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Sediment Core and Fish Tissue Assessments of Per- and Polyfluoroalkyl Substances and Microplastics in Delaware and Barnegat Bays

An Update

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Toxics Advisory Committee
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Thanks to Chris Sommerfield, Tom Belton, Tom Fikslin, and Rick Greene

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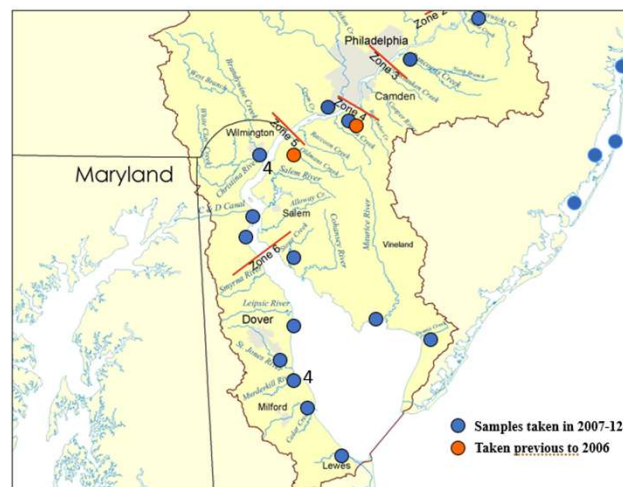
Goals and Objectives:

- 1. Reconstruct historical trends;** Analyze 11 archived sediment cores to chart ~100 years of Per- and Polyfluoroalkyl Substances (PFAS) and microplastic deposition.
- 2. Quantify present-day loading;** Sample and analyze surficial sediments at the same five sites for current contaminant levels.
- 3. Link sediments to food-web exposure;** Measure microplastic burdens in archived fillets of edible fish species already characterized for PFAS.

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Source of Sediments

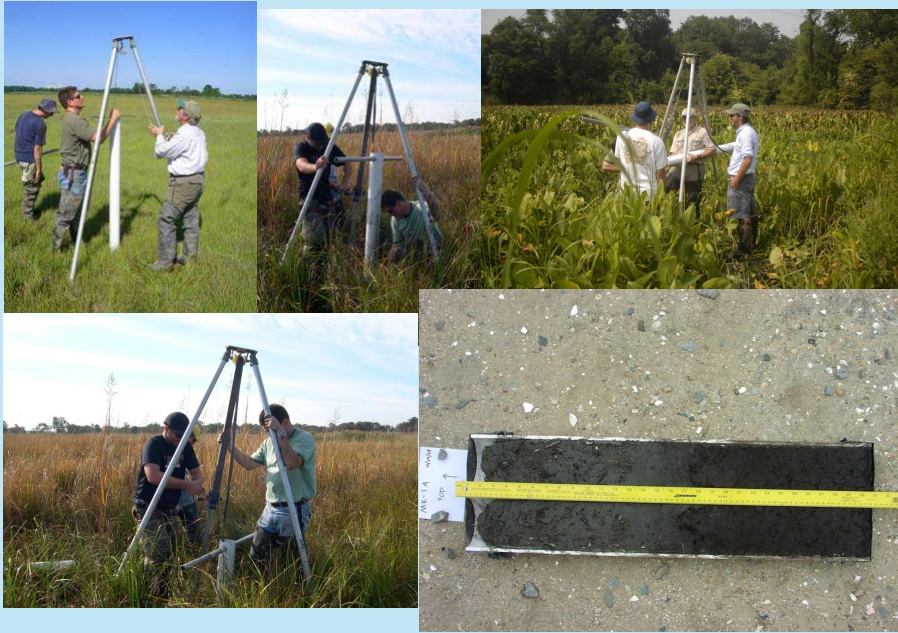
Delaware Estuary Sediment Core Sites 2007-2012



Three cores were collected at each site in mid-marsh areas.

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Field Sampling Around the Bay

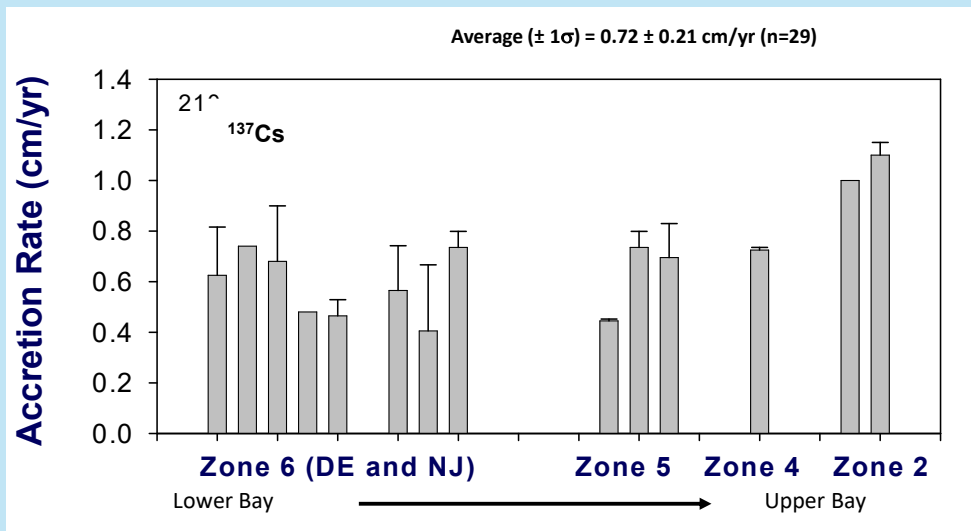


After collection – cores were sectioned and dated via gamma counting (Chris Sommerfield).

Sediments were stored in ICHM III glass containers with Teflon lids; at first frozen and later freeze-dried and stored.

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Sediment Accretion Rates



Averages of multiple cores taken from one marsh system

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Comparison between Delaware and Barnegat Bays: Accretion Rates

Tidal fresh and salt marsh accretion rates in Delaware Estuary:

All Sites

Mean 0.72 ± 0.21 cm/yr, n=29

Max 1.1 cm/yr

Min 0.39 cm/yr

Salt Marshes

Mean 0.65 ± 0.17 cm/yr, n=17

Max 1.0 cm/yr

Min 0.39 cm/yr

Tidal Freshwater Marshes

Mean 0.85 ± 0.24 cm/yr, n=12

Max 1.1 cm/yr

Min 0.60 cm/yr

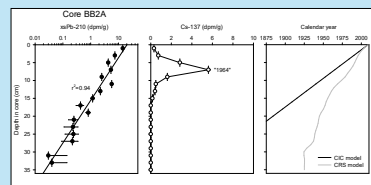
Barnegat Bay Sites:

All Sites

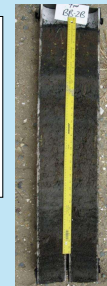
Mean 0.25 ± 0.06 cm/yr, n= 4

Max 0.29 cm/yr

Min 0.16 cm/yr



Profiles of excess ^{210}Pb and ^{137}Cs activity for core BB-2

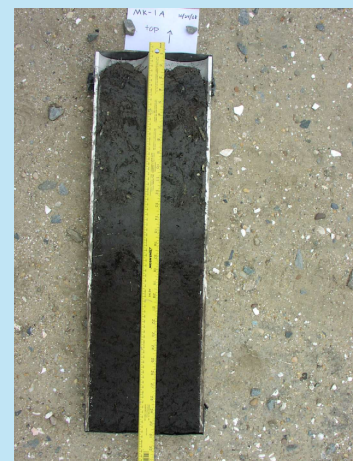


Note: ages based on the CIC model

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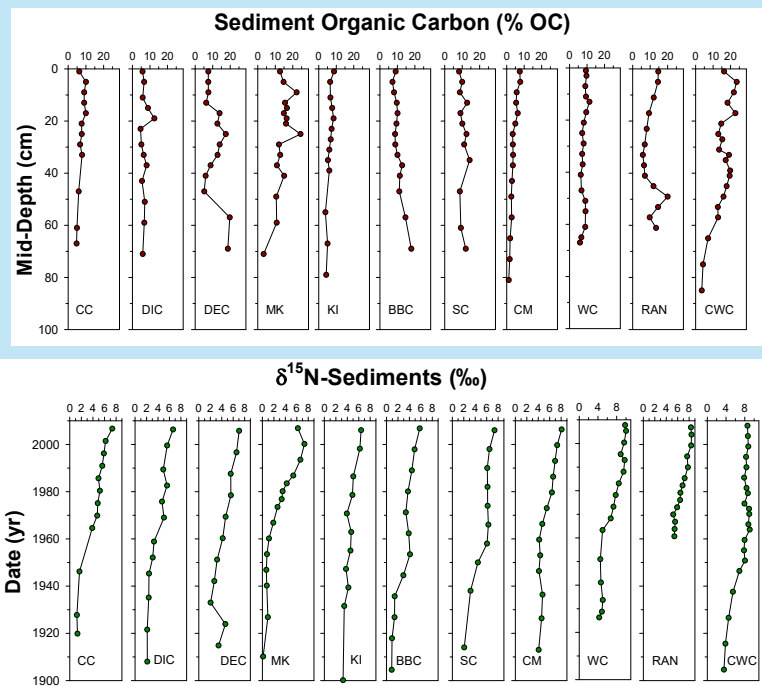
Analytical Parameters

- Sediment cores were analyzed for:
 - ❖ Organic Carbon, total Nitrogen and total Phosphorus (chemical forms)
 - ❖ Polychlorinated Biphenyl (PCB, ca. 110 congener specific cmpds) (DB)
 - ❖ Polycyclic Aromatic Hydrocarbons (PAH, ca. 39 parent cmpds) (DB)
 - ❖ Organo-Chlorine Pesticides (ca. 17 cmpds like DDT and Chlordane) (DB)
 - ❖ Diatom Species Composition (selected cores)
 - ❖ Stable Isotopes of Carbon ($\delta^{13}\text{C}$) and Nitrogen ($\delta^{15}\text{N}$)
 - ❖ Grain size (< 63 mm; clay+silt)
 - ❖ Radioactive Isotopes: ^{210}Pb and ^{137}Cs
 - ❖ NOW – MP and PFAS

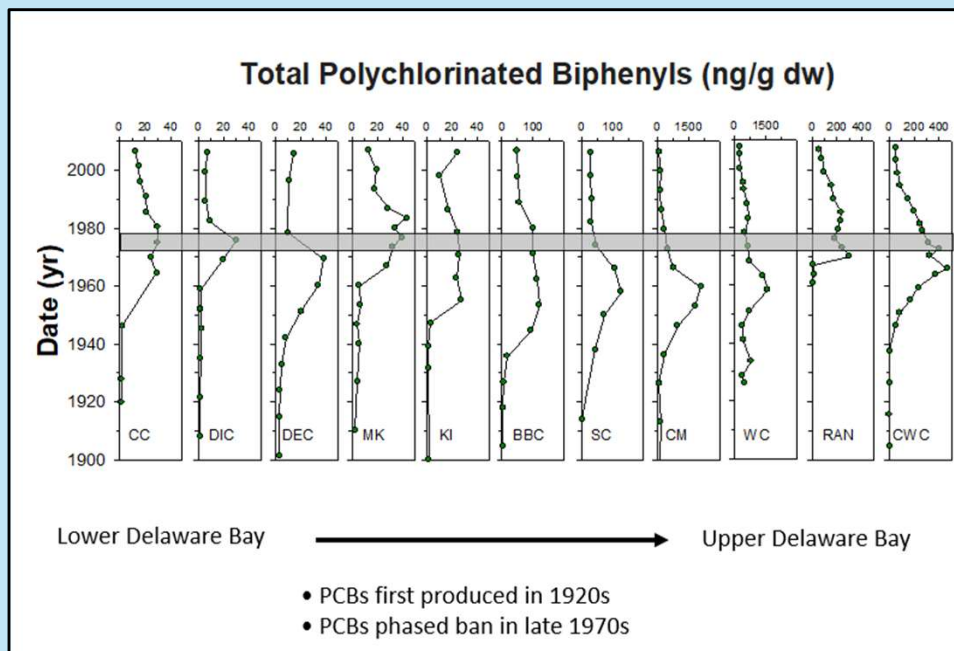


Note: DB – Del Bay only

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PCB accumulation in tidal marshes of Delaware Bay (2012)

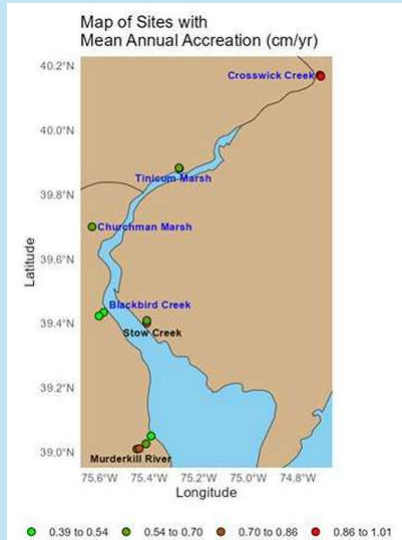
Marsh Type	Area (km ²)	Present Day Sediment Accumulation			Total PCB Flux		
		Low	High	Average	Low	High	Average
Tidal Freshwater Wetlands	73.5	12.6	104	38.1	9.3	76.4	28.0
Estuarine Marsh	469.5	4.6	9.8	7.6	21.6	46.0	35.7
Saline Fringe	<u>268.8</u>	2.2	6.0	3.3	<u>5.9</u>	<u>16.1</u>	<u>8.9</u>
Total	811.8				36.8	138.6	72.6

Current Estimate of total PCB loads to Delaware Bay = 93 kg/yr

Tidal marshes can account for ~ 80% (on average) of the total load

Wetland types based on Kreeger, Titus (2008) and areas from Sommerfield (unpublished estimates)

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Accretion rates will be used to estimate the appropriate sampling depth needed to complete the temporal sequence of the cores

Locations for DRBC Coring

Table 1. Sediment core sampling sites along the Delaware River and Bay have differing number of available archived cores.

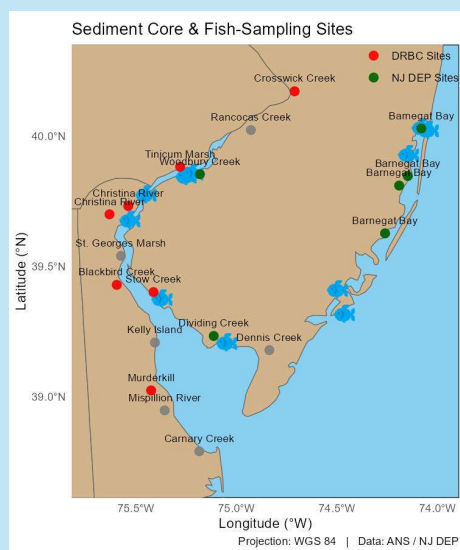
Location	Latitude	Longitude	No. Available Cores
Churchman Marsh	39.70035°	-75.6302°	1
Crosswick Creek	40.169792°	-74.7091°	2
Tinicum Marsh	39.882605°	-75.2789°	3
Blackbird Creek	39.428858°	-75.5927°	2
Murderkill River	39.024163°	-75.4234°	4
Stow Creek	39.405217°	-75.4095°	2

1 core per site will be subsamples and sent for PFAS analysis. 1 core per site plus 1 duplicate core will be analyzed for microplastics. Samples sent to ALS laboratories for PFAS

Subsamples will be taken from section for MP analysis.

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NJ DEP PFAS & MP: Sediment and Fish Tissue**



Core locations and collection dates for Barnegat Bay field work.

ID	Date	General Location	Lat (N)	Long (W)	Depth (cm)	Chem IDs
BB1	7/29/09	Mantoloking	40 01.793'	74 04.797'	0-94	3071-3117
BB2	7/29/09	Mid-Bay	39 50.855'	74 08.837'	0-96	3118-3165
BB3	7/29/09	Oyster Creek	39 48.653'	74 11.410'	0-50	3166-3190
BB4	7/30/09	West Creek	39 37.641'	74 15.614'	0-100	3191-3240

Stations are listed from upbay to downbay.

Table 1. Archived fish samples collected at or adjacent to sites which are stored within the Academy of Natural Science (fish collected in 2022-2023)(Keller et al., 2024).

Scientific Name	Common Name	Sample No.
<i>Morone americana</i>	White Perch	26
<i>Anguilla rostrata</i>	American Eel	16
<i>Leiostomus xanthurus</i>	Spot	15
<i>Opsanus tau</i>	Oyster Toadfish	7
<i>Cyprinus carpio</i>	Common Carp	6
<i>Lepomis gibbosus</i>	Pumpkinseed Sunfish	6
<i>Sphoeroides maculatus</i>	Northern Puffer	5
<i>Centropomus striatus</i>	Black Sea Bass	3
<i>Lepomis auritus</i>	Redbreast Sunfish	3
<i>Micropterus salmoides</i>	Largemouth Bass	3
<i>Perca flavescens</i>	Yellow Perch	3
<i>Paralichthys dentatus</i>	Summer Flounder	2

**Nutrient and Ecological Histories in Barnegat Bay, New Jersey (2005) PCER Report #10-05

**Estimation of fish BAF for selected PFAS contaminants in marine and freshwater systems (2024) PCER Report #24-XX

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Methods

- Subsample archived cores for PFAS and MP; archived fish tissue plugs for MP only
- Collecting short cores as each site (top ~15cm) using all metal coring system – Top, middle, bottom sections
- PFAS – EPA Method 1633/1633a; 40 compounds (Working with ALS; <https://www.alsglobal.com/en/>)
- Ancillary Data (on new sediments samples)
 - Organic Carbon and total Nitrogen
 - Percent water
- Microplastic Analysis – Digestion, staining, imaging and counting



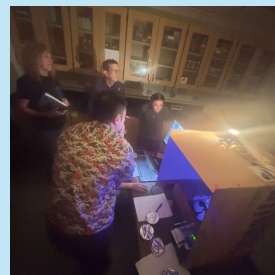
Groups

PFSA
ESA
FOSA
FOSAA
FOSE
FTCA
FTSA
PFCA
PFECA
PFSA

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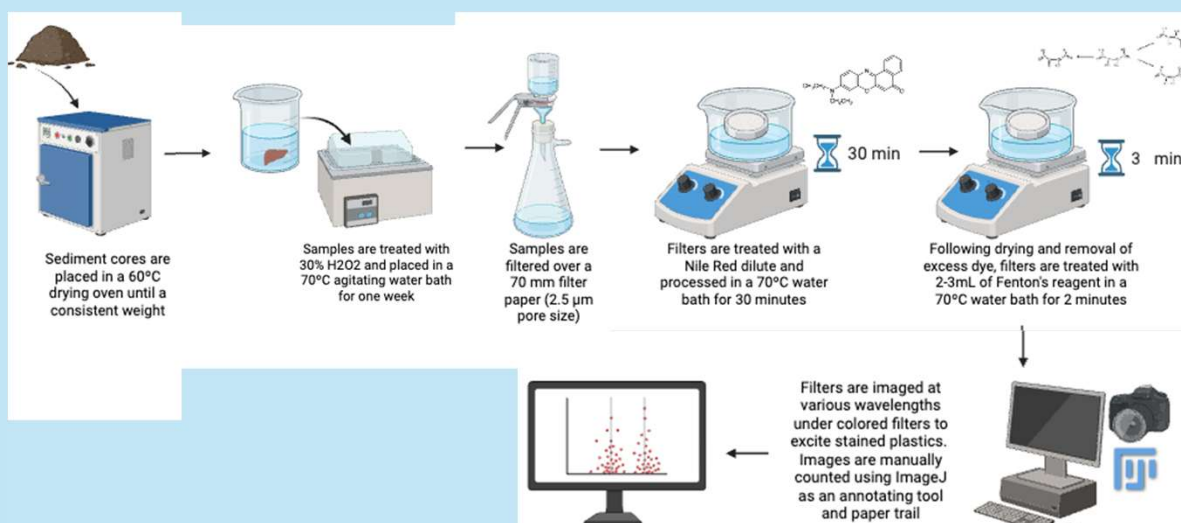
Environmental Matrices Capabilities for Microplastics

- Bird organs (Liver and stomach)
- Sediments
- Lichens
- Medical Equipment
(Future collaboration with Christiana Care)
- Mushrooms
- Water



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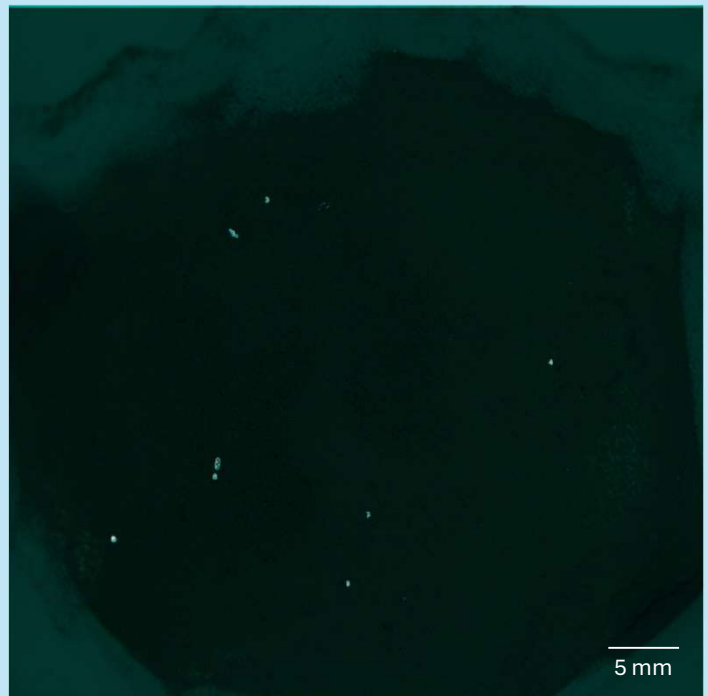
Processing Workflow for Sediment Microplastics



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ImageJ Particle selection (Yellow 365nm)

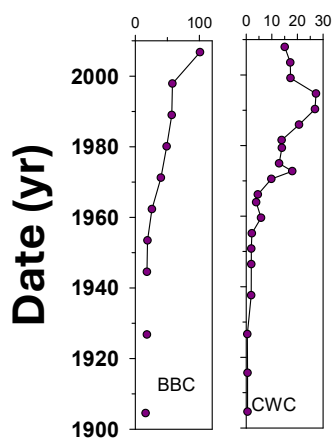
#	Length (Micron)
1	12055
2	59
3	208
4	59
5	63
6	201
7	90
8	44
9	101
10	51



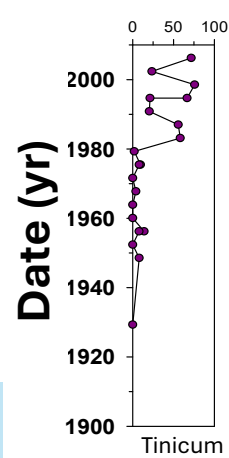
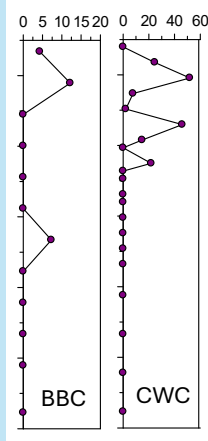
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Preliminary Data

TPFAS (ng/g dw)

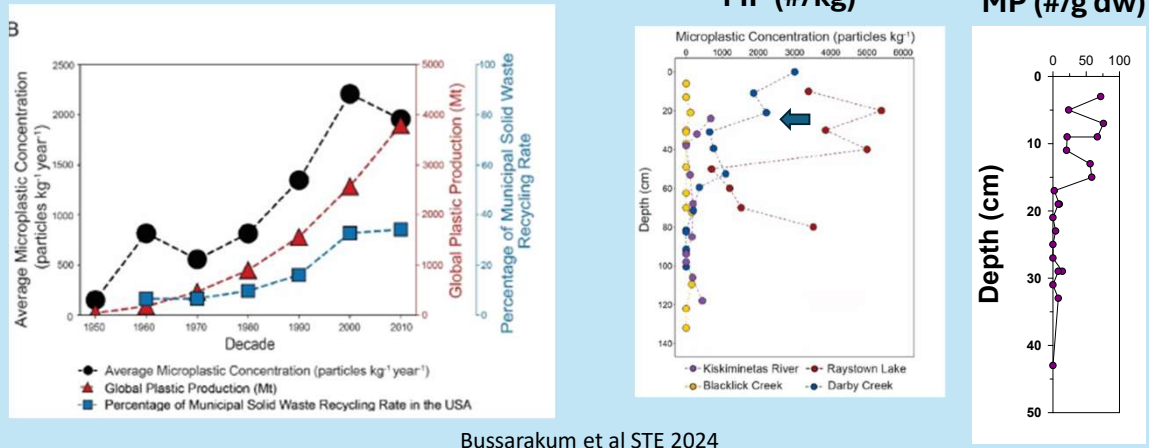


Microplastics (#/g dw)



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Comparison of Data



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Progress

- Finish collection of short cores
- Archived Cores and processing in Lab
- Fish tissue and sediments for MP

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Thank you

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