

Spatial and Temporal Distributions of Emerging Contaminants in Galveston Bay, Texas

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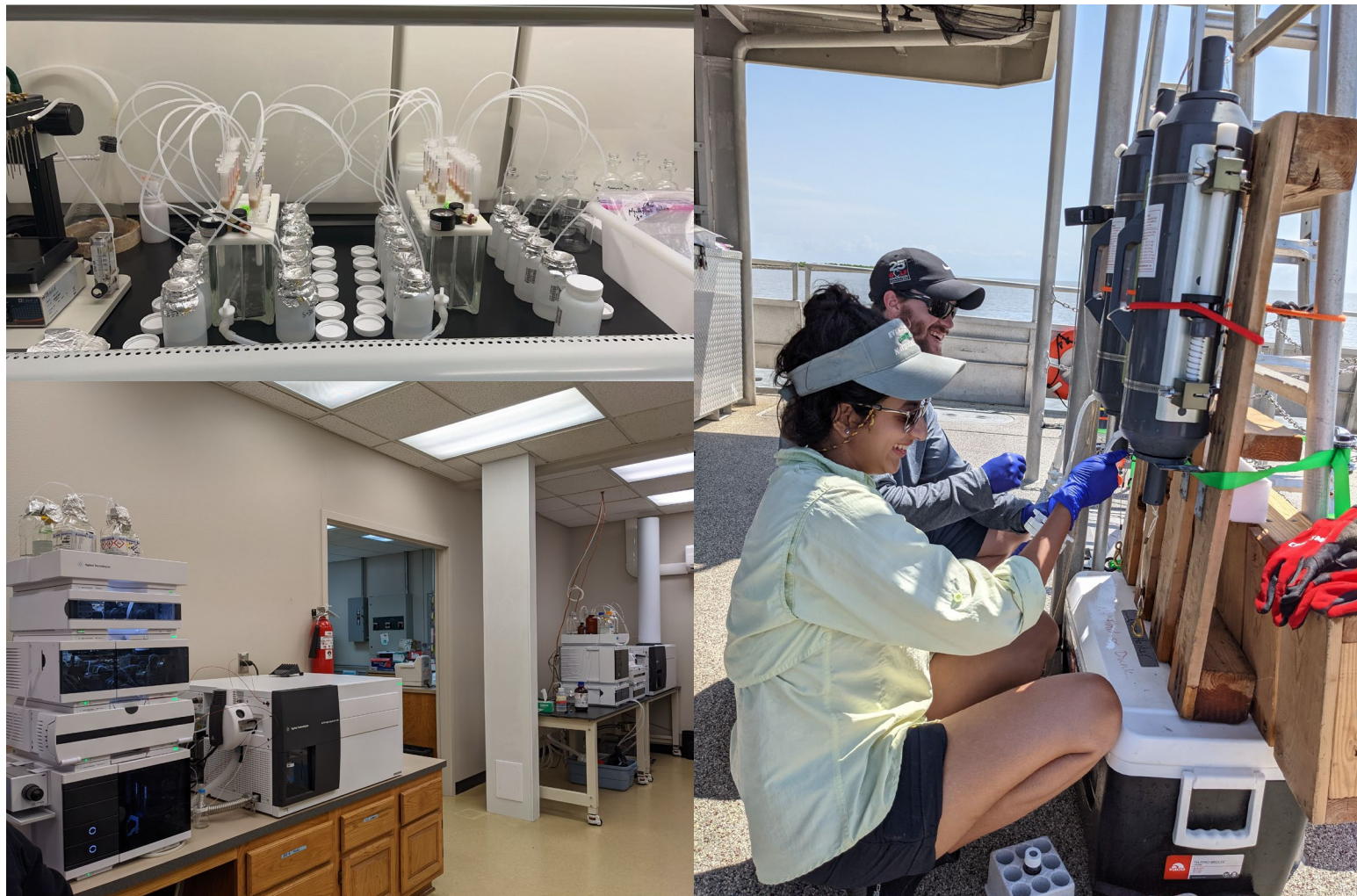


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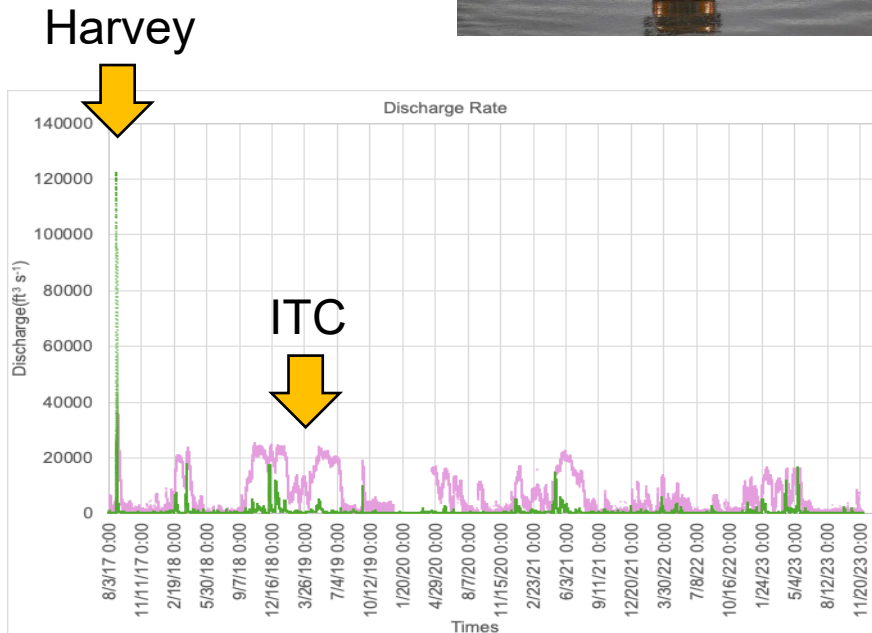
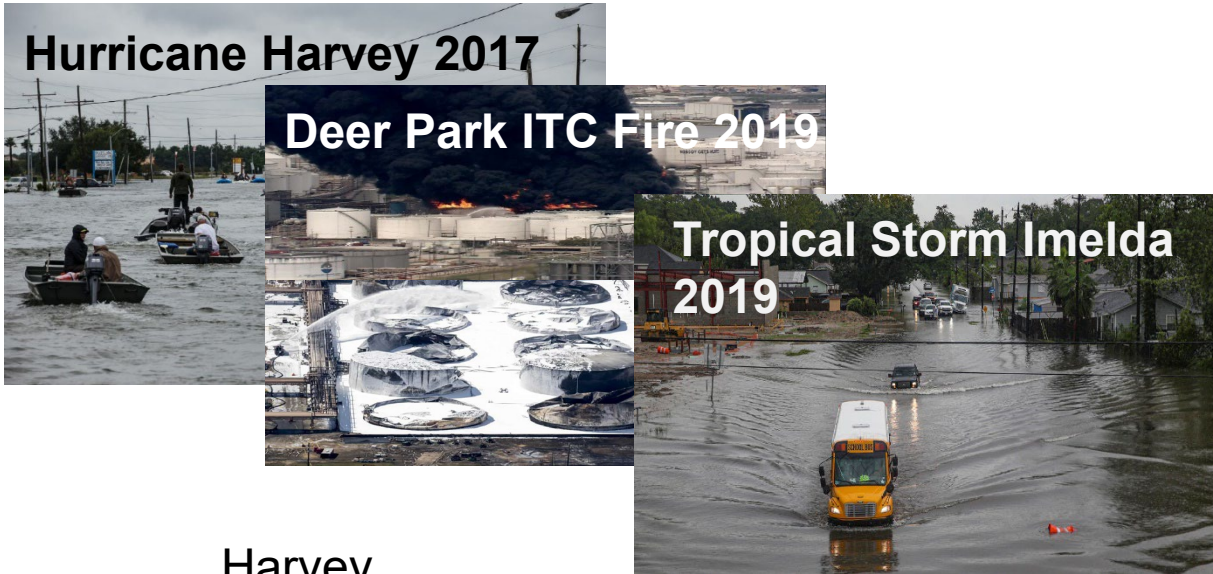
**GEOCHEMICAL AND
ENVIRONMENTAL RESEARCH GROUP**
TEXAS A&M UNIVERSITY

The Halo-Carbon Lab at TAMU



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

Emerging Contaminants in Galveston Bay



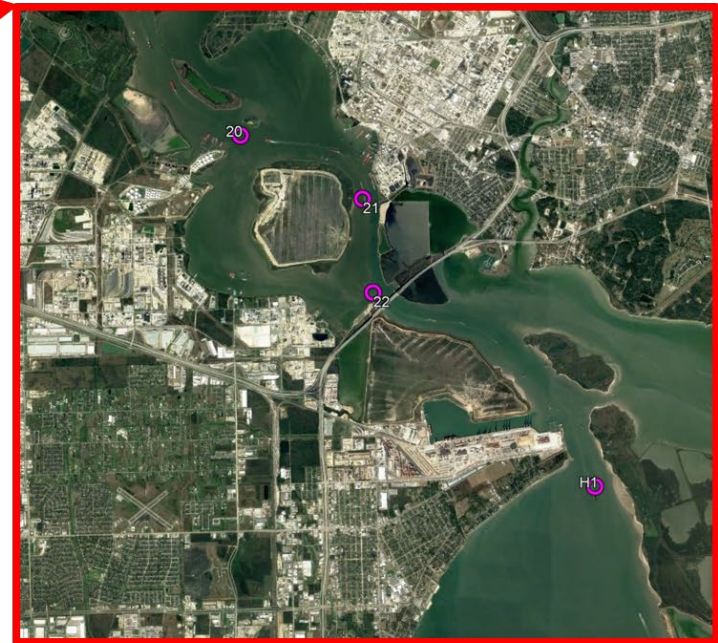
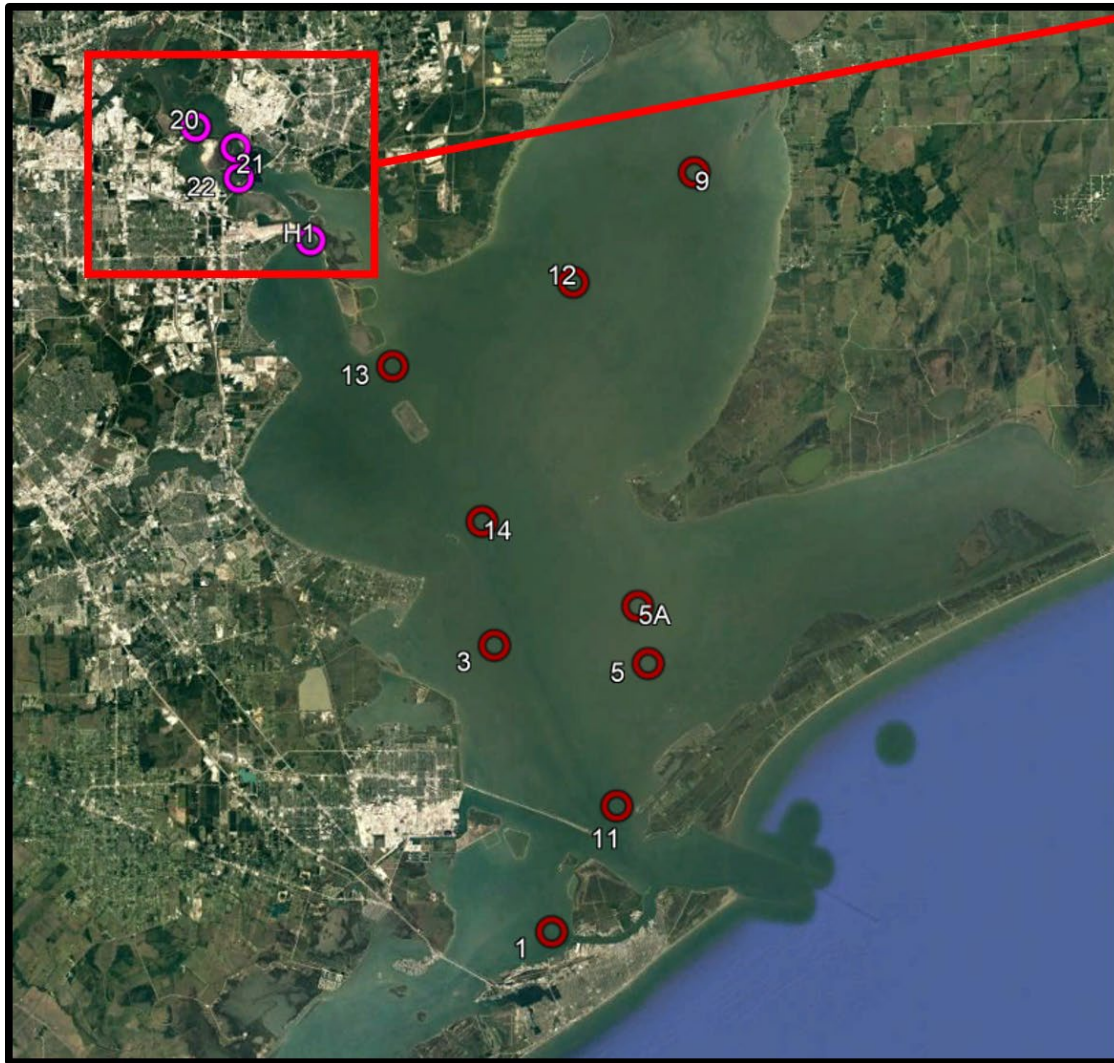
What can we learn about the Bay's resiliency towards extreme conditions that contribute to emerging contaminants?



- Are extreme events affecting Galveston Bay's water quality?
- How long does it take for the Galveston Bay system to recover?
- Monitoring of traditional contaminants have led to effective policies and treatments, but what about **emerging contaminants**?
- We monitored 30 PFAS and 14 PPCP from 2017 to 2023.
- The first time series of PFAS and PPCP in Texas.

Project Outcomes

- This is the first time series with 5 years of data on PFAS and PPCP in Texas.
- Data for 30 PFAS are available for 436 water samples and 173 sediment samples from 2017 to 2023.
- Data for 14 PPCPs are available for 299 water samples (2021 to 2023) and 173 sediment samples (2017 to 2023).
- Archived samples will enable future follow-up studies, e.g., tire additive toxic chemicals.
- Provided educational values by enabling graduate and undergraduate students to participate in the research cruises.

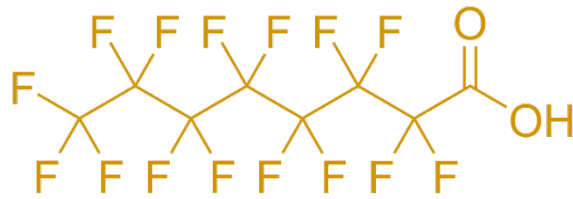
Galveston Bay Observation Cruises



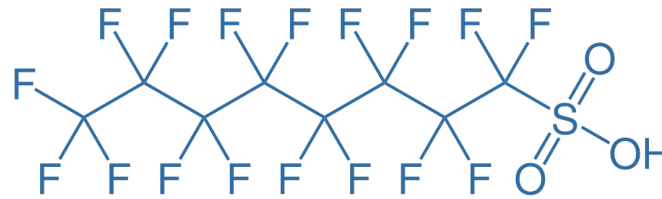
-  Quarterly Occupied Stations
-  Houston Ship Channel Stations Added Since March 2019

Background on PFAS

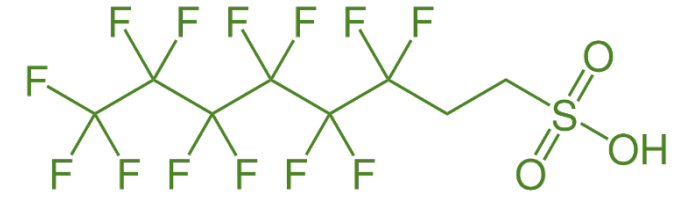
- Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals (>12,000 known chemicals)
- Now PFAS have many classes with different functional groups, e.g., perfluorinated carboxylic acids (PFCAs), perfluorinated sulfonic acids (PFSA), and fluorotelomer sulfonates (FTS)



Perfluorooctanoic acid(PFOA)



Perfluorooctanesulfonic acid (PFOS)



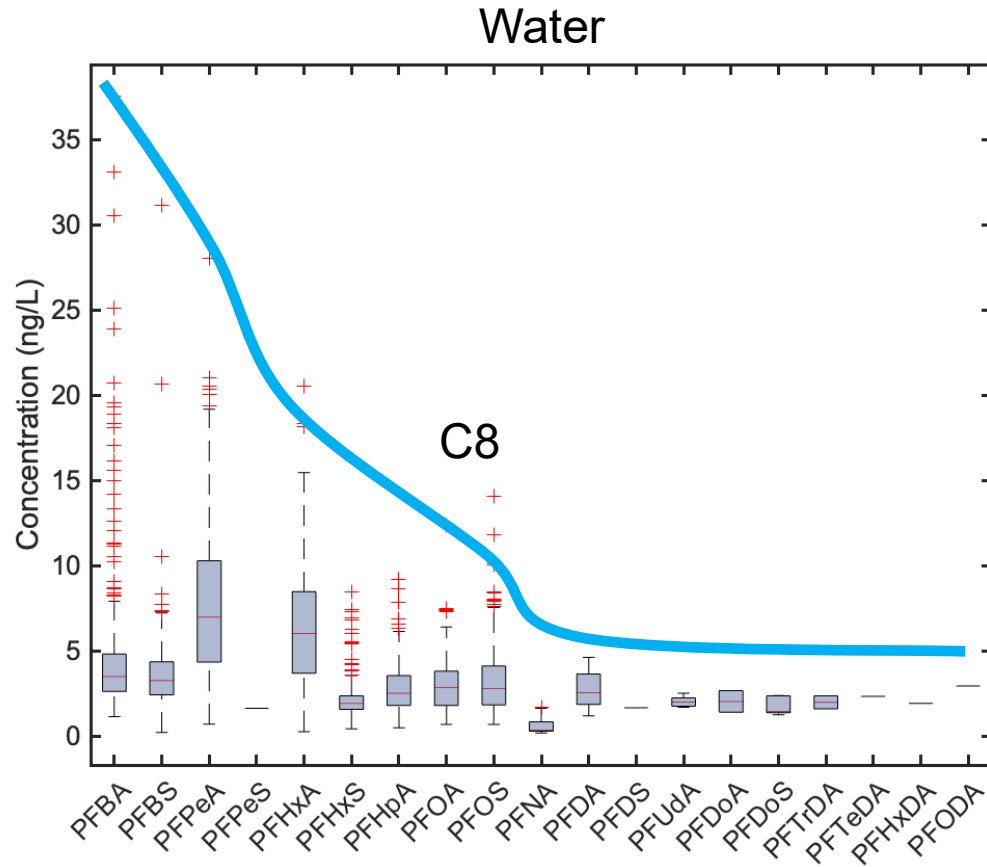
6:2 fluorotelomer sulfonic acid (6:2 FTS)

- Produced in the US since the 1940s for different consumer products
- Bioaccumulative in humans and marine life, and potentially toxic

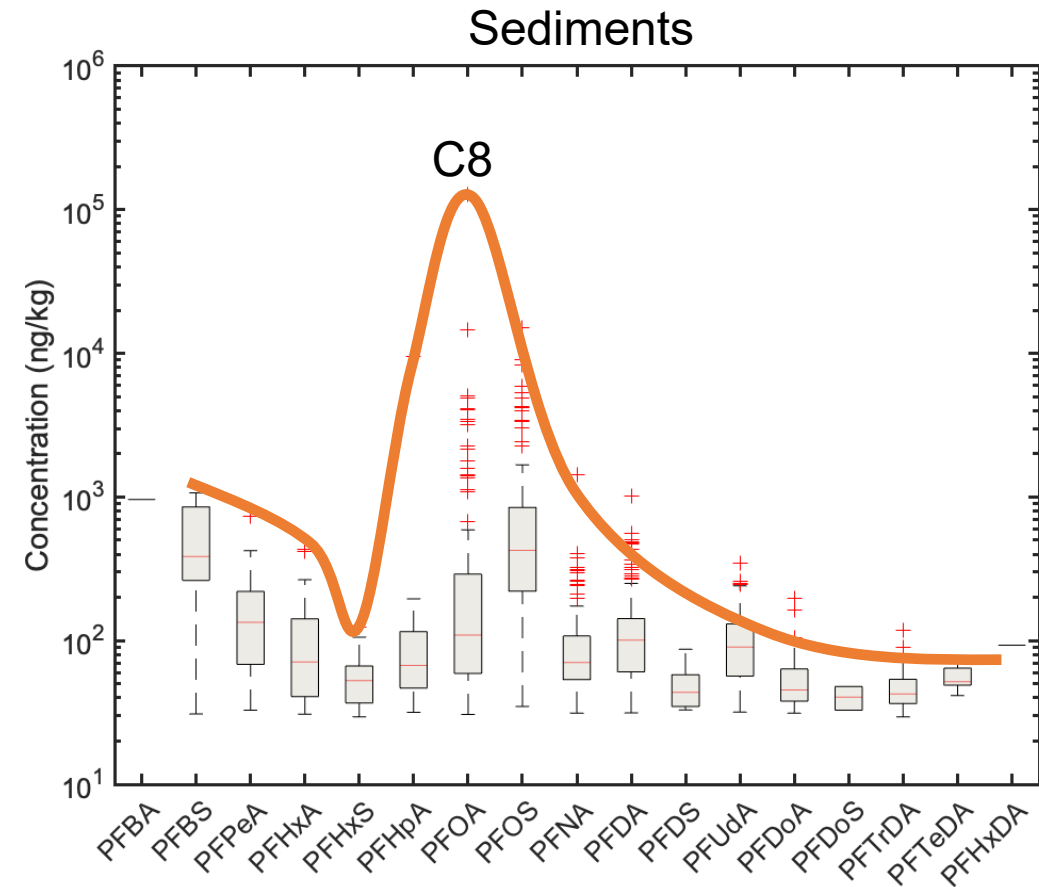


Molecular Weight Factors?

Data excluded ITC fire



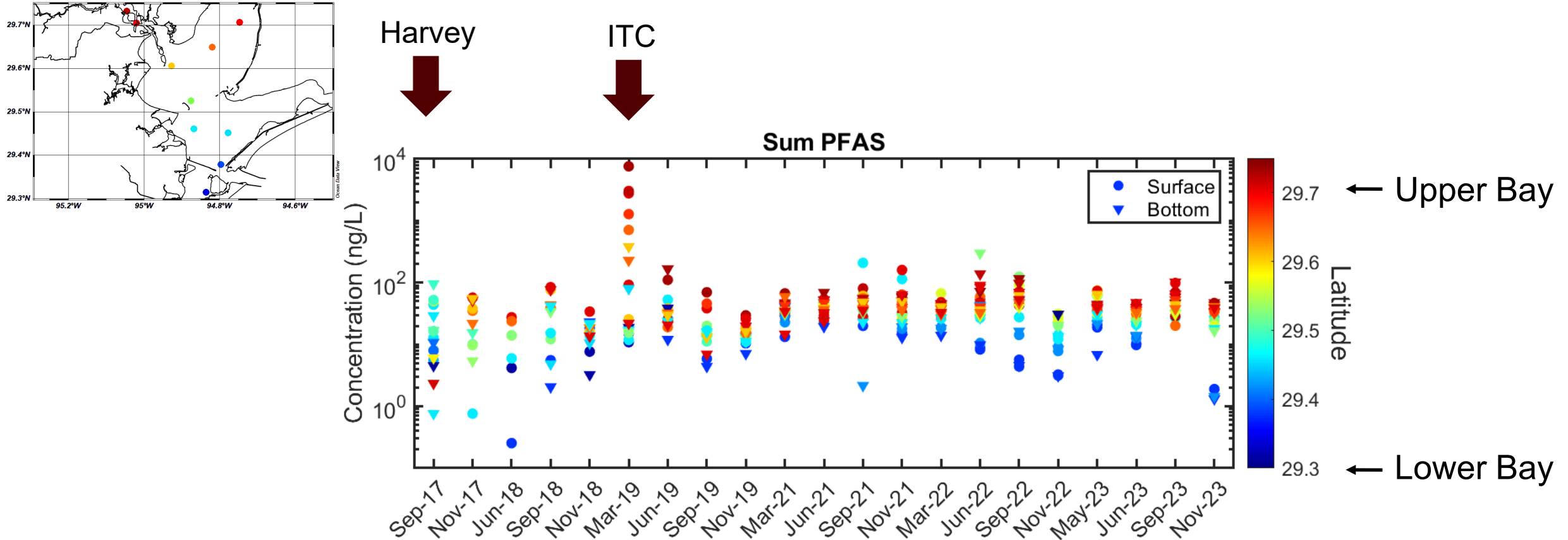
Mostly <C8 PFAS found in water



Mostly C8 PFAS found in sediments

Sediment PFAS concentrations were higher than water

The First PFAS Time Series in Texas

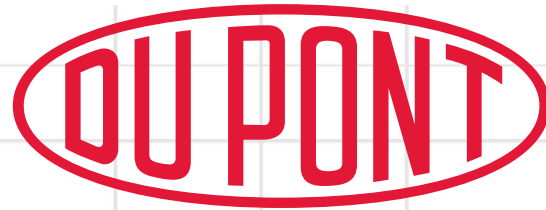


- Total PFAS in water exhibit significant spatial and temporal variabilities.
- PFAS found in water were mostly <C8.

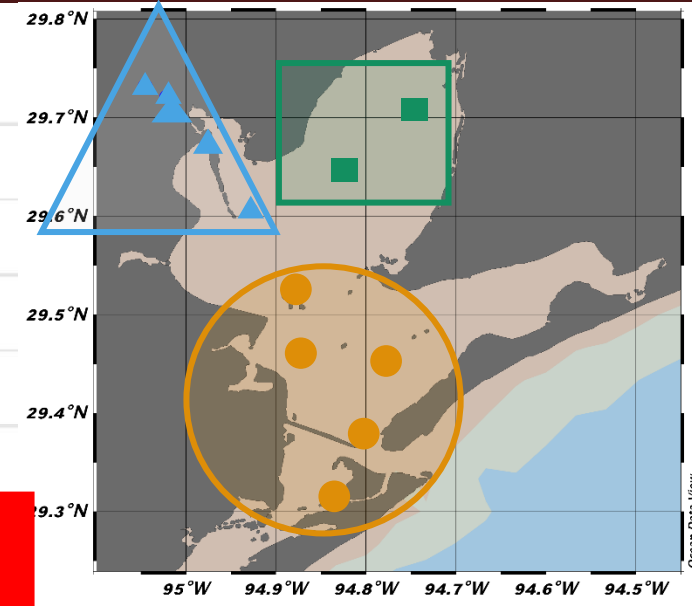
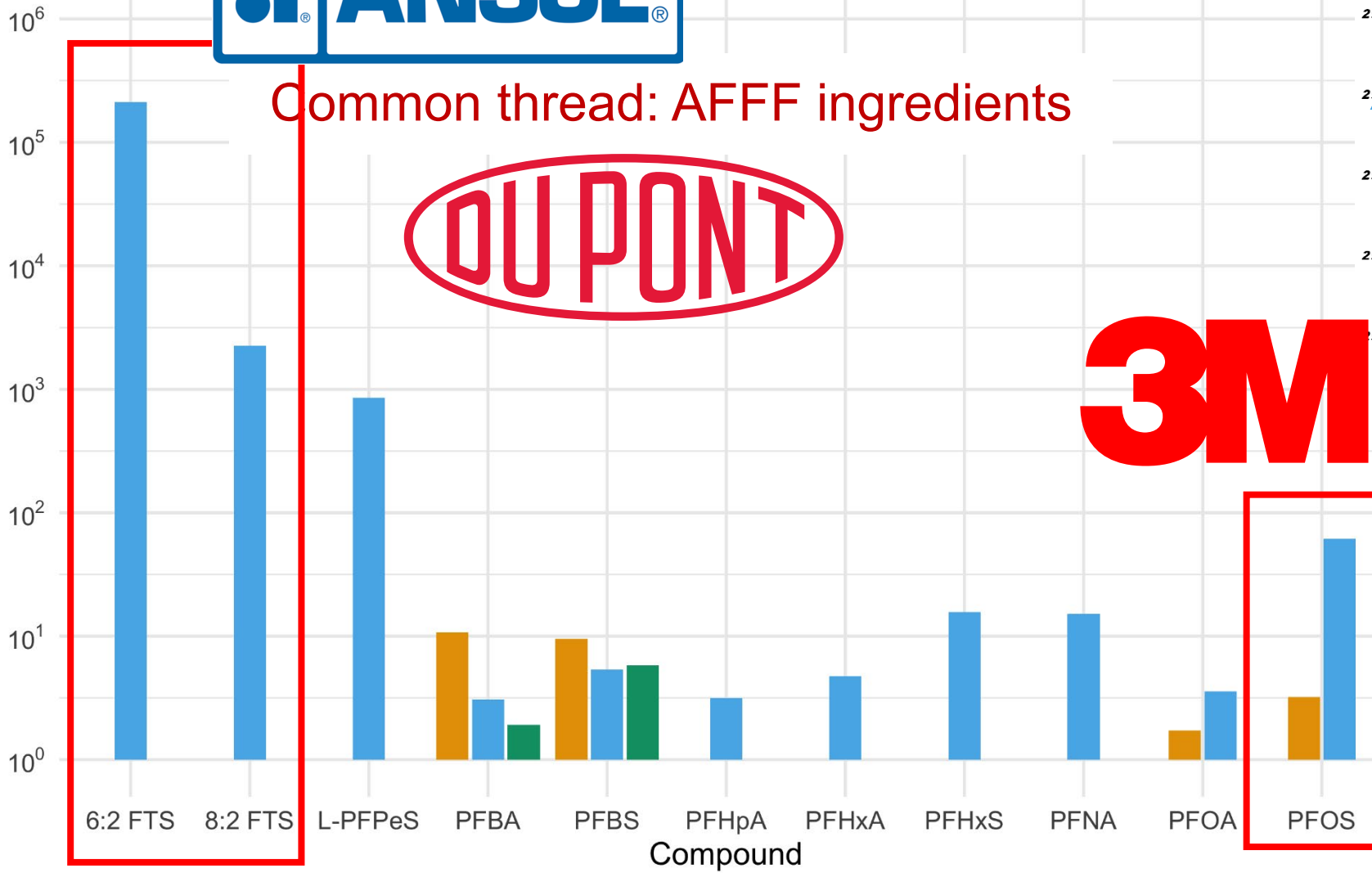
What was in the Water During TIC??



Common thread: AFFF ingredients



Times Greater than Baseline Concentration
(log scale)



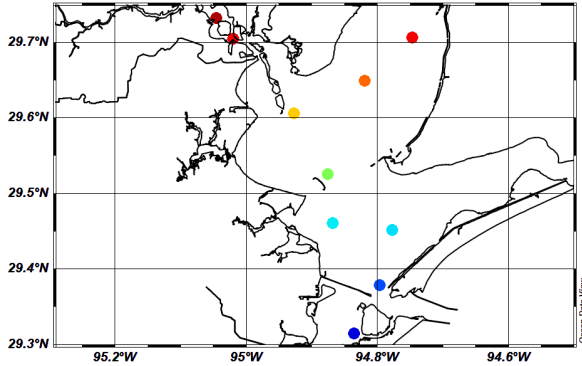
Location

- Bay
- San Jacinto
- Trinity

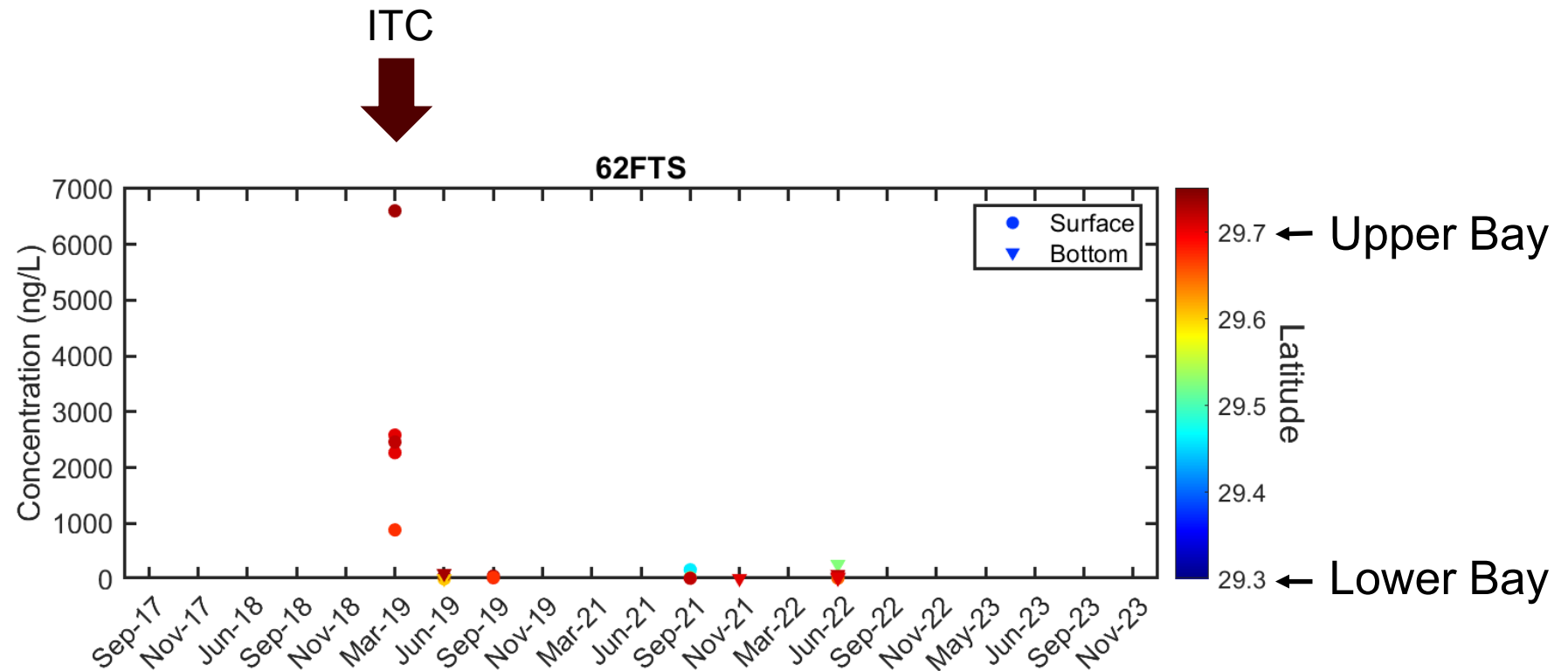


Backe et al., 2013; Houtz et al., 2013; Houtz et al., 2018; Rotander et al., 2015; Wang et al., 2013

The First PFAS Time Series in Texas



- 6:2 FTS was not detected before the ITC fire.
- Extremely high concentrations were observed in the Houston Ship Channel during ITC.
- It took six months for the concentration to return to “normal.”

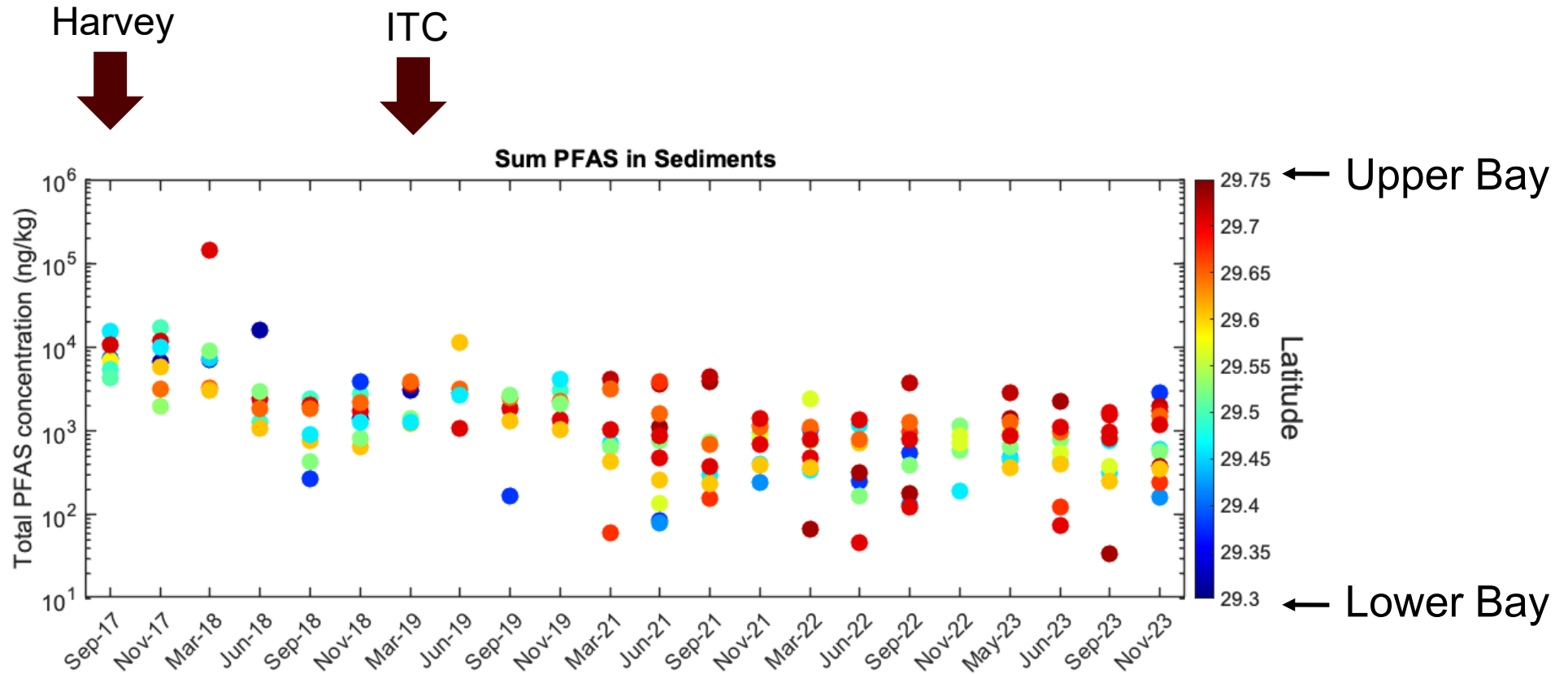
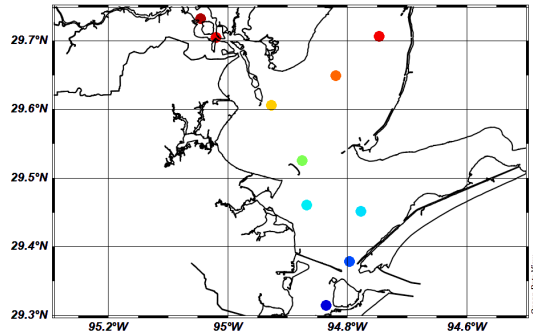


Baseline Values for PFAS in Galveston Bay Water

- Baseline PFAS concentrations in water were estimated as the mean values for PFAS detected in more than 20% of water samples after ITC data exclusion.
- PFOA and PFOS have been phased out, and they are both regulated

Compounds Name	Mean Concentration (ng/L)	Frequency (%)
PFBA	4.63	89.22
PFBS	3.65	67.66
PFPeA	7.86	94.95
PFHxA	6.32	95.18
PFHxS	2.15	65.60
PFHpA	2.83	79.82
PFOA	2.94	84.17
PFOS	3.27	71.33

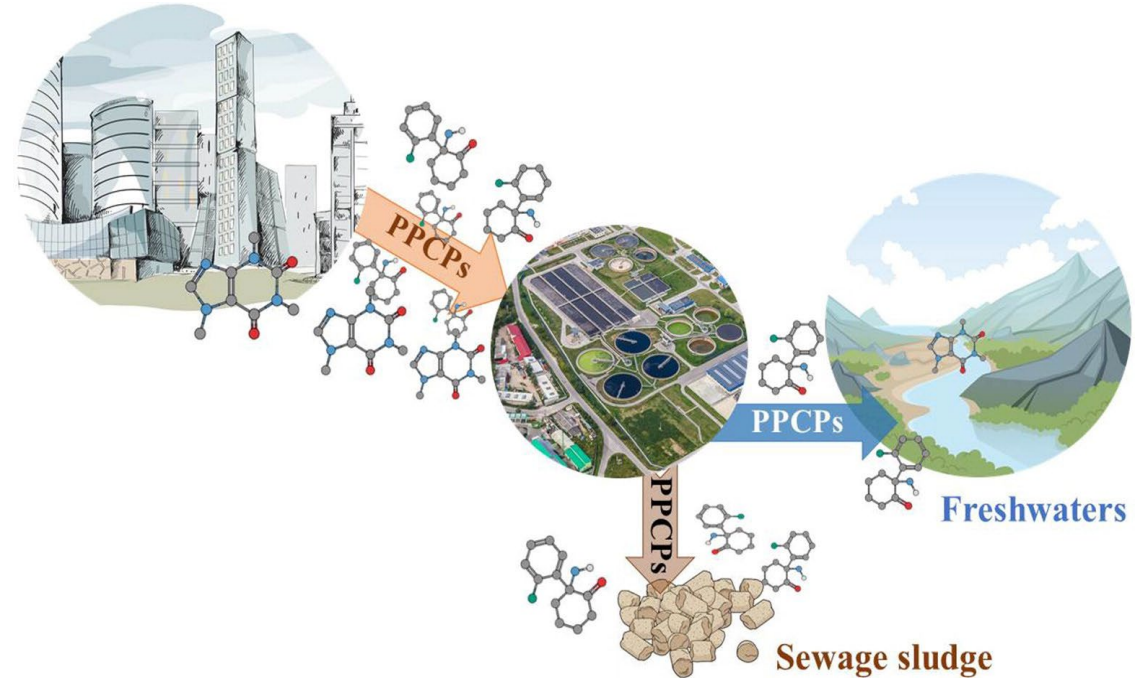
The First PFAS Time Series in Texas



- Total PFAS in sediments exhibit significant spatial and temporal variabilities.
- But seem to be de-coupled with events that led to high water concentrations.
- PFAS found in water were mostly C8.
- The concentration magnitude in sediment is generally higher in sediments than in water.

The Problem of PPCP

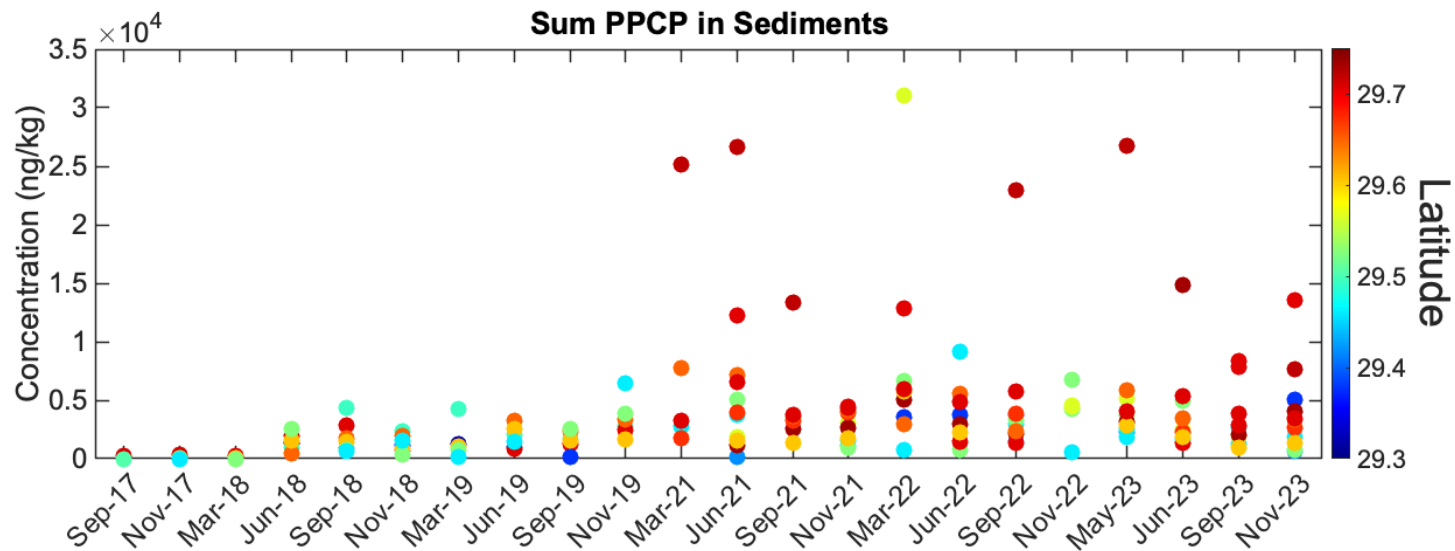
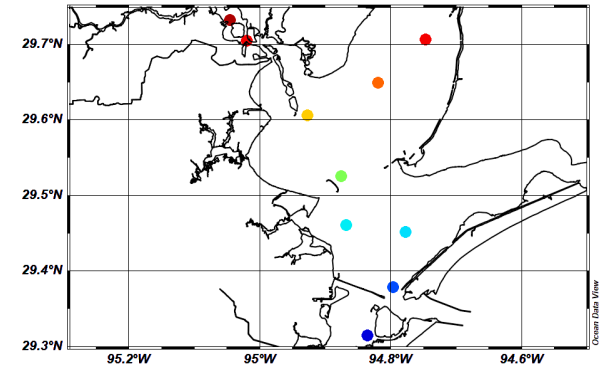
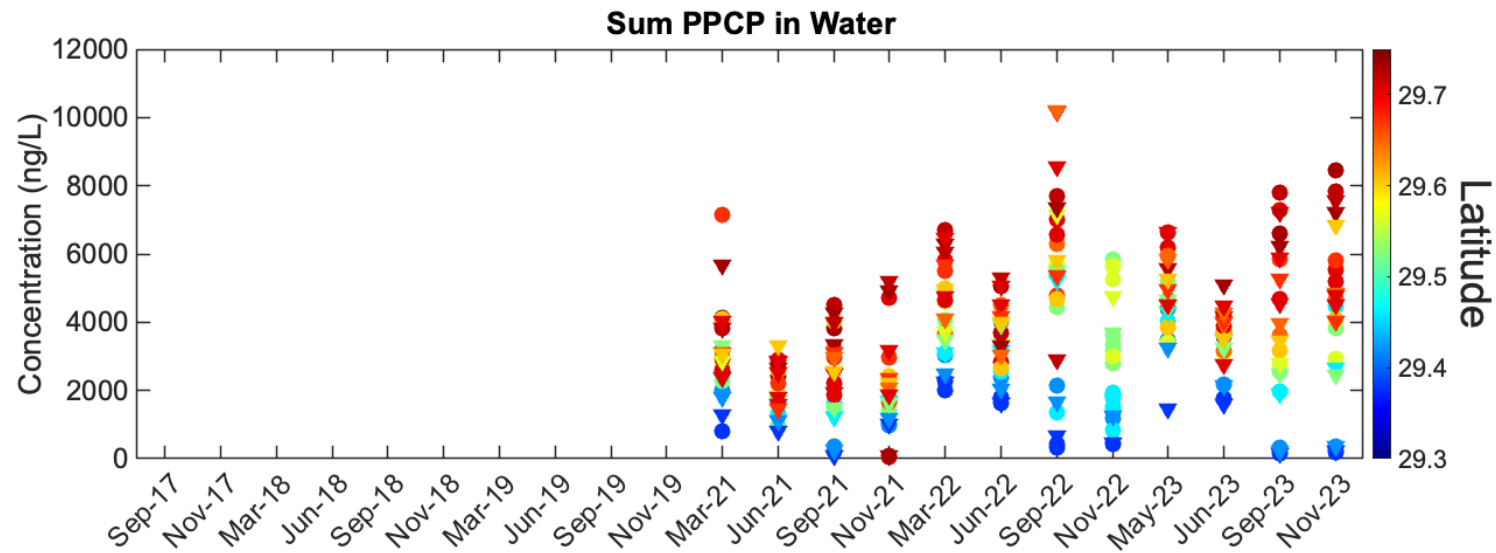
- Pharmaceuticals and personal care products (PPCPs) are a diverse group of compounds.
- They cannot be easily regulated.
- They are detected in water bodies.
- They are found to be bioactive and can have a negative impact on water quality, ecosystems, and human health.



Tarpani and Azapagic (2017)



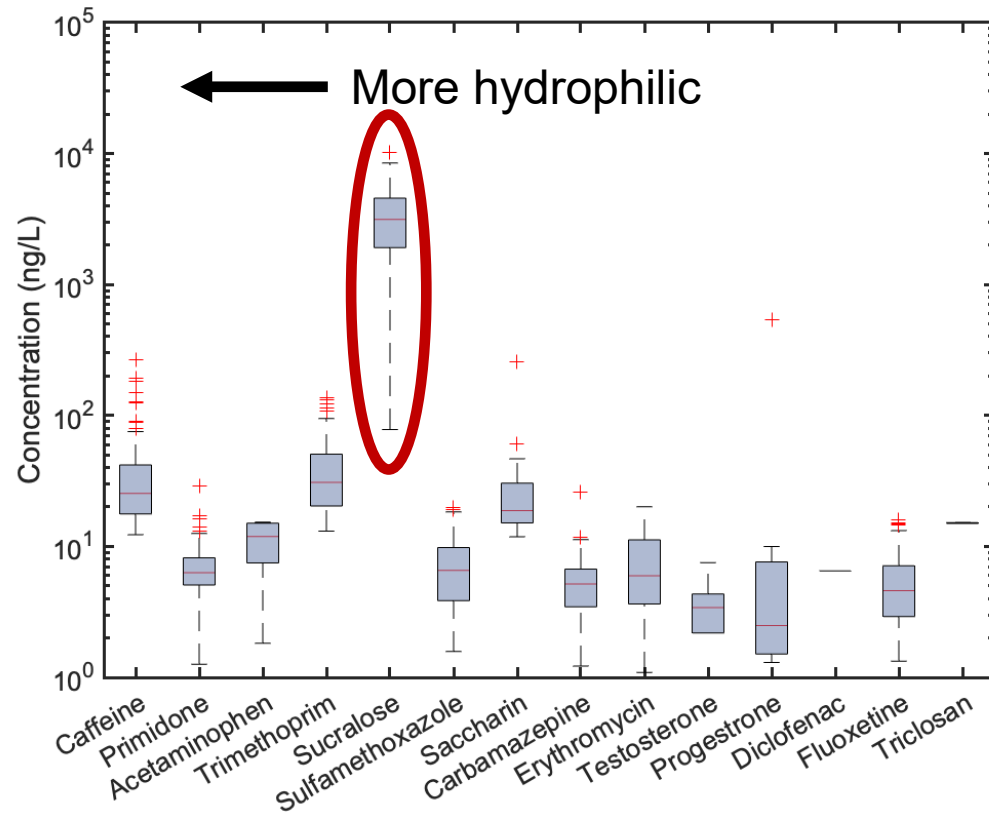
The First PPCP Time Series in Texas



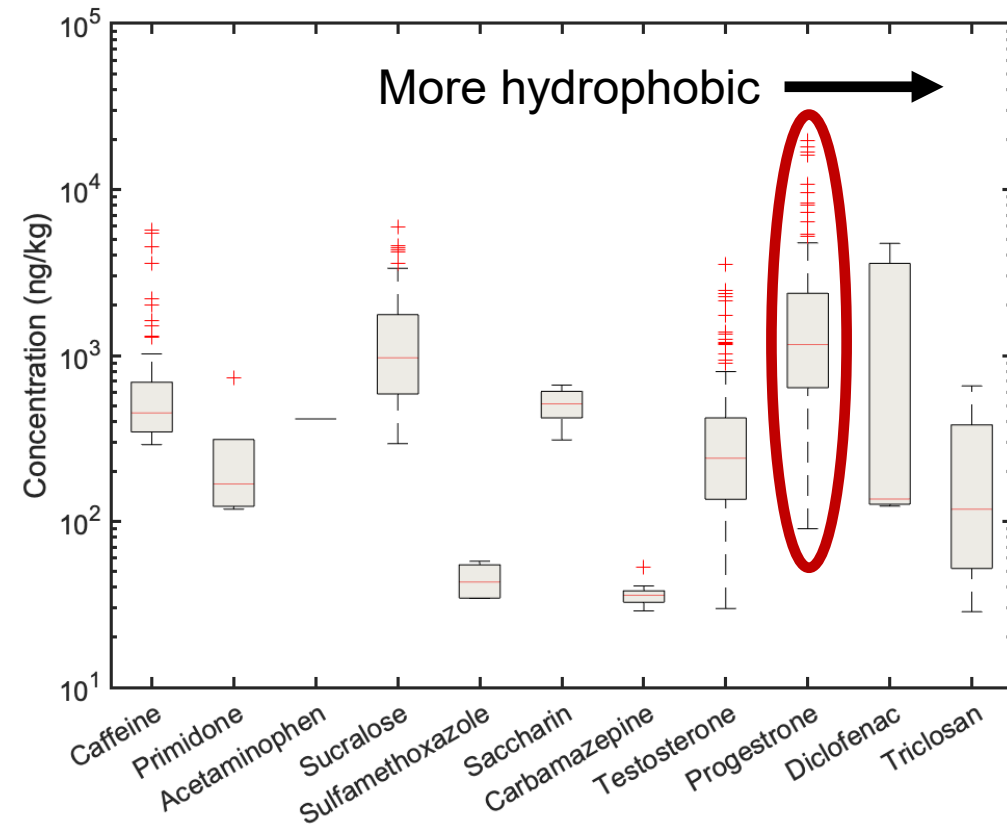
- PPCP in water and sediments varied with time but not as significantly as PFAS.

The First PPCP Time Series in Texas

Water



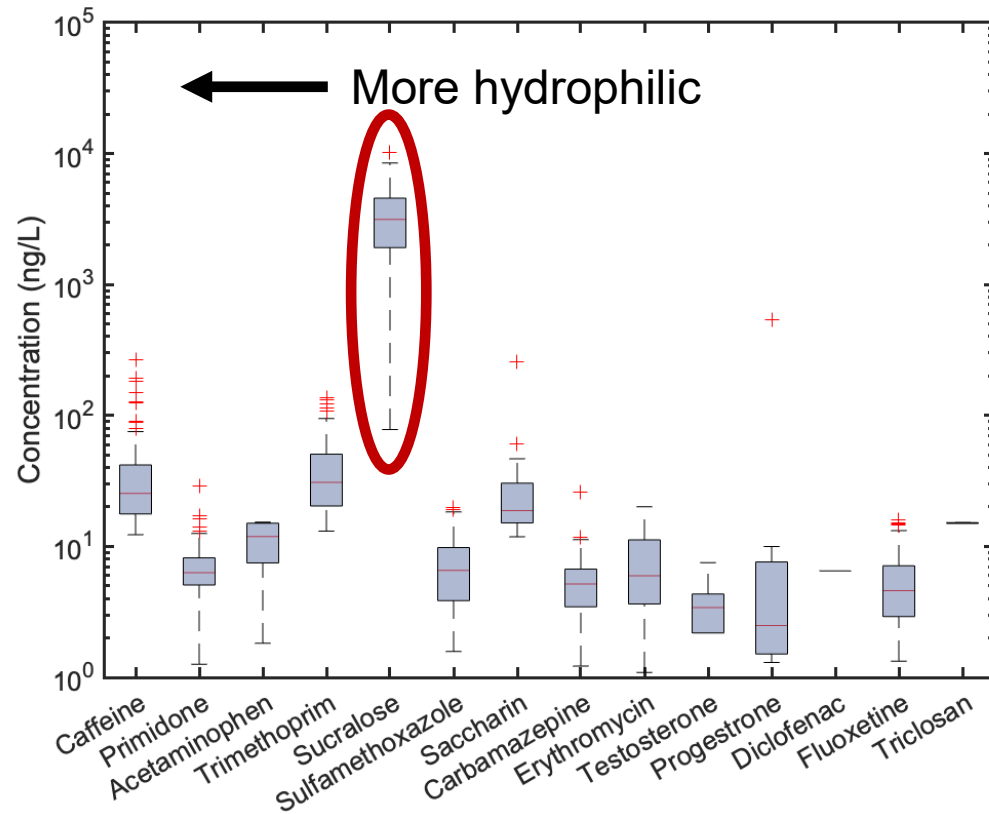
Sediments



- Less PPCP diversity in sediments.
- More hydrophobic PPCPs, such as progesterone, were found in sediments.
- Very high concentrations of sucralose were found in both water and sediments.
- Sucralose, a tracer for wastewater, is the dominant PPCP in water.

The First PPCP Time Series in Texas

Water



Sucralose is an artificial sweetener found Splenda



May come from wastewater treatment plants or untreated water.

May be used as a wastewater tracer.

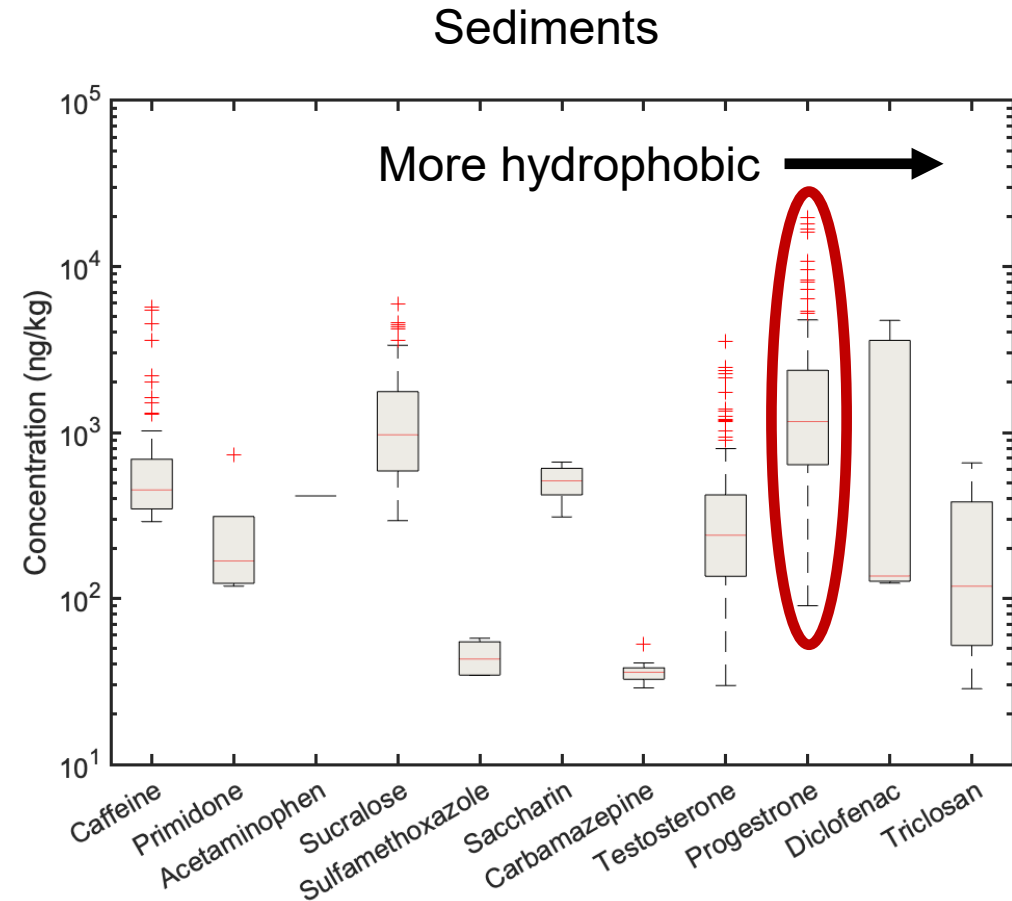
The First PPCP Time Series in Texas

Progesterone is a naturally occurring steroid hormone in the body.

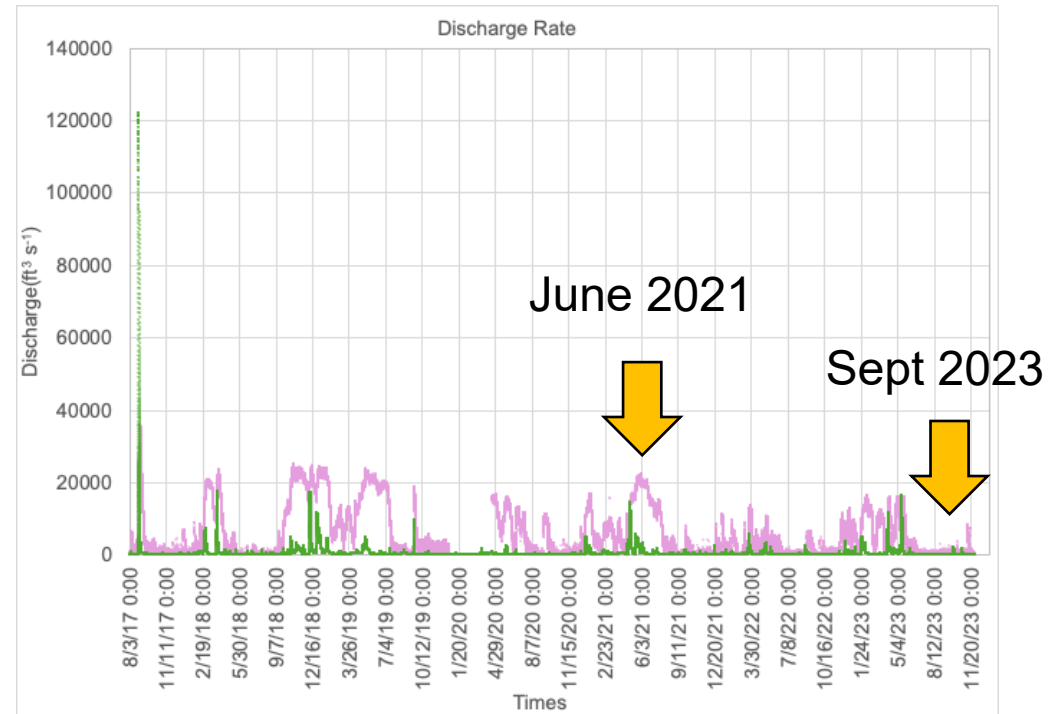
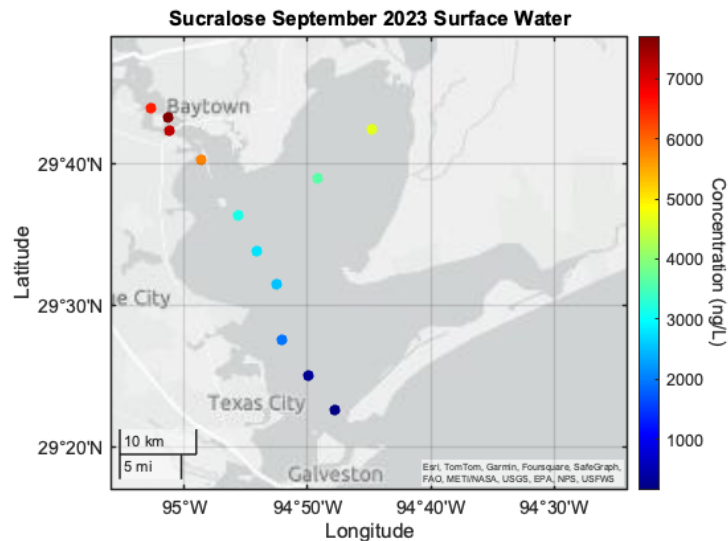
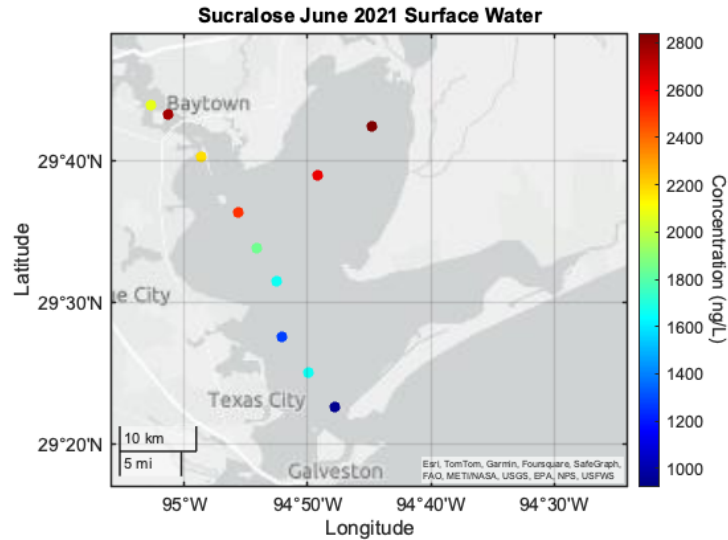
May be from human and animal excretion.

Contraceptives and hormone replacement treatments.

Plant degradation.

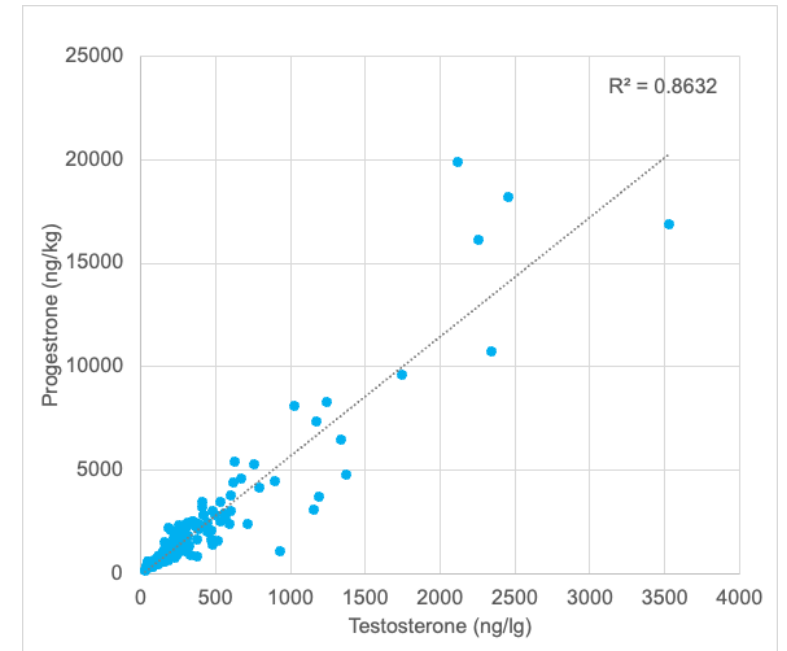
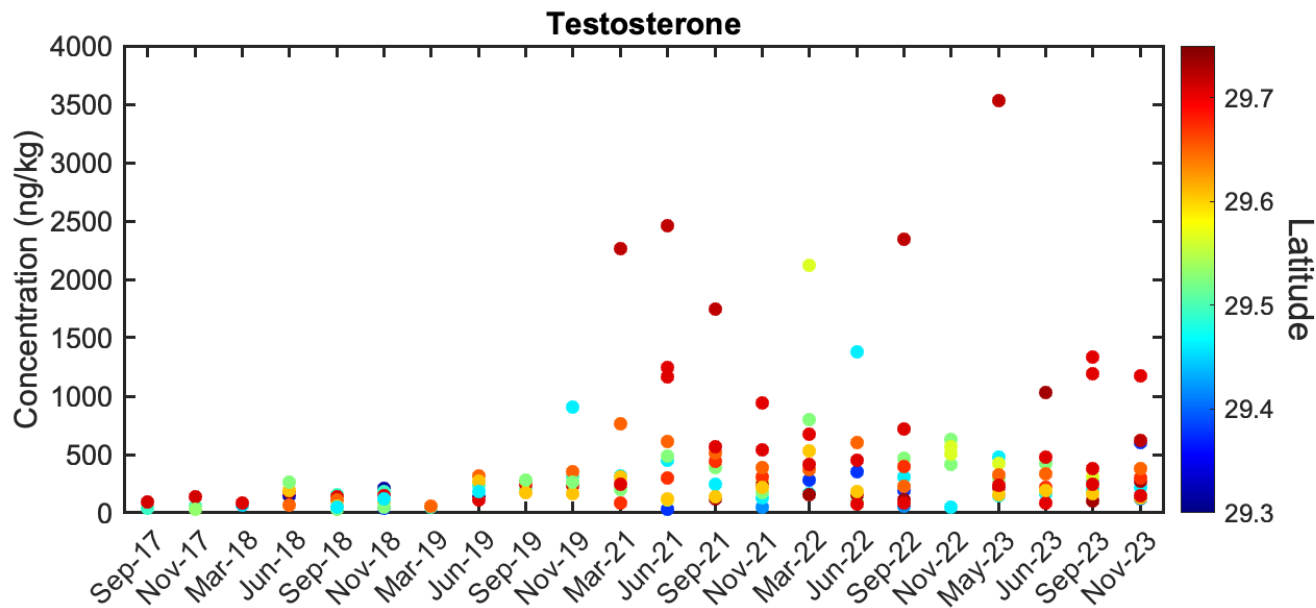
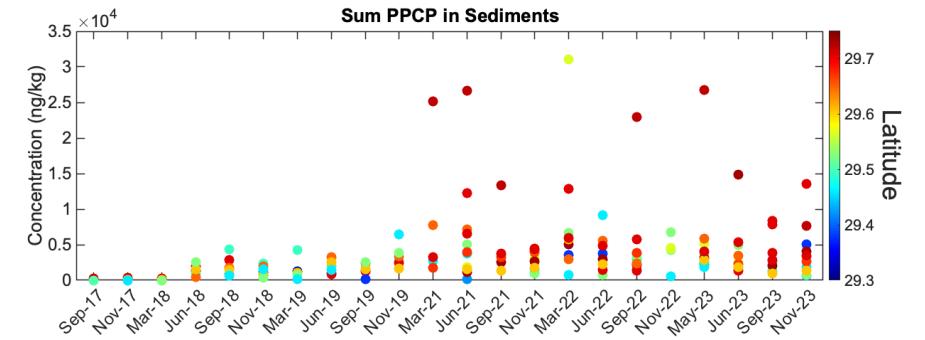
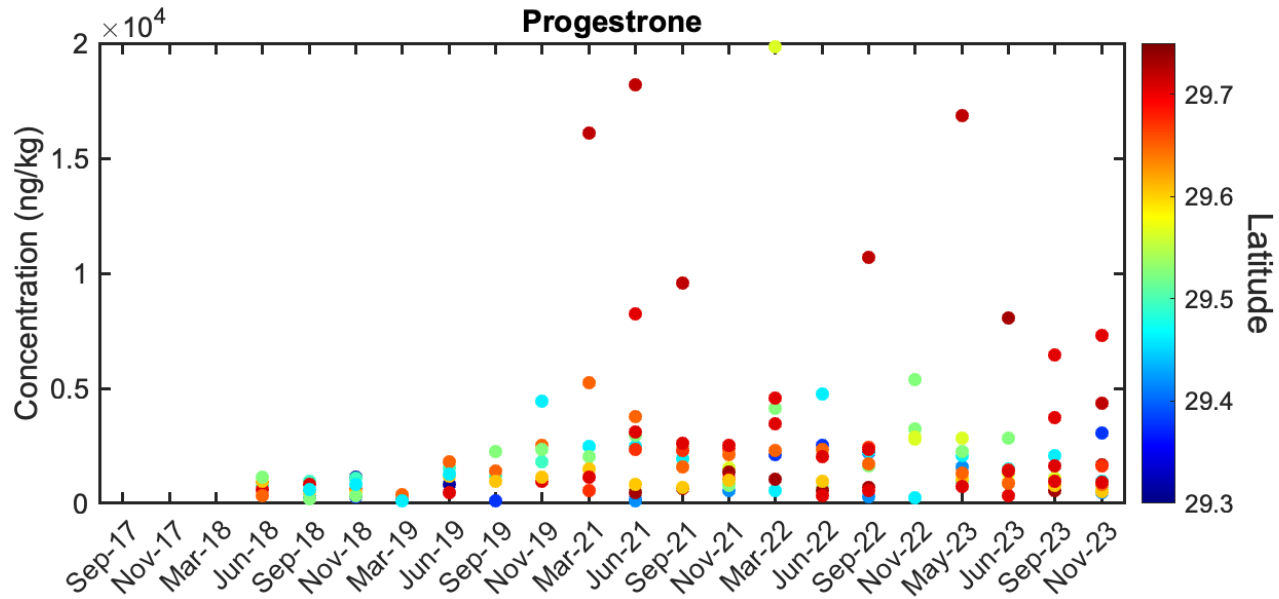


The First PPCP Time Series in Texas



- Total PCPP in June 2023 was higher than in June 2021 and progressed further into the bay.
- The relatively low river discharge in June 2023 may lead to less dilution.

The First PPCP Time Series in Texas

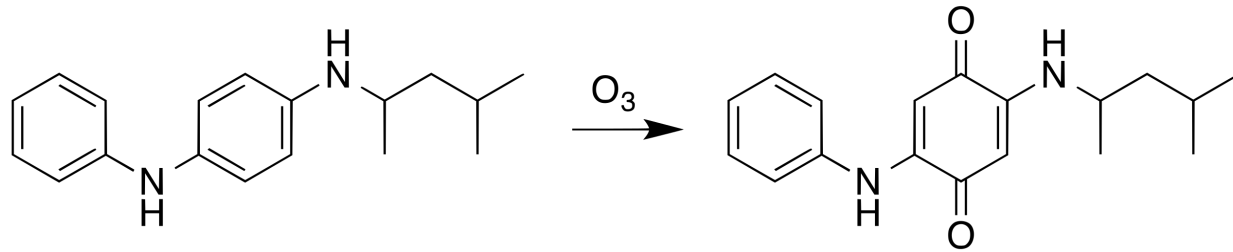


Summary

- This is the first time series of PFAS and PPCP in Texas.
- PFAS concentrations varied significantly spatially and temporally in water and sediment but were more variable in water.
- The types of PFAS in water and sediments are different.
- The ITC Fire in March 2019 contributed significant amounts (**above** “normal”) of PFOS and 6:2 FTS to Galveston Bay, and it took months to return to normal.
- PPCP spatial and temporal variabilities are not as significant as PFAS.
- Sucralose is the dominant PPCP in water, while progesterone dominates in sediments, likely due to their water solubility.
- Sex hormones such as progesterone and testosterone are found in sediments.

Next Steps

- Understand the chemical complexity in Galveston Bay water and sediments.
- Do emerging contaminants transform into something else?
- New project funded by leveraging samples collected by this project.



**6PPD Quinone - Coho Salmon fish kills
in urban streams (1990s to Present)**

Acknowledgement



Oceanography Trident Cruise Team

- Dr. Jessica Fitzsimmons (Chief Scientist of the Trident cruises and T3 PI)
- Dr. Kathryn Shamberger (T3 PI)
- Dr. Shari Yvon-Lewis (T3 co-PI and current TCEQ project co-PI)
- Oceanography students' heroic effort in all the cruises – Garrett Walsh, Alyssa Alsante, Tacey Hicks, Daianne Hofig, Janelle Steffen, Serena Smith, Nina Mangor, Hunter Adams, and more!

