Quarterly Progress Report

(June 2024)

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.

Due to several critical factors, we have approved a one-year extension at no additional cost. The change in the principal investigator (PI), challenges encountered in analyzing plastic samples using the Direct Mercury Analyzer, and complications arising from the COVID-19 pandemic have necessitated additional time to complete field experiments, conduct thorough analyses, and process the data effectively.

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 biota and its implications on the ecosystem as well as 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

We have completed four sampling surveys across twelve locations in San Antonio (SA) and Matagorda Bay (MB) between December 2021 and March 2023. During these surveys, we identified 5,054 types of plastics. A summary of the plastic polymer types identified in each sampling period is provided in Table 1. Additionally, the measurement of Hg concentration in all field-collected plastic samples has been completed.

Table 1: Summary of the FTIR characterization and polymer identification of the total samples collected in March, July, October 2022, and March 2023 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	439	524	179	89	330	83	19	133	1796

+ 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.

Planning experiments and making supplies list. Experiments will start in September 2024, after the summer fieldwork season ends. Supplies will be purchased over the summer.

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

A preliminary four-week Hg sorption study was conducted at four sampling sites across Lavaca Bay. Four polymer types (PE - Polyethylene, PP - Polypropylene, PS - Polystyrene, and NY - Nylon) were deployed at each site, with three replicates for each polymer type per site. This resulted in a total of 48 samples per week and 192 samples for the entire study period (4 weeks). We achieved a 92.7% recovery rate of the exposed samples, totaling 180 samples. All recovered

samples were processed at TAMU-CC and then shipped to Texas State University - San Marcos for mercury quantification and data analysis.

Additionally, we analyzed all collected samples for polycyclic aromatic hydrocarbons (PAHs) using a GC triple quadrupole mass spectrometer. The data is currently being processed and analyzed.

We plan to conduct a more comprehensive Hg sorption study at the end of August 2024. This study will include field incubation experiments conducted around Lavaca Bay, near the Superfund Site.

Objective 4.

All sample collection has been completed for this objective. 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

All Hg analysis has been completed for this objective (Table 2)

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	Y
Black drum	Y	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	Y
Striped mullet	Y	Y	Y	Y	Y	Y	Y
Atlantic croaker	Y	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

All Se analyses have been completed for this objective (Table 3).

Table 3: Fishes and shellfishes that have undergone Se 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	Y
Black drum	Y	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	Y
Striped mullet	Y	Y	Y	Y	Y	Y	Y
Atlantic croaker	Y	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

Goals for the next quarter:

- Master's student is writing her thesis on Se:Hg molar ratios in fishes and shellfishes throughout the Matagorda Bay system and San Antonio Bay. Expected to graduate in December 2024.

Project milestones

Rehkopf, J., K. Banks, M. Streich, and J. Dutton (2024) Mercury concentrations in biota from the Alcoa Superfund site in Lavaca Bay (Point Comfort, Texas). Society of Environmental Toxicology and Chemistry South-Central Regional Meeting. Kerrville, TX.

Daniels, J., and J. Dutton (2024) Mercury concentrations in commercially and recreationally important fish and shellfish species in the Alcoa/Point Comfort Superfund site compared to Port Lavaca (Lavaca Bay, Texas). Society of Environmental Toxicology and Chemistry South-Central Regional Meeting. Kerrville, TX.

Two abstracts have been accepted for the Society of Environmental Toxicology and Chemistry North America 45th Annual Meeting in Fort Worth, TX in November 2024.

Kiersten M. Ivy has successfully defended her master's thesis entitled *"Distribution of Polymer Types in Matagorday Bay & Biofilm Presence on Surface of Plastic Pollution: A Study using Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy and Principal Component Analysis"* Texas A&M University-Corpus Christi. P Partial Fulfillment of the Requirements for the Degree of Master of Science in Coastal and Marine System Science program-TAMUCC.

The Spatial and temporal patterns of plastic and microplastic pollution in the Matagorda Bay System was presented at the Society of Environmental Toxicology and Chemistry (SETAC) South Central Annual Meeting, November 12-16, 2023, in Louisville, KY.

Insight into the Eco-corona formation and interaction of environmentally weathered microplastics using Fourier transform infrared spectroscopy (FTIR) and spectra pattern recognition techniques was presented at the Society of Environmental Toxicology and Chemistry (SETAC) South Central Annual Meeting, November 12-16, 2023, in Louisville, KY.

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 Hussain, AA (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 Hussain, AA (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 Hussain, AA (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

Co-PI Dutton was part of a workshop organized by the US Army Corps of Engineers (USACE). The USACE met with community organizations and PI Dutton on March 5th, 2024 to discuss the status of their Supplemental Environmental Impact Statement for the proposed Matagorda Bay ship channel expansion project and hear concerns about the proposed dredged. Co-PI Dutton summarized the findings from Objective 4.

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, Conkle, JL, Dutton, J, Abdulla, H (in preparation). Plastics, Polycyclic Aromatic Hydrocarbons, and Mercury Interactions within the Matagorda Bay System: Does this pose a risk to fish health?

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

Fadare, OO, Lascelles, N, Hoang, Q, Gallagher, C, Lewis, S, Ivy, K, de Vries, N, Haley, C, Myers, JT, Conkle, JL and Abdulla, HA (in preparation). 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 (in preparation). 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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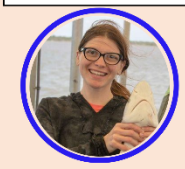

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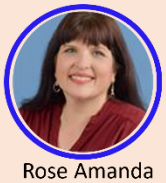

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