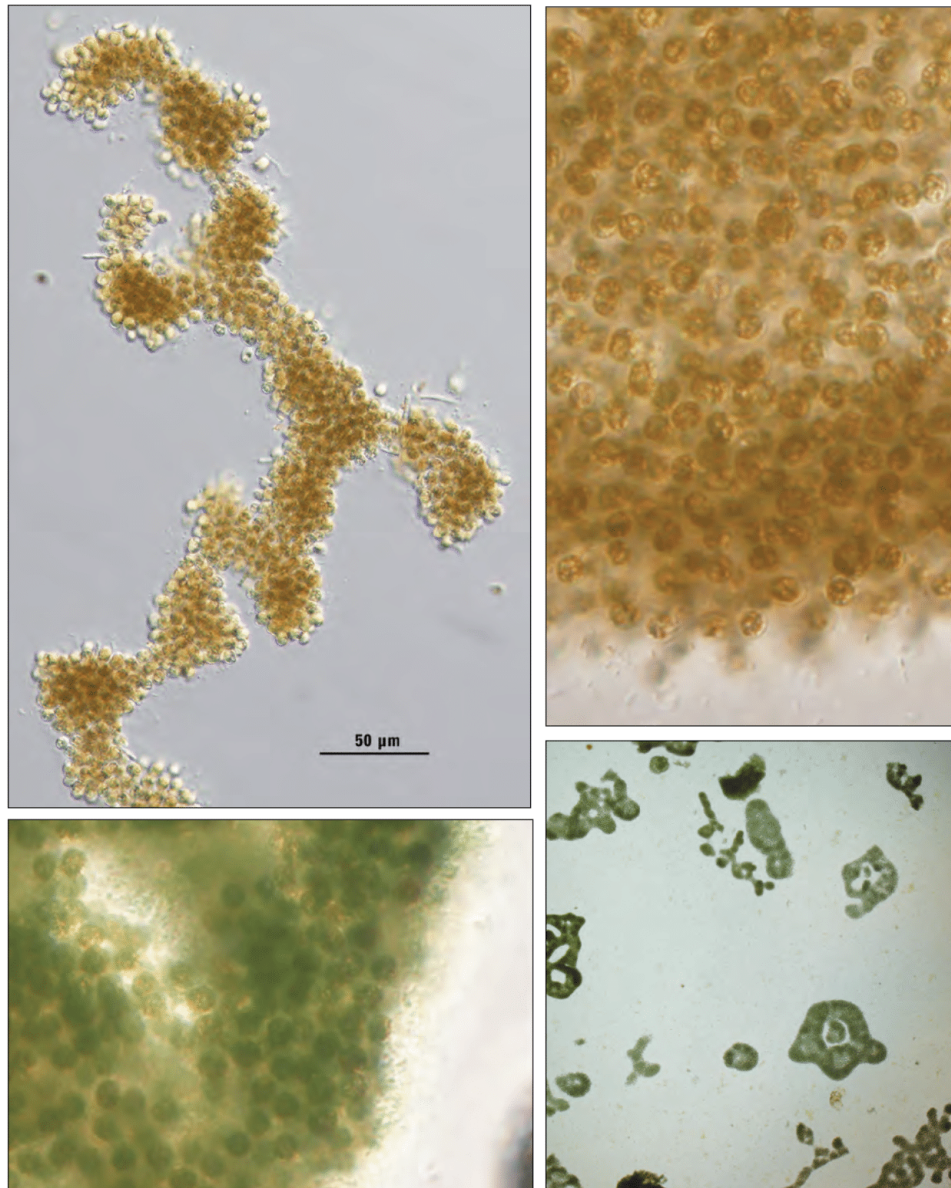
Macroalgae



FTIR_Carbohydrates



Microcystis aeruginosa



Wang et al. 2020

Figure 47. *Microcystis aeruginosa*. Round to oval cells embedding a mucilaginous matrix. Cell color varies from brown to various shades of green and blue-green. (Photographs: Barry H. Rosen)

Surface Slicks, 2023



Surface Slicks, 2023



Surface Slicks, 2023



Foam formation affects the distribution of chemical compounds in lakes

1.) Offshore formation



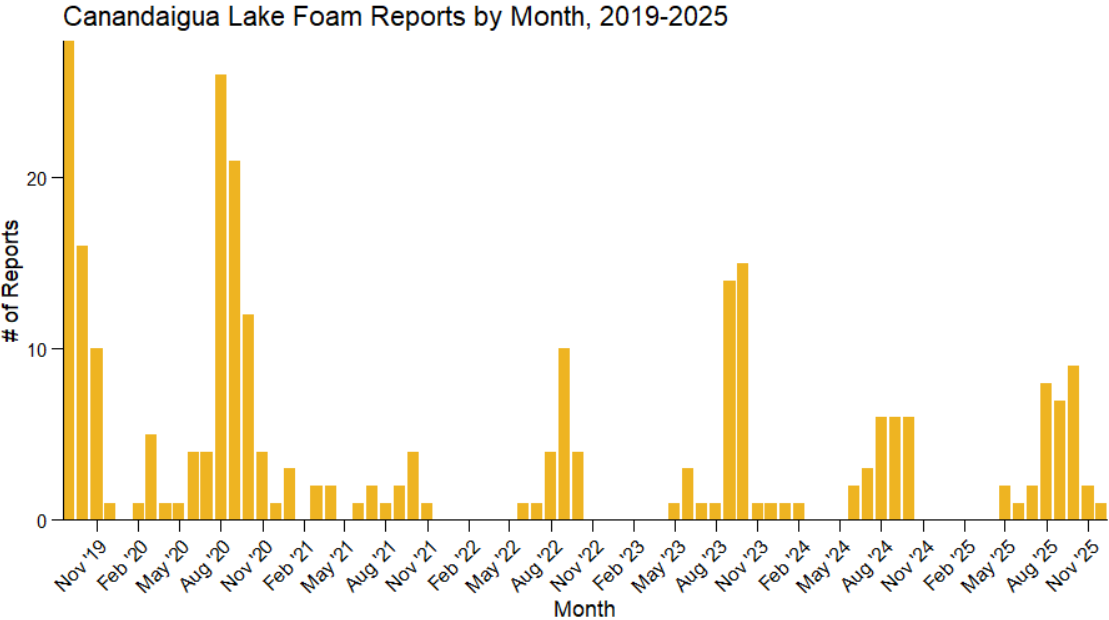
Photo: Lindsay McMillan, Canandaigua Lake

2.) Shoreline transport and accumulation

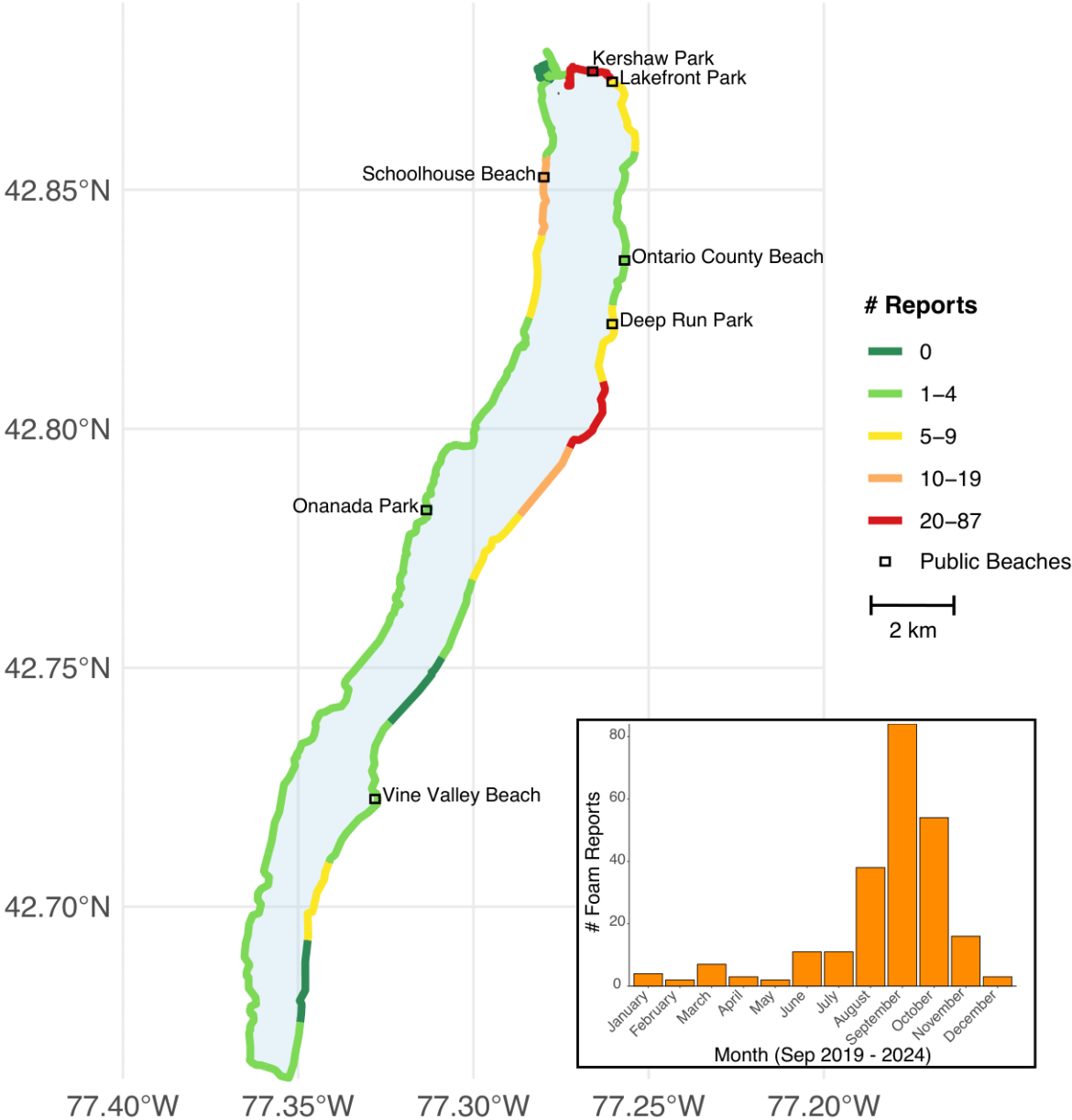


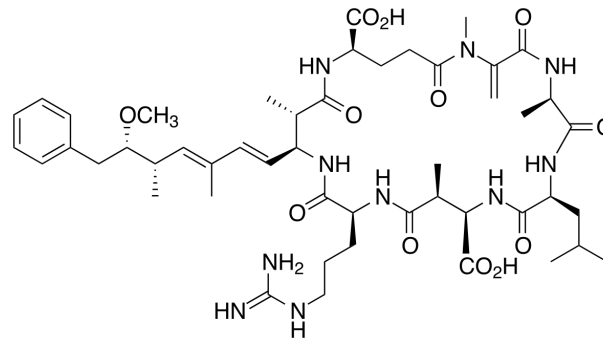
Photo: Richard Smith, Keuka Lake

Continuing to report foam can unlock new insights
- targeted shorelines for sampling/cleanup

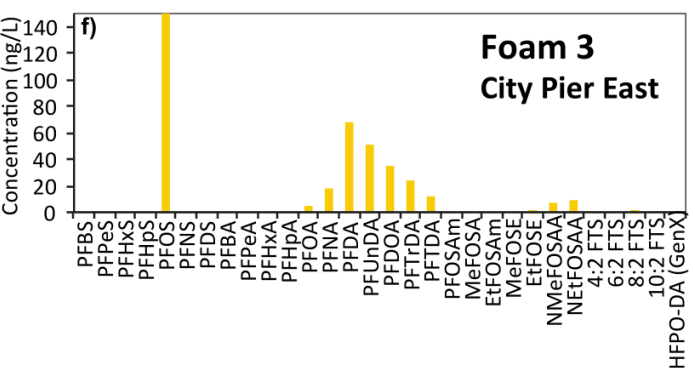
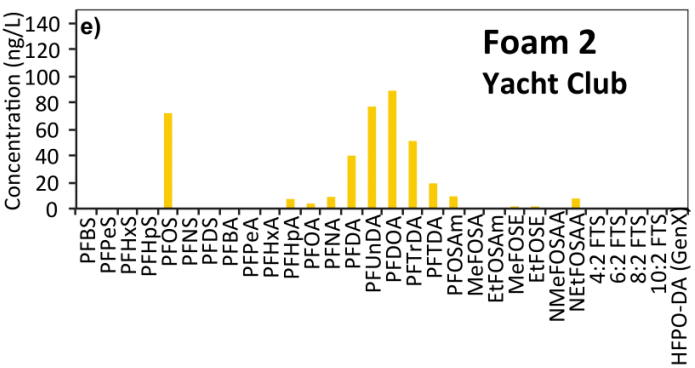
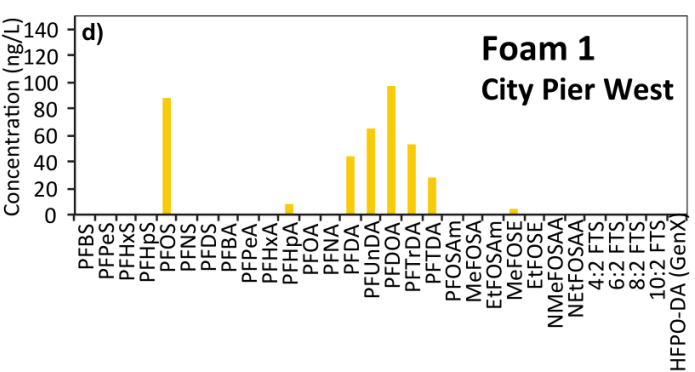
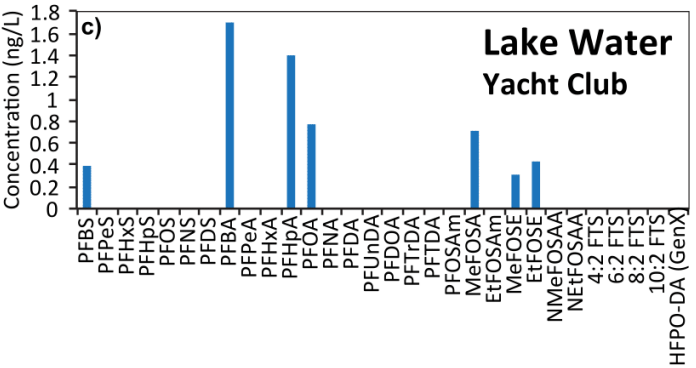
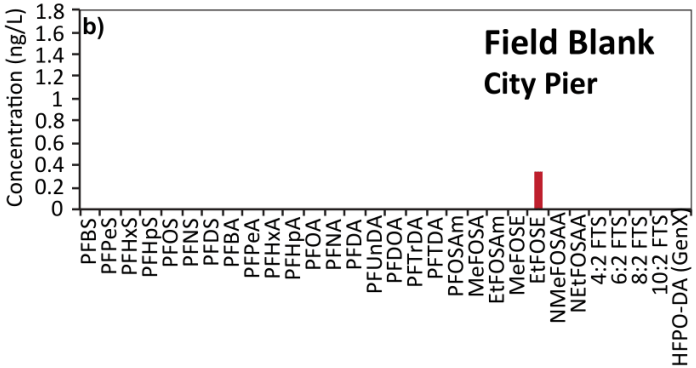
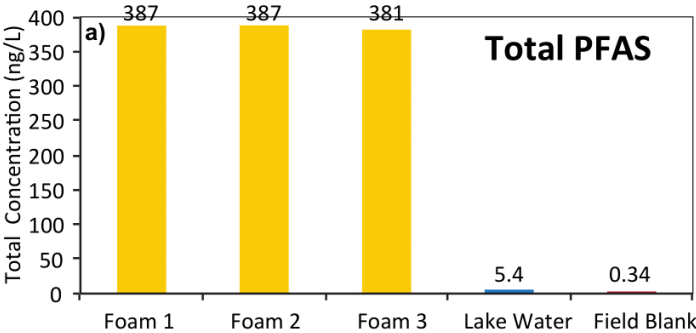


Canandaigua Lake Foam Sightings, 2019–2025



[illegible]

Lake Foam and Per- and Polyfluoroalkyl Substances (PFAS)



Sampling Campaign – 4 Finger Lakes

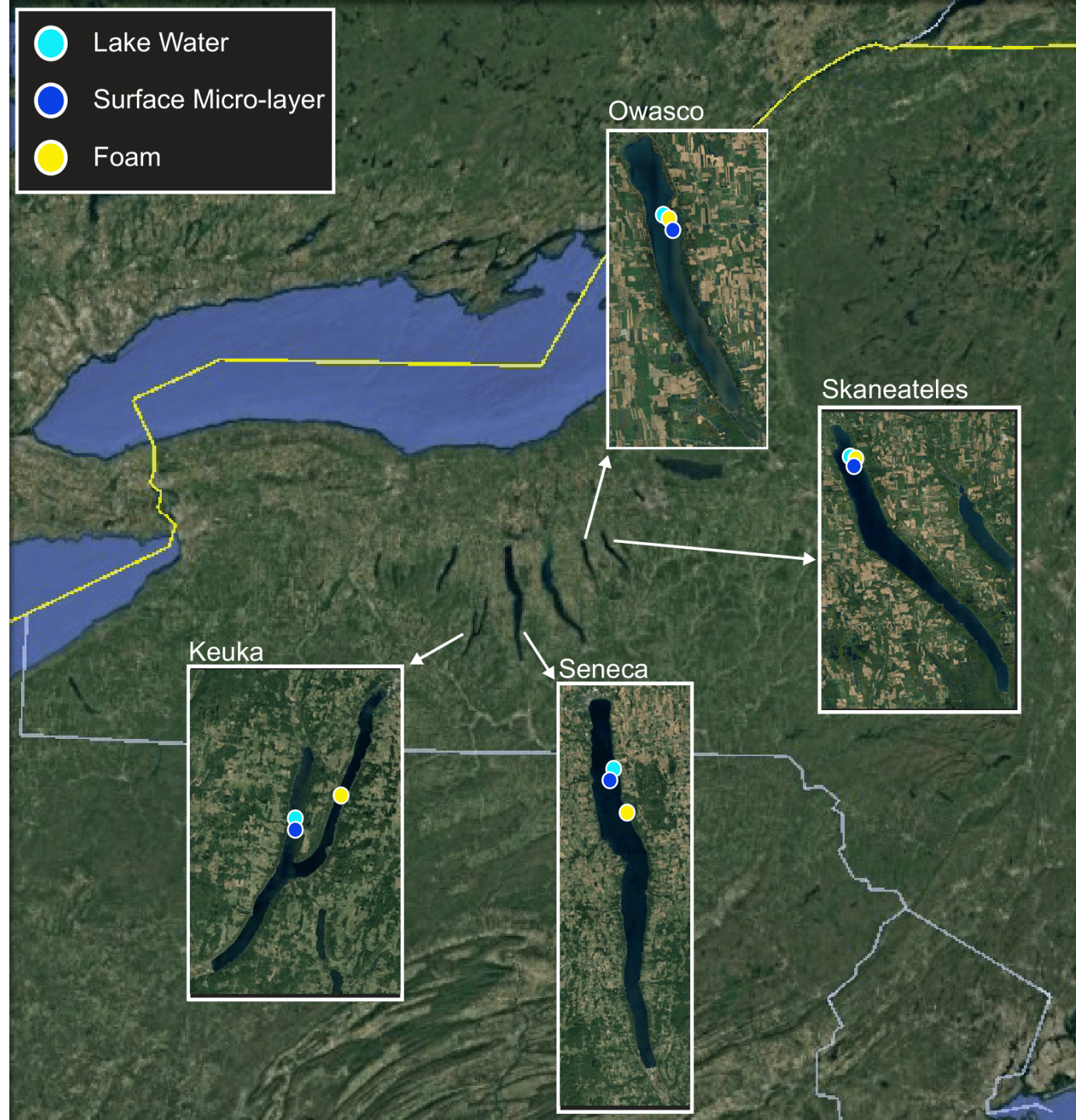
- WRI Funding (award # 103439)
- September and October 2025
- Guided by submitted foam surveys
- Partitioning of PFAS in surface waters

SML sampling using a Garret screen

Step 1 – SML collection

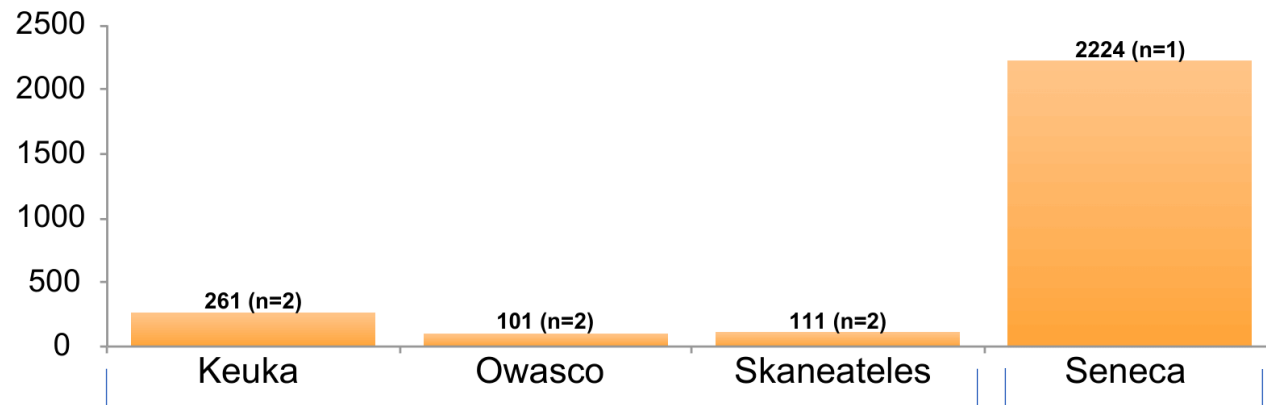


Step 2 – Drain into bottle



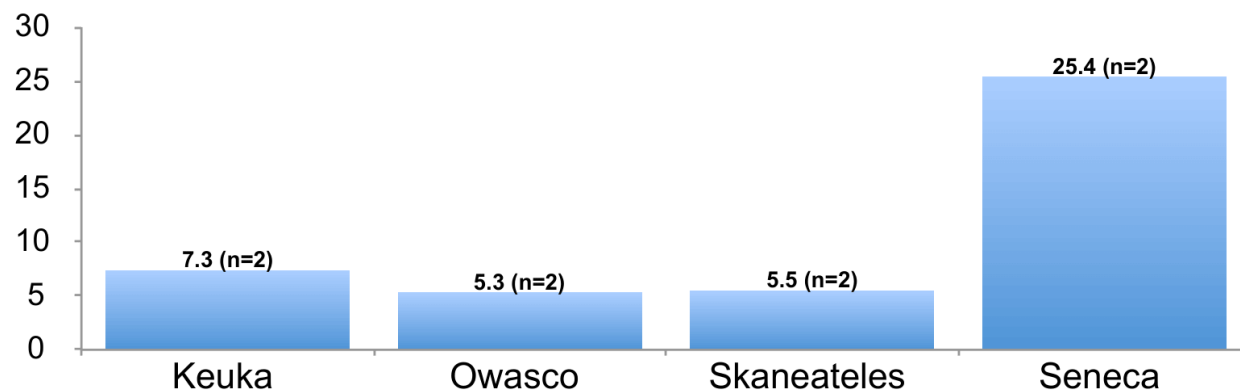
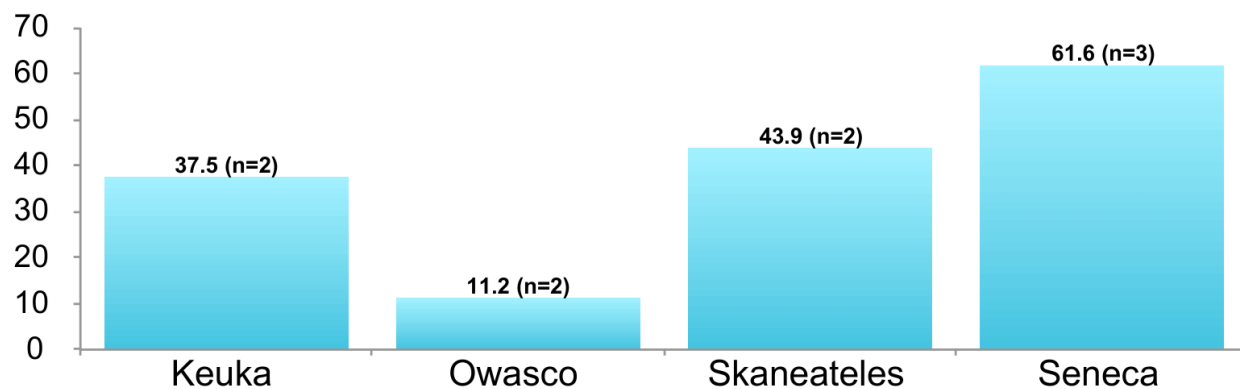
Total PFAS

■ Foam
 ■ SML
 ■ Water

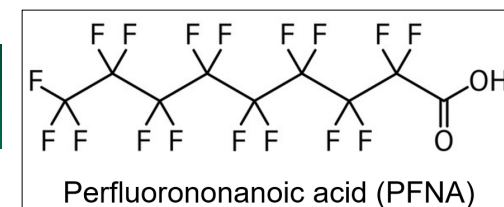
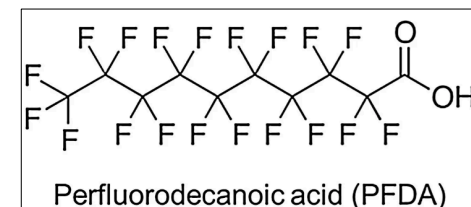
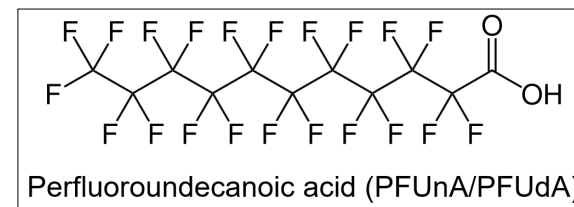
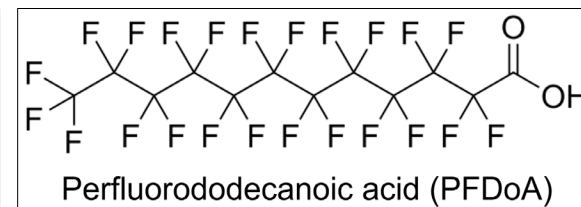
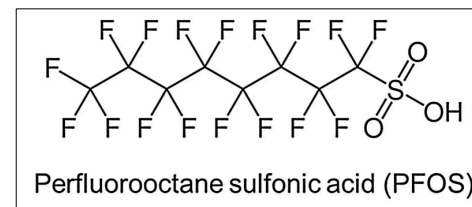
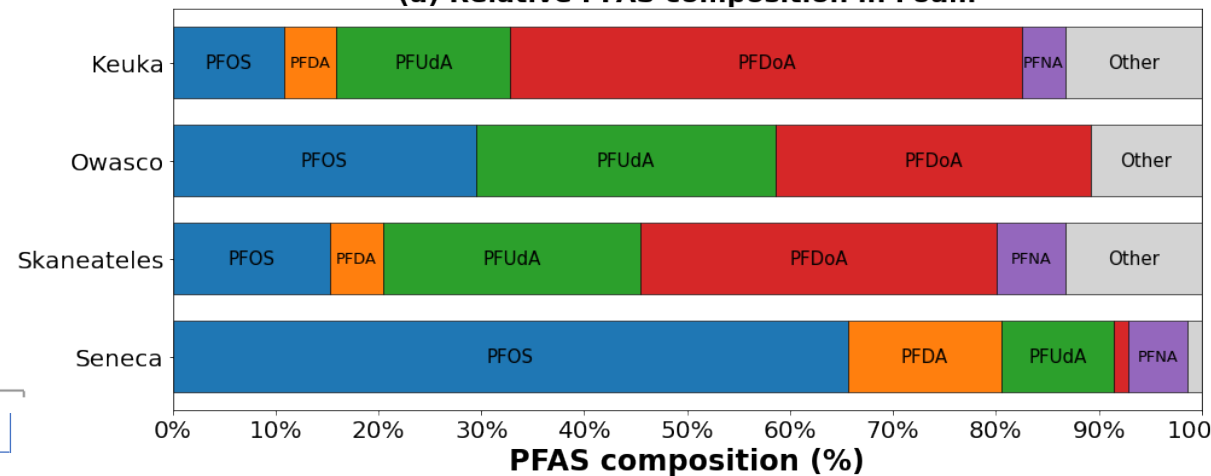


Open Water Foam

Shoreline Foam



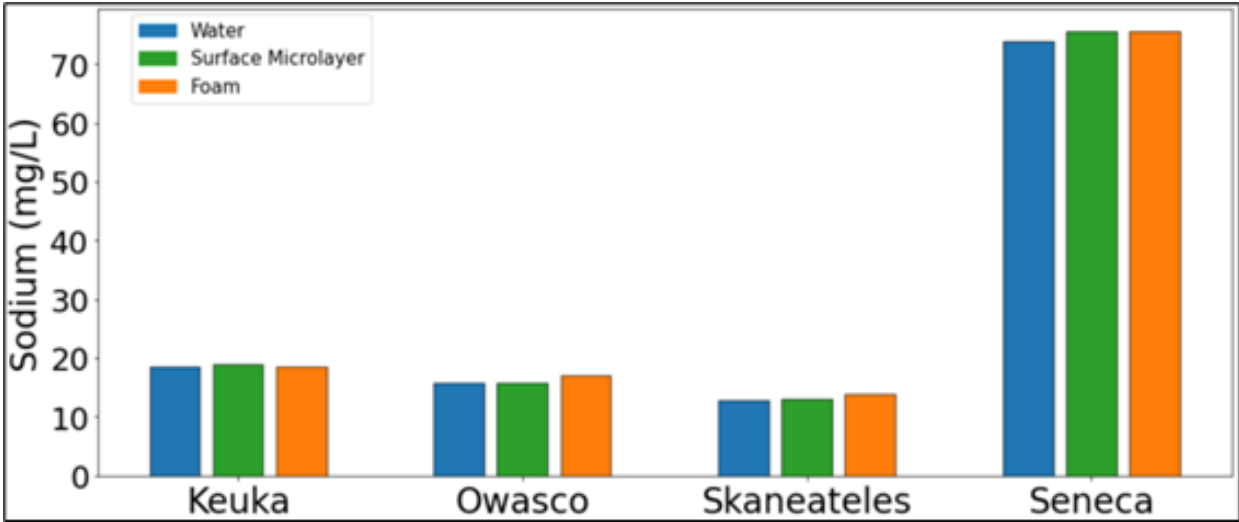
(a) Relative PFAS composition in Foam



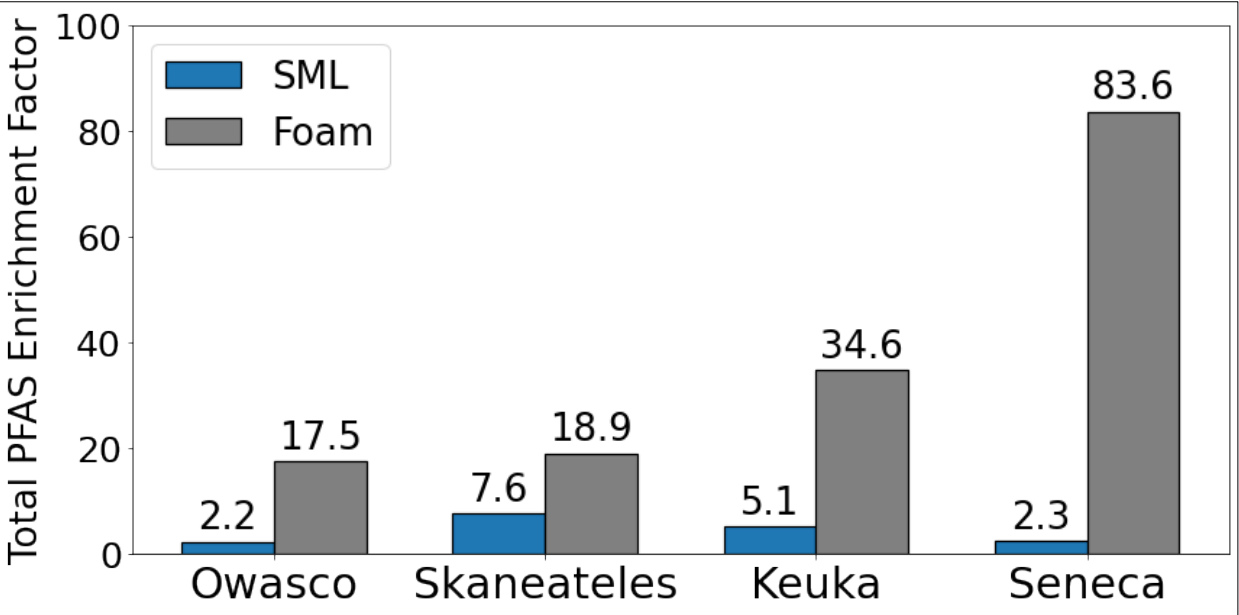
PFAS Enrichment Factors

Sodium normalization

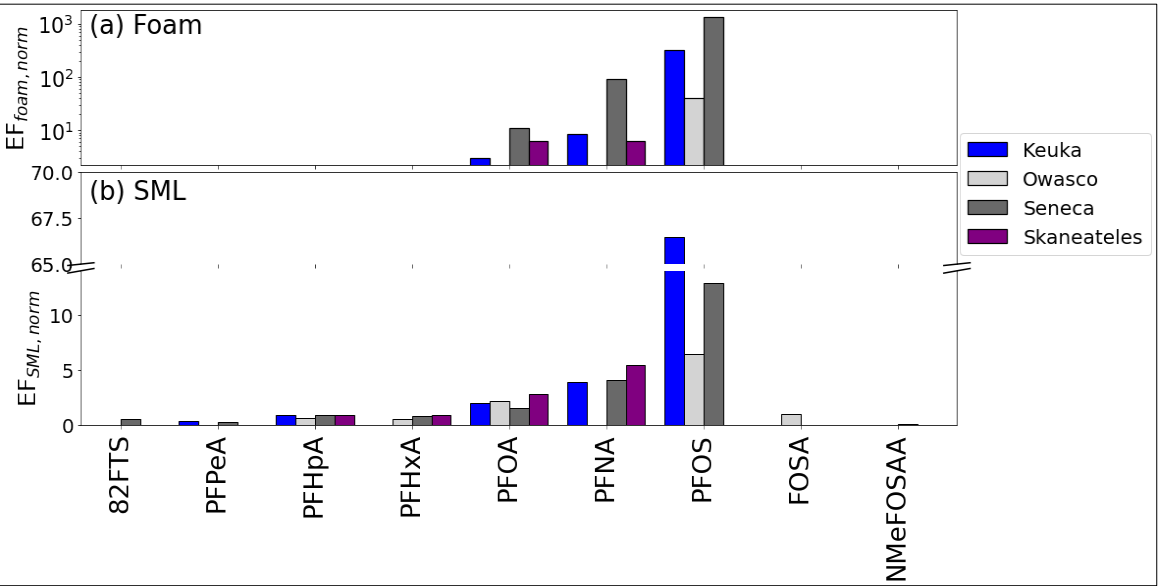
$$EF_{\text{foam, norm}} = \frac{[\text{PFAS}]_{\text{foam}} / [\text{Na}^+]_{\text{foam}}}{[\text{PFAS}]_{\text{water}} / [\text{Na}^+]_{\text{water}}}$$



Total PFAS EFs



Compound-specific EFs



← Foam

Next Steps

HABs →

Q: Why do some lakes get more foam? How can we respond?

Approaches

Additional composition analysis
Quantify more contaminant types
Soil testing
Clean-up



Q: How do we better manage and mitigate HABs

Approaches

Expanded view of nutrients
Targeted sub-watershed studies
HABs data analysis
Outreach/Fundraising



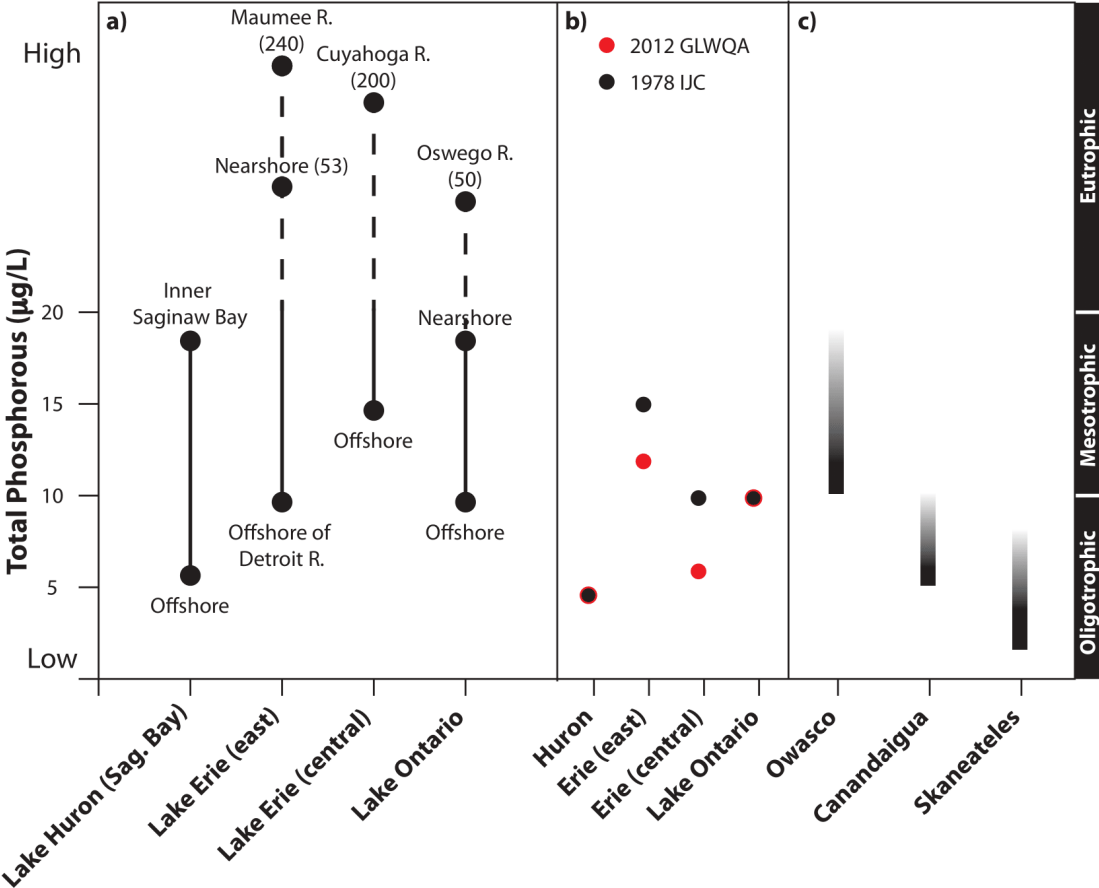
SCIENCE STUFF

OUTDOORS: Why harmful algal blooms in the Finger Lakes are so challenging to mitigate

By CHRIS KENYON ckenyonrun@gmail.com Aug 31, 2024 Updated Sep 2, 2024

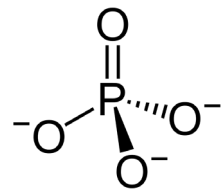


Richard W. Smith and Stella C. Woodard sample the surface microlayer (top millimeter of water) of Skaneateles Lake on Aug. 7,

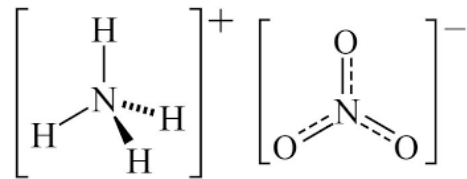


If nutrients are the only thing we can control, we have to do it well

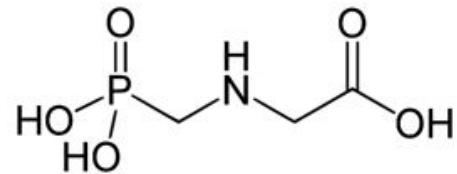
- Expanding our view to include multiple forms of nitrogen and phosphorus
- What causes cyanobacteria to outcompete other algal types? Enhanced toxicity?



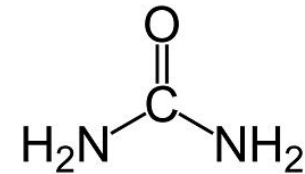
Phosphate
(DIP)



Ammonium & Nitrate
(DIN)



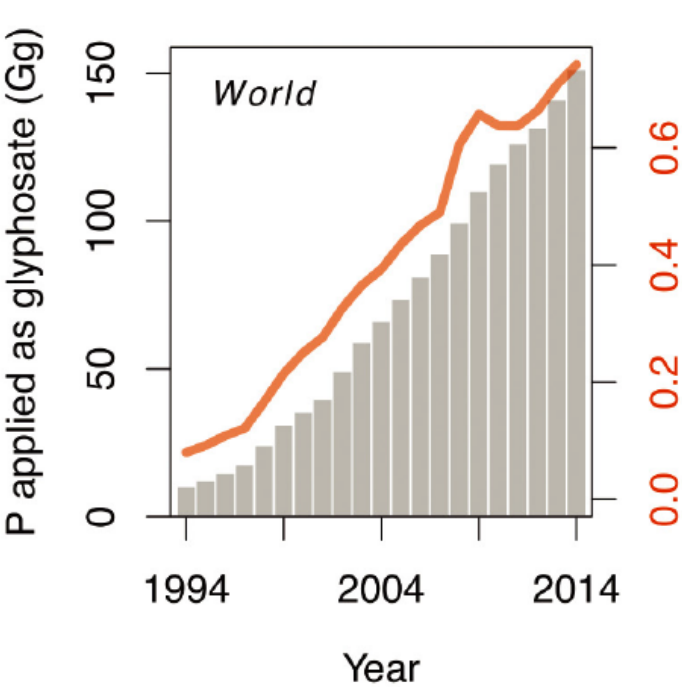
Glyphosate
(DOP, DON)



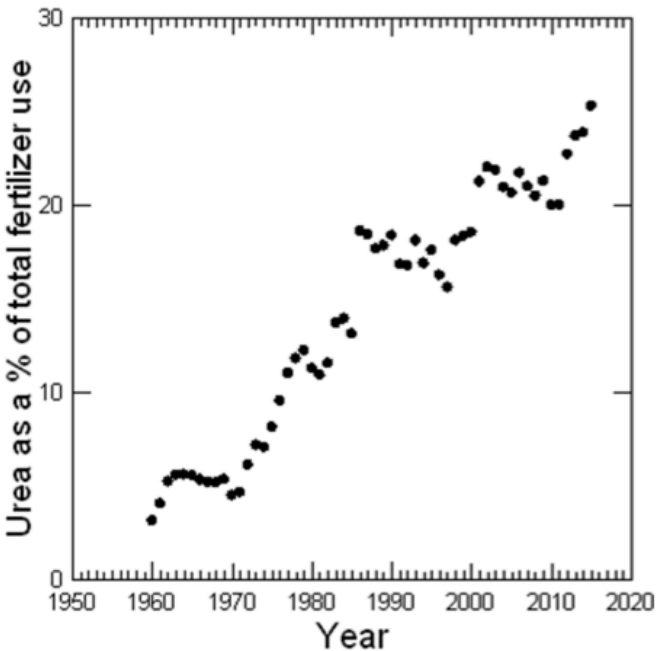
Urea
(DON)

Phosphorus	Total	Inorganic	Organic
Total	TP	TIP	TOP
Dissolved	TDP	DIP	DOP
Particulate	PP	PIP	POP

Nitrogen	Total	Inorganic	Organic
Total	TN	TIN	TON
Dissolved	TDN	DIN	DON
Particulate	PN	PIN	PON

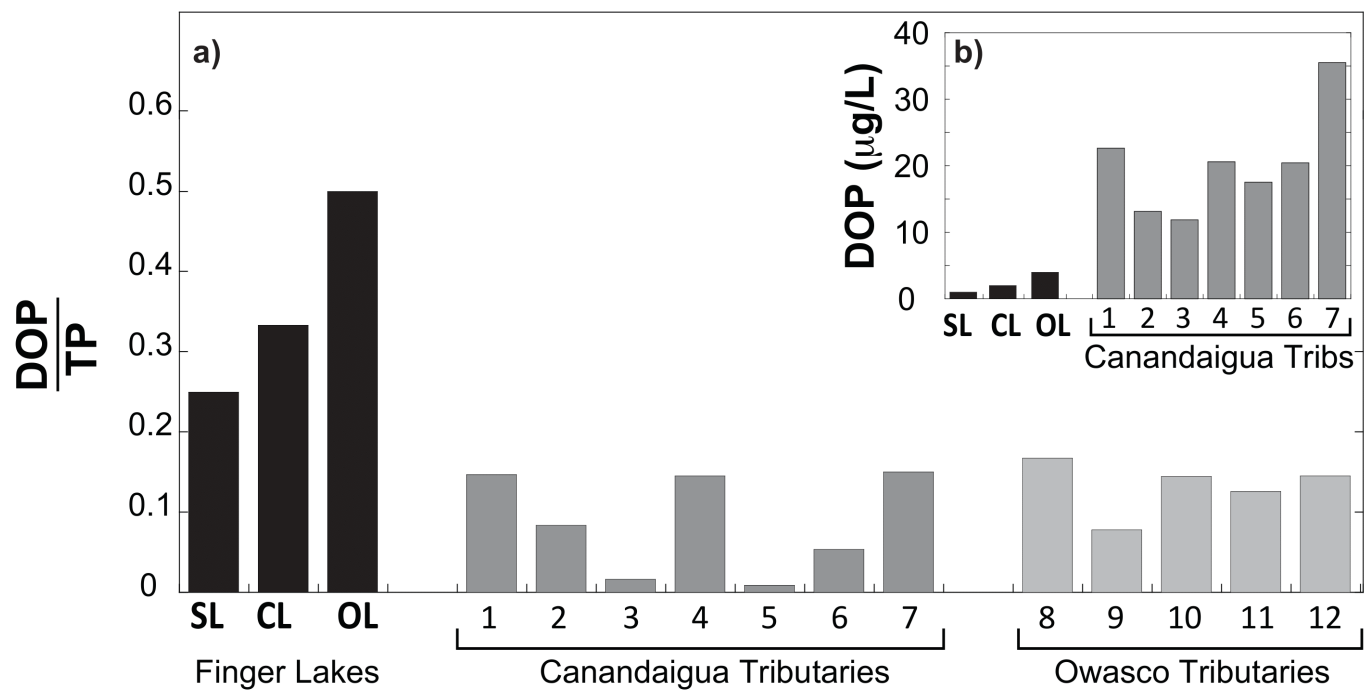
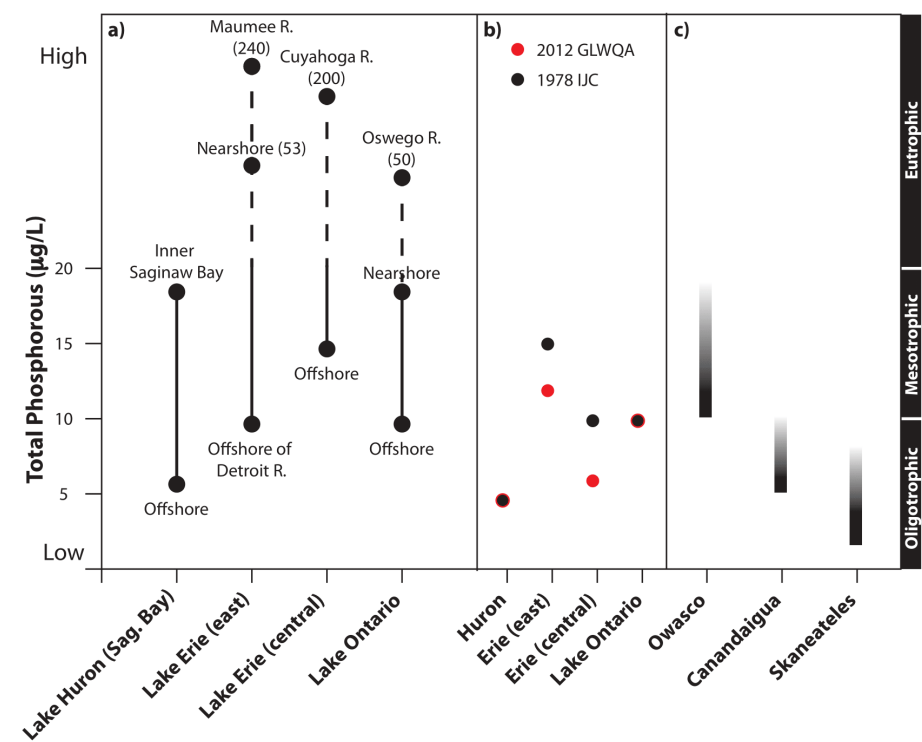
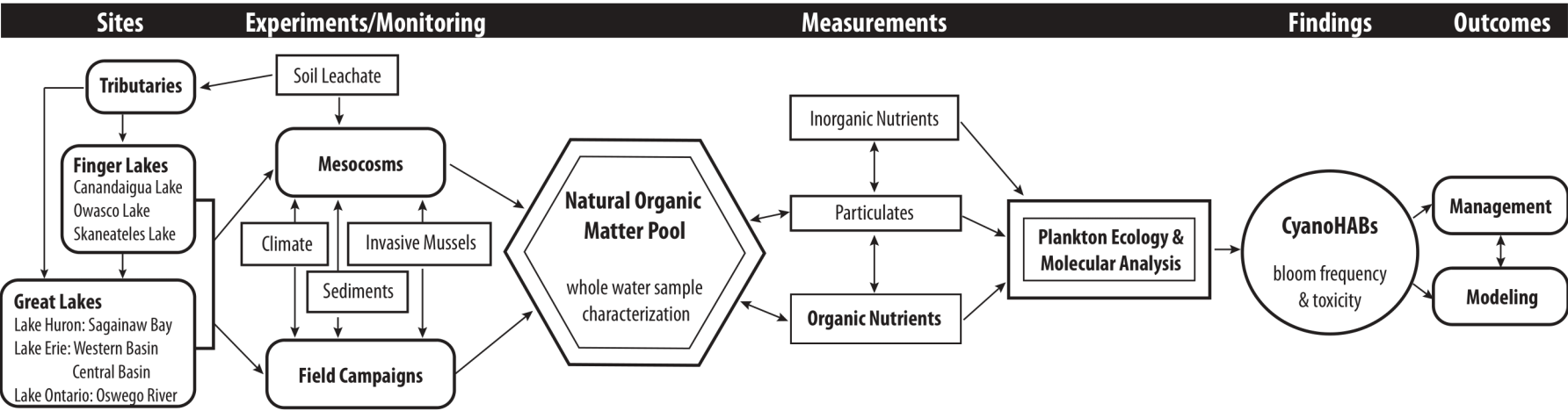
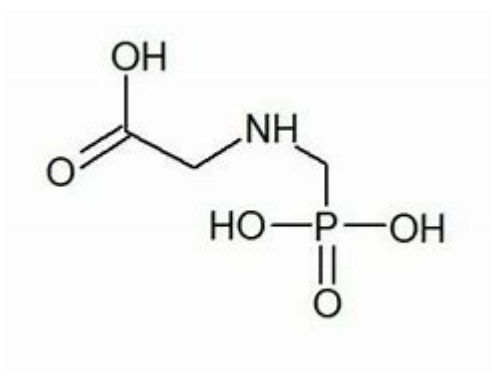


Hebert et al. 2019



Reinl et al. 2022

Role of organic nutrients



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