

# The Distribution and Fate of Tire Rubber-Derived Chemicals in Galveston Bay

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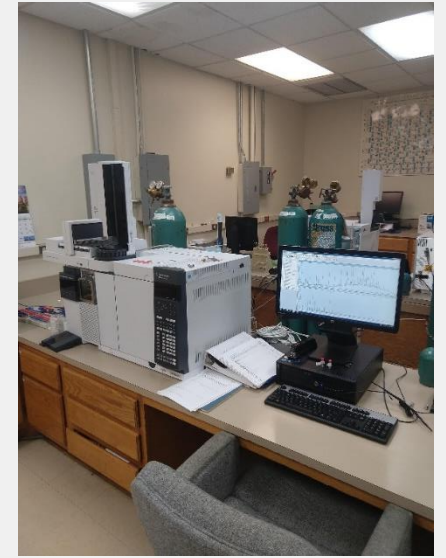
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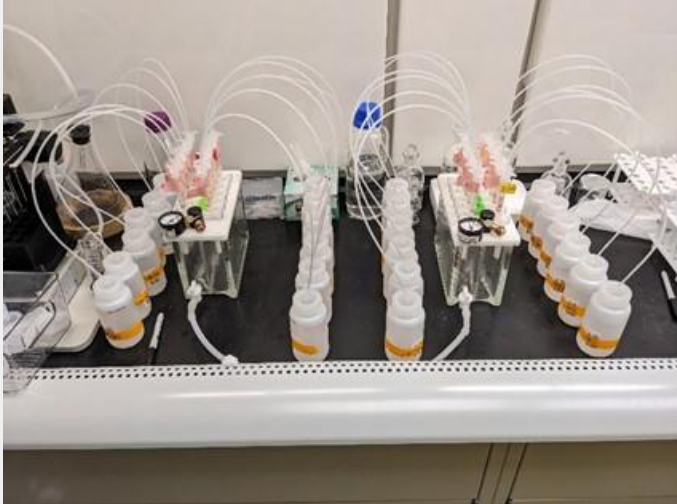
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# Geochemical & Environmental Research Group

- Persistent organic pollutants (POPs)
  - PAHs, PCBs, Dioxins/Furans, PBDEs, etc.
- Emerging Contaminants
  - PFAS, PPCPs, Antibiotics, 6PPD-Q
- Dissolved Nutrients
- Total Mercury



# The Halo-Carbon Lab



- We study organic chemistry in natural waters.
- Novel extraction methods for trace chemicals.
- High-resolution mass spectrometry to understand the fate of organic compounds.
- Data Science – Compound identification algorithm for previously unknown transformation products.

# Background

## Coho Salmon fish kills in urban streams (1990s to Present)

- Anomalous behaviors and high pre-spawn mortality rates (60-100%) in urban streams
- Urban runoff mortality syndrome



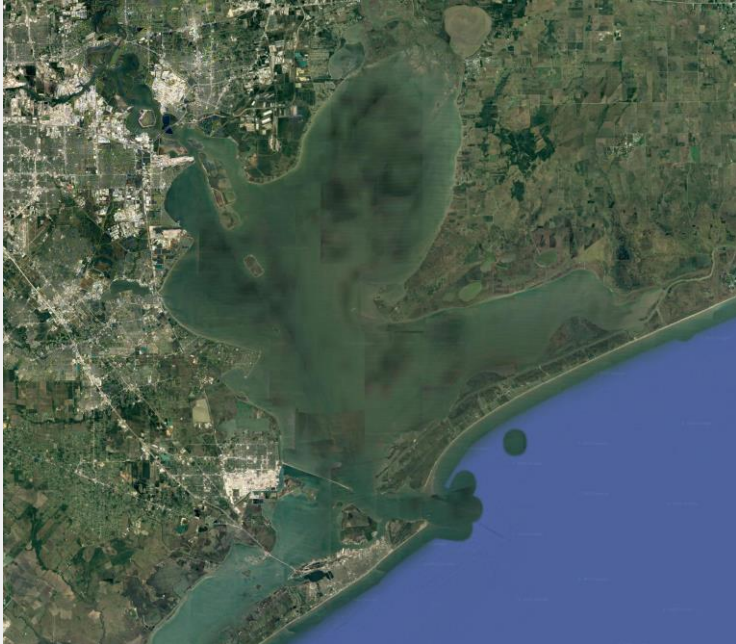
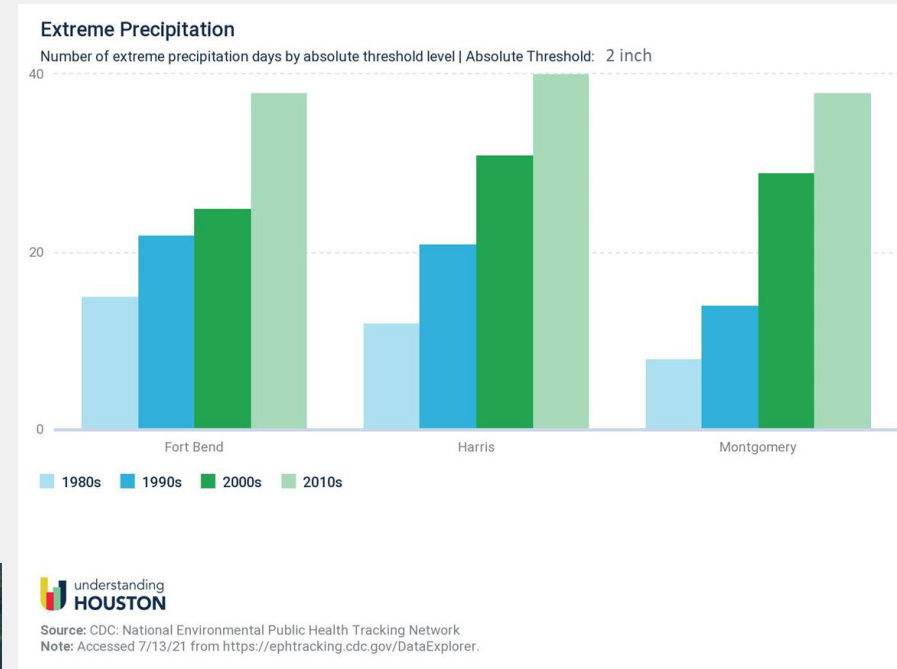
Image: (Scholz et al., 2011; PNAS)

## 6PPD-quinone (6PPD-Q)

- Derived from tire rubber
- Product of 6PPD degradation
  - Prevents your tires from becoming brittle
- 6PPD constitutes significant portion (0.4-2.0%) of tire rubber
- Acutely toxic at very low concentrations (ppt range)
  - EPA report released in May 2024 suggests a screening value of 11 ppt.
- High concentrations coincide with storm events
- Data in estuarine/marine waters are extremely limited (EPA report, May 2024)

# Background

- 6PPD-Q considered ubiquitous in our waterways
- Galveston Bay is the receiving basin of two major metropolitan areas
- Average traffic on I10 near Lynchburg was 126K vehicles per day in 2021 (TxDot)
- The frequency of extreme precipitation events is increasing



# Objectives

## Proposed Work

- Leverage a multi-year Galveston Bay time series (2021-2023)
  - 12 quarterly cruises
- Measure 6PPD, 6PPD-Q, and transformation products in water (n = 323) and sediments (n = 149)
- Investigate the partitioning and transformation of 6PPD-Q in Galveston Bay
  - Sediment sorption/desorption experiments
  - Photooxidation experiments

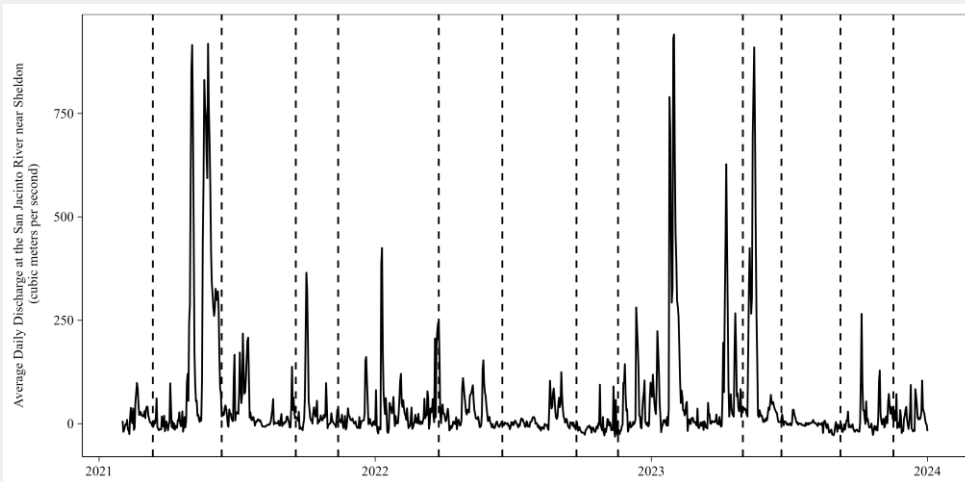
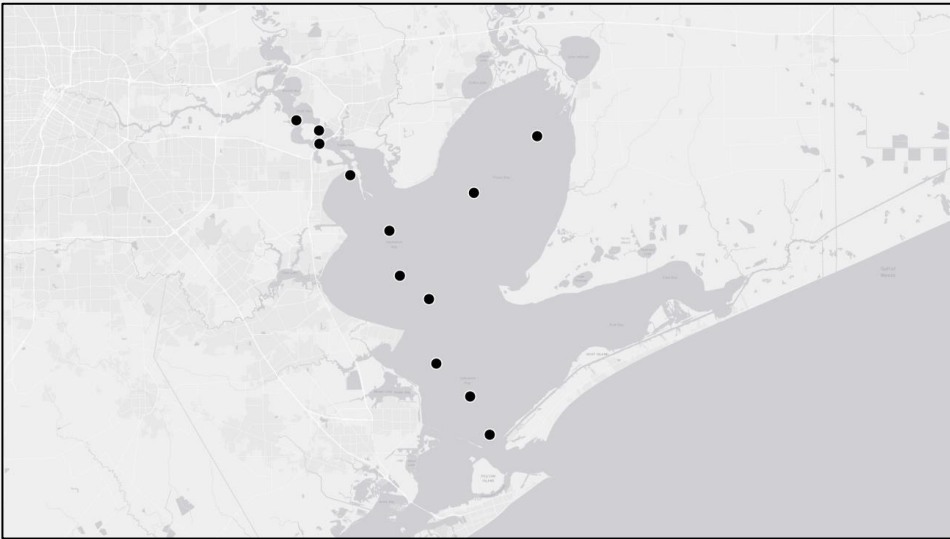
## Expected Outcomes

Ensure Safe Human and Aquatic Life Use

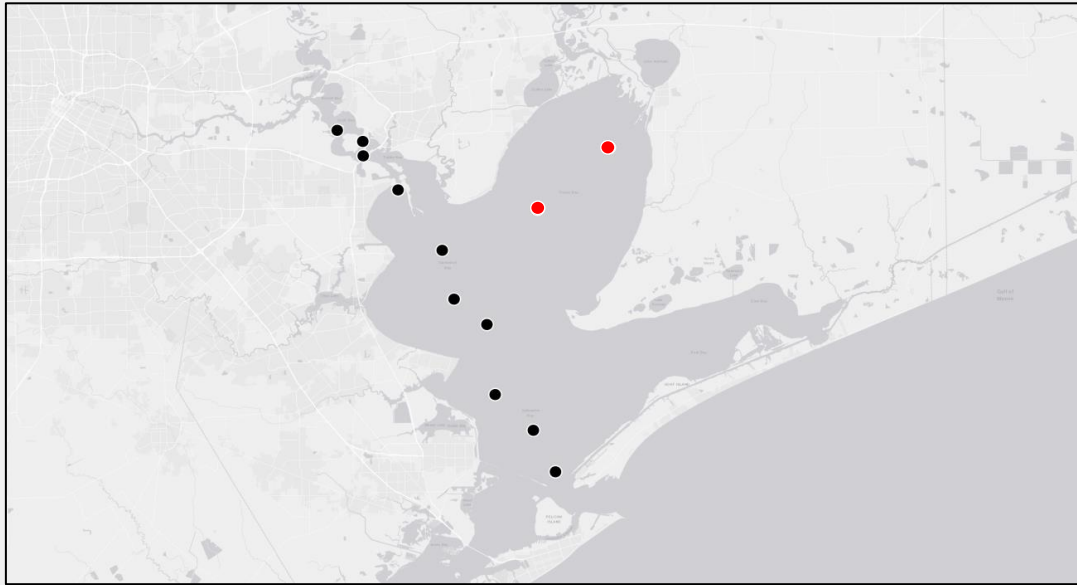
- The toxicity of 6PPD-Q to Galveston Bay fish and shellfish species is unknown
  - This project will help inform future toxicity studies by providing a time series of environmentally relevant concentrations under different hydrographic regimes

Inform Science-Based Decision Making

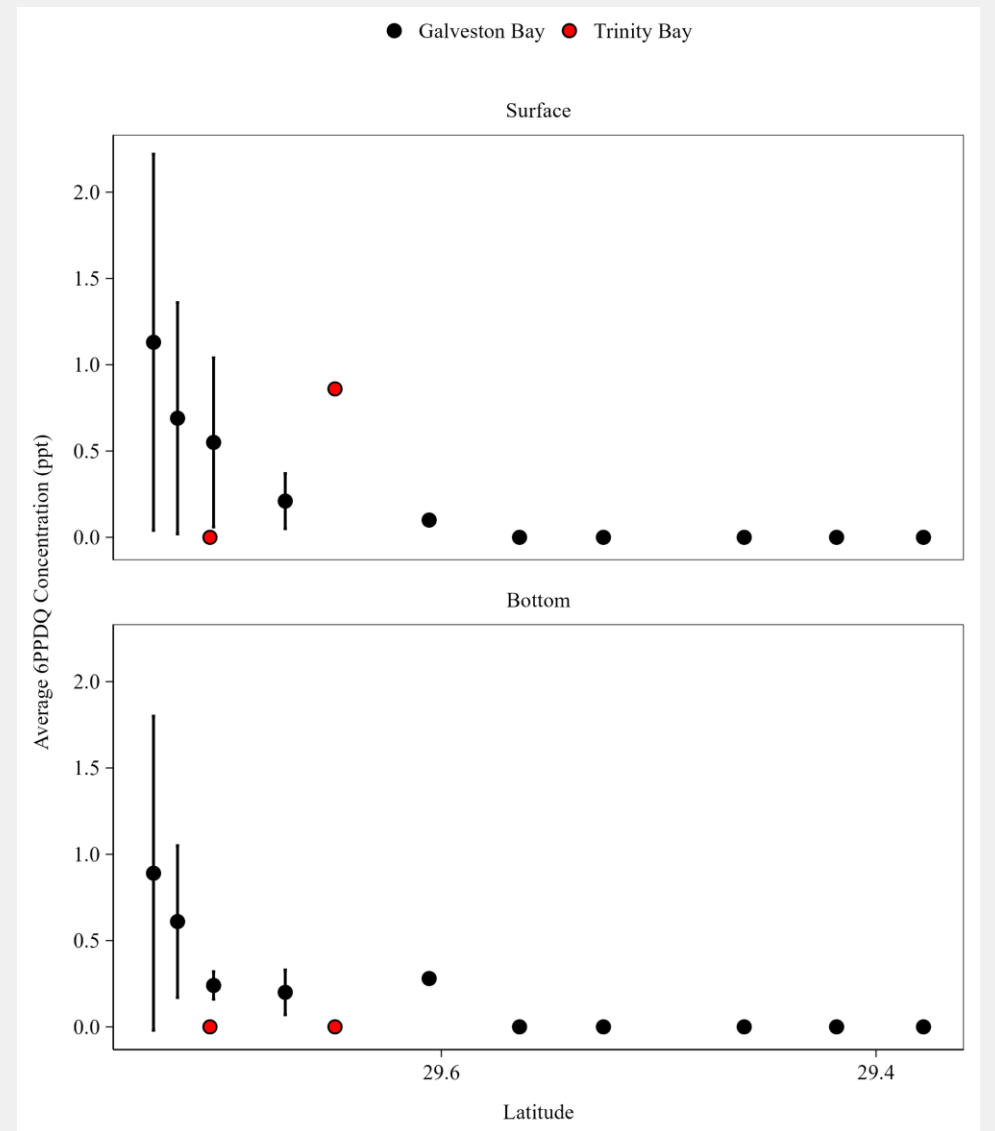
- Better understand the fate of 6PPD-Q in the Galveston Bay estuary



# Average 6PPD-Q Conc. in Galveston Bay Water



- 6PPD-Q concentrations are highest in the Houston Ship Channel and decrease towards the lower bay (maximum 3.32 ppt)
- High temporal variability in the Houston Ship Channel

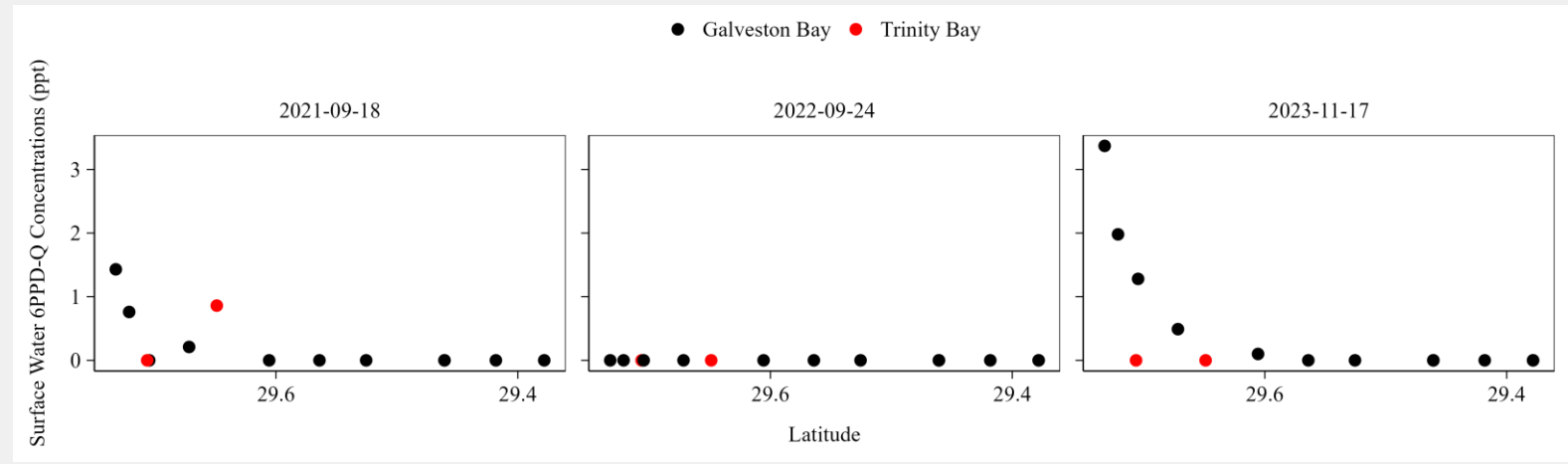
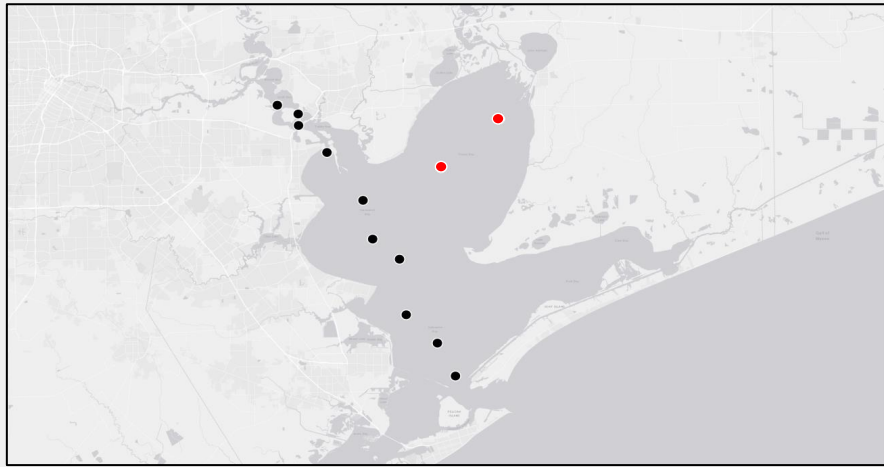


Upper Bay

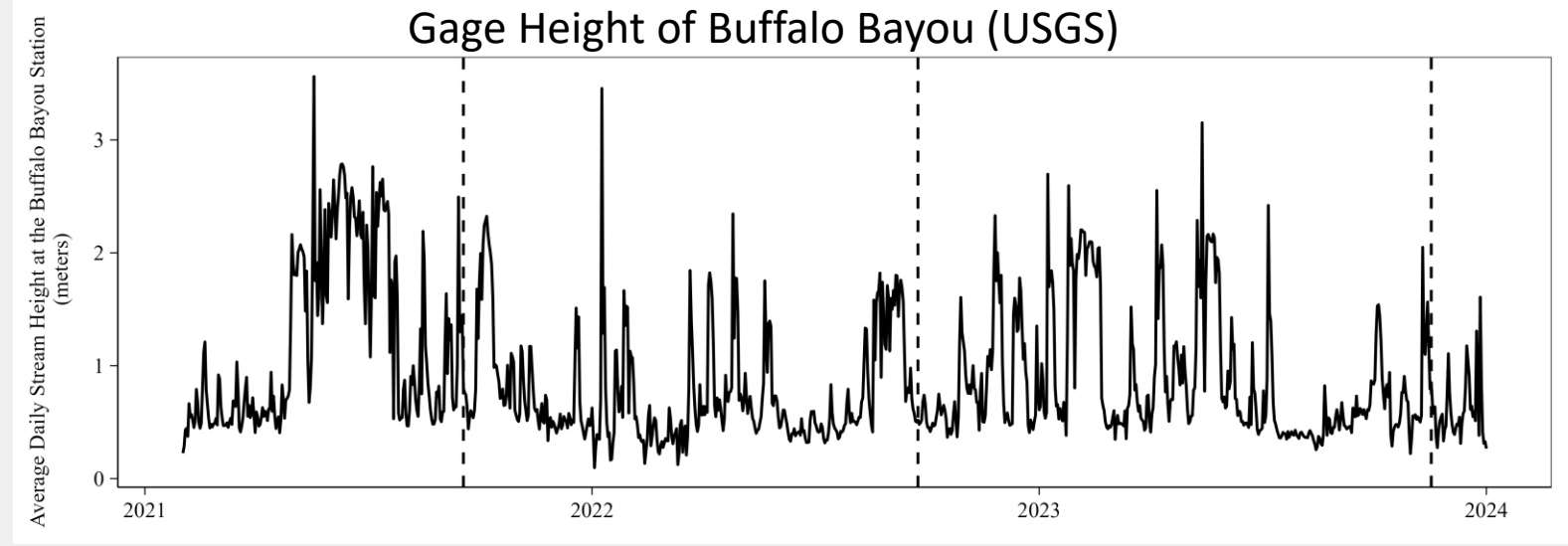


Lower Bay

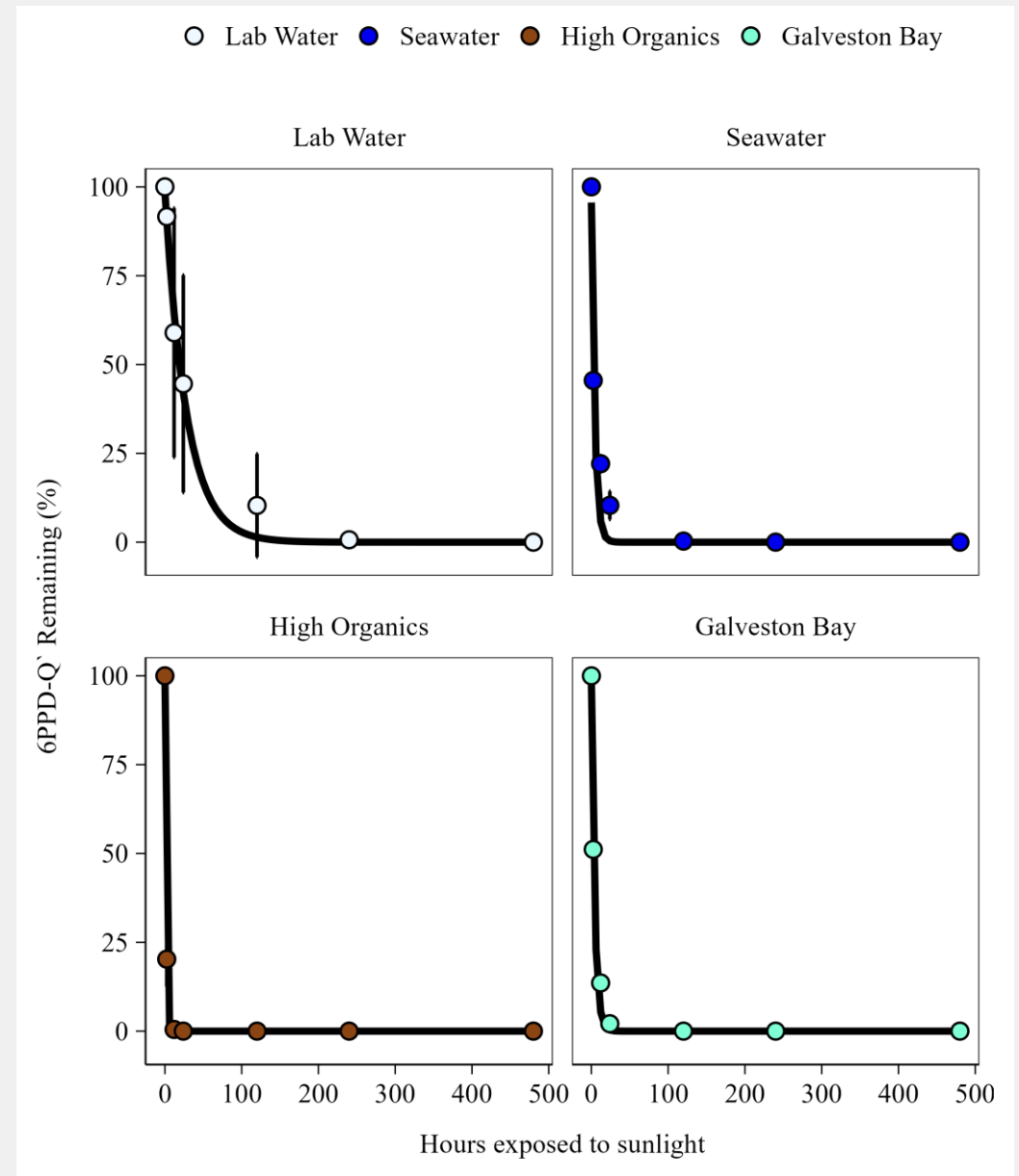
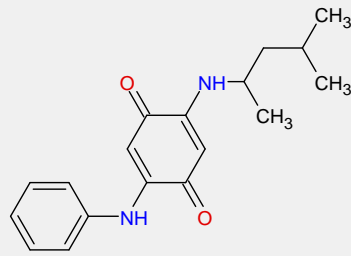
# 6PPD-Q in Surface Waters (Variability with Discharge)



- 6PPD-Q not quantifiable during low river discharge
- 6PPD-Q in the Houston Ship Channel may be more related to discharge from Buffalo Bayou

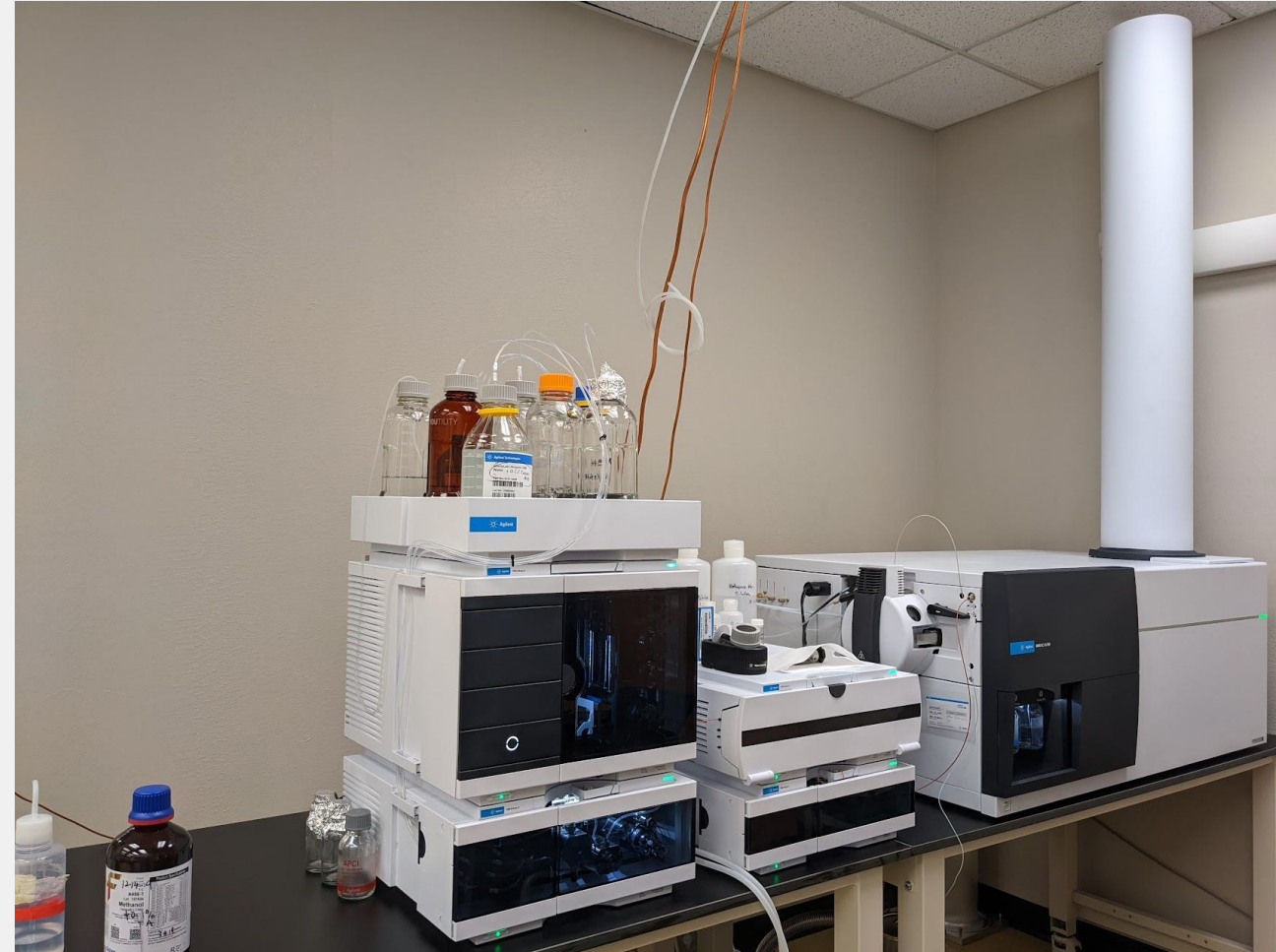


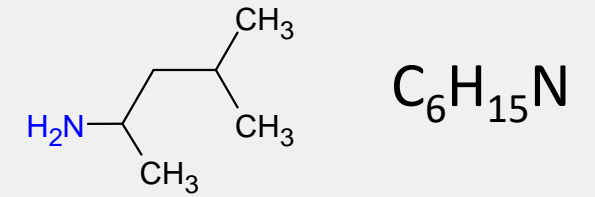
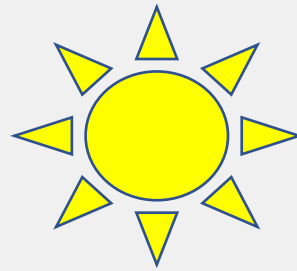
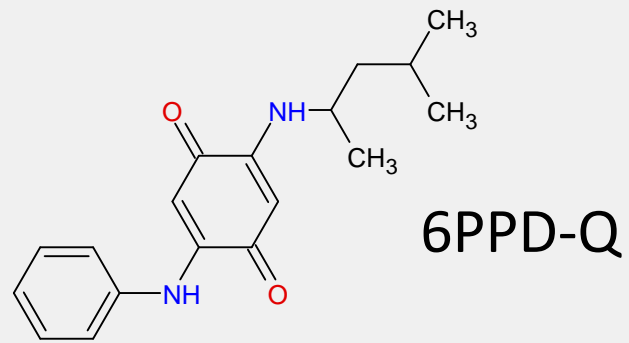
# 6PPD-Q and Sunlight



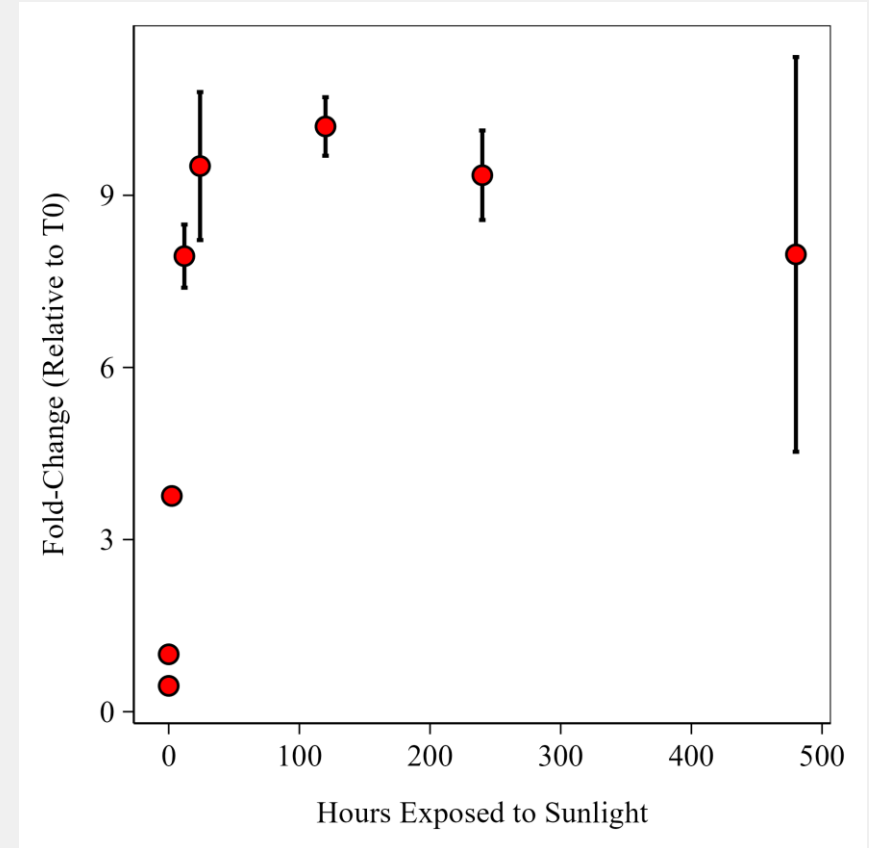
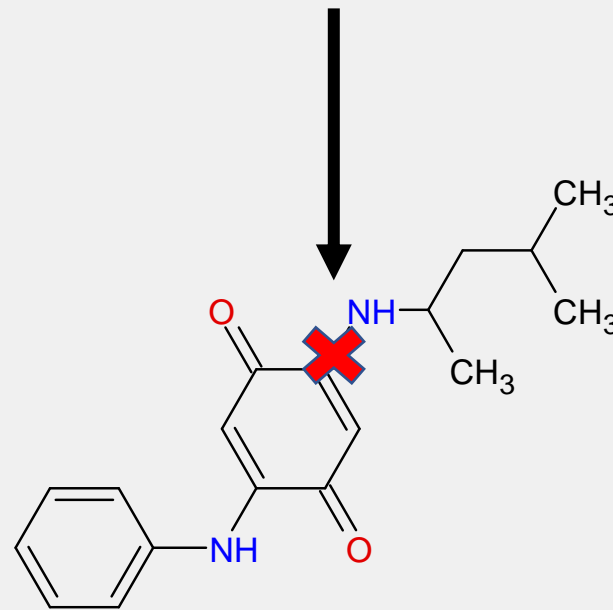
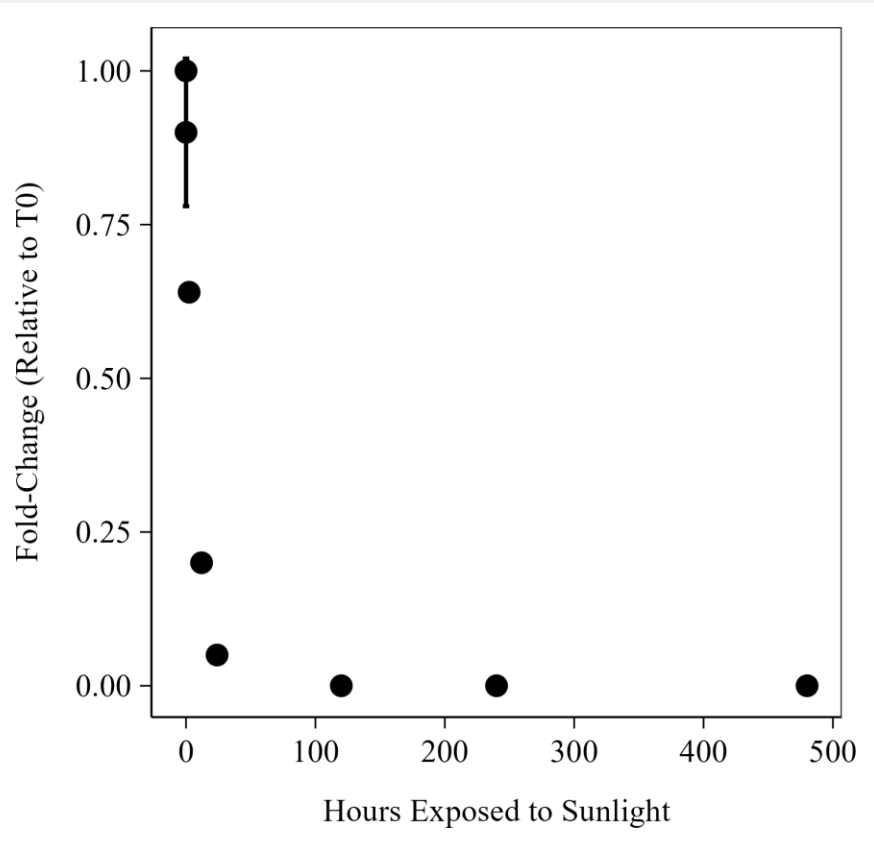
# Did 6PPD-Q Break Down Completely?

- Ultrahigh-resolution mass spectrometry enables the detection of **previously unknown** reaction byproducts





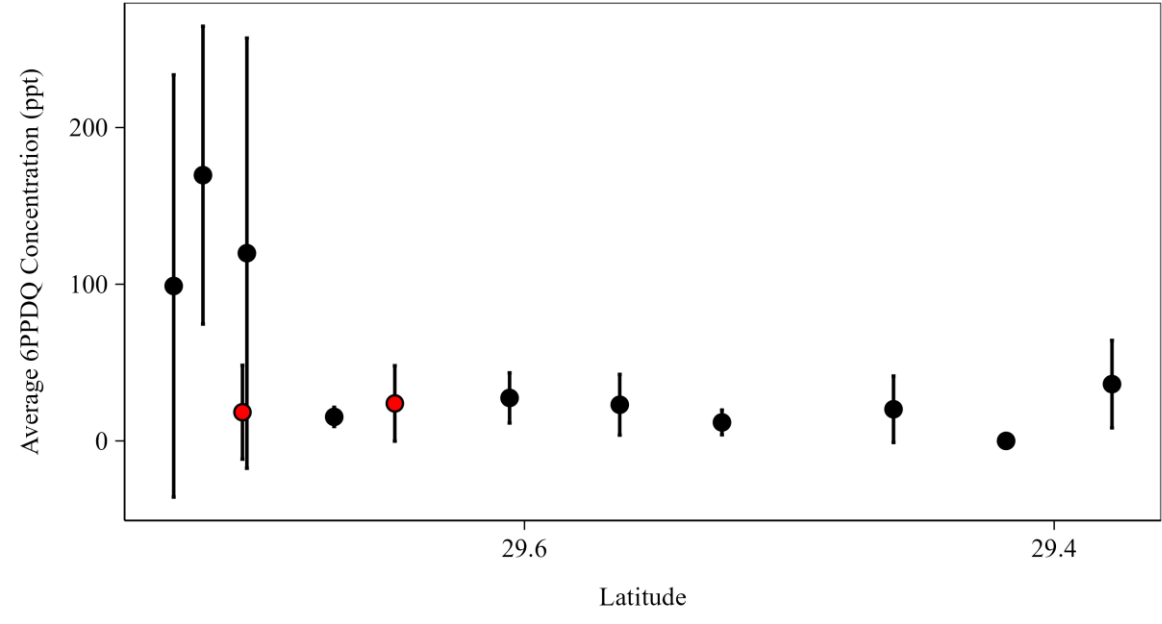
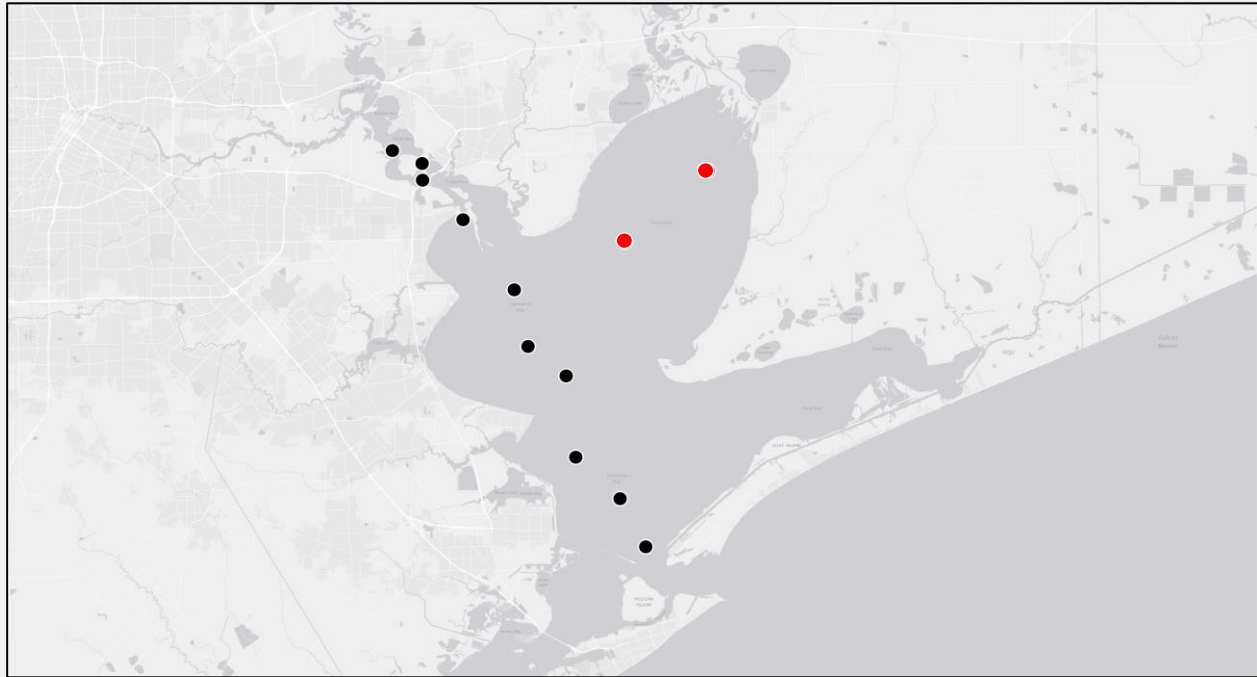
Likely: 1,3-Dimethylbutylamine (1,3-DMBA)



# Average 6PPD-Q Conc. in Sediments

2021-2023

● Galveston Bay ● Trinity Bay



- 6PPD-Q concentrations are greater in sediments vs. the water, showing preferential binding to sediments
- 6PPD-Q concentrations are highest in the Houston Ship Channel and decrease towards the lower bay (maximum: 472 ppt).
- High temporal variability

Upper Bay



Lower Bay

# Current Tasks:

- Sediment sorption/desorption experiment
  - Determine the kinetics of 6PPD-Q and 6PPD sorption to sediments from Galveston Bay (~800 samples for sorption and ~800 for desorption)
- Task Reports and Data Submission
- Final Report



# Project Update Takeaways

- 6PPD-Quinone (6PPD-Q) is a contaminant of emerging concern that forms during the breakdown of tire rubber
- 6PPD-Q is detected in water from stations near or in the Houston Ship Channel
- Sediments follow a similar pattern with higher concentrations in the Ship Channel
- 6PPD-Q is photo-degraded in sunlight, but also forms transformation products
- The previously funded work from GBEP has allowed us to examine new contaminants of emerging concern in archived field samples and examine fates more mechanistically.

# Acknowledgements

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