Quarterly Progress Report

(September 2023)

Project Title

Mercury and Plastic in Commercial and Recreational Fisheries in Lavaca, Matagorda, and San Antonio Bays: Risk Assessment and Interaction between the Two Contaminants

Submitted to

Matagorda Bay Mitigation Trust

Domicile Laboratories

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Objectives of the proposed project

Objective 1. Quantify the abundance and spatial distribution of plastic debris, Hg, and Hg sorbed to plastic in water, sediment and fisheries throughout the three bays

Objective 2. Investigate the influence of water chemistry (salinity and dissolved organic matter concentration), temperature, plastic type, and age on the accumulation of Hg on plastic through a series of controlled laboratory experiments

Objective 3. Determine environmental rates of Hg sorption to new and fouled plastics in the three bays over one year.

Objective 4. Undertake a Hg risk assessment to determine the percentage of each species that exceed federal and state Hg advisory levels in each bay, determine how much of each species a person can consume per week, and calculate the Se: Hg molar ratios in fishes and shellfishes to determine whether Se has a protective role against Hg toxicity, how Se: Hg molar ratios vary with body length, and whether the ratios can be used as a seafood safety criterion in risk assessment.

Project Summary

Lavaca Bay is a hotspot for plastic and mercury, which can be transported to surrounding bays. This study will investigate the prevalence of plastic, measure Hg concentrations, and calculate the selenium: mercury molar ratios in commercial and recreational fisheries (e.g., red drum, black drum, spotted seatrout, shrimp, blue crab, oyster) in Lavaca, Matagorda, and San Antonio Bay. Experiments will investigate the extent to which Hg can bind to plastic and its potential role as a source of mercury to biota. They will help to improve ecosystem and human health while aiding the recovery of economically important fisheries in the three bays.

Introduction

It is common knowledge and an issue of public concern that Lavaca Bay is highly polluted with plastics of various sizes, colors, and shapes, which has been traced to the sharp practices of Formosa Plastics Cooperation and other anthropogenic activities. Also, Lavaca Bay was contaminated with mercury (Hg) from the industrial process of aluminum by the then Alcoa Point Comfort plant in the Superfund Site, which was shut down in the 1980s. Therefore, this project investigates the extent and impact of plastics-mobilized mercury in different environmental matrices across the Lavaca and its surrounding bays.

The knowledge from this study will advise on the possible impact of both plastics and mercury on the biota and its implications on the ecosystem and human health.

Project Update

Objective 1. Quantify the abundance and spatial distribution of plastic debris, Hg, and Hg sorbed to plastic in the water, sediment, and fisheries throughout the three bays

Between December 2021 and March 2023, we carried out five sampling surveys (December, March, July, October 2022, and March 2023) in twelve (12) locations in San Antonio (SA) and Matagorda Bay (MB). Water parameters, sampling locations, GPS, and photographs of each sampled location were documented accordingly. Processing of collected plastic litter continues at TAMU-CC. The FTIR characterization and polymer identification for two batches of samples (March and July 2022) have been completed (Table 1); October 2022 and March 2023 are ongoing and await data cleaning and analysis. December 2021 is still on hold due to the sampling error observed. All samples collected, processed, and characterized await mercury quantification and data analysis.

Table 1: Summary of the FTIR characterization and polymer identification of the total samples collected in March, July, and October 2022 across all twelve sites.

Sampling Period	PE	PP	PET	Nylon	PS	PVC	PU	Other	Total
March 2022	158	122	43	37	38	36	9	57	500
July 2022	216	110	35	35	57	15	4	88	560
October 2022	1047	791	76	46	130	21	32	55	2198
March 2023	21	20	29	15	61	10	-	8	165[+]

+ FTIR Characterization ongoing.

*PE- Polyethylene; PP- Polypropylene; PET- Polyethylene terephthalate; PS- Polystyrene; PVC- Polyvinyl chloride; PU- Polyurethane

Objective 2. Investigate the influence of water chemistry (salinity and dissolved organic matter concentration), temperature, plastic type, and age on the accumulation of Hg on plastic through a series of controlled laboratory experiments.

Jordan Daniels is working on this objective for her thesis. Experiments have commenced since Spring 2023.

Objective 3. Determine environmental rates of Hg sorption to new and fouled plastics in the three bays over one year.

In August 2023, we conducted a four-week Hg sorption study in four sampling sites across Lavaca Bay (Bayfront Peninsula, Corner Beach, Point Comfort, and Six Mile). Four polymer types were deployed to the sampling sites (PE- Polyethylene, PP- Polypropylene, PS- Polystyrene, and NY- Nylon), and three replicates for each polymer type per site. The total number of samples per week is 48, and 192 for the entire study (4 weeks). 92.7% recovery of the exposed samples were

recovered (totaling 180 samples in all). All recovered samples were processed at TAMU-CC and shipped for mercury quantification and data analysis at Texas State University- San Marcus.

Figure 1: *Hg Adsorption study - samplers comprising four different polymer types in triplicates for each sampling site for four weeks.*

Figure 2: Samplers ready to be transported to the field.

Figure 3: Deployment of samplers at four locations within the Lavaca Bay System.

Figure 4: Deployment of samplers at four different locations within the Lavaca Bay System.

Figure 5: Recovered samplers and samples at three different locations across Lavaca Bay

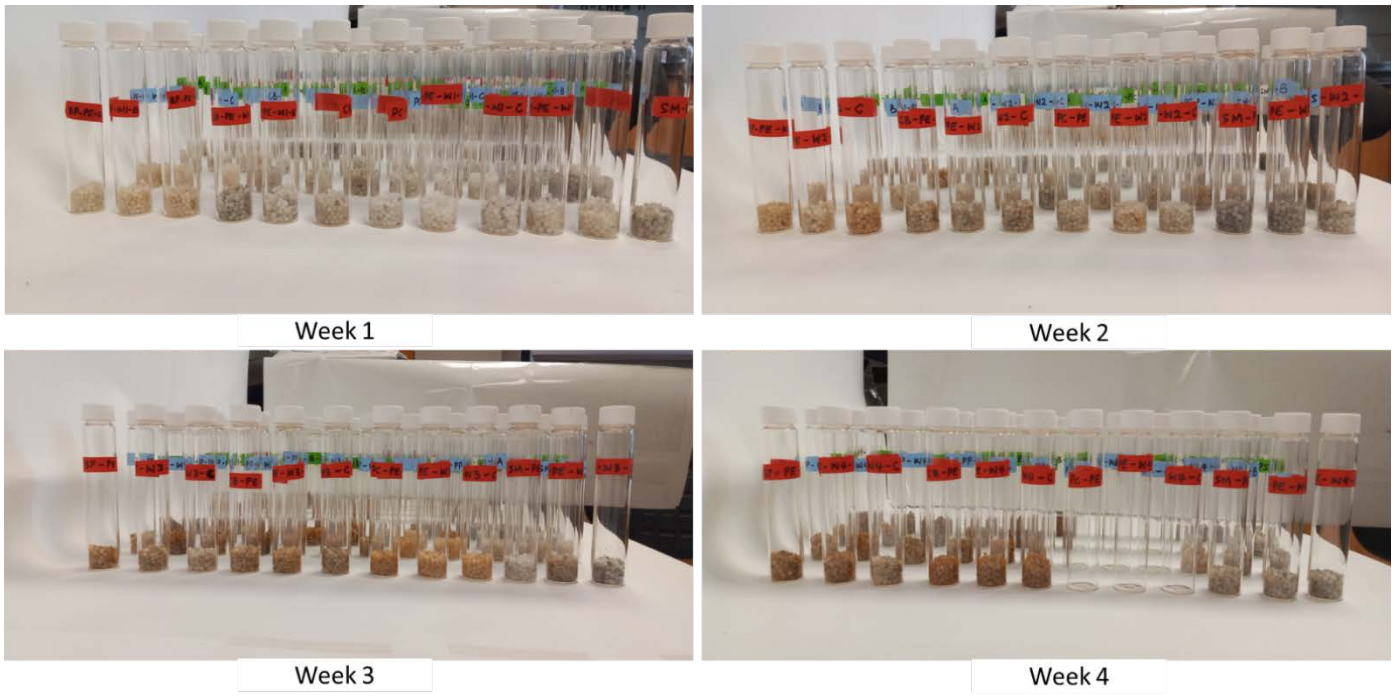

Figure 6: Polyethylene exposure for four weeks in four different locations within the Lavaca Bay

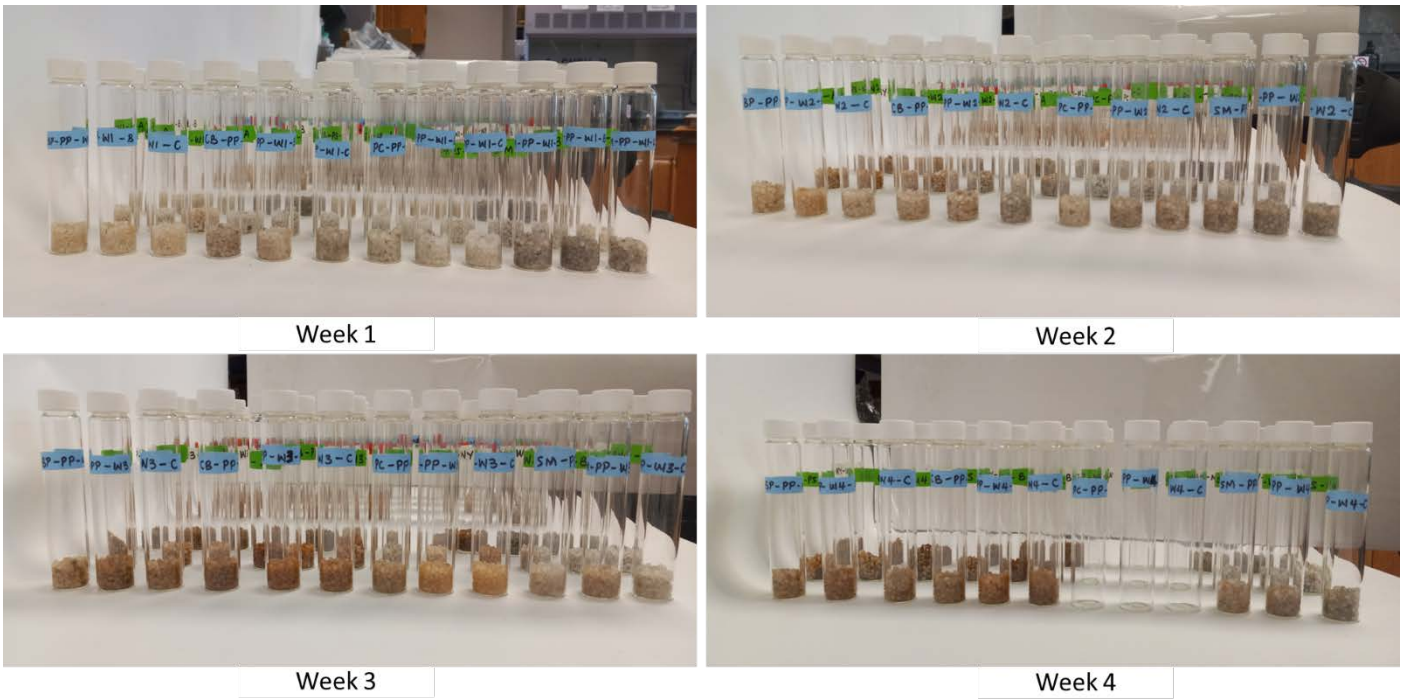

Figure 7: Polypropylene exposure for four weeks in four different locations within the Lavaca Bay

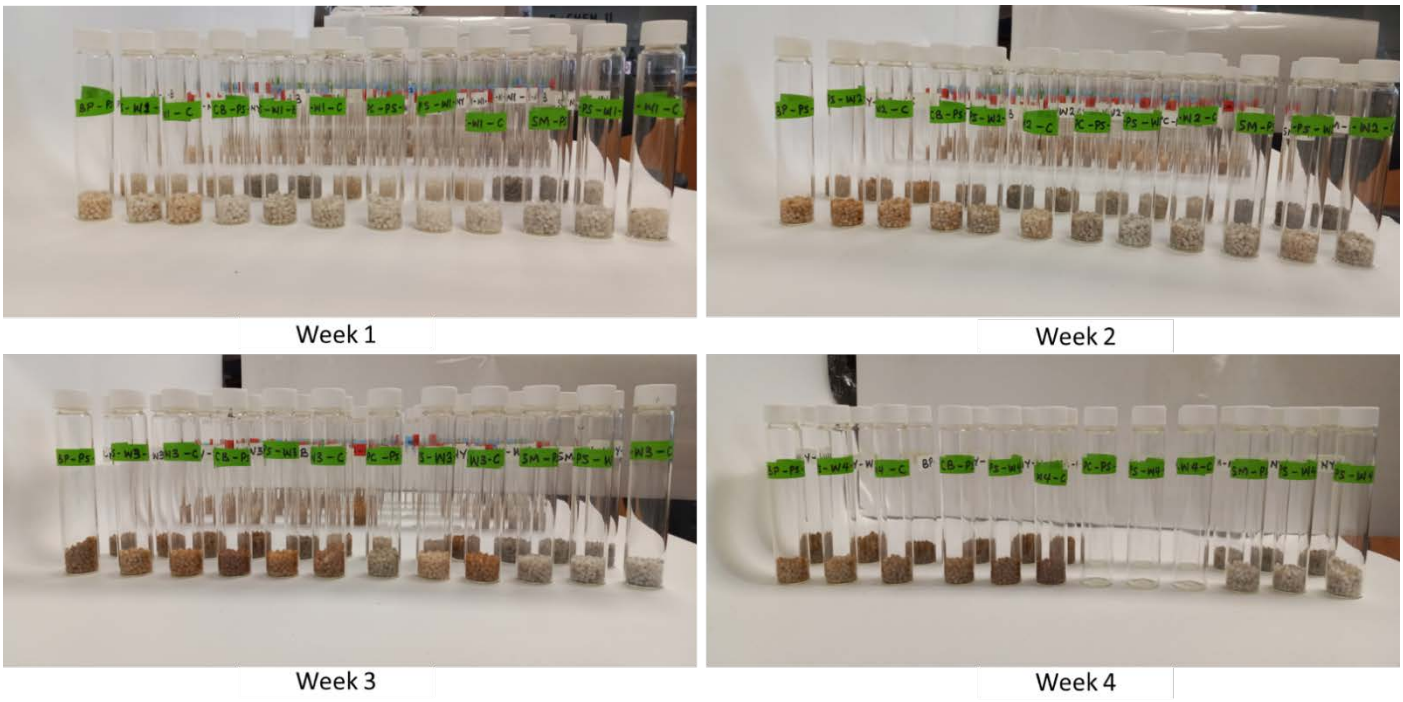

Figure 8: Polystyrene exposure for four weeks in four different locations within the Lavaca Bay

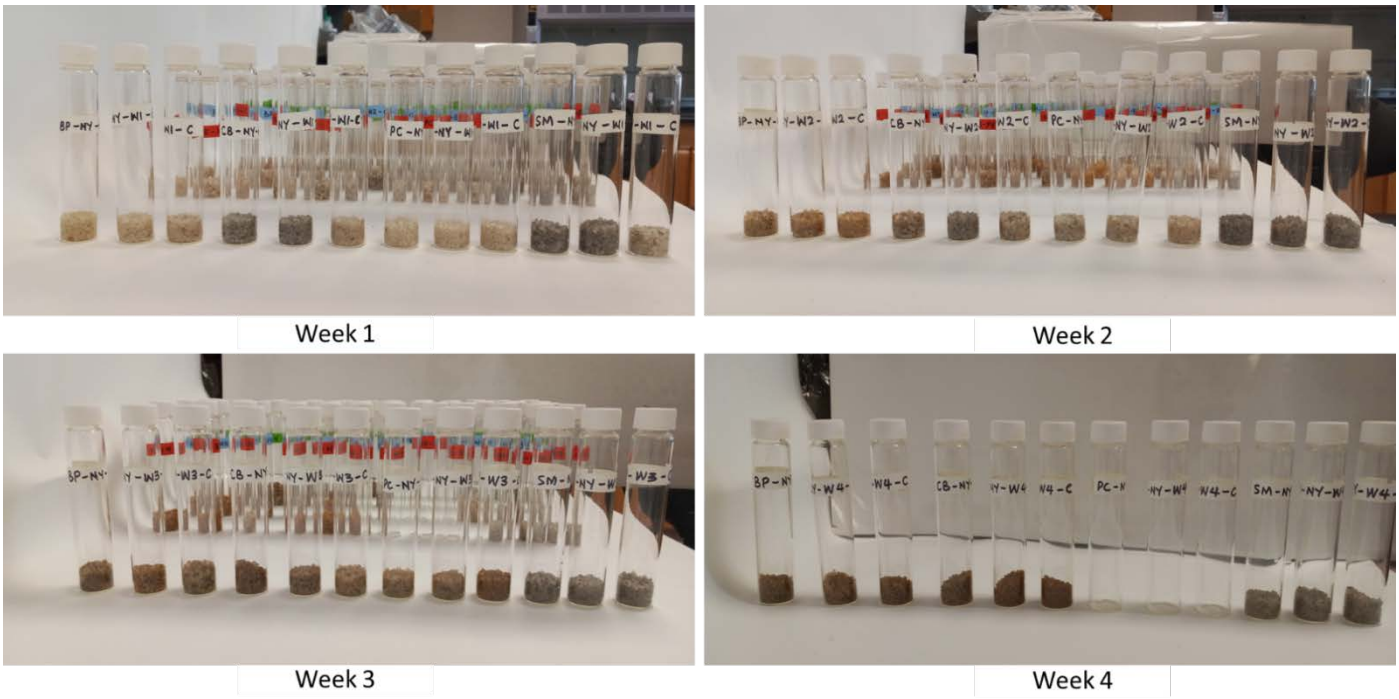

Figure 9: Nylon exposure for four weeks in four different locations within the Lavaca Bay

Objective 4. Sampling is now complete for Austwell, Seadrift, Port O'Connor, and Matagorda. After several delays due to COVID-19, the weather, and poor fishing, all sample collection in all collection locations is now completed. The sample size for each species and collection location is shown in Table 1.

Table 1: Fish and shellfish sample sizes to date at each collection location. NA = not available.

	Austwell	Seadrift	Port Lavaca	Point Comfort	Palacios	Port O'Connor	Matagorda
Red drum	4	82	54	54	28	63	86
Black drum	20	53	70	63	NA	17	53
Spotted seatrout	29	62	60	25	29	122	90
Southern flounder	1	25	26	33	4	52	52
Sheepshead	NA	2	3	7	NA	3	4
Hardhead catfish	54	67	56	56	3	62	50
Striped mullet	6	60	60	83	60	61	60
Atlantic croaker	1	61	60	65	60	99	60
Blue crab	NA	64	60	24	23	NA	60
White shrimp	NA	60	60	63	60	60	60
Eastern oyster	NA	63	85	60	67	NA	60

Mercury analysis is ongoing. The species at each site which have been analyzed are shown in Table 2. All Hg analysis has been completed for all sites except the Closed Area (7 out of 11 species have been analyzed so far).

Table 2: Fishes and shellfishes that have undergone Hg analysis at each collection location. Y = all samples have been analyzed. ND = not determined because it is not sampled.

	Austwell	Seadrift	Port Lavaca	Point Comfort	Palacios	Port O'Connor	Matagorda
Red drum	Y	Y	Y		Y	Y	Y
Black drum	Y	Y	Y		ND	Y	Y
Spotted seatrout	Y	Y	Y	Y	Y	Y	Y
Southern flounder	Y	Y	Y	Y	Y	Y	Y
Sheepshead	ND	Y	Y	Y	ND	Y	Y
Hardhead catfish	Y	Y	Y		Y	Y	Y
Striped mullet	Y	Y	Y	Y	Y	Y	Y
Atlantic croaker	Y	Y	Y		Y	Y	Y
Blue crab	ND	Y	Y	Y	Y	ND	Y
White shrimp	ND	Y	Y	Y	Y	Y	Y
Eastern oyster	ND	Y	Y	Y	Y	ND	Y

Selenium analysis is ongoing. The species at each site which have been analyzed are shown in Table 3. Selenium analysis has been completed for all sites except the Closed Area.

Table 3: Fishes and shellfishes that have undergone Se analysis at each collection location. Y = all samples have been analyzed. Y = samples have been digested and are waiting on ICP-MS analysis. ND = not determined because it is not sampled.

	Austwell	Seadrift	Port Lavaca	Point Comfort	Palacios	Port O'Connor	Matagorda
Red drum	Y	Y	Y		Y	Y	Y
Black drum	Y	Y	Y		ND	Y	Y
Spotted seatrout	Y	Y	Y		Y	Y	Y
Southern flounder	Y	Y	Y		Y	Y	Y
Sheepshead	ND	Y	Y		ND	Y	Y
Hardhead catfish	Y	Y	Y		Y	Y	Y
Striped mullet	Y	Y	Y		Y	Y	Y
Atlantic croaker	Y	Y	Y		Y	Y	Y
Blue crab	ND	Y	Y		Y	ND	Y
White shrimp	ND	Y	Y		Y	Y	Y
Eastern oyster	ND	Y	Y		Y	ND	Y

Goals for the next quarter:

- Finish the Hg and Se analysis (only the Closed Area is left)
- Begin data and statistical analysis and calculate the Se: Hg molar ratios

Project milestones

The Hg and Se data for the Matagorda samples was presented at the Society of Environmental Toxicology and Chemistry (SETAC) South Central Annual Meeting in late March 2023.

Daniels, JL, McInerney, BJ, and Dutton, J. (2023). Selenium: mercury molar ratios in commercially and recreationally important fish and shellfish species in southeastern Matagorda Bay, Texas. Society of Environmental Toxicology and Chemistry South-Central Regional Meeting. Denton, TX.

Plastic data was presented at the Society of Environmental Toxicology and Chemistry (SETAC) South Central Annual Meeting in late March 2023 and the Texas Plastics Pollution Symposium in early April in Houston.

Fadare, OO, Lascelles, N, Myers, JT, Conkle, JL, Dutton, J, and Abdulla, HA (2023). Plastics, Polycyclic Aromatic Hydrocarbons, and Mercury Interactions within the Matagorda Bay System: Does this pose a risk to fish health? Society of Environmental Toxicology and Chemistry South-Central Regional Meeting. Denton, TX.

Fadare, OO, Martin, L, Lascelles, N, Myers, JT, Kaiser, K, Xu, W, Conkle, JL and Abdulla, HA (2023). A Novel Method for Micro(nano)plastics extraction in Particulate Organic Matter from Lavaca Bay System. Society of Environmental Toxicology and Chemistry South-Central Regional Meeting. Denton, TX.

Gallagher, C, Fadare, OO, Conkle, JL, and Abdulla, HA (2023). Towards long-term monitoring of Plastic pollution in the Matagorda Bay Systems: Quantitative Analysis and FTIR Characterization of Macroplastics. Texas Plastics Pollution Symposium. Houston, TX.

Fadare, OO, Lascelles, N, Conkle, JL, 2023. https://www.youtube.com/watch?v=zEc-RnzAwDM

Published Article:

Fadare, OO, Martin, L, Lascelles, N, Myers, JT, Kaiser, K, Xu, W, Conkle, JL (2023). Binary solvent extraction of microplastics from a complex environmental matrix. *Limnol. Oceanogr.: Methods*. 21 (7), 414-420. IF: 3.1

Article in-prep:

Fadare, OO, Lascelles, N, Myers, JT, Abdulla, HA, Conkle, JL, and Dutton, J (2023). Plastics, Polycyclic Aromatic Hydrocarbons, and Mercury Interactions within the Matagorda Bay System: Does this pose a risk to fish health?

Fadare, OO, Lascelles, N, Abdulla., H, Conkle, JL, and Dutton, J (2023). Microplastics and Polycyclic Aromatic Hydrocarbons adsorption kinetics within the Matagorda Bay System.

To be presented at the Society of Environmental Toxicology and Chemistry (SETAC) South Central Annual Meeting coming up between November 12-16, 2023, in Louisville, KY.

Fadare, OO, Lascelles, N, Hoang, Q, Gallagher, C, Lewis, S, Ivy, K, de Vries, N, Haley, C, Myers, JT, Conkle, JL and Abdulla, HA (2023). Spatial and temporal patterns of plastic and microplastic pollution in the Matagorda Bay System: Domestic or Industrial Source Concern?

Fadare, OO, Conkle, JL and Abdulla, HA (2023). Insight into the Eco-corona formation and interaction of environmentally weathered microplastics using Fourier transform spectroscopy (FTIR), and spectra pattern recognition techniques.


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