Texas A&M University at Galveston
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THIRTEENTH INTERIM PERFORMANCE REPORT

AUGUST 31ST, 2024

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

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

Personnel

Principal Investigators:

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Consulting MBMT Project Coordinator:

Mr. Steven J. Raabe

Location(s):

Texas A&M University at Galveston

Project Duration:

01 June 2021 – 31 August 2024 (a no cost extension is approved until 12/31/2024)

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.

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1. INTRODUCTION

1.1 Background

This project is studying the extent of microplastics, and persistent pollutant exposure of resident biota (shellfish and fish) sampled from Matagorda Bay and 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 thirteenth interim report (June 1st, 2024 – August 31st, 2024) we provide a list of key accomplishments as per the first quarter of Year 4 of the project (as per a no cost extension approved until 12/31/2024 by Mr. Steven J. Raabe on 6/24/2024).

2. Key Updates

As of the period encompassing the thirteenth interim report (June 1st, 2024 – August 31st, 2024), 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.

- We have completed all analysis of microplastics in the body-burdens (muscle and liver) of biota from Matagorda Bay.
- We are currently preparing manuscripts for intended submission in Spring/Summer 2025.

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

- We have completed all analyses of PAHs and PCBs in the body-burdens (muscle and liver) of biota from Matagorda Bay.
- Our current focus is on preparing a high-impact manuscript for intended submission in Spring/Summer 2025.

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

- We have completed all single and mixtures toxicity studies with select PAHs, PCBs, and microplastics (0.1 µm polystyrene particles).
- The toxicological study design has been previously described in the twelfth interim report.
- A key finding of the toxicity trials was that the exposure of embryo/larval fish to 10 µg/L polystyrene (PS) latex beads (0.1 µm) appears to result in additive stress by increasing mass specific metabolic rate (or oxygen consumption rate) when fish are co-exposed with the PAH, phenanthrene (0.2 µM, PHE), or PCB-81 (0.02 µM) (**Fig. 1** and **2**).
- For co-exposure to PHE and PS (i.e., PHE+PS), there was a statistically significant ~2x increase in mass specific metabolic rate in the PHE+PS group vs. exposure to PHE only (**Fig. 1(a)**). Interestingly, the increase in metabolic rate did not result in an increase of fish heart rate (**Fig. 1(b)**). However, exposure to PS only did cause a statistically significant increase in blood flow rate in the exposed embryo-larval fish (**Fig. 1(c)**).

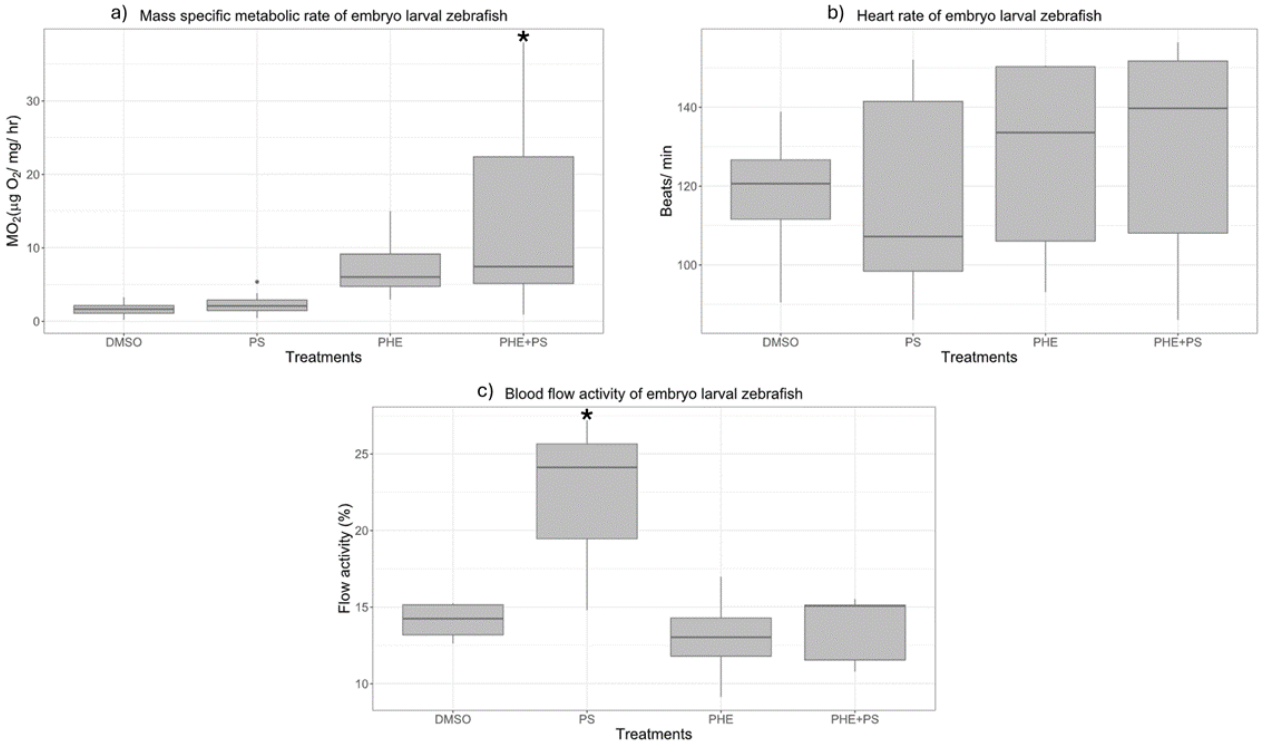

Fig. 1. Effects of single compound (i.e., PS or PHE) and their co-exposure on **(a)** mass specific metabolic rate; **(b)** heart rate; and **(c)** blood flow in embryo-larval zebrafish (* $p \leq 0.05$).

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- For the co-exposure of PCB-81 and PS (i.e., PCB-81+PS), there was a statistically significant ~7x increase in mass specific metabolic rate in the PCB-81+PS group vs. exposure to PCB-81 only (**Fig. 2(a)**). And while there was no effect on fish heart rate (**Fig. 2(b)**), exposure to PCB-81 or PCB-81+PS caused a statistically significant decrease in blood flow rate in the exposed embryo-larval fish (**Fig. 2(c)**).

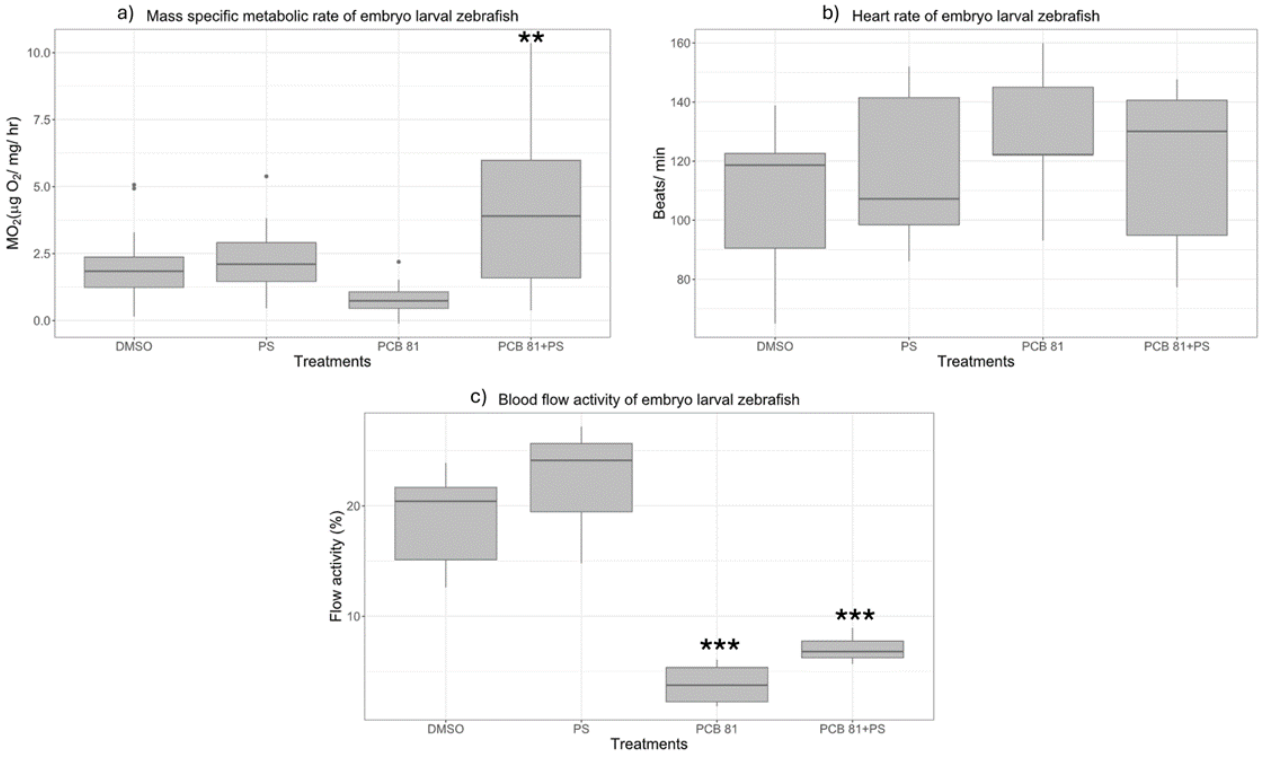

Fig. 2. Effects of single compound (i.e., PS or PCB-81) and their co-exposure on **(a)** mass specific metabolic rate; **(b)** heart rate; and **(c)** blood flow in embryo-larval zebrafish (** $p \leq 0.01$; *** $p \leq 0.001$).

- Microplastics are known to be cardiotoxic (Persiani et al., 2023). A study by Sun et al., (2021) has shown exposure of embryo-larval zebrafish (up to 4 days post hatch) to 200 µg/L of 0.1 µm polyethylene nanoplastics beads to cause increased pericardial edema and lowered blood flow (and with no effects on heart rate). The authors suggest the likely damage of vascular endothelia (i.e., cells that form the inner layer of blood vessels) may

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causes blood vessels to vasodilate, hence causing increased blood flow while not affecting the heart rate (Sun et al., 2021).

- In our study, PS exposure only increased blood flow in the PHE exposure study only and no effects with co-exposure, i.e., PHE+PS (**Fig. 1(c)**). Whereas blood flow decreased in the PCB-81 and PCB-81+PS exposure group (**Fig. 2(c)**). Given that in our study we tested microplastics levels 20x lower that used by Sun et al., (2021), it is likely that the lower blood flow rate seen for the PCB-81 exposure study is indicating effects that are caused by PCB-81 alone (and not by the PS).
- PCB body-burdens in humans are typically correlated with hypertension or high blood pressure (Goncharov et al., 2011; Perkins et al., 2016). It is therefore unclear whether the lowered blood flow observed in our study (**Fig. 2(c)**) indicates an initial vascular damage, which may later manifest as hypertension. However, our continued analysis of cardiac morphology may allude to a mechanism of cardiovascular dysfunction, and whose results will be reported in the next interim report.

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

- Educational outreach engagement is <u>completed</u> and was pursued in collaboration with the TAMUG Sea Camp program in Summer 2022. Outcomes from the outreach activity were reported in the *sixth* interim report.

3. FURTHER WORK

<u>Planned work</u> for completion for the Final Project report are as follows:

1) Prepare and submit manuscripts for publication over Spring 2025 on PAHs, PCBs, and microplastics levels in biota from Matagorda Bay.
2) Prepare a manuscript describing the microplastics analysis methods and application to measuring levels in biota from Matagorda Bay (Spring 2025).
3) Complete all statistical and data analyses of toxicological datasets on the effects and prepare for a manuscript submission (to be completed by Fall 2024).

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4. REFERENCES

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Reviewed by:

8/29/2024

_____ Date: _____

Dr. David Hala, TAMUG, P.I.

Approved by:

_____ Date: 8/29/2024

Mr. Steven J. Raabe, Trustee