Texas A&M University at Galveston
1001 Texas Clipper Road
Galveston, TX 77554

SECOND INTERIM PERFORMANCE REPORT

NOVEMBER 30TH, 2021

Project Title: The Fate and Toxicity of Microplastics and Persistent Pollutants in the Shellfish and Fish of Matagorda Bay

Submitted To:

Matagorda Bay Mitigation Trust

Performing Laboratory:

Texas A&M University on behalf of Texas A&M University at Galveston

Authors:

Ms. Emily Meese (Ph.D. student)

Mr. Asif Mortuza (Ph.D. student)

Mr. Marcus Wharton (Ph.D. student)

Dr. David Hala, Ph.D.

Dr. Karl Kaiser, Ph.D.

Dr. David Wells, Ph.D.

Dr. Lene H. Petersen, Ph.D.

Dr. Antonietta Quigg, Ph.D.

Texas A&M University at Galveston
1001 Texas Clipper Road
Galveston, TX 77554

The Fate and Toxicity of Microplastics and Persistent Pollutants in the Shellfish and Fish of Matagorda Bay

Personnel

Principal Investigator(s):

Drs. David Hala, Karl Kaiser, David Wells, Lene H. Petersen, Antonietta Quigg

Consulting MBMT Project Coordinator:

Mr. Steven J. Raabe

Location(s):

Texas A&M University at Galveston

Project Duration:

01 June 2021 – 31 August 2024

Objectives:

Objective 1: Quantify the extent of microplastics pollution in the surface waters and biota of Matagorda Bay.

Objective 2: Measure levels of persistent pollutants in surface waters, adsorbed to microplastics, and bioaccumulated in the biota of Matagorda Bay.

Objective 3: Study the toxicity of microplastics and adsorbed pollutants using embryo-larval life stages of sheepshead minnow.

Objective 4: Public educational outreach to local high school students on the science of ecosystem health monitoring.

Texas A&M University at Galveston
1001 Texas Clipper Road
Galveston, TX 77554

1. INTRODUCTION

1.1 Background

The pollution of the Matagorda Bay system by microplastics particles released from the Formosa Plastics Corporation (as recorded from 2016-2018) has caused concern for the widespread exposure of resident biota (shellfish and fish) (Conkle, 2018; Wilson, 2018). Microplastics (i.e. particles <5 mm in diameter) can also act as important carriers of pollutants in the marine environment. The ingestion of such tainted plastic particles by aquatic organisms can lead to the increased exposure and body-burdens (or bioaccumulation) of persistent organic pollutants (Hirai et al., 2011; Hüffer and Hofmann, 2016), and contribute to the toxicity of the ingested particles (Vázquez and Rahman, 2021).

This project is studying the extent of microplastics and persistent pollutant exposure of resident biota (shellfish and fish) sampled from Matagorda Bay, and also assessing any likely toxicity effects due to exposure. The *new knowledge* gained from the successful completion of this project will contribute to an understanding of the long-term fate and toxicity of microplastics (and adsorbed pollutants) in the Matagorda Bay system.

In this second quarterly interim report (September 1st – November 30th, 2021) we provide a list of key updates to date.

2. Key Updates

As of the period encompassing the second interim report (September 1st – November 30th, 2021), the key achievements associated with each stated objective are detailed below.

Objective 1: Quantify the extent of microplastics pollution in the surface waters and biota of Matagorda Bay.

- The collection of fish and water samples from Matagorda Bay has continued. As of current evaluation, the numbers of fish sampled are listed in **Table 1**.

Texas A&M University at Galveston
1001 Texas Clipper Road
Galveston, TX 77554

Table 1. Summary of the total numbers of fish (muscle, liver, and digestive tract) and oysters (gill and mantle) sampled from Matagorda Bay (May – October 2021).

Common Name	Scientific Name	Numbers Sampled
Gulf menhaden	*Brevoortia patronus*	44
Red drum	*Sciaenops ocellatus*	5
Black drum	*Pogonias cromis*	6
Hardhead catfish	*Ariopsis felis*	80
Flathead grey mullet	*Mugil cephalus*	70
Gafftopsail catfish	*Bagre marinus*	5
Bluefish	*Pomatomus saltatrix*	3
Atlantic croaker	*Micropogonias undulatus*	16
Spot	*Leiostomus xanthurus*	1
Lady fish	*Elops saurus*	9
Spotted seatrout	*Cynoscion nebulosus*	8
Pinfish	*Lagodon rhomboides*	6
Southern kingfish	*Menticirrhus americanus*	3
Atlantic spadefish	*Chaetodipterus faber*	2
Atlantic croaker	*Micropogonias undulatus*	16
American gizzard shad	*Dorosoma cepedianum*	10
Crevalle jack	*Caranx hippos*	2
Eastern Oyster	*Crassostrea virginica*	7
	Total biota sampled =	**293**

- The GCMS-pyrolysis system is being optimized for use and has been used to qualitatively identify microplastics particles in oyster tissue (**Fig. 1**).

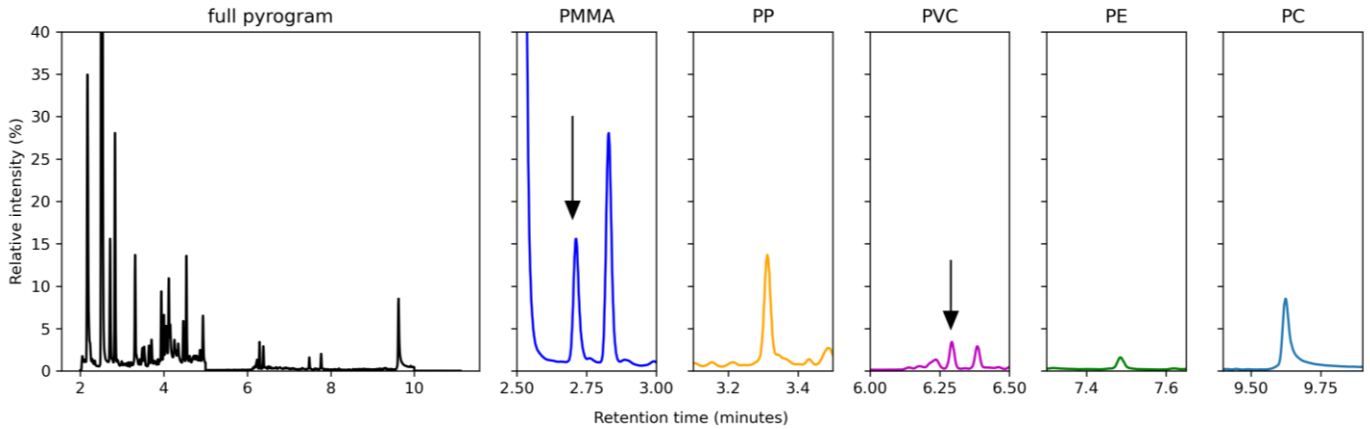

Fig. 1. Pyrogram of microplastics in oyster tissue. The relative distribution of peaks act as a chemical fingerprint of body-burdens. (PMMA=Poly(methyl methacrylate), PP=polypropylene, PVC=polyvinyl chloride, PE=polyethylene, PC=polycarbonate)

Texas A&M University at Galveston
1001 Texas Clipper Road
Galveston, TX 77554

- To date, two water sampling trips on Matagorda Bay have been completed. The first trip was on August 17th, 2021, during this trip we filtered and collected surface water samples from 7 locations in the Matagorda Bay waters (please see **Fig. 2**). The second trip was on September 12th, 2021, we collected samples from 6 locations from the beaches of Port O'connor, Magnolia Beach, Port Lavaca, Weedhaven, Palacios and Wadsworth around the bay (not shown on the map in **Fig. 2**). On the second trip we used a pump to filter the surface water and about 13-26 gallons was filtered each time and then collected in mason jars. A third trip of water sampling in the Matagorda Bay waters is planned for December 16th, 2021.

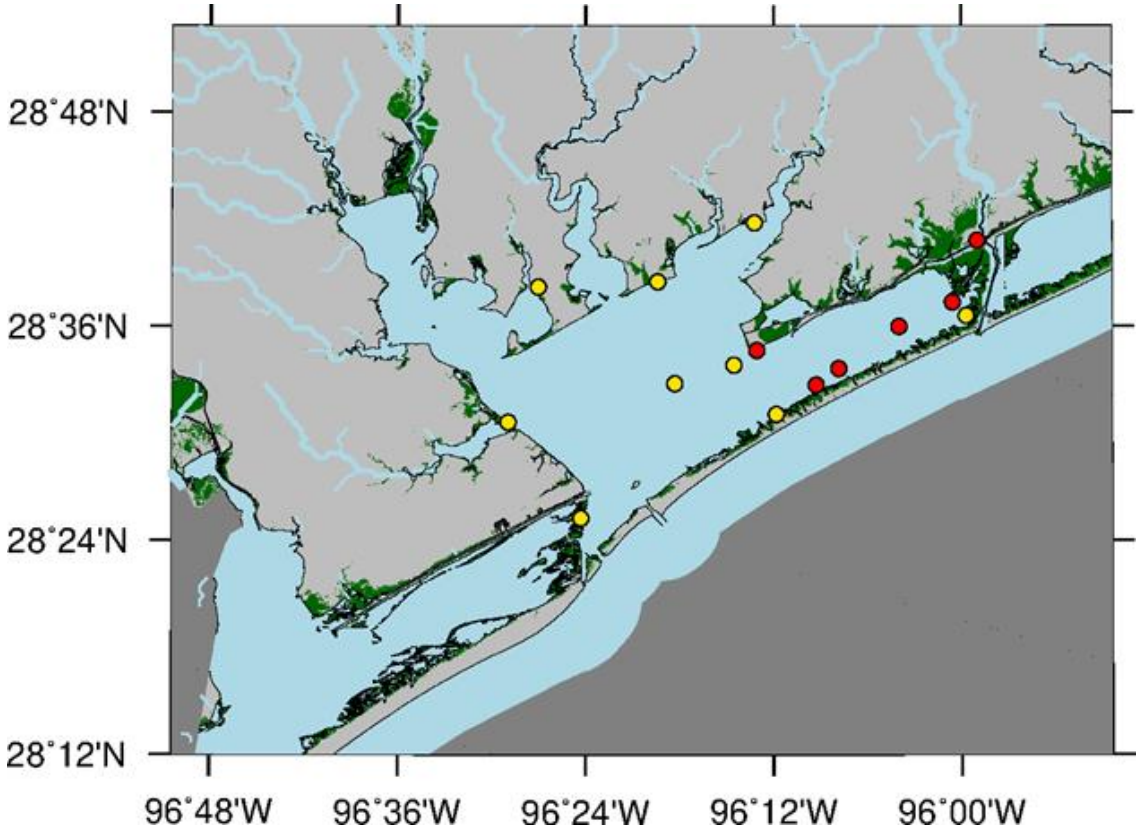

Fig. 2. Map of Matagorda Bay showing the various sites from which various fish species have already been collected (May – July 2021) (shown as yellow circles); and sites from which water samples were recently collected (August 2021) (shown as red circles).

Texas A&M University at Galveston
1001 Texas Clipper Road
Galveston, TX 77554

Objective 2: Measure levels of persistent pollutants in surface waters, adsorbed to microplastics, and bioaccumulated in the biota of Matagorda Bay.

- An Accelerated Solvent Extraction (ASE) and gas chromatography mass spectrometry (GCMS) method for the analysis of select persistent organic pollutants, namely polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs), has been completed (**Fig. 3**).

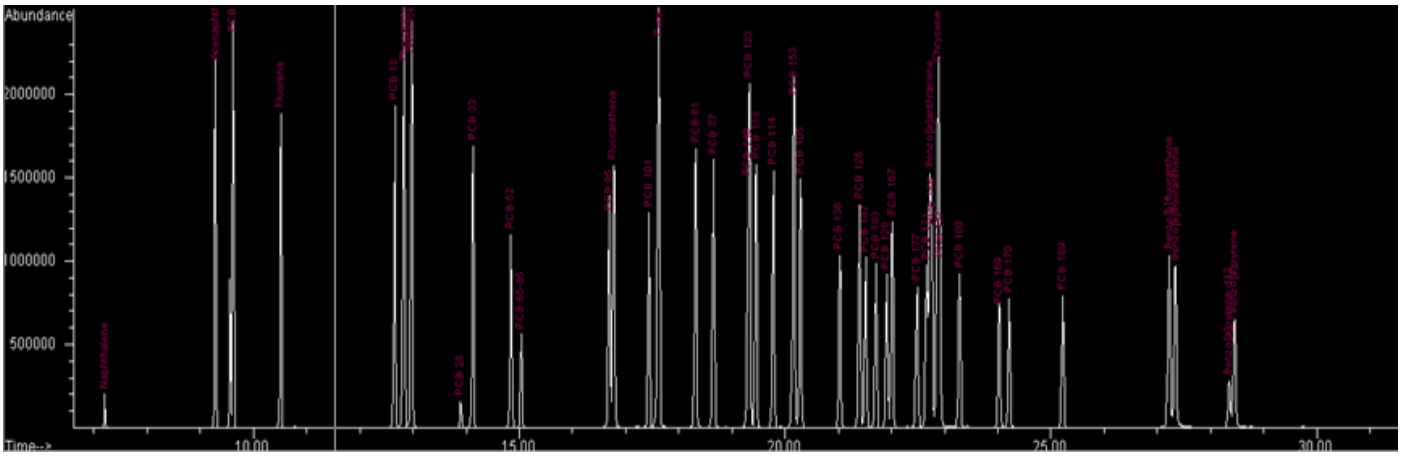

Fig. 3. A chromatograph of PAHs and PCBs as determined using GCMS. A total of 16 PAHs and 29 PCB congeners (all EPA priority pollutants) are quantified. The 16 PAHs include: naphthalene, acenaphthene, acenaphthylene, fluorene, anthracene, phenanthrene, fluoranthene, chrysene, pyrene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, dibenz[a,h]anthracene, benzo[g,h,i]perylene, and indeno[1,2,3-cd]pyrene. The 29 PCB congeners include PCBs 1, 18, 28, 33, 52, 95, 101, 81, 77, 149, 123, 118, 114, 153, 105, 138, 126, 187, 183, 128, 167, 177, 171, 156, 157, 180, 169, 170, and 189. Of the 29 PCB congeners, 12 are dioxin-like: PCBs 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189. All PCBs are identified according to the IUPAC numbering system.

- Quality assurance studies for PAH and PCB analysis has also been completed. Blank samples (i.e., not containing biological samples) were spiked with select PAHs (Benzo[a]pyrene, pyrene) and PCBs (PCB 18, PCB 101). The ASE extraction method and subsequent sample processing method showed a recovery of 72% for Benzo[a]pyrene,

Texas A&M University at Galveston
1001 Texas Clipper Road
Galveston, TX 77554

68% for Pyrene, 32% for PCB 18 and 93% for PCB 101. When the PAHs and PCBs were spiked on liver tissue from fish and subjected to ASE extraction and lipid removal, the recovery was as follows, 77% for Benzo[a]pyrene, 38% for Pyrene, 90% for PCB 18 and 63% for PCB 101.

Objective 3: Study the toxicity of microplastics and adsorbed pollutants using embryo-larval life stages of sheepshead minnow.

- This objective will be engaged with starting in January 2022 and onwards.
- An Animal Use Protocol (AUP) to perform *in vivo* experimentation with early life-stages of embryo-larval sheepshead minnows (*Cyprinodon variegatus*) has been approved by the Texas A&M University's Institutional Animal Care and Use Committee (IACUC).

Objective 4: Public educational outreach to local high school students on the science of ecosystem health monitoring.

- This objective will be engaged with in summer 2022.
- At present, an educational module that involves hands-on learning by students, and includes the assessment of various pollution sources into a Gulf of Mexico estuary (and the complexity associated with their mitigation), has been approved by the Director of Outreach for Texas A&M University at Galveston's Sea Camp Program, Ms. Daisy Dailey.

3. FURTHER WORK

Further planned work for completion over the duration of the third interim report are as follows:

1) Continue to collect biota and water samples from Matagorda Bay. Additional biota sampling is planned for September 2021, with additional water sampling also planned for December 2021; and tentatively for March, August, and December 2022.
2) Commence microplastics, PAHs and PCBs analysis of surface water samples and biota tissues collected from Matagorda Bay.

Texas A&M University at Galveston
1001 Texas Clipper Road
Galveston, TX 77554

Reviewed by:

11/30/2021

_____ Date: _____

Dr. David Hala, TAMUG, P.I.

Approved by:

_____ Date: November 30,2021

Mr. Steven J. Raabe, Trustee

Texas A&M University at Galveston
1001 Texas Clipper Road
Galveston, TX 77554

5. REFERENCES

Conkle, J. L., 2018. San Antonio Bay Estuarine Waterkeeper and S. Diane WIlson vs. Formosa Plastics Corp., Texas RioGrande Legal Aid, Inc., pp. 1-112.

Hirai, H., Takada, H., Ogata, Y., Yamashita, R., Mizukawa, K., Saha, M., Kwan, C., Moore, C., Gray, H., Laursen, D., Zettler, E. R., Farrington, J. W., Reddy, C. M., Peacock, E. E., Ward, M. W., 2011. Organic micropollutants in marine plastics debris from the open ocean and remote and urban beaches. Marine Pollution Bulletin 62, 1683-1692, doi:https://doi.org/10.1016/j.marpolbul.2011.06.004.

Hüffer, T., Hofmann, T., 2016. Sorption of non-polar organic compounds by micro-sized plastic particles in aqueous solution. Environ Pollut 214, 194-201, doi:10.1016/j.envpol.2016.04.018.

Vázquez, O. A., Rahman, M. S., 2021. An ecotoxicological approach to microplastics on terrestrial and aquatic organisms: A systematic review in assessment, monitoring and biological impact. Environ Toxicol Pharmacol 84, 103615.

Wilson, D., 2018. Water Keeper Alliance: Report Shows Plastic Pollution a Threat to Texas Gulf Coast, on-line: https://waterkeeper.org/news/report-shows-plastic-pollution-a-threat-to-texas-gulf-coast/ (accessed on 8/16/2021).