

Quarterly Progress Report
(June 2025)

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

As noted in the previous quarterly update, we carried out four sampling campaigns—covering twelve sites in San Antonio (SA) and the Matagorda Bay (MB) area—between December 2021 and March 2023. Over the course of these surveys, we catalogued 5,054 distinct plastic items. Table 1 summarizes the types of polymers recorded in each sampling period. We have also finished analyzing mercury (Hg) concentrations in plastic specimens collected in the field.

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

*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.

We have completed the experimental setup and run a trial using PVC powder and aerated polystyrene. We were waiting for the results from the field experiment to make the lab tests more environmentally relevant. Still, since that data will not be available in time, we will proceed with the experiments. The study will investigate the influence of salinity and DOM (as separate variables) on the uptake of Hg to PVC powder and aerated polystyrene at three different Hg concentrations. We will then repeat the same experiment but using field-collected water from Port Lavaca (instead of lab-amended seawater with Instant Ocean).

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

As mentioned in our last quarterly update we reported a four-week pilot study on mercury (Hg) sorption at four Lavaca Bay sites. At each site we deployed four polymer types—polyethylene (PE), polypropylene (PP), polystyrene (PS) and nylon (NY)—in triplicate, yielding 48 samples per week (192 in total). We recovered 92.7% of the exposures (180 usable samples), but several bottles were damaged en route to Texas State University–San Marcos for Hg analysis, which reduced the data set.

To remedy these losses and extend the work, a full-scale Hg sorption study will begin in December 2024. Despite clear TMUCC labels and advanced notice to Formosa Plastics Texas and the Port Authority, the last batch was compromised. Therefore, a third deployment was launched two weeks ago and is now undergoing periodic inspection. This field-incubation series, focused on sites around Lavaca Bay, especially near the Superfund area, will run through the end of August 2025.

Objective 4.

All sample collection for this objective has been completed, and a Master's student has defended her thesis and graduated. The citation is:

Daniels, J. (2024) Spatial variability in selenium: mercury molar ratios and selenium health benefit values in fishes and shellfishes from the Matagorda Bay system and San Antonio Bay. Master's thesis, Texas State University.

We are currently writing and finishing up for publication. We expect to publish three articles from this objective.

Project milestones

Two posters will be presented at the Society of Environmental Toxicology and Chemistry North America 45th Annual Meeting in Fort Worth, TX in October 2024.

Daniels, J., L. McInerney, and J. Dutton (2024) Spatial variability in mercury concentrations in fishes and crabs in the Matagorda Bay system (Texas, USA) with a focus on the Alcoa/Point Comfort Superfund site. Society of Environmental Toxicology and Chemistry North America 45th Annual Meeting. Fort Worth, TX.

Rehkopf, J., K. Banks, M. Streich, W. Nowlin, and J. Dutton (2024) Mercury concentrations in biota from the Alcoa/Point Comfort Superfund site (Lavaca Bay, Texas). Society of Environmental Toxicology and Chemistry North America 45th Annual Meeting. Fort Worth, TX.

To date, five news articles have resulted from the talk Dr. Dutton gave in Port Lavaca in August:

The future of Lavaca Bay. Crossroads Today. October

30. https://www.crossroadstoday.com/news/local-news/calhoun-county/the-future-of-lavaca-bay/article_280bc290-96ba-11ef-8eff-472a03b1e2a4.html

New research revealing high levels of mercury in Texas bay raises alarms about dredging for oil tankers. Oil and Gas Watch. August 29. <https://news.oilandgaswatch.org/post/new-research-revealing-high-levels-of-mercury-in-texas-bay-raises-alarms-about-dredging-for-oil-terminal>

Experts warn of mercury levels in Lavaca Bay. The Port Lavaca Wave. August 28. <https://www.portlavacawave.com/articles/333/view>

What dangers does the mercury in Lavaca Bay pose for the community? The Victoria Advocate. August 23. https://www.victoriaadvocate.com/news/business/what-dangers-does-the-mercury-in-lavaca-bay-pose-for-the-community/article_5e3e6298-6170-11ef-8d80-0f5961e3cebb.html

Mercury found in Lavaca Bay poses serious health risks, warning from experts. Crossroads Today. August 22. https://www.crossroadstoday.com/lifestyle/mercury-found-in-lavaca-bay-poses-serious-health-risks-warning-from-experts/article_53c34740-6105-11ef-8942-0b254a4dc7ea.html

Dr. Dutton attended the community meeting hosted by the EPA in Port Lavaca on December 9th 2024 to discuss the status of the Alcoa Superfund site. She spoke with federal and state agencies, and industry about the results of this objective.

Dr. Jessica Dutton presented the Objective 4 Hg results at a public meeting. Public presentation “Mercury concentrations in sediment and biota in the Alcoa (Point Comfort) Superfund site”. Hosted by the San Antonio Bay Estuarine Waterkeeper. August 22, 2004, Port Lavaca, TX. Attended by ~200 people (federal and state agencies, city council, industry, environmental groups, community members). Livestreamed (~1000 views to date). Translated into Spanish and Vietnamese.

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.

Kiersten M. Ivy has successfully defended her master's thesis entitled “*Distribution of Polymer Types in Matagorda 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:

Ivy, K., Cogar, L., de Vries, N, Fadare, O., Conkle, J., Abdulla, H. (in preparation). 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. To be submitted to Environmental Science and Technology

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

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

Fadare, O., Conkle, J. and Abdulla, H. (in preparation). Insight into the Eco-corona formation and interaction of environmentally weathered microplastics using Fourier transform spectroscopy (FTIR), and spectra pattern recognition techniques.