Microplastic Abundance and Characteristics in Lake Superior and Adjacent Harbor

Dr. Melissa A. Maurer-Jones

Department of Chemistry & Biochemistry
University of Minnesota Duluth

Great Lakes Microplastic Summit

October 2025

Acknowledgements

Maurer-Jones Research Group

maujones@d.umn.edu

Funding

UMD

Sea Grant Minnesota

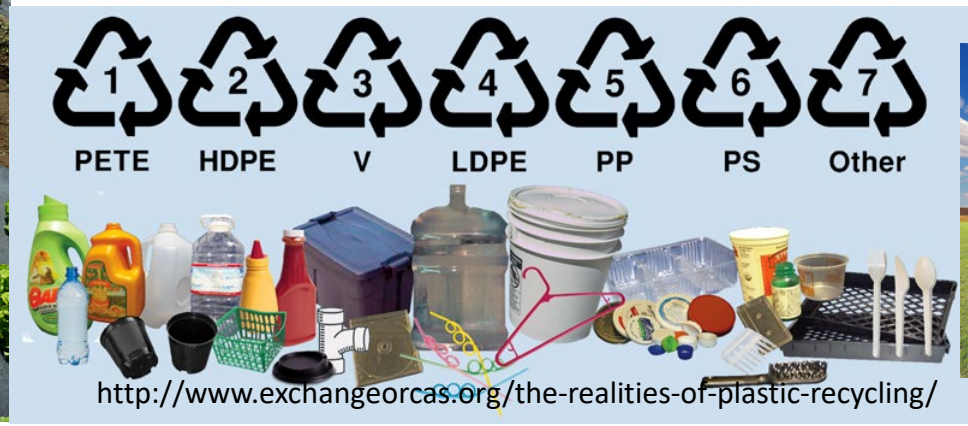
NSF

NSF Center for Sustainable Polymers

Collaborators

Elizabeth Minor (UMD)
Kathryn Schreiner (UMD)
Margaret Elmer-Dixon (MSOE)
Jessica Sieber (UMD)
R Lee Penn (UMN-TC)
Matt Simcik (UMN-TC)

Plastics are in our environment in a number of ways



http://www.exchangeorcas.org/the-realities-of-plastic-recycling/

sundancesolar.com

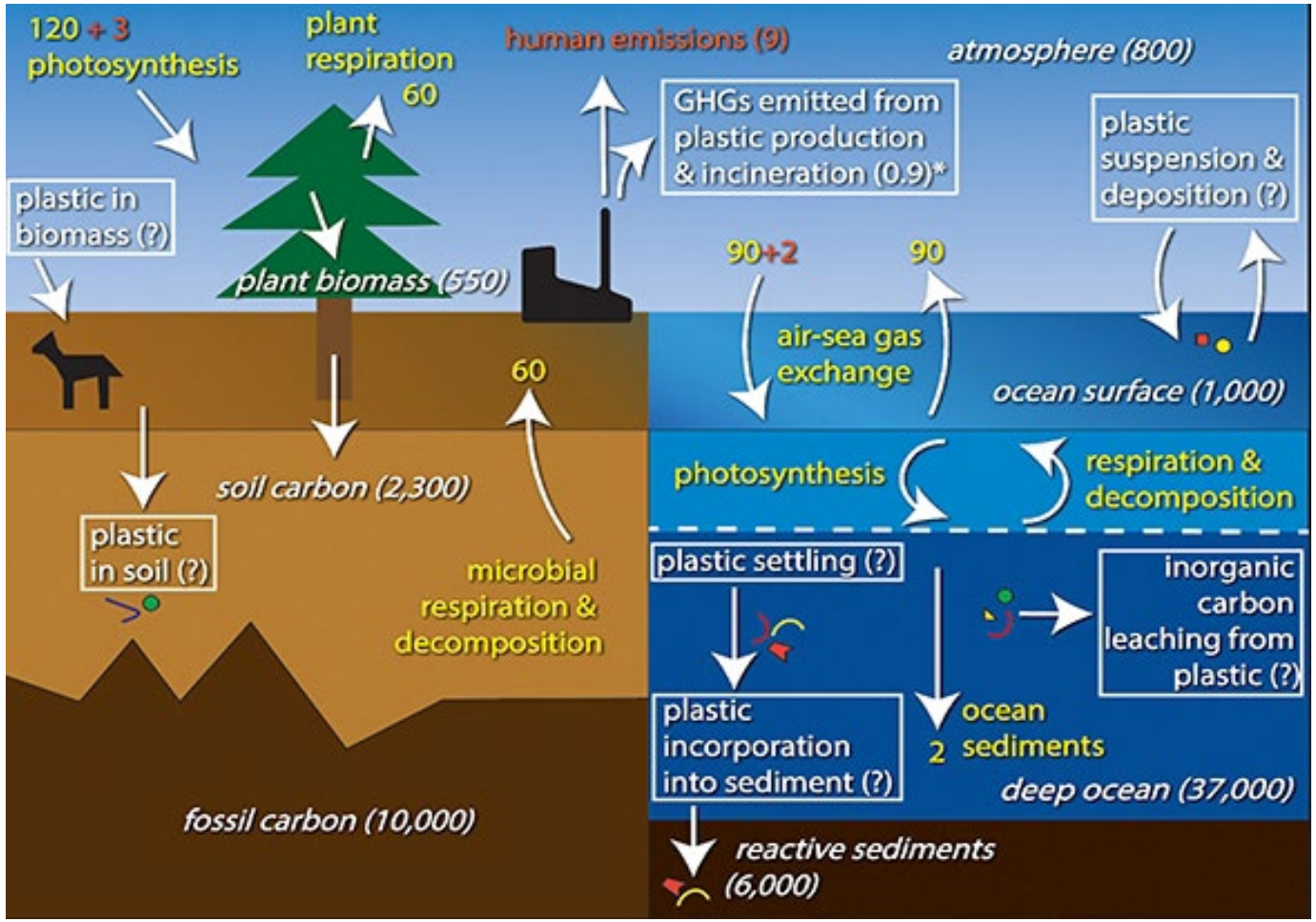
- Plastic production = ~9.2 billion tonnes as of 2019
- Disposed through energy recovery (12%), landfilling (79%), and recycling (9%)

Plastics Europe 2015; OurWorldData 2019

https://plus.google.com/+sciencesunday/posts/1uFz9aC67om

Plastics are an under-studied part of the carbon cycle

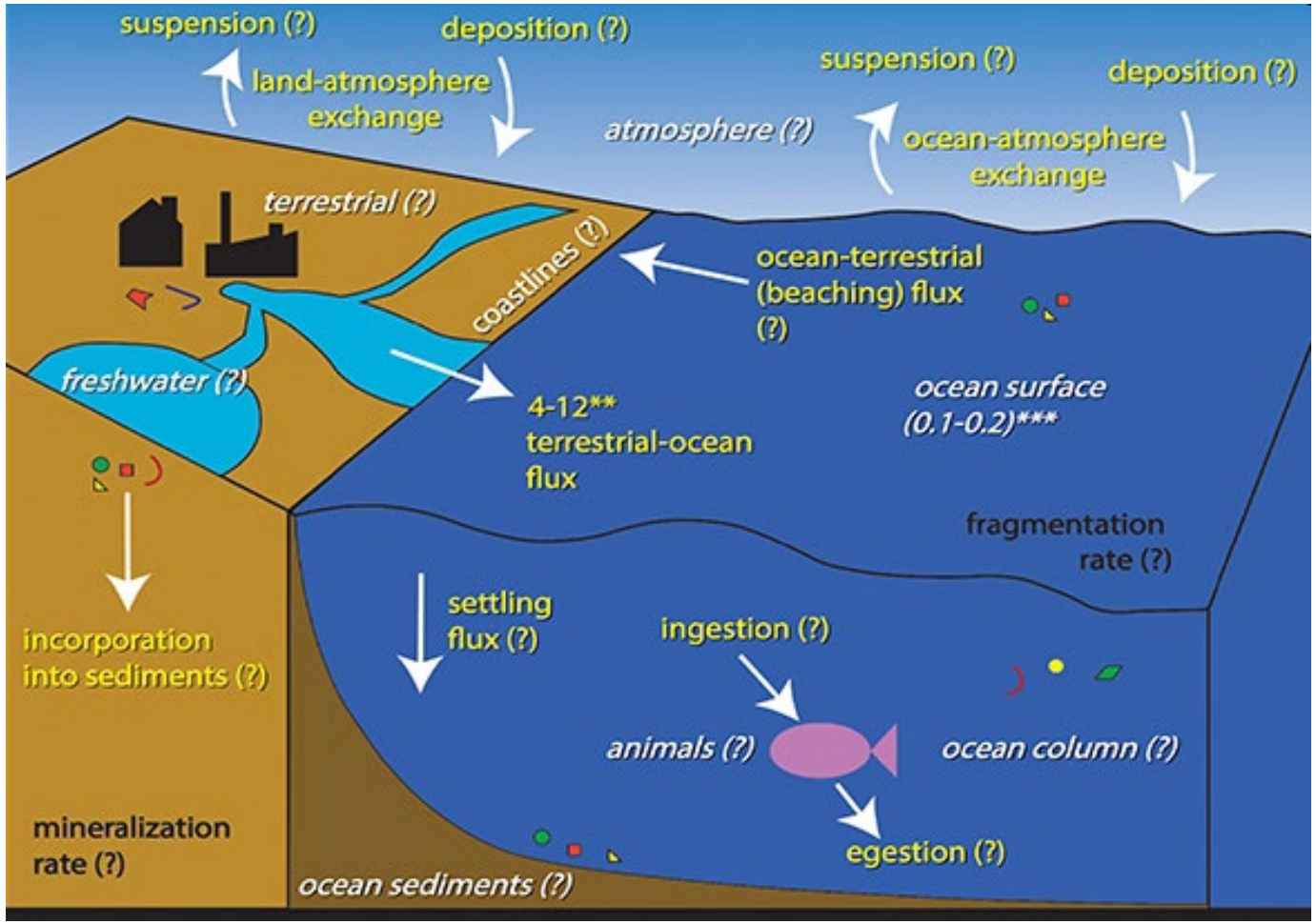
Carbon Cycle



Zhu (2021)

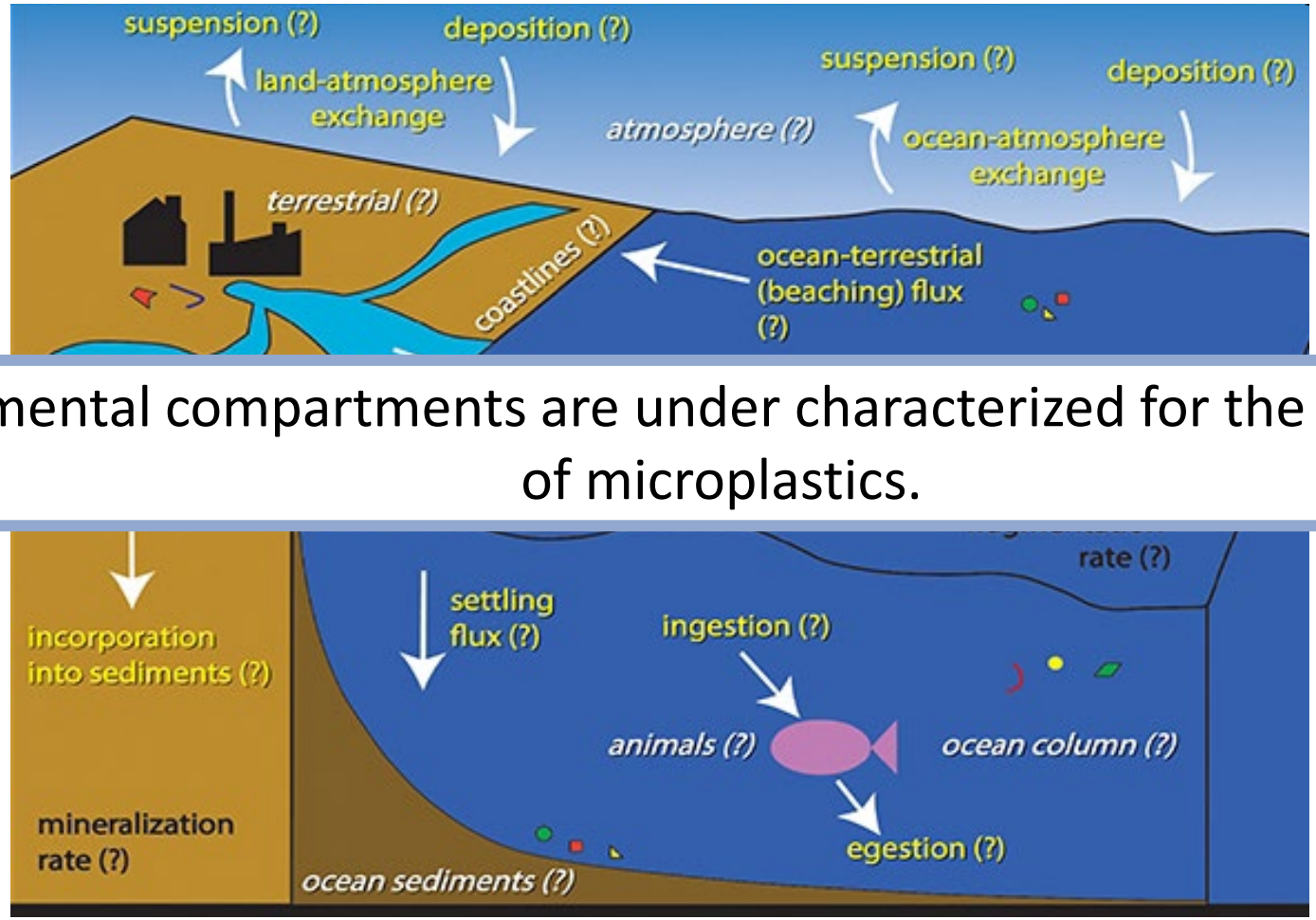
Plastic distribution through the environment

Plastic Cycle



Zhu (2021)

Plastic distribution through the environment

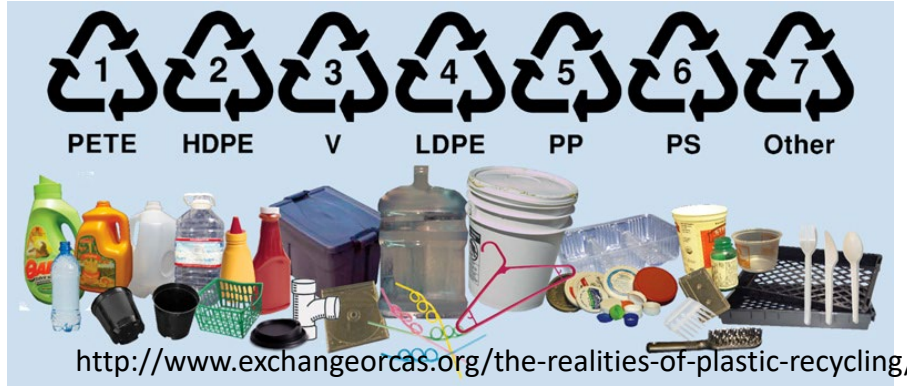


Many environmental compartments are under characterized for the abundance and flux of microplastics.

Zhu (2021)

Plastics and Microplastics – some definitions

- Plastics – a mixture of chemicals that include polymer + additives



http://www.exchangeorcas.org/the-realities-of-plastic-recycling/

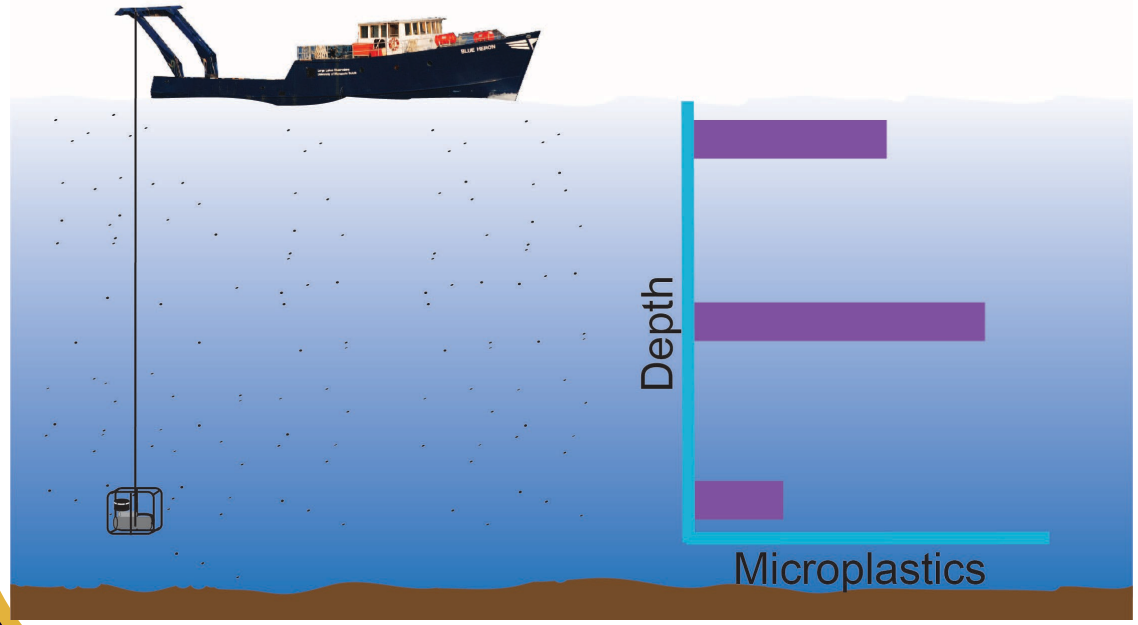
- Microplastics – tiny plastic particles (<5mm) found in water bodies, air, soil, sediment.

Questions tackled in Lake Superior sampling

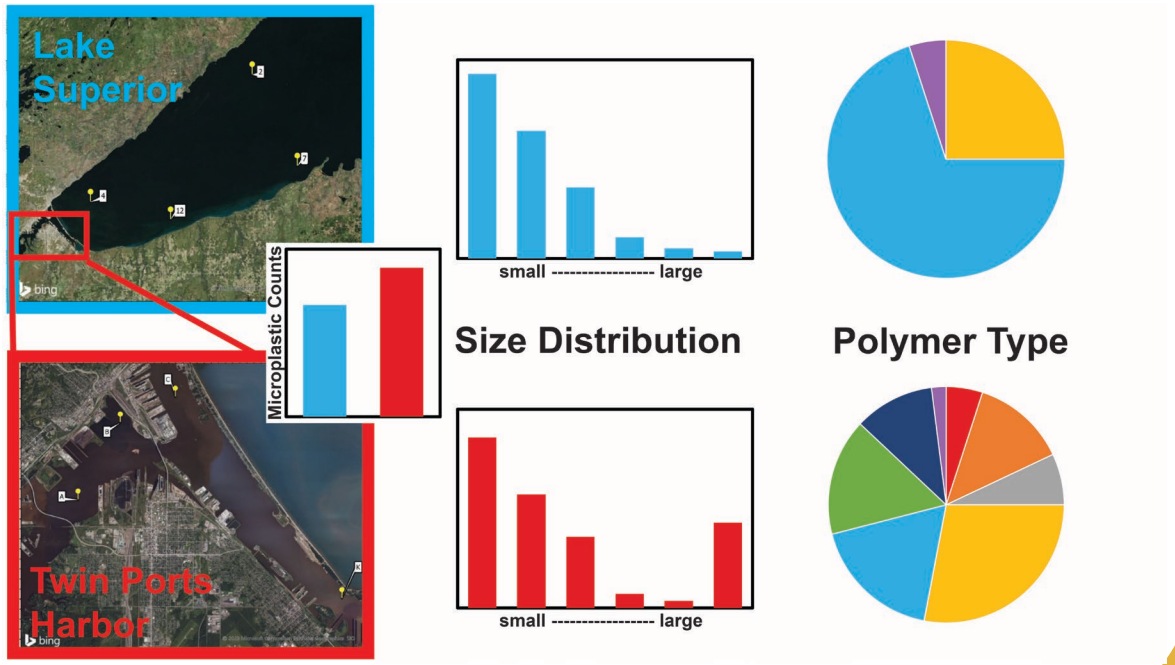
What methods can we use to collect samples at various size ranges and in different areas of the lake and estuary?

How do we characterize plastics (composition) at the different size classes?

How do we ensure our particle counting is accurate?

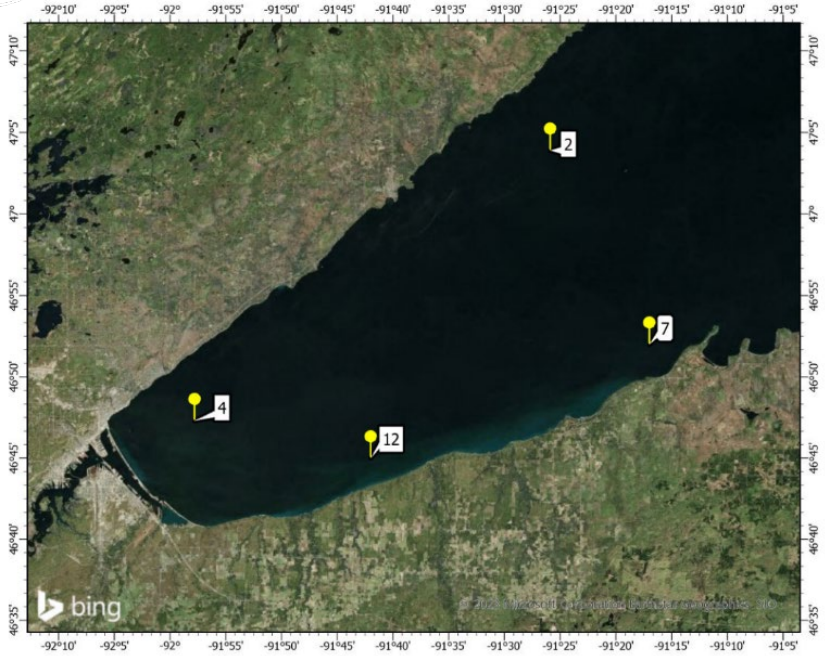


Fox et al., *ACS ES&T Water* 2022



Minor et al., *L&O Methods* 2023; Thomas et al., *ES&T* 2024

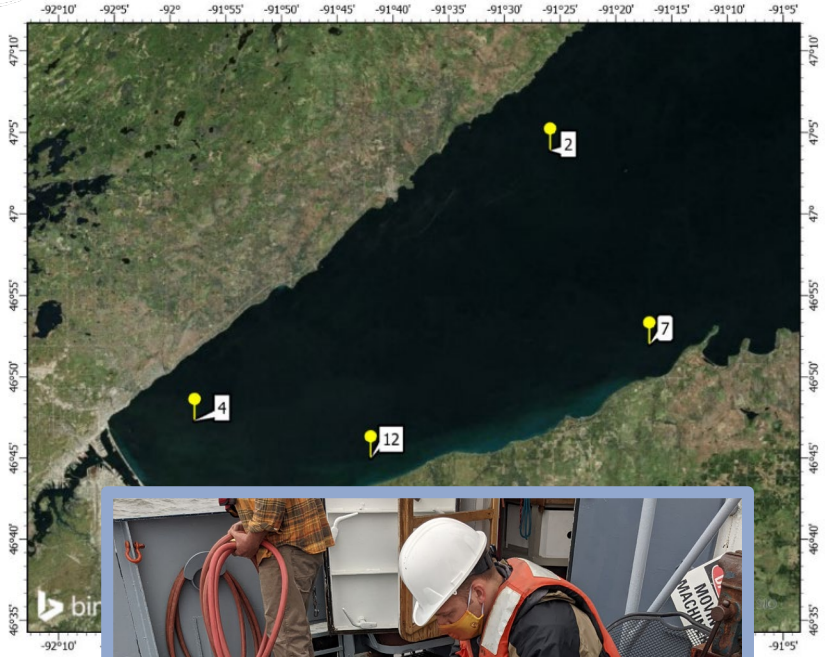
Our Field Site and Sampling Approaches



Sampled 4 locations in Western Lake Superior in Aug 2020, May 2021, and Aug 2021 on *R/V Blue Heron*

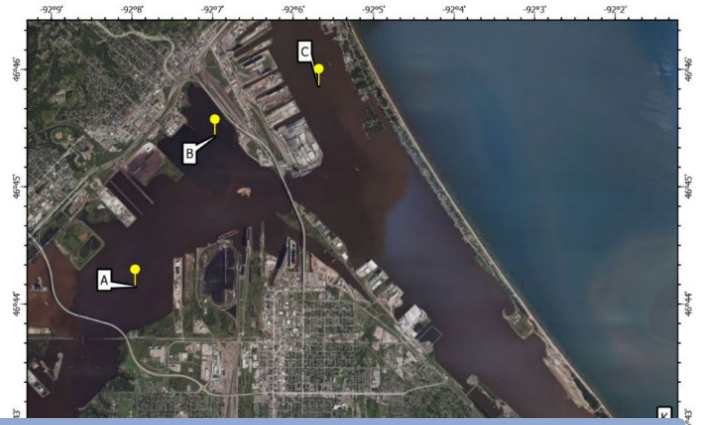
Sampled 4 location in St. Louis River Estuary in Sept 2021 *R/V Kingfisher*

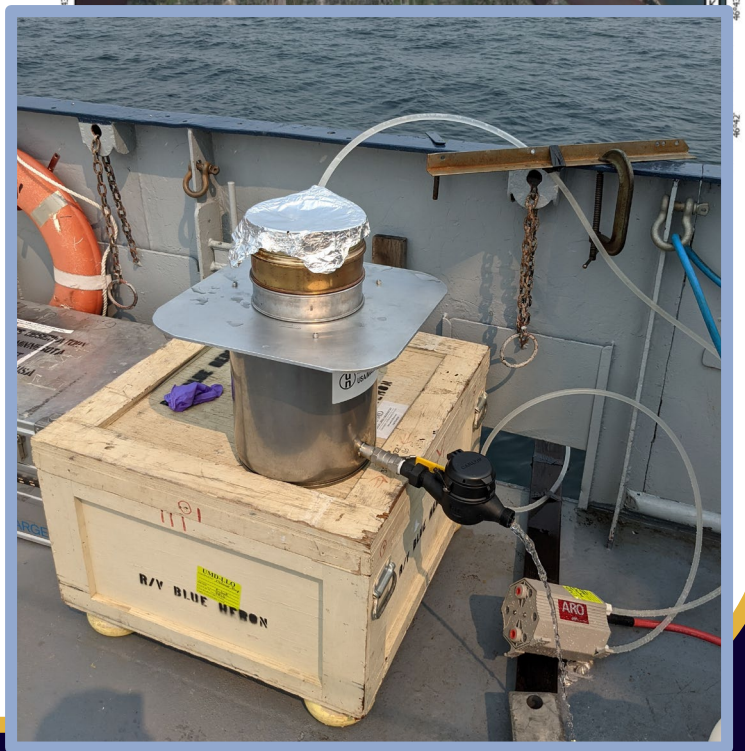
Our Field Site and Approaches



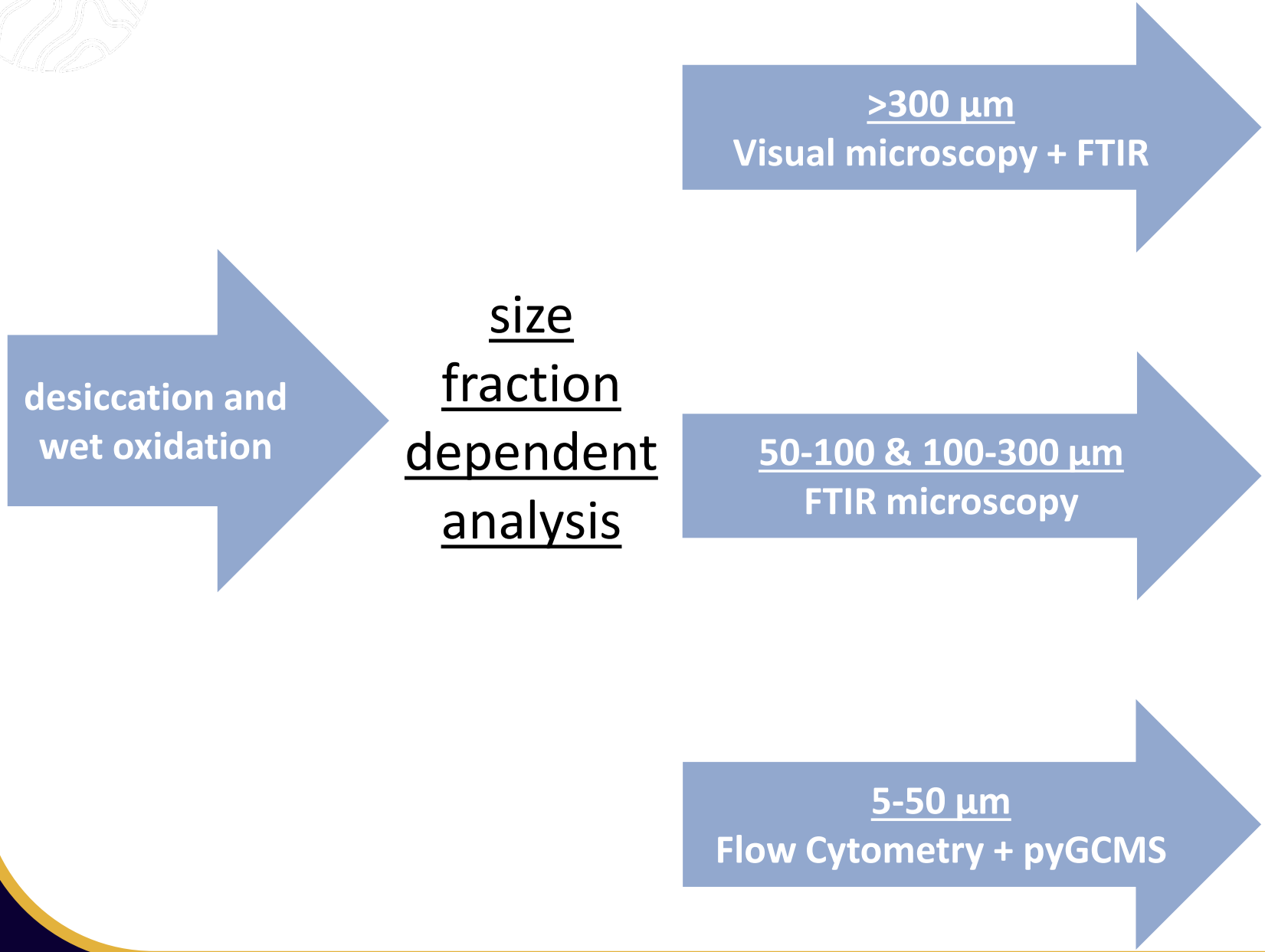
McLane pump collect samples in the water column using the McLane pump off the end of the *R/V Blue Heron*

Cascade filter tower used to collect samples both in lake and in harbor.





Our methods of sample processing and analysis

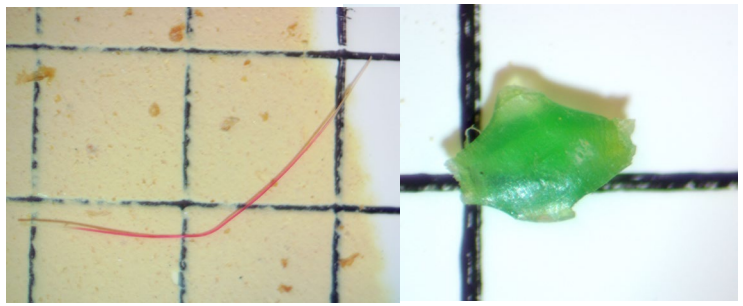


Our methods of sample processing and analysis

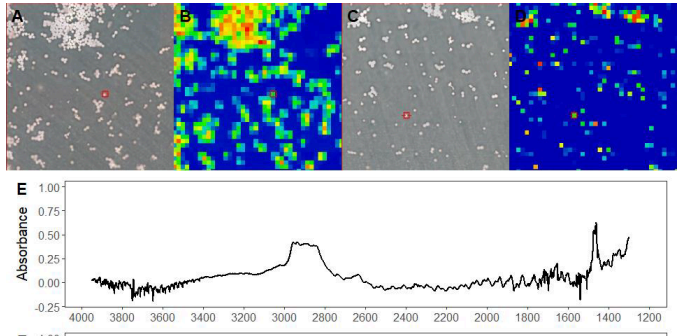
desiccation and wet oxidation

size fraction dependent analysis

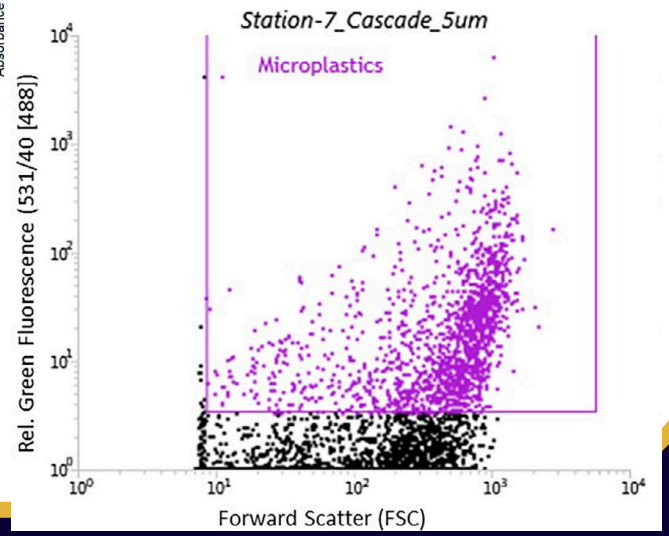
>300 µm
Visual microscopy + FTIR



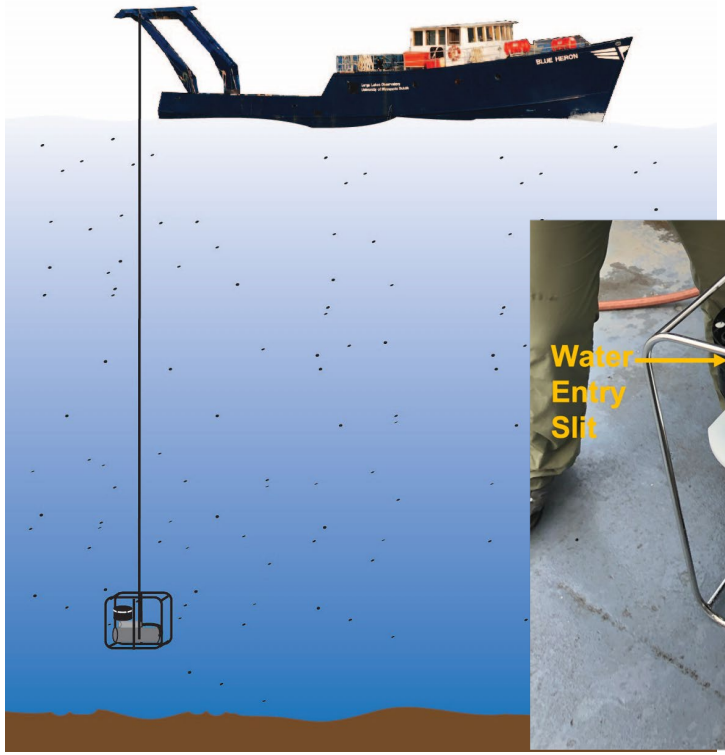
50-100 & 100-300 µm
FTIR microscopy

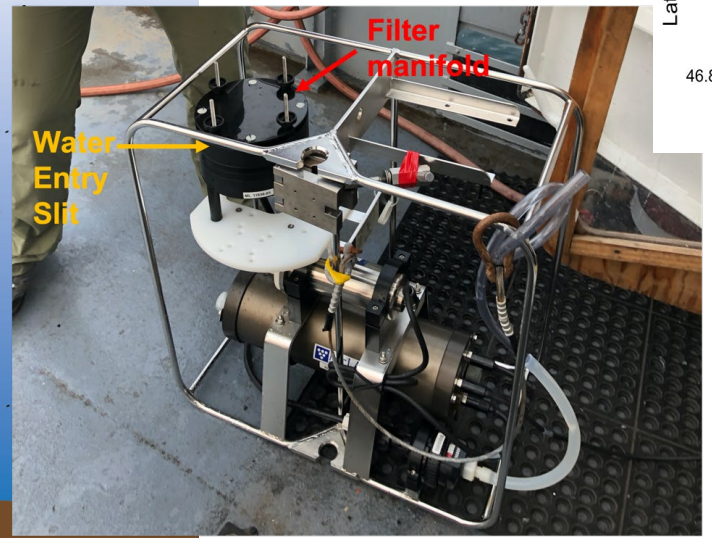


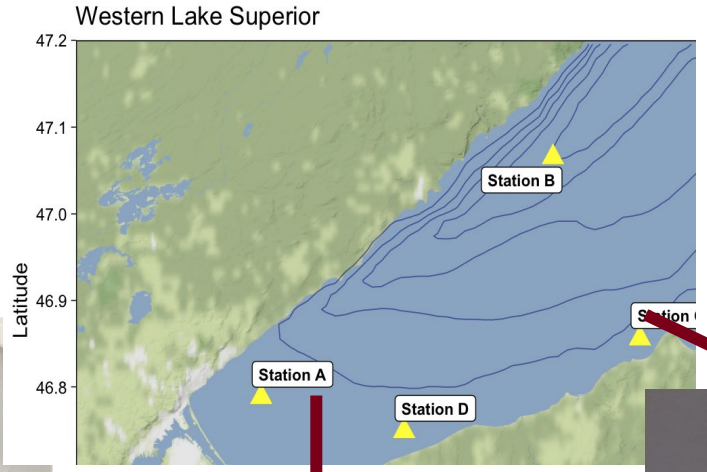
5-50 µm
Flow Cytometry + pyGCMS



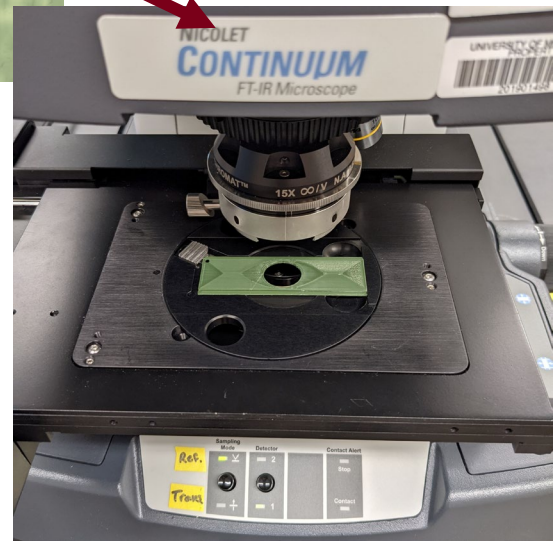
Our Major Findings – Microplastics through the water column



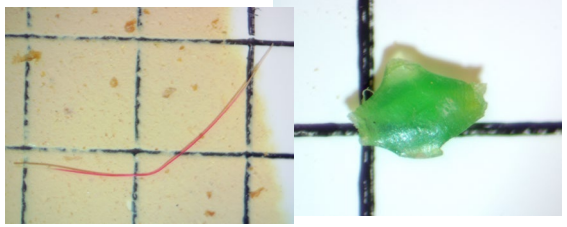




100-300 µm: FTIR microscopy



>300 µm: visual microscopy

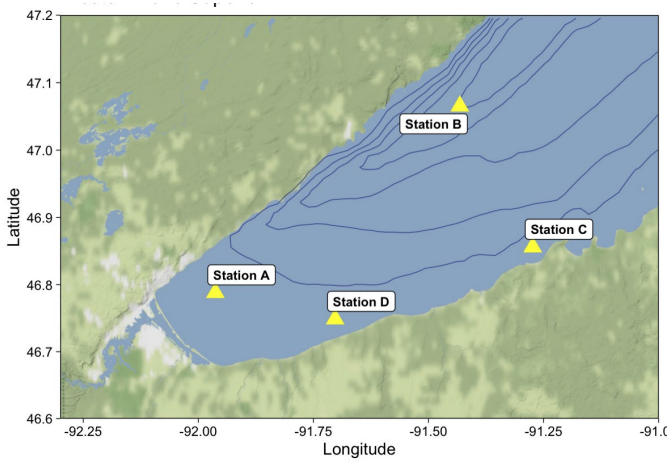


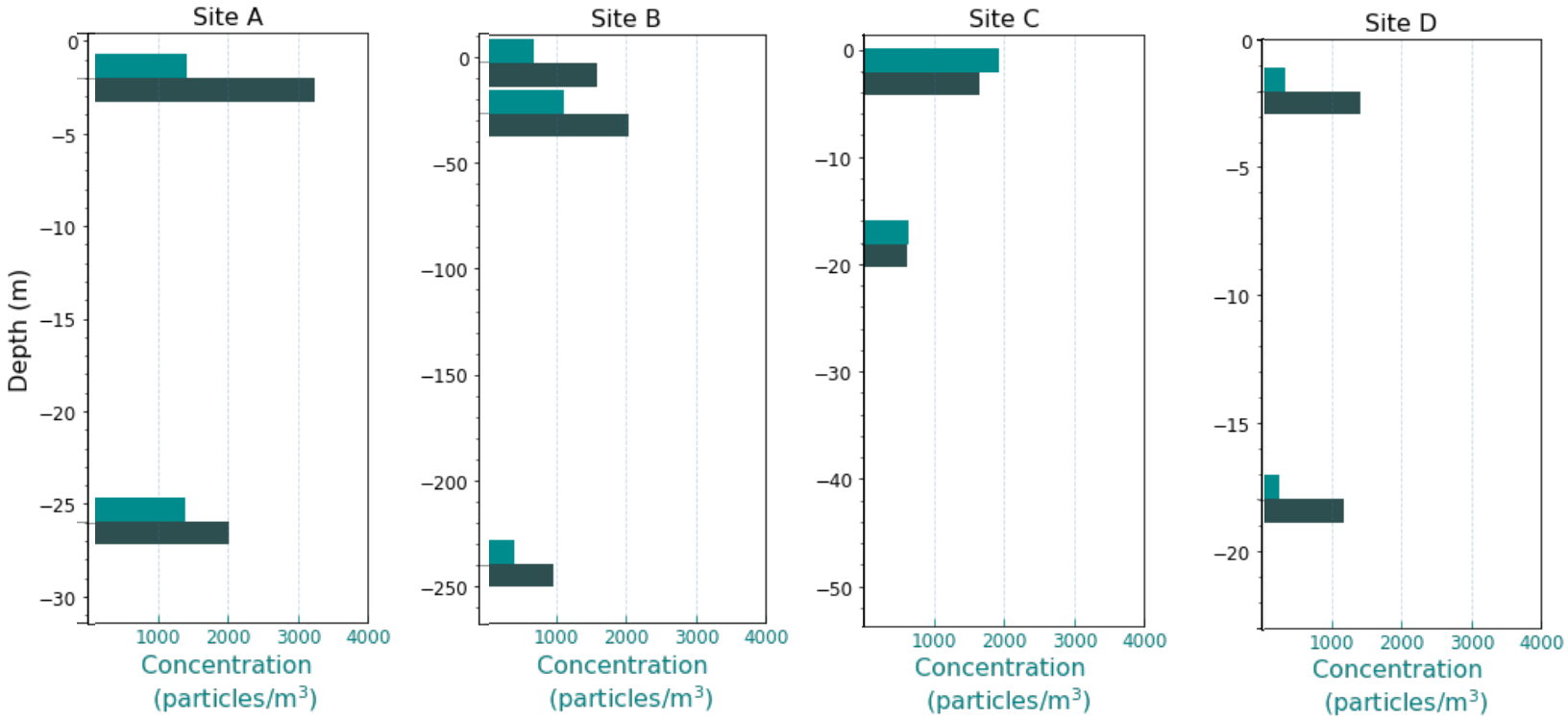
Sampled 4 locations in Aug 2020 and May 2021, collecting samples in the water column using the McLane pump off the end of the *R/V Blue Heron*

We observe microplastics through the the water column

Microplastics collected on 100 µm filters at 2-3 depths per site in Aug 2020

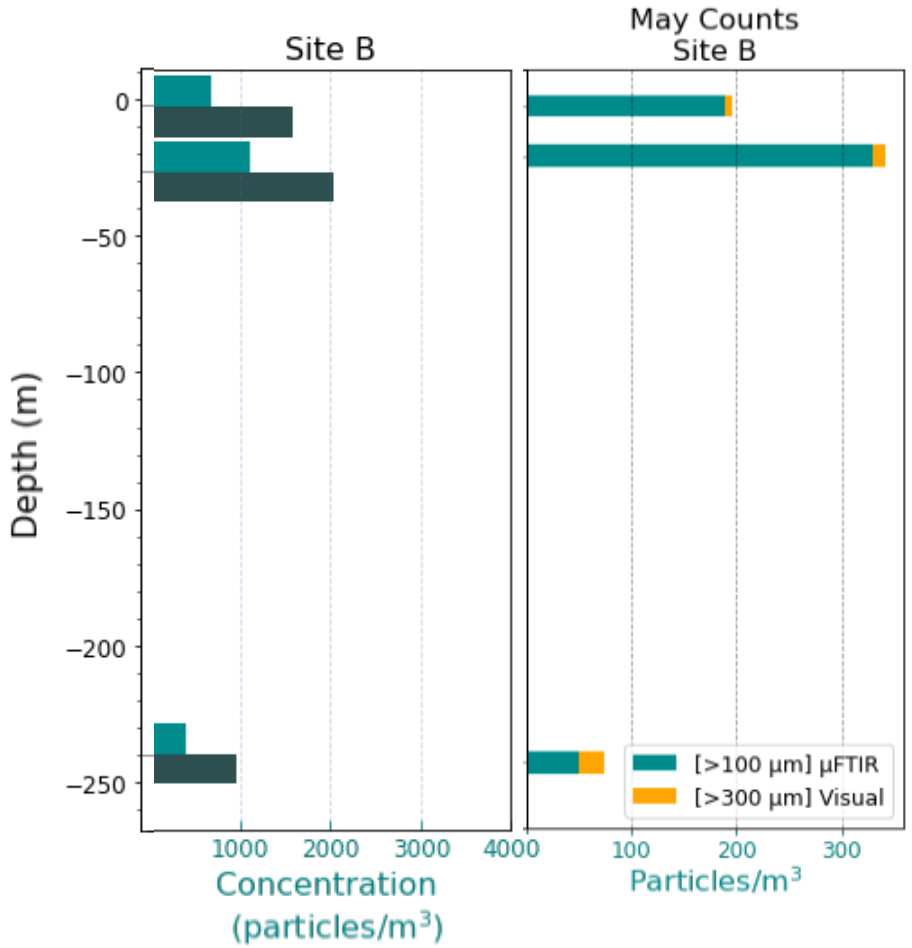
= manual counting
= python automated counting





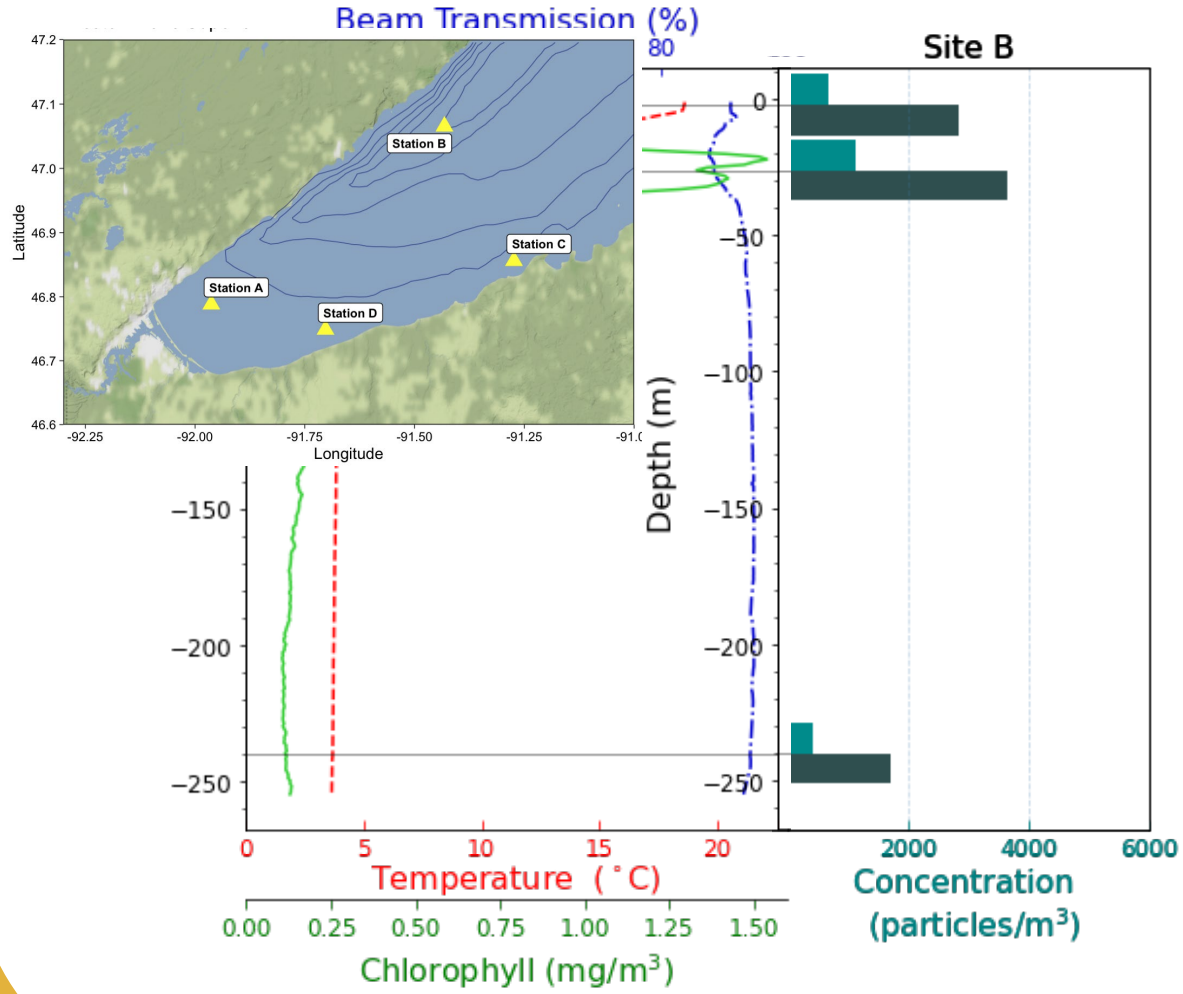
- Variability of abundance depending on site, not correlative with population centers
- Some variation in counts based on depth in water column with 2 m have relatively highest abundance
- Automated FTIR analysis represents accurate trends

While these represent a snapshot in time, resampled site shows plastics at all depths

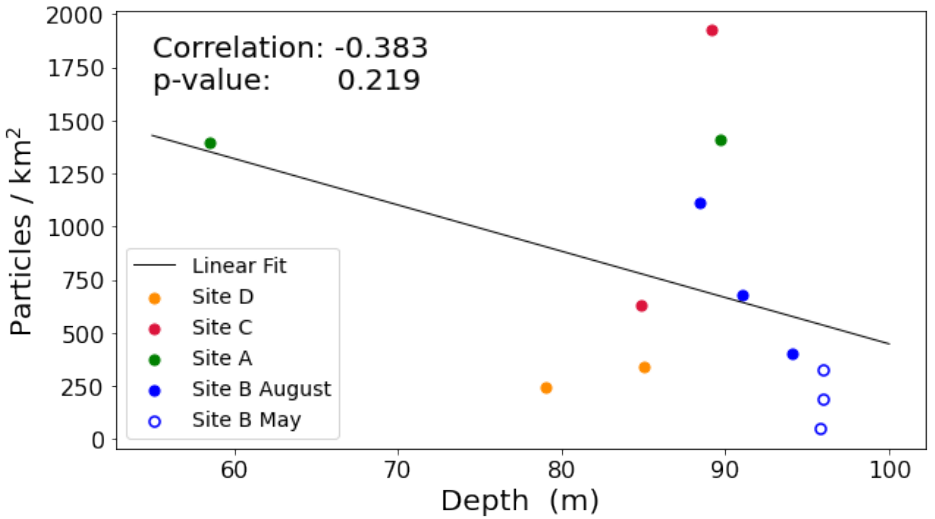


- We observe a substantial decrease in overall counts of microplastics in May 2021
- Early size fractionation results confirm lab results where much higher amount of smaller particles

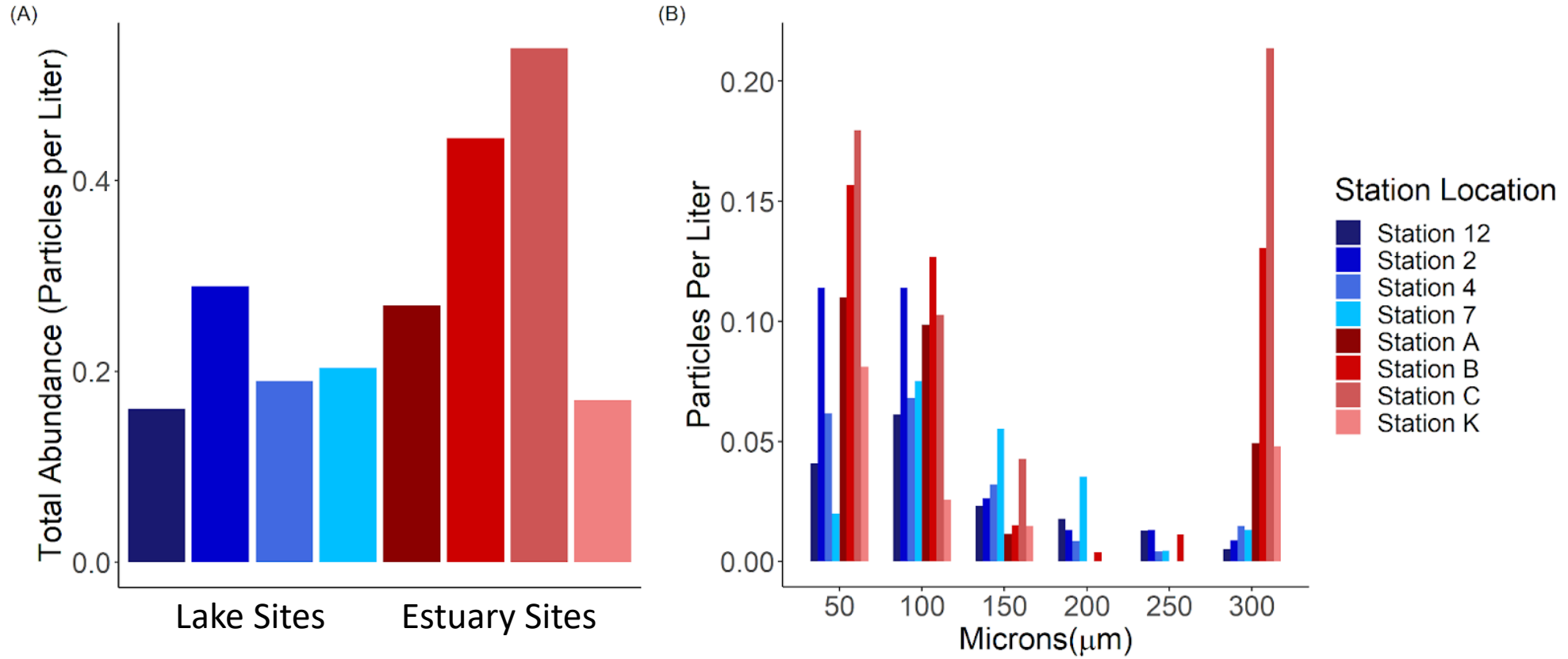
Do the microplastics correspond with water column characteristics?



No strong correlation with markers in the water column that would suggest they are present where other particles are present.

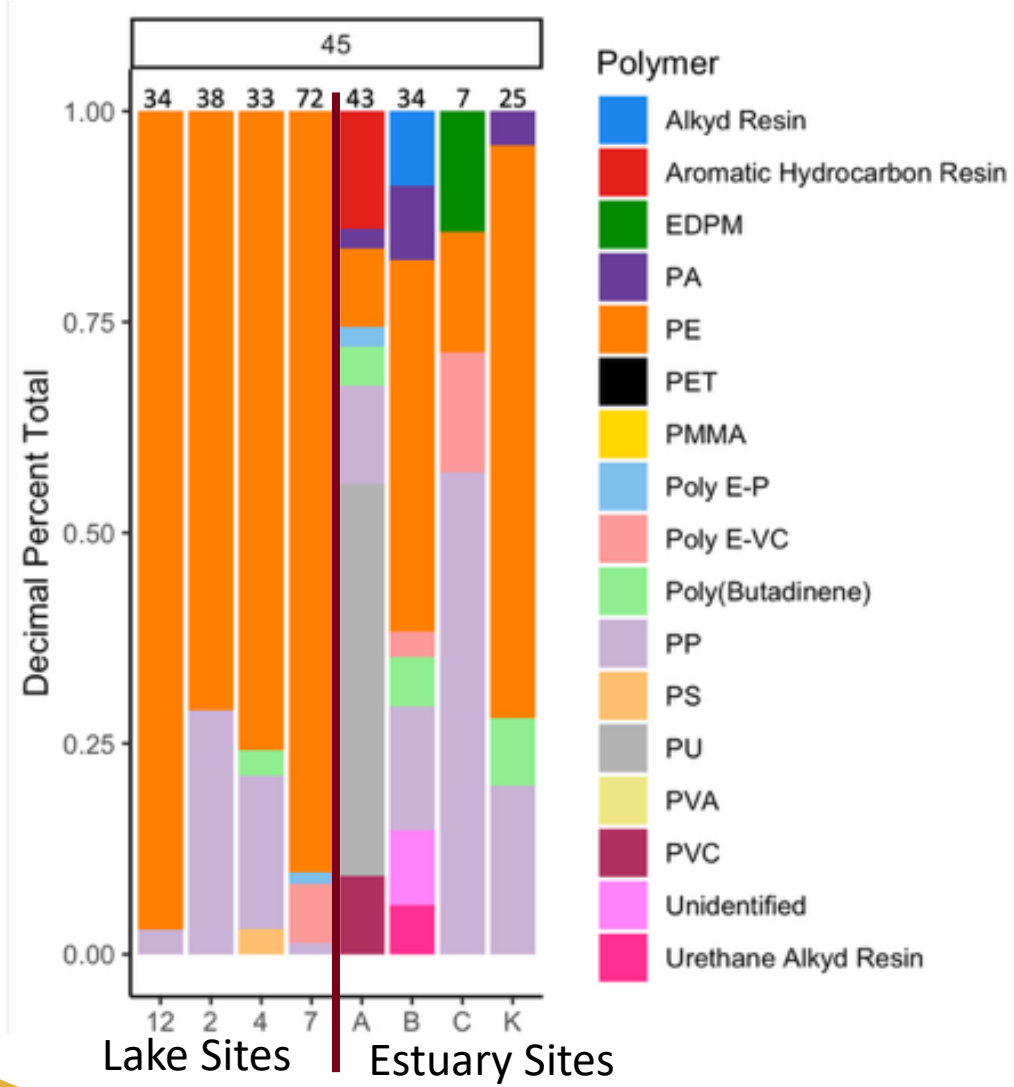


Our Major Findings – size distribution of microplastics in lake and estuary are different



- Overall counts similar between estuary and lake sites
- Differences in size distribution have meaningful differences

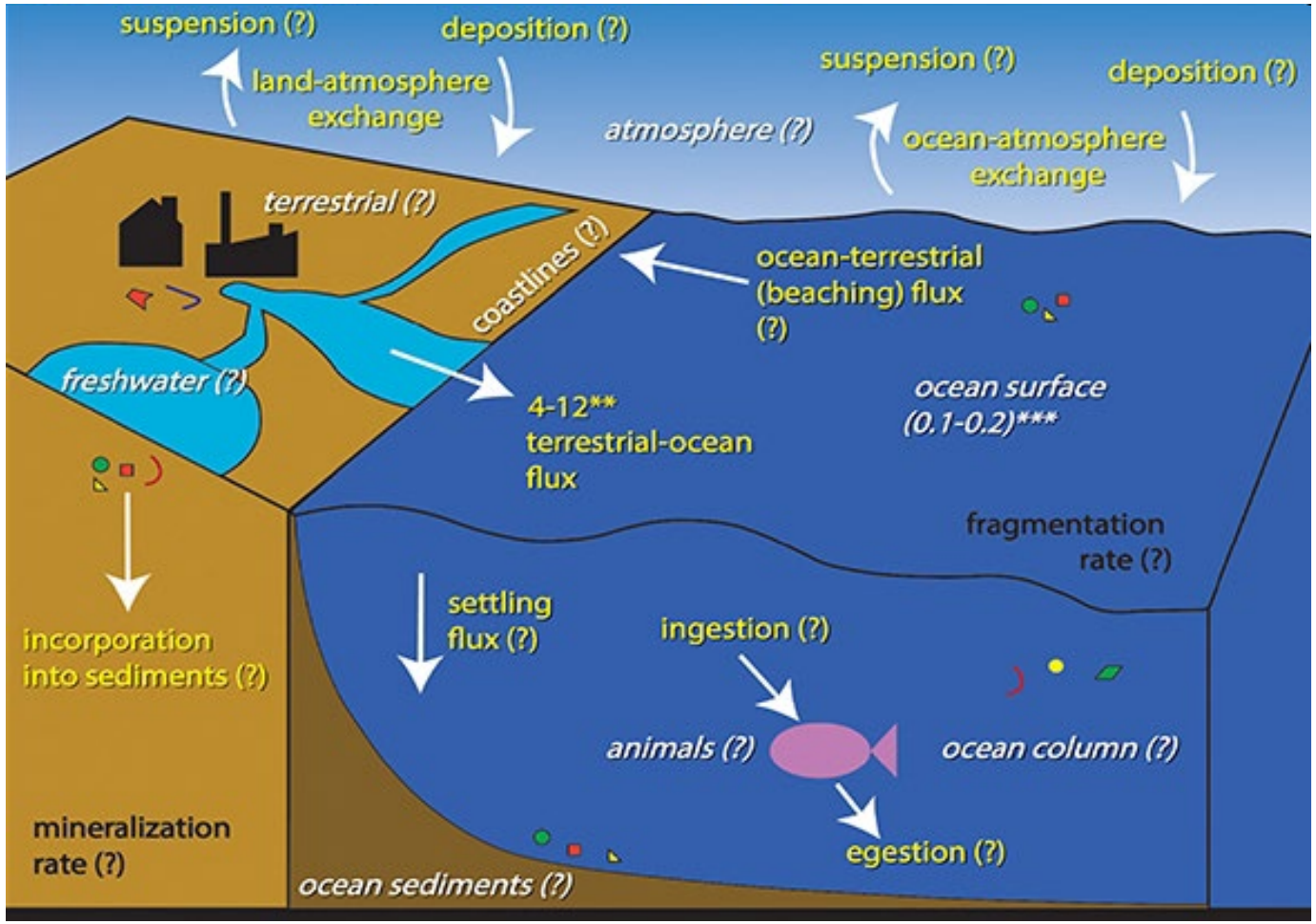
Our Major Findings – identity of microplastics in lake and estuary are different



- Estuary sites have larger variety of polymer types likely a function of the proximity to population centers and harbor activity

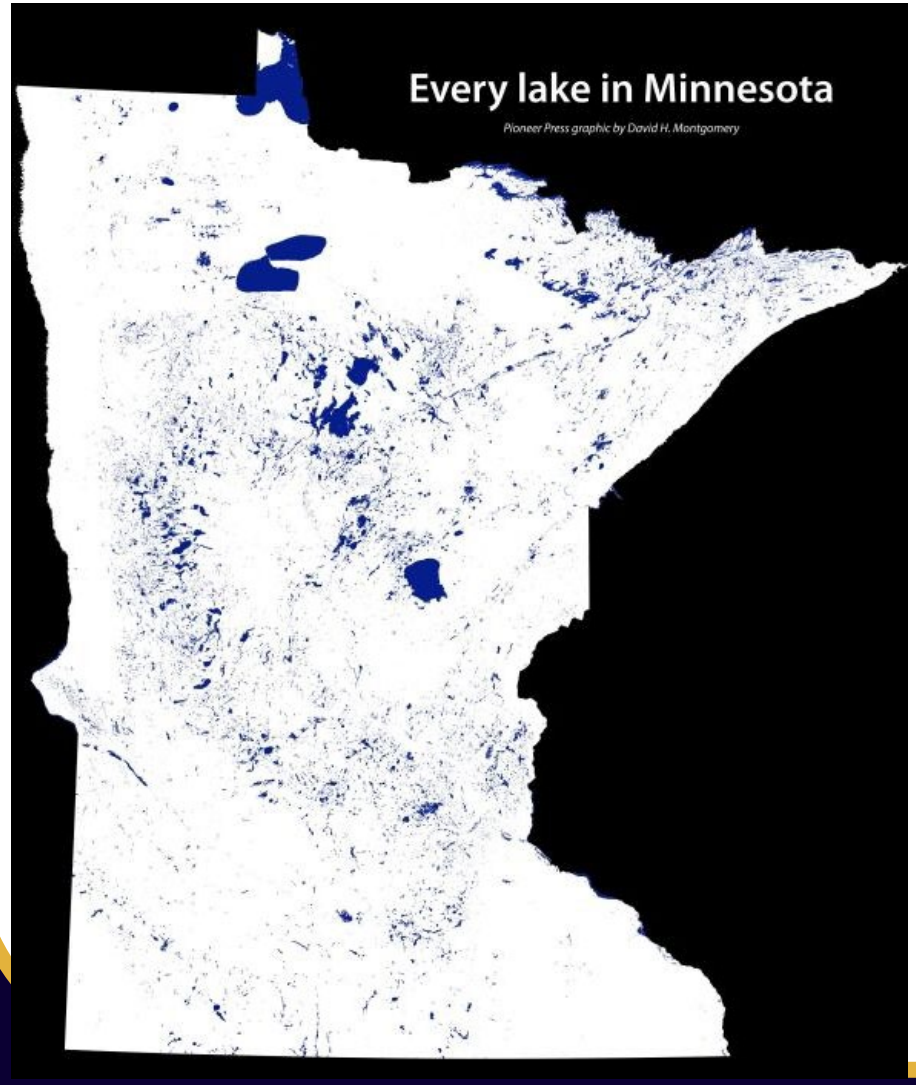
Plastic distribution through the environment

Plastic Cycle



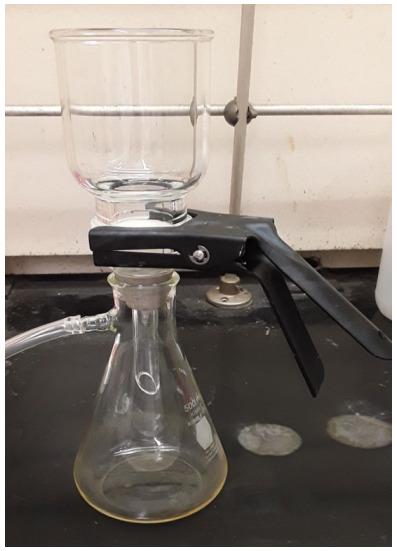
Zhu (2021)

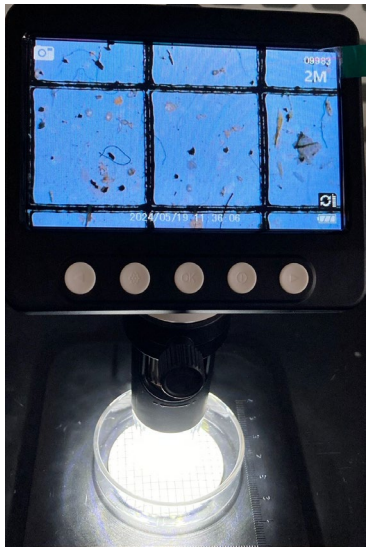
How do we move toward more widescale sampling and analysis of microplastics?



Our Solution:
Develop a citizen science sampling kit with tools for 6-12th grade classrooms + new detection technology

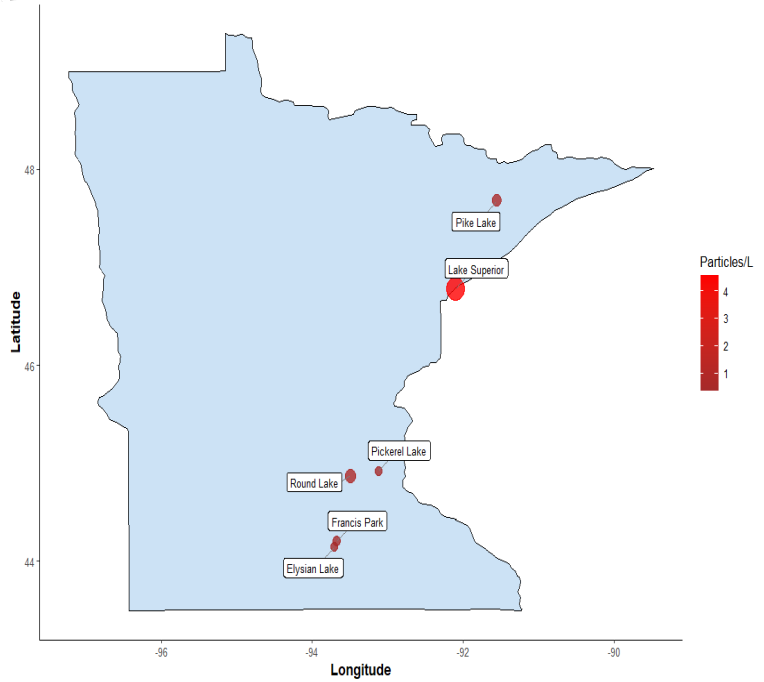
Progress on Citizen Science Microplastics Project

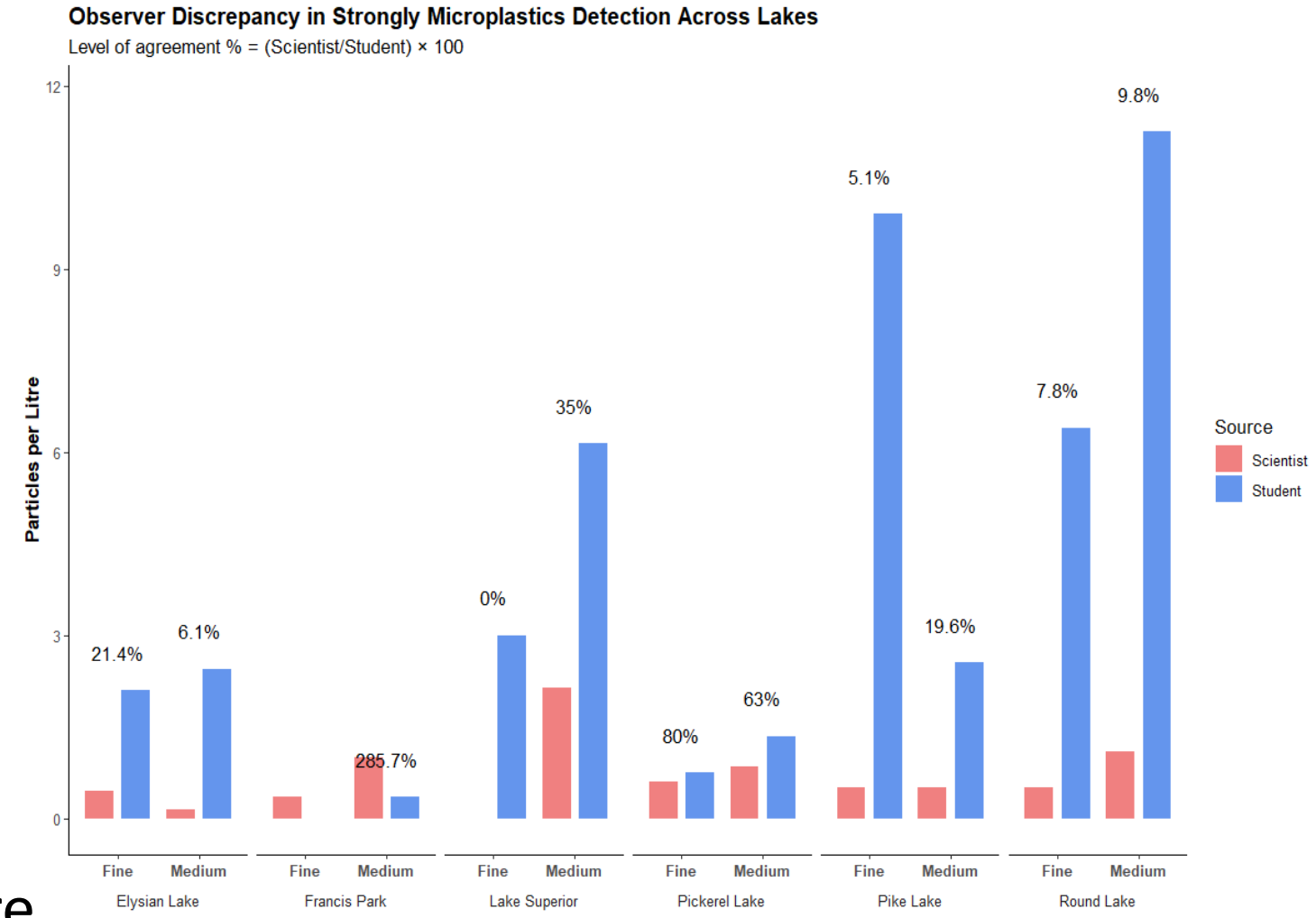




Scientists sample similarly to students using the kits for comparative QA/QC analysis

Progress on Citizen Science Microplastics Project





"Non-experts" count 20 to >90% more particles than researcher, with greater differences at sites with more particles

Microplastic Abundance and Characteristics in Lake Superior and Adjacent Harbor

QUESTIONS?

QR Code for Citizen Science