Macro-plastic pollution retention in storm-water ponds and rivers

Shelby Negosian[1], Nikki Fuller[2], Evan Batte[2], Malika Gottfried[3], Theodore Halidy[4], Jayson Kucharek[2], Paige Arieno[2], Autumn Potts[2], Sophia Holmes[3], Vanessa Baker[2], Karl Korfmacher[2], Matthew J. Hoffman[2], Christy Tyler[2], Nathan C. Eddingsaas[2]

Washington University in St. Louis[1], Rochester Institute of Technology[2], Smith College[3], California State University - Sacramento[4]

Background

- Plastic pollution has attracted significant public attention, but 98.5% of plastic waste does not output to the large marine environments and remains within the terrestrial ecosystem and inland aquatic ecosystems (Meijer et al. 2021)
- Research on the movement of plastic throughout these inland water systems is understudied

OBJECTIVE

Evaluate anthropogenic debris in storm-water ponds and tributaries to gauge the characteristics of these bodies that cause plastic retention.

Site Description

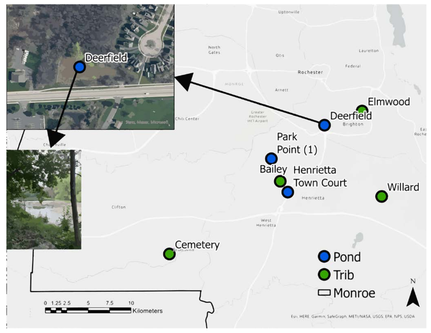

Figure 3. Deerfield was one of the storm-water ponds pictured here to exemplify my sites.

Pond/Trib	Site	Land use	Vegetation	Substrate	Slope
Pond	HTC	Commercial	Thick	Mucky	Flat-gentle
Pond	Deerfield	Res./ Com.	Thick and tall	Very mucky	Gentle-steep
Pond	PRP (1)	Residential	Sparse	Muddy	Flat-steep
Trib	Elmwood	Res. - Suburban	Very little	Rocky	Med.-steep
Trib	Willard	Rural	Sparse	Sandy-mucky	Gentle-med.
Trib	Bailey	Commercial	Wooded	Mucky	Steep
Trib	Cemetery	Rural	Sparse	Very mucky	Flat-gentle

Methods

- Sampled three storm-water ponds and four tributaries
- Storm-water ponds: 4 transects treating the pond like a clock with 12 pointing North: 12:00 is T1, 9:00 is T2, 6:00 is T3, and 3:00 is T4.
- Tributaries: a 20 m upstream span was identified and 6 transects (3 on each bank) were randomly selected.
- Transects span 3 m upland from the bank and 0.5 m into the water.
- At each transect, four quadrats (3 on land and 1 in the water) were taken identifying plant cover, slope, and substrate type.
- Debris within the transects were photographed, GPS coordinates captured, and collected.
- The debris around each storm-water pond and along a 20 m stretch of each tributary (outside the transects) were collected and separated based off distance from shore: Herbivory Border (3 m – 1 m), Riparian (1 m – 0 m), and in water (0 m - -0.5 m).
- The in-water samples were separated into four bins based on the density of emergent vegetation.

Figure 1. I recorded measurements on my field sheet, took pictures of plastic within transects for Survey123, and collected debris from the perimeter.

- Macro-plastics were cleaned, dried, counted, categorized and weighed,
- Select set analyzed by Infrared spectroscopy to determine material type and degree of aging (degree of oxidation determined by the presence of carbonyl groups, extent of oxidation determined by carbonyl index)

Figure 2. We count and categorize, dry, and sonicate on the water-perimeter and transect plastics in order to prepare for IR.

Results

All figures are of samples collected in water outside of transects

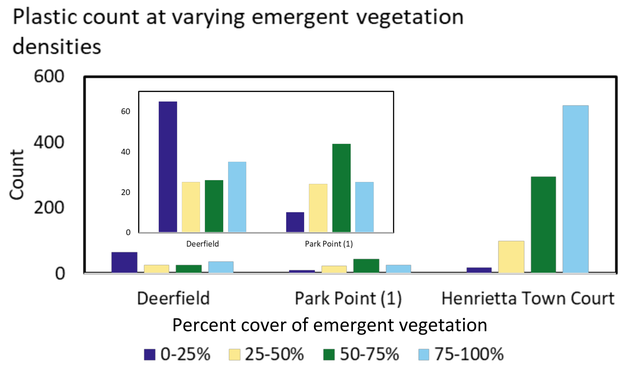

Figure 4. Total number of plastic collected from each storm-water pond from the bank 0.5 m into the water at 4 different emergent vegetation. Note: large quantities of styrofoam (EPS) found at Henrietta Town Court.

Polymer types in varying emergent vegetation densities

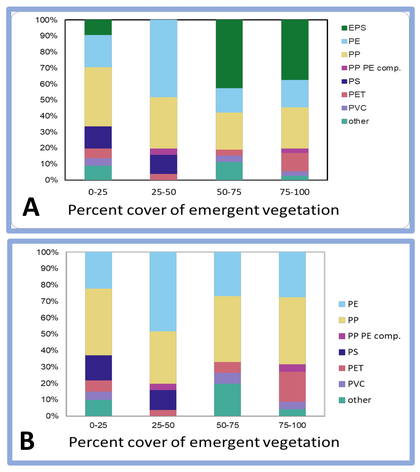

Figure 5. A) Polymer types and B**)** polymer type excluding EPS at Deerfield as a function of emergent vegetation densities.

Figure 6. a) Polymer types and **b)** polymer type excluding EPS at Park Point (1) as a function of emergent vegetation densities

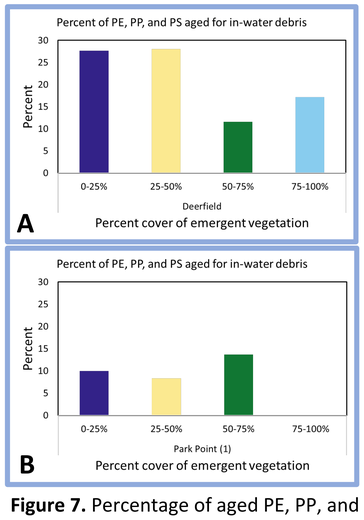

Figure 7. Percentage of aged PE, PP, and PS found at **A)** Deerfield and **B)** Park Point (1) for in-water debris.

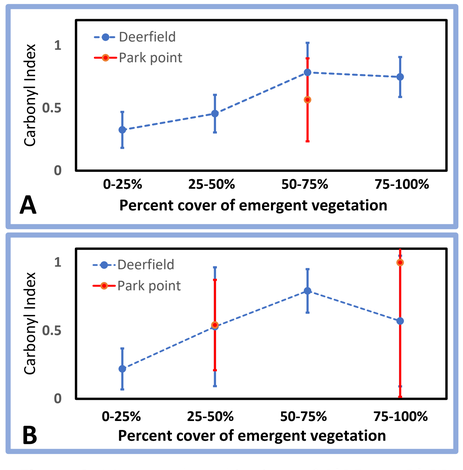

Figure 8. Mean carbonyl indices of **A)**PE and **B)** PP at varying percent cover are shown to increase with density. Note: CI calculated only for plastics that showed signs of aging.

Discussion

Transects:

- **Minimal samples collected n = 41 from 6 sites**
- **Small portion demonstrated aging (14%)**

In-water plastic debris:

- **Does increased vegetation density-**
  - **Increase number of plastics: Yes for EPS more vegetation leads to increased retention of EPS**
  - **Change plastic composition: Only EPS varies**
  - **Lead to increased aging: Increased vegetation leads to increased aging as seen from CI.**
- **Preliminary results indicate that plastic debris is found throughout storm-water ponds regardless of vegetation density, however the length of time spent within the system increased with increased vegetation**
- **More data is needed for statistically relevant results**

Citations:

Meijer, L. J. J et al. 2021. More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean. Sci Adv. doi: 10.1126/sciadv.aaz5803

Acknowledgements: This project was funded by the NSF Research Experiences for Undergraduates Program (Award #1950690) and supported by the RIT College of Science, Waste Management of NE and NY, LLC and etc. Funding was provided under NOAA Marine Debris Program Cooperative Agreements NA21NOS9990117 & NA21NOS9990111.