Quarterly Progress Report

December 2024

Project Title

Sediment Mercury Concentrations in the Closed Area of Lavaca Bay and the Risk to Wildlife from Mercury Remobilization During Dredging

Contract # 041

Submitted to

Matagorda Bay Mitigation Trust

Principal Investigator

Jessica Dutton, Ph.D.

Department of Biology, Texas State University, San Marcos, TX

Co-Principal Investigator

Lindsay Prothro, Ph.D.

Department of Physical and Environmental Sciences, Texas A&M University – Corpus Christi. Corpus Christi, TX

Prepared by

Jessica Dutton, Ph.D.

Project Summary

The Closed Area of Lavaca Bay is a mercury (Hg) Superfund site that is undergoing long-term environmental monitoring. The proposed Matagorda ship channel expansion project will dredge in the Closed Area and could remobilize Hg stored in sediment back into the bay. This study will investigate how sediment Hg concentrations vary with depth throughout the proposed dredging area and undertake lab-based toxicity and bioaccumulation experiments to determine whether the Hg-rich sediment is toxic to benthic organisms. Agencies can use the data to make informed decisions about how to dredge and dispose of the Hg-rich sediment to minimize its environmental impact.

Project Goals and Objectives

The goal of this project is to investigate sediment Hg concentrations in the Closed Area of Lavaca Bay (with a focus on the area that will be dredged) and determine whether sediment Hg concentrations are high enough to pose a threat to the health of benthic organisms if Hg is remobilized during the proposed dredging activities. This study can be broken down into six objectives:

Objective 1: Investigate how THg concentrations change with sediment depth to determine 1) at what depth the greatest THg concentrations are found; 2) how thick the Hg layer is; and 3) how THg concentrations vary spatially throughout the Closed Area.

Objective 2: Map the bay floor and investigate the relationship between sediment THg concentrations and sediment characteristics (grain size and organic matter content).

Objective 3: Use radioisotopes (^{210}Pb and ^{137}Cs) to create sediment age-depth profiles and determine sedimentation rates.

Objective 4: Speciate THg in the surface and Hg layer sediment to determine the MeHg concentration and percent MeHg and determine the bacterial composition of the sediment.

Objective 5: Calculate how much Hg could potentially be released into Lavaca Bay from the proposed dredging activities.

Objective 6: Determine whether sediment Hg concentrations are high enough to cause toxicity to benthic organisms (polychaete worms, amphipods, bivalves, gastropods) using laboratory-based toxicity tests and bioaccumulation experiments.

Project Update

This quarter we completed work on Objectives 1, 2, and 4.

Objective 1

All sediment cores for this project have been collected. 32 cores were collected in June 2023 and 28 cores were collected in May 2024 (Fig. 1). All the cores have been sectioned into 1 cm or 2 cm depth intervals and each depth interval has been subsampled for different analyses.

Figure 1. 2023 and 2024 sediment core collection locations. The yellow pins show the location of each core.

Out of the 60 cores, Hg analysis has been completed for 65% (n = 39) of them. The breakdown by year is as follows:

2023

- Number of cores subsampled for the different analyses = 32
- Number of cores that have been freeze dried = 24
- Number of cores that have had the Hg concentration measured in each depth interval = 22

2024

- Number of cores subsampled for the different analyses = 28
- Number of cores that have been freeze dried = 17
- Number of cores that have had the Hg concentration measured in each depth interval = 17

The Hg concentration in each sediment sample (190 – 220 mg) was measured using a Direct Mercury Analyzer (DMA-80; Milestone Inc., Shelton, CT) which utilizes thermal decomposition, amalgamation, and atomic absorption spectrophotometry. One set of quality control, including a blank, certified reference material (either MESS-4 marine sediment; PACS-3 marine sediment; DORM-5 fish protein; or ERM CE-464 tuna), and duplicate sample was included with every 10 samples analyzed.

Key findings this quarter:

1. A 89.5 cm sediment core was collected next to a black drainage pipe on the west side of Dredge Island in May 2024 (Fig. 2). While the Hg concentration in the surface sediment was low (0 – 4 cm depth = 0.0448 – 0.0768 mg/kg dry weight), it increased with depth, peaking at 9.2 mg/kg dry weight at 48 – 50 cm depth. This is 18.4-times greater than the U.S. EPA open water sediment cleanup goal of 0.5 mg/kg dry weight and warrants further investigation.

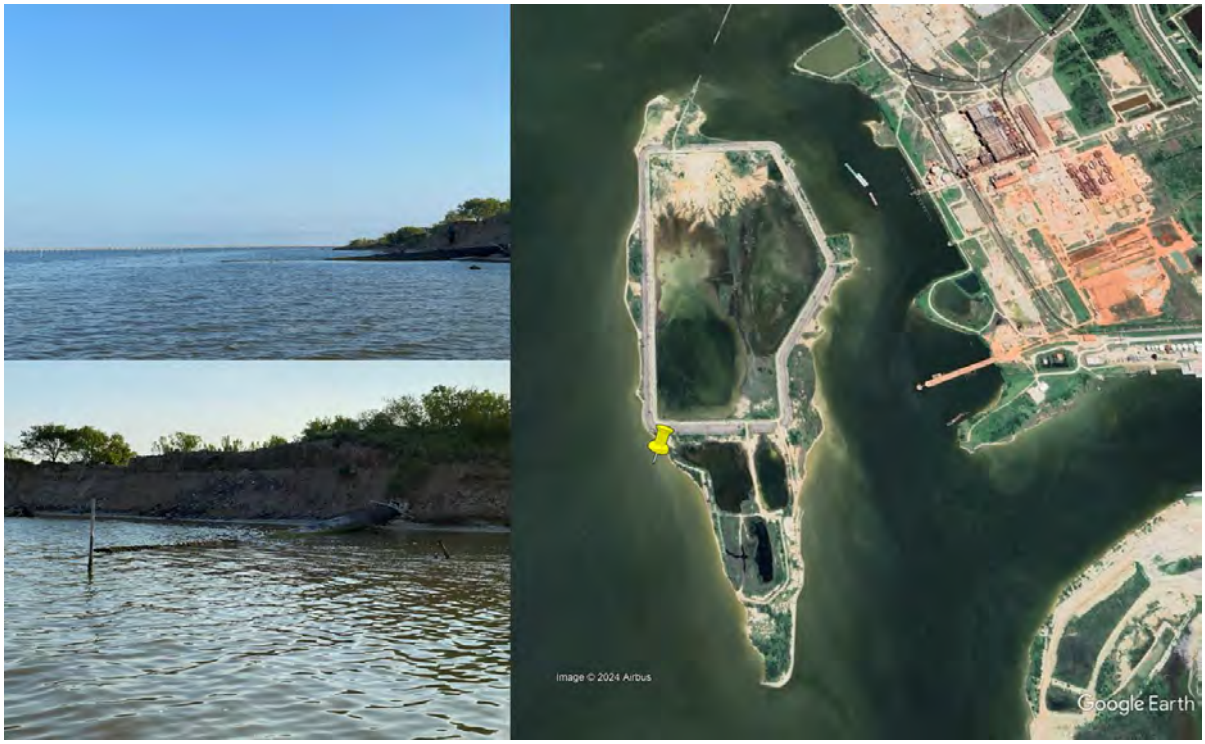

Figure 2. Sediment core collection location on the west side of Dredge Island (yellow pin) and photographs of the black drainage pipe.

2. In May 2024, a 36 cm core was collected close to the slurry wall next to the former Witco coal tar tank farm (Fig. 3). Runoff from this area can drain into Lavaca Bay where the sediment core was taken. The top 4 cm of the core had a Hg concentration of 1.1 mg/kg dry weight, 2.2-times greater than the U.S. EPA open water sediment cleanup goal of 0.5 mg/kg dry weight. By 6 cm, the Hg concentration had decreased 0.0493 mg/kg dry weight, and remained low down to 36 cm. Further investigation is needed to determine why the surface sediment Hg concentration is so high next to where material from land washes into the bay. Since benthic organisms (e.g., mud crabs and polychaete worms) reside in the surface sediment and are exposed to this Hg, they can act as a conduit for the transfer of Hg to higher trophic level organisms.

Figure 3. Sediment core collection location (yellow pin) where the drainage area next to the slurry wall enters Lavaca Bay. The red arrow shows the location of the slurry wall and direction of runoff from land.

3. A 73.5 cm sediment core was collected in the cove next to the former Witco processing area in May 2024 (Fig. 4). The surface sediment (0 – 2 cm) had a Hg concentration of 0.510 mg/kg dry weight. At all depths below 28 cm, the Hg concentration was > 1.00 mg/kg dry weight, peaking at 4.08 mg/kg dry weight at 48 – 50 cm. Most red drum, black drum, spotted seatrout, and hardhead catfish collected under MBMT contract #012 were collected in this area. The high sediment Hg concentration could help explain why the fish collected here had a Hg concentration that was 2.5 to 3-times greater than the same species in Port Lavaca.

Figure 4. Sediment core collection location (yellow pin) at the edge of the cove next to the former Witco process area.

Objective 2

CHIRP profiling

The CHIRP profiling of the Superfund site was completed in June 2024. Along and across the axis of greater Lavaca Bay, Cox Bay, and Keller Bay, seven long profiles were collected to demonstrate the regional sub-bottom characteristics of the bay floor. Eight profiles were then collected in the Superfund site (five in the ship channel, two between Alcoa and Dredge Island, and one next to Witco marsh). The CHIRP profiles have undergone basic processing including bandpass filtering, automatic gain control, and preliminary depth conversion using IHS Kingdom.

Grain size analysis

Co-PIs Prothro's group has completed basic grain size analysis (passed through a 63 µm sieve) to determine the percent coarse versus fine grain size distribution in low Hg (<0.2 mg/kg dry weight) depth intervals in seven cores collected in 2023. This objective is behind schedule; to overcome this issue, PI Dutton's group will complete the basic grain size analysis on the 2024 cores starting mid-January 2025.

Organic matter content

The organic matter content in each depth interval from each core is determined using the loss-on-ignition (LOI) method. Freeze dried sediment is heated in an oven at 105°C for 1 hour to make sure there is no residual moisture. 3 – 3.5 g of weighed sediment is then burned in a muffle furnace at 550°C for 4 hours and allowed to cool overnight, after which it is weighed again. The percent organic matter content is then calculated using the follow equation:

$$\% \text{ organic matter content} = [(\text{weight}_{105} - \text{weight}_{550})/\text{weight}_{105}] * 100$$

where weight_{105} is the sample weight prior to burning and weight_{550} is the sample weight after burning.

The data collected so far indicates that muddier sediment has a greater organic matter content (4-7%) than sandier sediment (1-2%).

Objective 4

Sediment microbial community

The sediment microbial composition is being investigated in 10 cores collected in 2023. For each core, depending on the thickness of the Hg layer, between five and 11 different depths have been investigated. In total, 68 samples have been analyzed. To date, DNA has been extracted from all the samples and each sample will be analyzed twice. The first round has been amplified and sequenced and is being reviewed by the bioinformatician. Once complete, the duplicate samples will be amplified and sequenced.

Mercury speciation to determine percent methylmercury in the sediment

43 of the samples used to determine the sediment microbial community composition have been shipped to the USGS Mercury Research Lab in Madison, WI to determine the methylmercury (MeHg) concentration. The MeHg analysis should be completed between February and April 2025, and PI Dutton plans to go the USGS lab to observe the analytical procedure.

Community presentation and resulting media interest

PI Dutton gave a public presentation in Port Lavaca on August 22nd, 2024, titled "Mercury concentrations in sediment and biota in the Alcoa (Point Comfort) Superfund site". To date, five news articles have been published about the event:

a. The future of Lavaca Bay. Crossroads Today. October 30, 2024. https://www.crossroadstoday.com/news/local-news/calhoun-county/the-future-of-lavaca-bay/article_280bc290-96ba-11ef-8eff-472a03b1e2a4.html

b. New research revealing high levels of mercury in Texas bay raises alarms about dredging for oil tankers. Oil and Gas Watch. August 29, 2024. https://news.oilandgaswatch.org/post/new-research-revealing-high-levels-of-mercury-in-texas-bay-raises-alarms-about-dredging-for-oil-terminal

c. Experts warn of mercury levels in Lavaca Bay. The Port Lavaca Wave. August 28, 2024. https://www.portlavacawave.com/articles/333/view

d. What dangers does the mercury in Lavaca Bay pose for the community? The Victoria Advocate. August 23, 2024. 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

e. Mercury found in Lavaca Bay poses serious health risks, warning from experts. Crossroads Today. August 22, 2024. https://www.crossroadstoday.com/lifestyle/mercury-found-in-lavaca-bay-poses-serious-health-risks-warning-from-experts/article_53c34740-6105-11ef-8942-0b254a4dc7ea.html

Goals for the Next Quarter

- Continue to measure the Hg concentration in the remaining sediment cores (Objective 1)
- Correlate cores to CHIRP profiles to determine which lithologic intervals are clearly resolvable in the CHIRP data and refine the depth conversion on CHIRP profiles through calibration with major lithologic changes in cores to more accurately determine the spatial extent of clay and shell hash layers (Objective 2)
- Continue the grain size analysis and organic matter content analysis (Objective 2)
- Ship samples for ^{210}Pb and ^{137}Cs dating (Objective 3)
- Finish the sediment microbial community analysis (Objective 4)
- Complete the MeHg analysis (Objective 4)