Evaluation of Microplastic Loading in Texas Diamondback Terrapin (*Malaclemys terrapin littoralis*) and their Associated Habitats

Gabrielle Hammerbach[1,2*], Mandi Gordon[2], Danielle DeChellis[2], Lydia Thurman[1,2], Cynthia Howard[1]

[1]University of Houston-Clear Lake, College of Science and Engineering, Houston, Texas

[2]University of Houston-Clear Lake, Environmental Institute of Houston, Houston, Texas

[*]Corresponding and presenting author; hammerbach@uhcl.edu

Houston Regional Ecology and Evolution Symposium
Houston, TX; May 2nd, 2025

Acknowledgements

Academic mentors Mandi Gordon and Cindy Howard

Field and lab assistants

A. Castillo, T. Goldstein, C. Gonzalez, K. Perkins, T. Pytlak, N. Reese, A. Sak, N. Santee, L. Soliz, B. Steward, E. Underwood

Other Contributors

K. Chau, S. McDaniel, M. Mokrech, J. Oakley, R. Puzdrowski, M. Rogers, D. Walker, C. Zhang

Permitting, Institutional Protocols, Access Permissions

TPWD Scientific Collection Permits SPR-0321-026; UHCL IACUC Protocol 0224.001.R0, special land access permits issued by TPWD

University of Houston Clear Lake

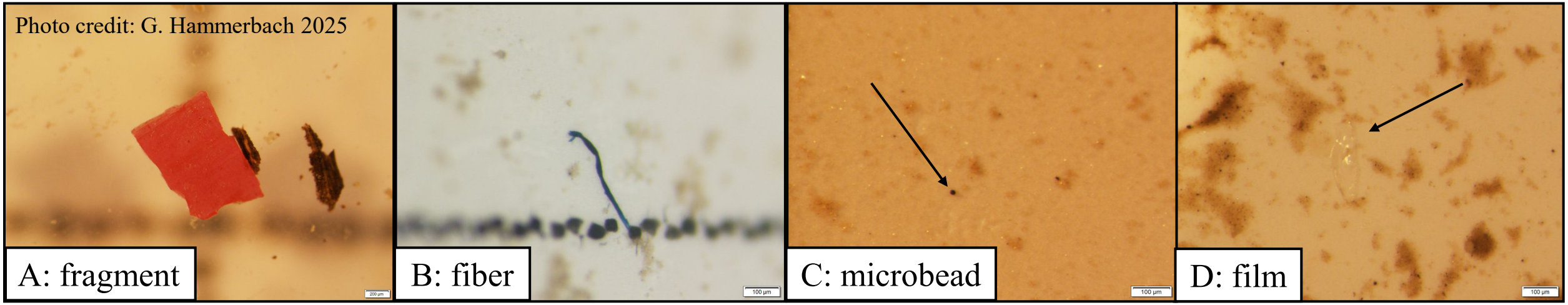
Environmental Institute of Houston

Funding

MATAGORDA BAY MITIGATION TRUST

Introduction

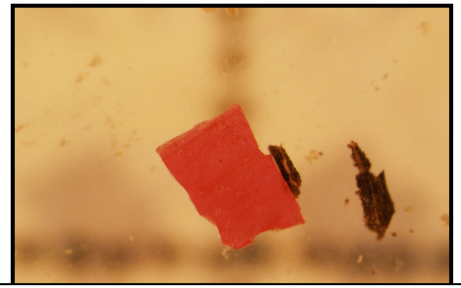
- 1-µm to 5-mm in dimension (Dong et al., 2023)
- Composed of synthetic polymers such as polyethylene (PE), polyvinyl chloride (PVC), polypropylene (PP), polystyrene (PS) (Hou and Rao, 2022)
- Classified by type (i.e., fragment, fiber, microbead, film, etc.) (Markley et al. 2024)



Microplastics as an emerging contaminant of concern

Nurdles

Accidental spillage during production



Microplastics (<5-mm)

PCB's, PAH's, pesticides, dioxins, other industrial byproducts

Industrial processes

Macroplastics (>5-mm)

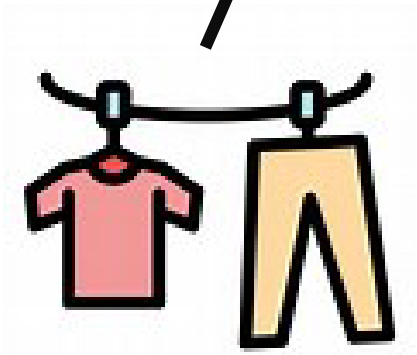
Physical and/or chemical degradation

Adhesion

Washed into wetland habitats by rain, wastewater treatment, improper disposal

Exposure to wildlife

Potential impacts to metabolic processes, reproductive timing, predatory behavior



Synthetic fiber clothing

Adams et al. 2016; Hou and Rao, 2022; Lavers et al. 2019

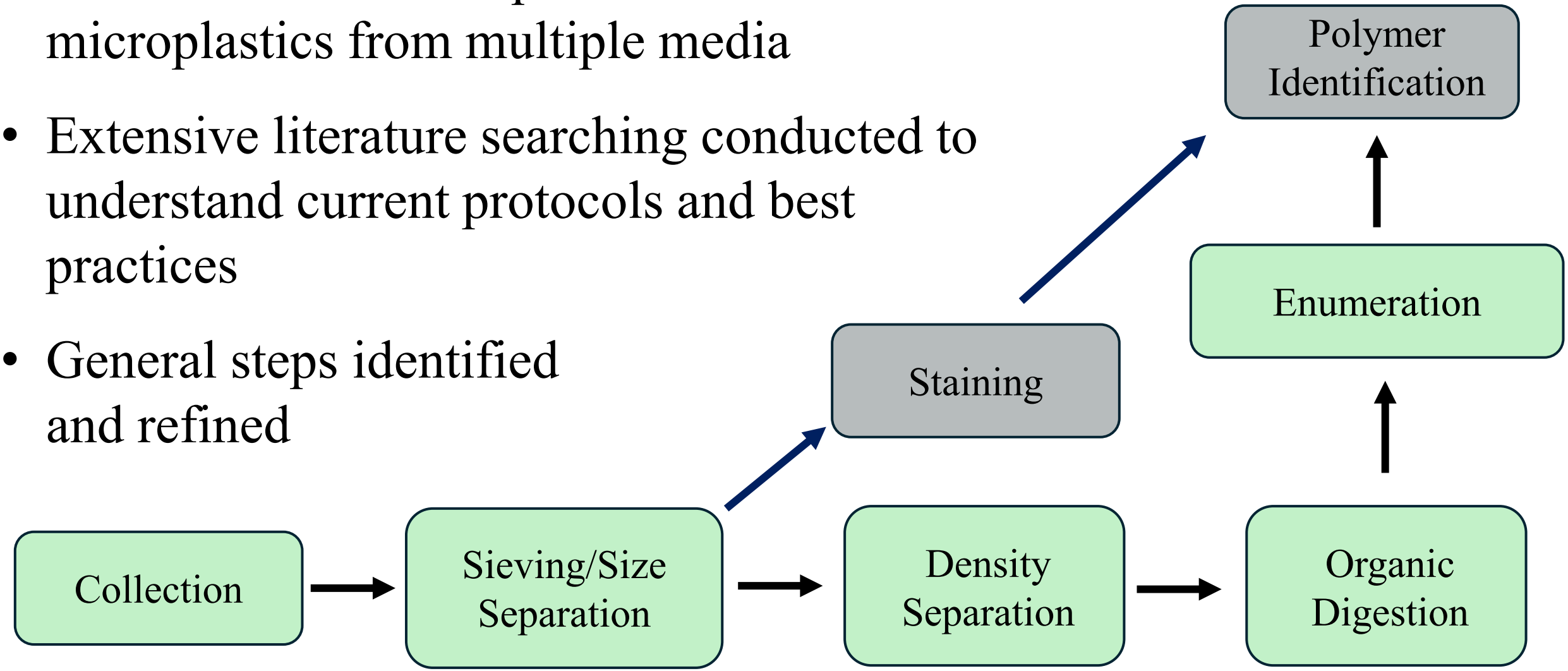
Terrapin as a Sentinel Species

Texas Diamondback Terrapin (*Malaclemys terrapin littoralis*)

- Species of greatest conservation need (TPWD, 2023)
- Representative of many species
- Long life span (Brennessel, 2006)
- Critical habitat (brackish, low-lying wetlands)

Steps for Identifying Microplastics

- Lack of standardized protocols for extraction of microplastics from multiple media
- Extensive literature searching conducted to understand current protocols and best practices
- General steps identified and refined



Objectives

1. Quantify baseline microplastic loading in saltmarshes throughout Matagorda and San Antonio Bay.
2. Compare microplastic loading between spatially distinct sites in Matagorda and San Antonio Bay.
3. Compare site level microplastic loading to health factors in Texas Diamondback Terrapin.
4. Compare excreted microplastics in fecal samples to health factors in Texas Diamondback Terrapin.

Site Distribution

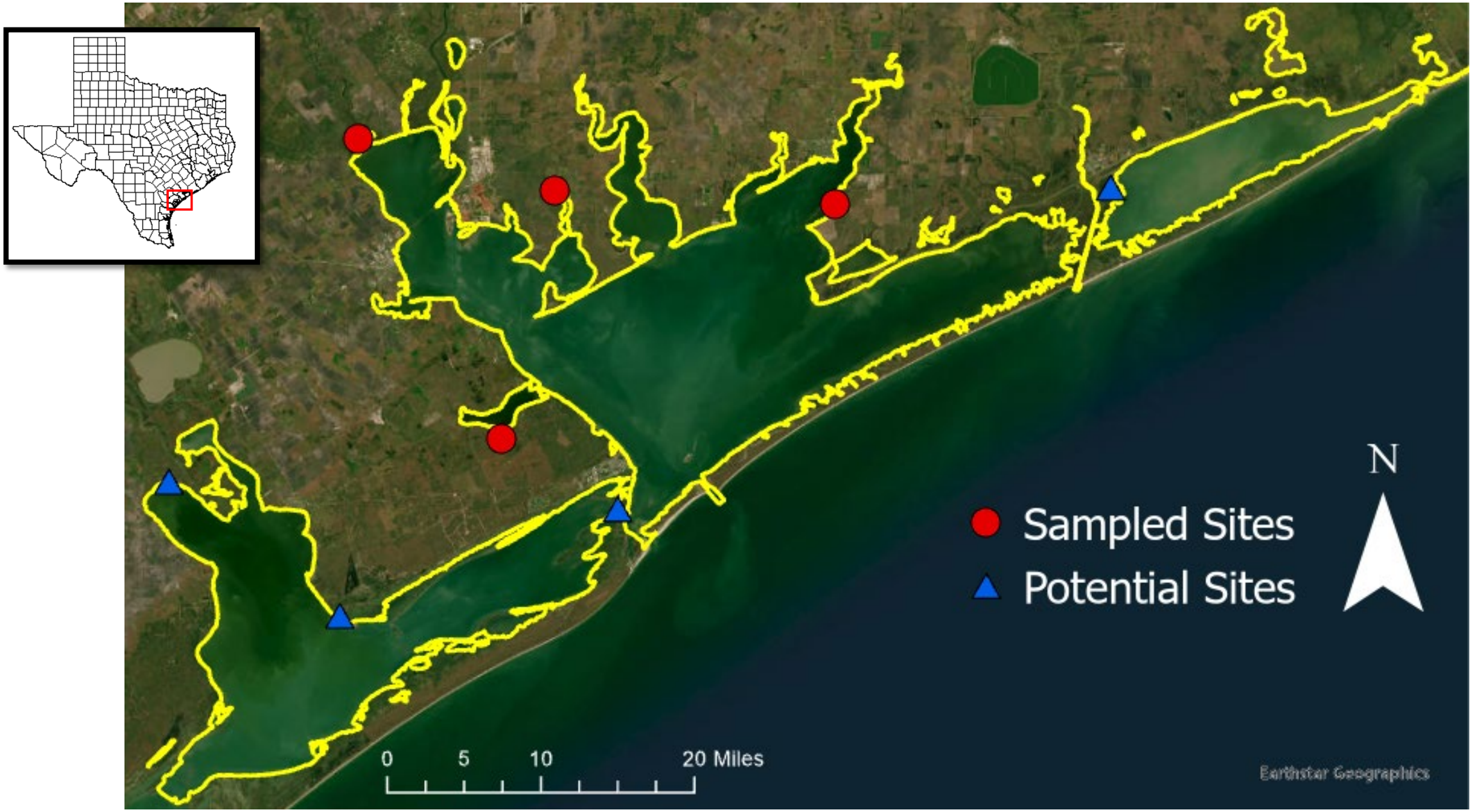
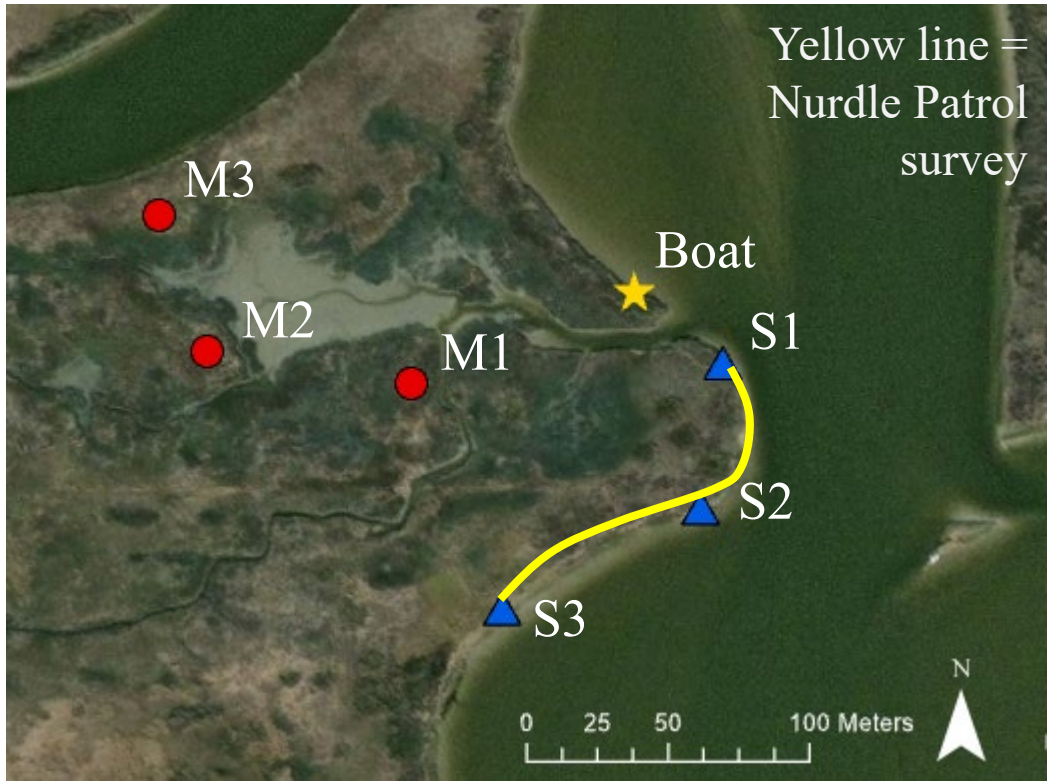


Table 1. Sources, sediment types, core sizes, and sieve sizes across a subset of microplastic literature.

Source	Sediment type	Core diameter	Number of cores	Sample depth(s)
Alvarez-Zeferino et al. 2020	Beach shorelines	19-cm	10 per site	5-cm
Khan and Prezant 2018	Salt marsh (mussel bed)	7.62-cm	3 per plot	10-cm
Lloret et al. 2021	Estuarine marsh	9-cm	2 total	127.5-162.5-cm
Lourenco et al. 2017	Intertidal wetlands	3-cm square (PLOT)	1 per site	1-cm
Lo et al. 2018	Sandy beaches to mud flats (1:1)	50-cm x 50-cm PLOT	10 per transect	2-3-cm
Sartain et al. 2018	Beach shorelines	50-cm x 50-cm PLOT	Unknown	3-cm
Zhou et al. 2020	Sandy to Muddy	30-cm x 30-cm PLOT	5-7 per transect	2-cm

Sediment Sample Collection

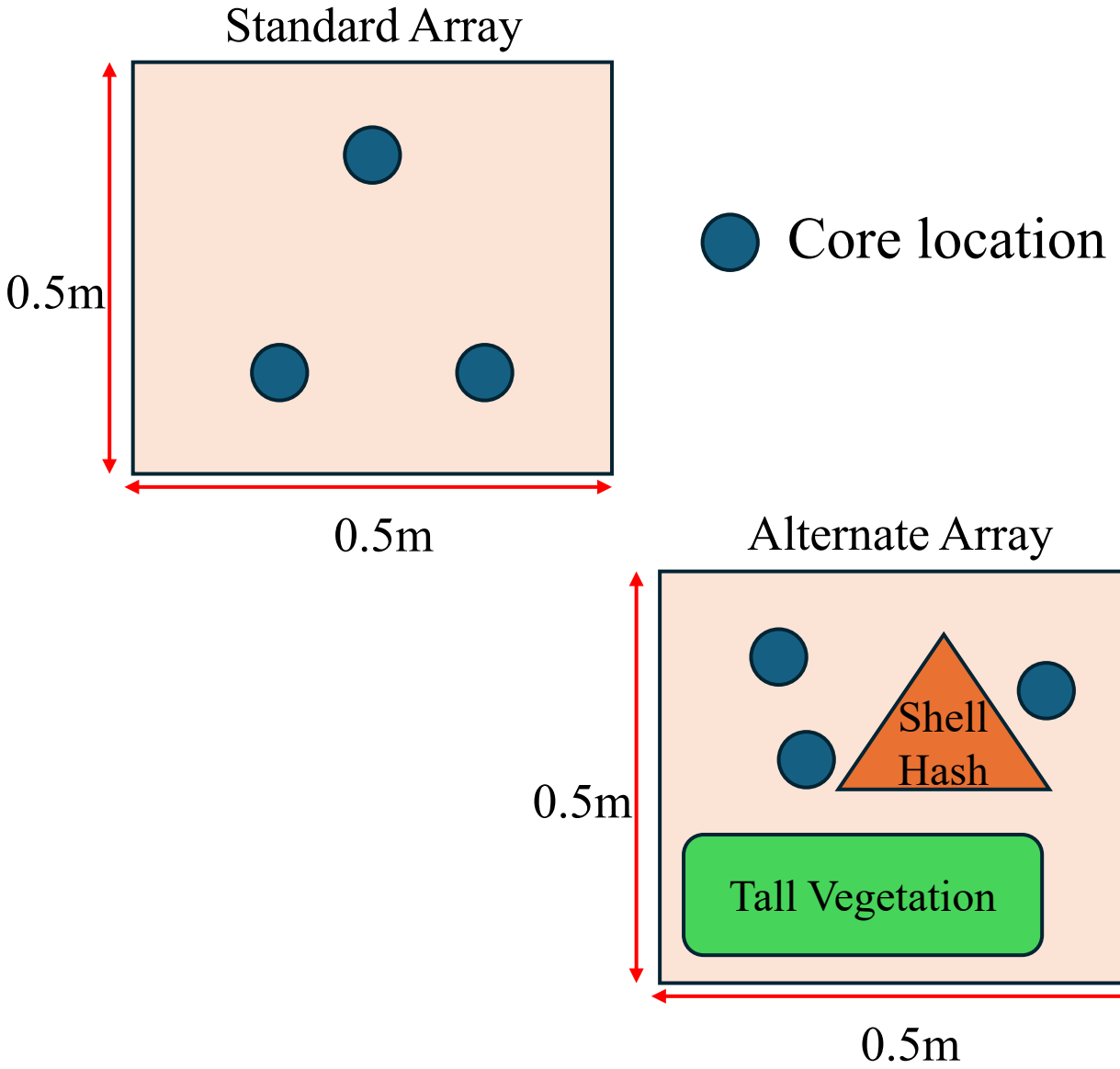
Quadrat Distribution



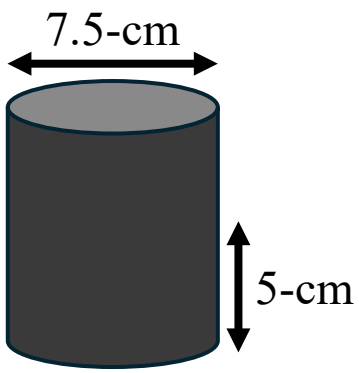
Inner marsh samples (n = 3) per quadrat

Shoreline samples (n = 3) per quadrat

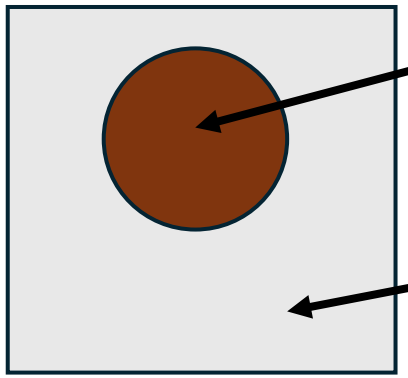
Core Distribution

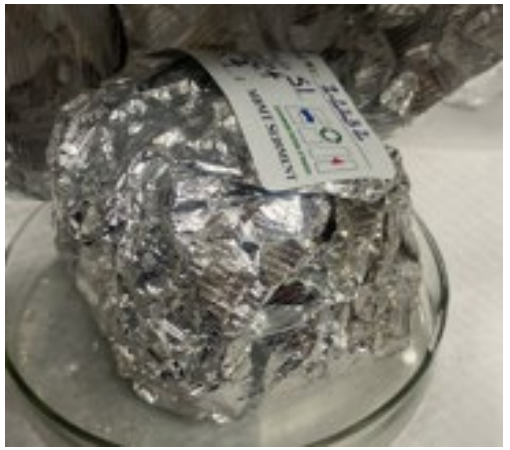


Sample Storage



Rinsed metal corer





Gently wrapped, weighed, and labeled

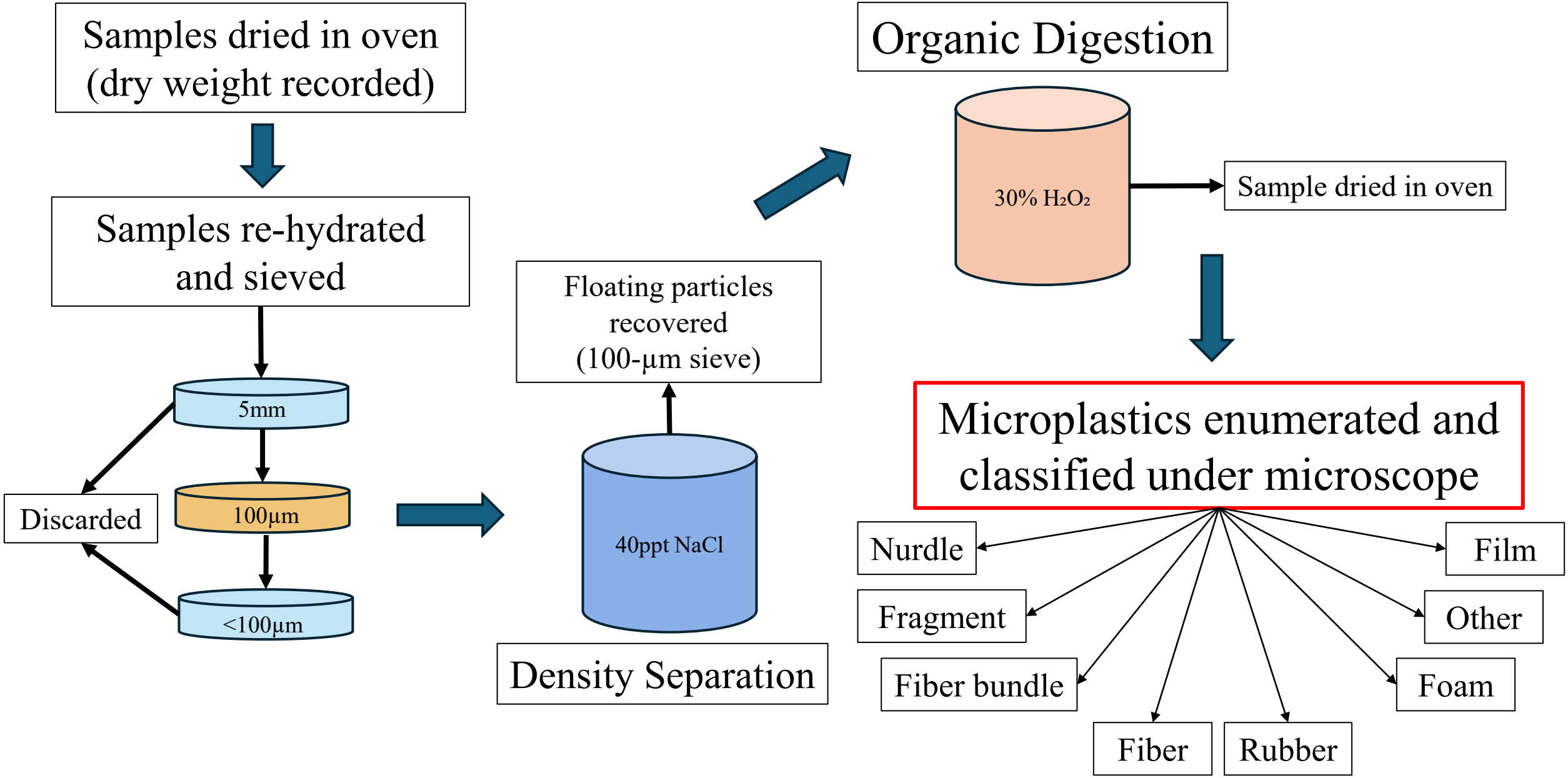
Wrapped with additional foil and stored in aluminum container with aluminum wrapped lid

Samples refrigerated until lab processing

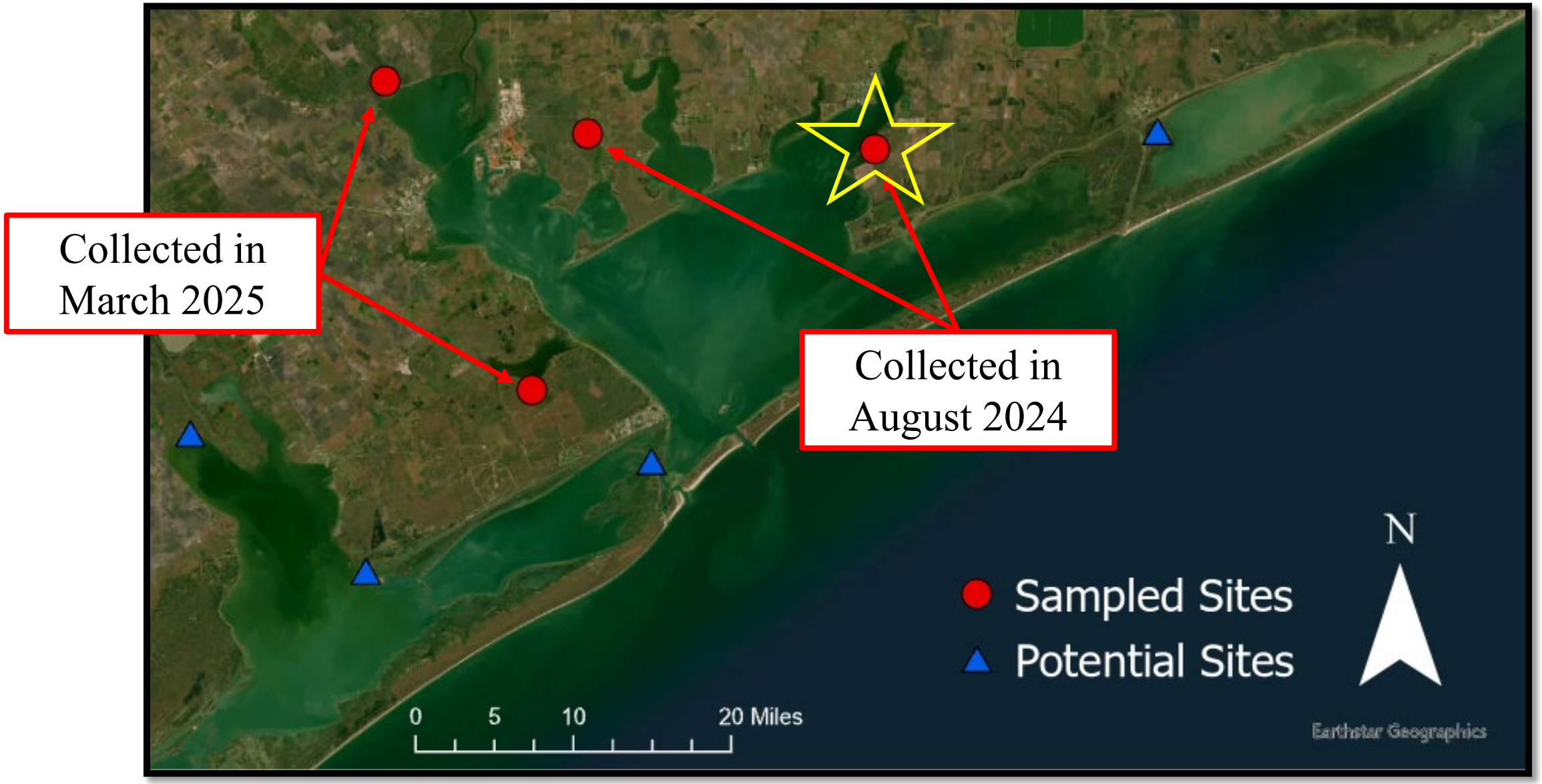
Table 2. Sources, sediment types, sieve size, density separation reagent, and digestion reagent across a subset of microplastic literature.

Source	Sediment type	Sieve Range	Density Separation Reagent	Organic Digestion Reagent
Alvarez-Zeferino et al. 2020	Beach shorelines	1.13–mm – 5-mm	$CaCl_2$	HCl then 30% H_2O_2
Beckwith and Fuentes 2018	Beach shorelines	63–µm – 125-µm	NaCl	None
Lloret et al. 2021	Estuarine salt marsh	250–µm – 5-mm	$ZnCl_2$	Fenton's reagent
Lo et al. 2018	Sandy beaches to mud flats (1:1)	250–µm – 5-mm	$ZnCl_2$	Fenton's reagent
Sartain et al. 2018	Beach shorelines	55–µm – 5-mm	NaCl	None
Vermeiren et al. 2020	Estuary (low to high)	50–µm – 0.5-mm	$ZnCl_2$	30% H_2O_2 vs Fenton's
Zhou et al. 2020	Sandy to Muddy	5–µm – 50-µm	NaCl	Fenton's reagent

Laboratory Processing Flow Chart

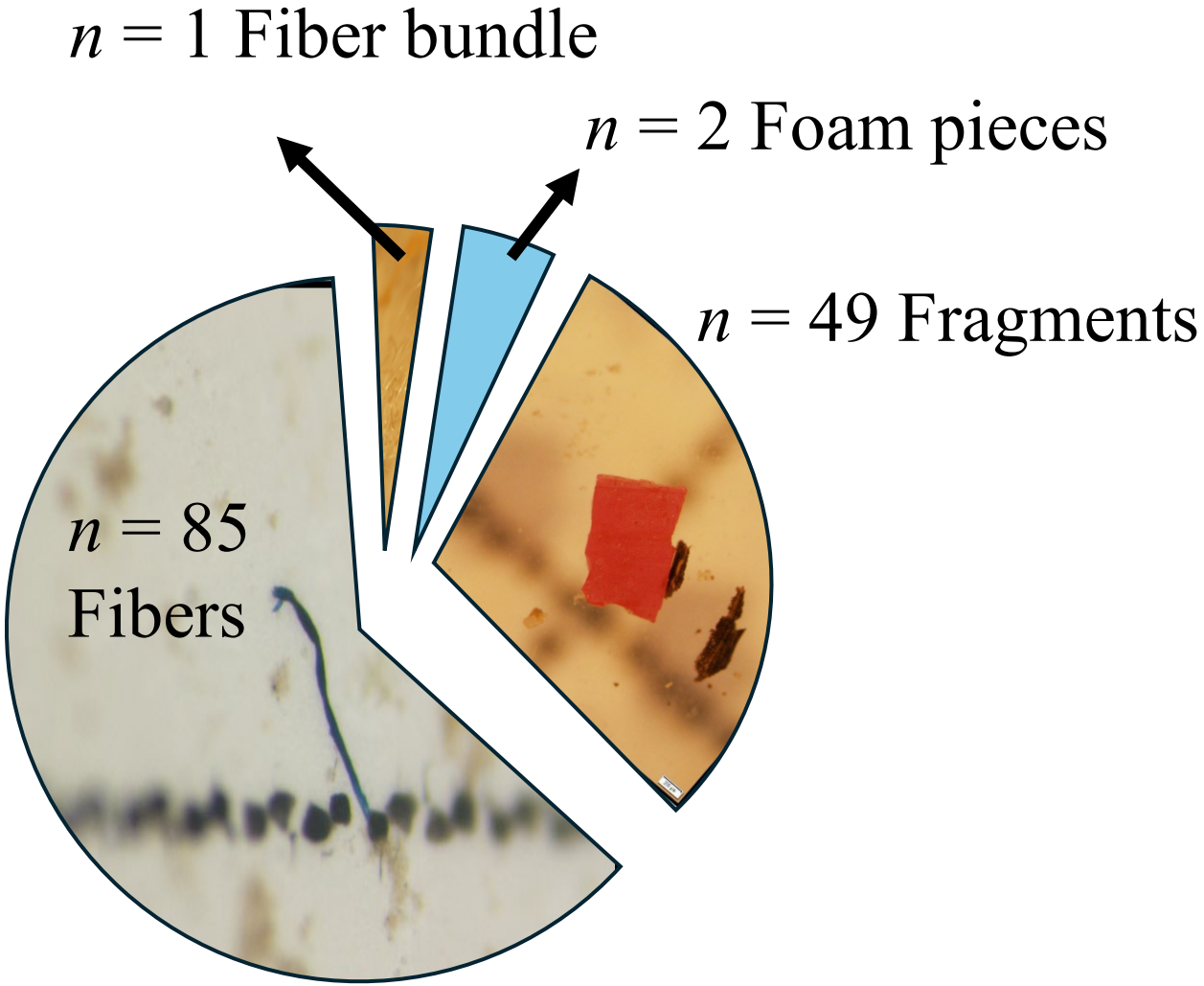


Preliminary Results

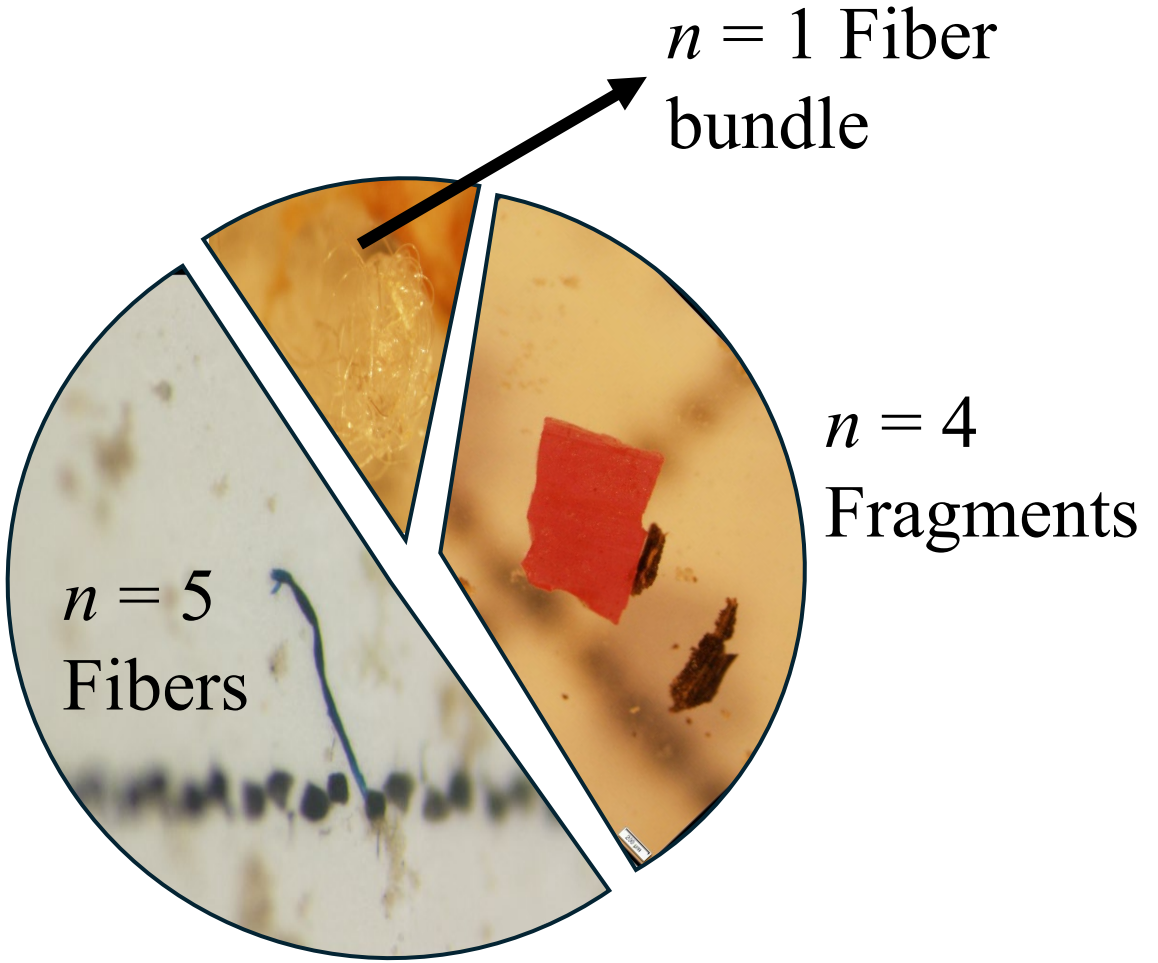


Preliminary Results: Baseline Microplastics

Shoreline Samples (n = 9 cores)



Marsh Samples (n = 4 cores)



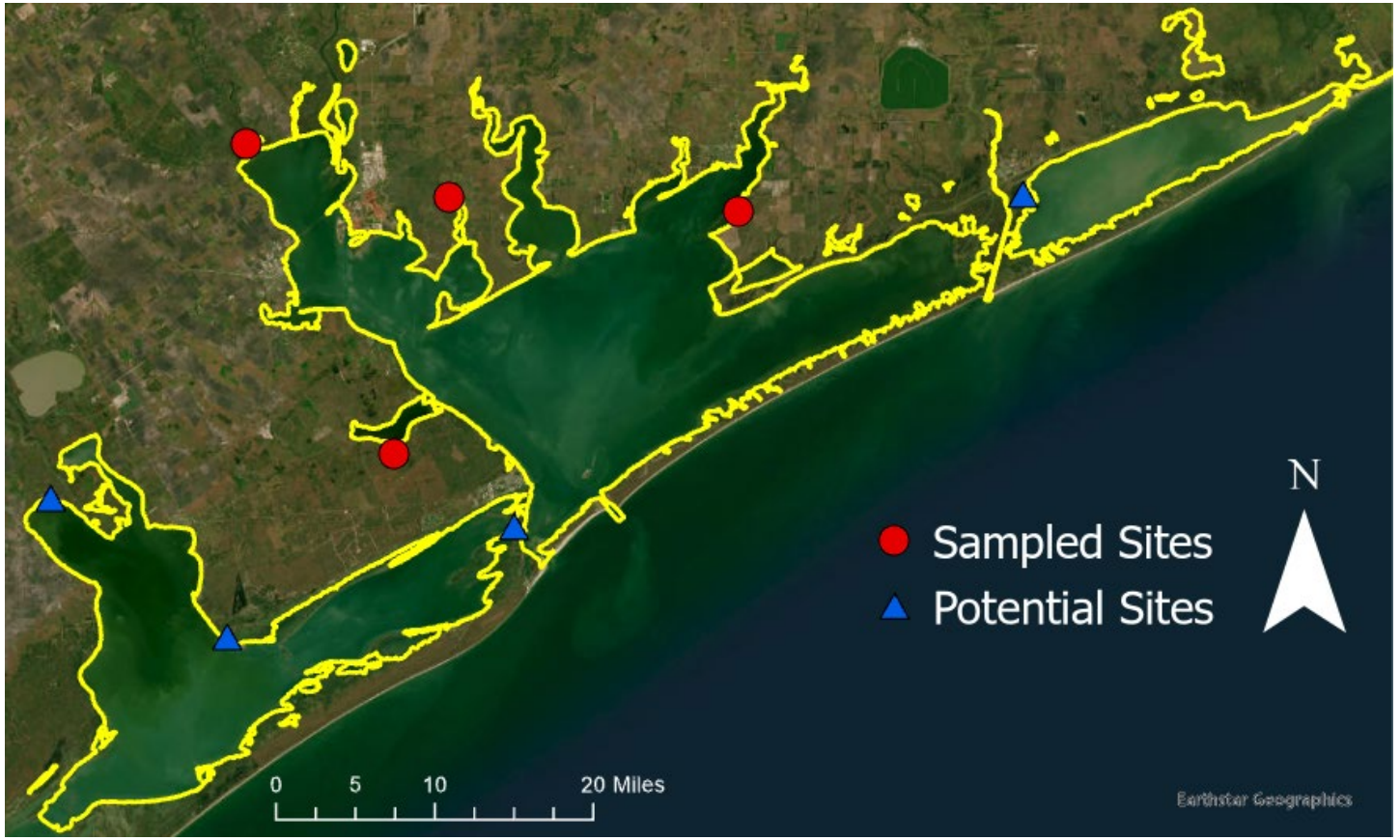
Anticipated Results

- Geographic distinctions in microplastic loading across sites
- Higher levels of loading in shoreline vs inner marsh samples
- Presence/Accumulation of microplastics = overall ecosystem impacts
- Hypothesize correlations in high levels of microplastics and deviations in health panels

- Aspartate Aminotransferase (AST)
- Creatine Kinase (CK)
- Albumin (ALB)
- Globulin (GLB)

Future Plans

- Objective 1: Additional sample collection and processing
- Objective 2: Comparison of microplastic loading between sites and sample types
- Objectives 3 and 4: Comparing microplastic loading at the site level and in fecal samples to health factors in Texas Diamondback Terrapin



Upcoming study in Galveston Bay funded by Galveston Bay and Estuary Program to incorporate staining techniques.

Thank you!

University of Houston Clear Lake

Environmental Institute of Houston

Funding

MATAGORDA BAY MITIGATION TRUST

Literature Cited

Adams, C.I.M., J.E. Baker and B.V. Kjellerup. 2016. Toxicological effects of polychlorinated biphenyls (PCBs) on freshwater turtles in the United States. Chemosphere. 154: 148-154.

Alvarez-Zeferino, J.C., S. Ojeda-Benítez, A.A. Cruz-Salas, C. Martínez-Salvador and A. Vázquez-Morillas. 2020. Microplastics in Mexican Beaches. Resources, Conservation and Recycling. 155:104633. https://doi.org/10.1016/j.resconrec.2019.104633

Beckwith, V.K. and M.M.P.B. Fuentes. 2018. Microplastic at nesting grounds used by the northern Gulf of Mexico loggerhead recovery unit. Marine Pollution Bulletin. 131:32-27. https://doi.org/10.1016/j.marpolbul.2018.04.001

Brennessel, B. 2006. Diamonds in the Marsh: A Natural History of the Diamondback Terrapin. University Press of New England.

Corbett, J. L., 2023. Microplastics Sources, Pathways, and Fate Conceptual Diagram. USGS. Microplastics Sources, Pathways and Fate Conceptual Diagram | U.S. Geological Survey

Dong, X., X. Liu, Q. Hou, and Z. Wang. 2023. From natural environmental to animal tissues: A review of microplastics (nanoplastics) translocation and hazards studies. Science of the Total Environment, Science Direct. 855:158686. http://dx.doi.org/10.1016/j.scitotenv.2022.158686

Hou, D. and D.Q. Rao. 2022. Microplastics: Their Effects on Amphibians and Reptiles- A Review. Pakistan Journal of Zoology. 54(6):2931-2951. https://dx.doi.org/10.17582/journal.pjz/20210820080823

Lavers, J.L., I. Hutton and A.L. Bond. 2019. Clinical Pathology of Plastic Ingestion in Marine Birds and Relationships with Blood Chemistry. Environmental Science and Technology. 53:9224-9231. 10.1021/acs.est.9b02098

Lloret, J., R. Pedrosa-Pamies, N. Vandal, R. Rorty, M. Ritchie, C. McGuire, K. Chenoweth and I. Valiela. 2021. Salt marsh sediments act as sinks for microplastics and reveal effects of current and historical land use changes. Environmental Advances. 4:100060. https://doi.org/10.1016/j.envadv.2021.100060

Lo, H.S., X. Xu, C.Y. Wong amd S.G. Cheung. 2018. Comparisons of microplastic pollution between mudflats and sandy beaches in Hong Kong. Environmental Pollution. 236:208-217. https://doi.org/10.1016/j.envpol.2018.01.031

Lourenço, P.M., C. Serra-Gonçalves, J.L. Ferreira, T. Catry and J.P. Granadeiro. 2017. Plastic and other microfibers in sediments, macroinvertebrates and shorebirds from three intertidal wetlands of southern Europe and west Africa. Environmental Pollution 123-133. http://dx.doi.org/10.1016/j.envpol.2017.07.103

Markley , L.A.T., C.T. Driscoll, B. Hartnett, N. Mark, A.M. Cárdenas and H. Hapich. 2024. Guide for the visual identification and classification of plastic particles. 10.13140/RG.2.2.27505.45927

Sartain, M., C. Wessel and E. Sparks. 2018. Microplastics Sampling and Processing Guidebook. Mississippi State University, MS. extension.msstate.edu/sites/default/files/publications/publications/P3243.pdf.

Texas Parks and Wildlife Department (TPWD), 2023. Species of greatest conservation need: All taxa (Excel Database).

Vermeiren, P., C. Muñoz and K. Ikejima. Microplastic identification and quantification from organic rich sediments: A validated laboratory protocol. Environmental Pollution 262: 114298. https://doi.org/10.1016/j.envpol.2020.114298

Zhou, Q., C. Tu, C. Fu, Y. Li, H. Zhang, K. Xiong, X. Zhou, L. Li, J.J. Waniek and Y. Luo. 2020. Characteristics and distribution of microplastics in the coastal mangrove sediments of China. Science of the Total Environment. 703:134807. https://doi.org/10.1016/j.scitotenv.2019.134807