

# From Flood to Lesion: Bottlenose Dolphins as Early Indicators of Estuarine Change

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# Marine Mammals as Ecosystem Sentinels

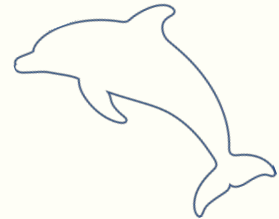
Long-lived apex predators in the coastal environment

Studies of bottlenose dolphins in Galveston Bay have taken place since the late 1980s (Jones, 1988; Bräger et al., 1994; Fertl, 1994; Beier, 2001; McDaniel, 2022; Mintzer et al., 2023)

The Galveston Bay Dolphin Research Program (GDRP) has identified over 1,000 unique individuals since 2014

High site fidelity to Galveston Bay, TX with **exposure** (Mintzer et al., 2023)

**known freshwater**



The objective of this research is to apply the Dolphin FRESH Protocol (Fazioli et al., in press) to a real-world dataset for the first time and begin characterizing the progression and severity of freshwater-related skin lesions.

# Freshwater Skin Disease

## What is FSD?

A response characterized by the development of skin lesions and physiological stress

## Environmental Changes

Ex. Increased precipitation events and future coastal infrastructure projects

Altering salinities within estuarine ecosystems



*Examples of 'positive' case of FSD. Photo Credits: Galveston Bay Dolphin Research Program, NMFS MMPA Permit #18881*

# Methodology

## Boat-based Surveys

942 distinct dolphins were sighted on boat-based surveys in Galveston Bay from 2014 - 2019.

## 'Case'

A 'case' is defined as all photographs of an individual at a **single point** in time

## Selection Criteria

15+ sightings during the study period

Distinct fins and high site fidelity

Further methods laid out in Mintzer et al., 2023

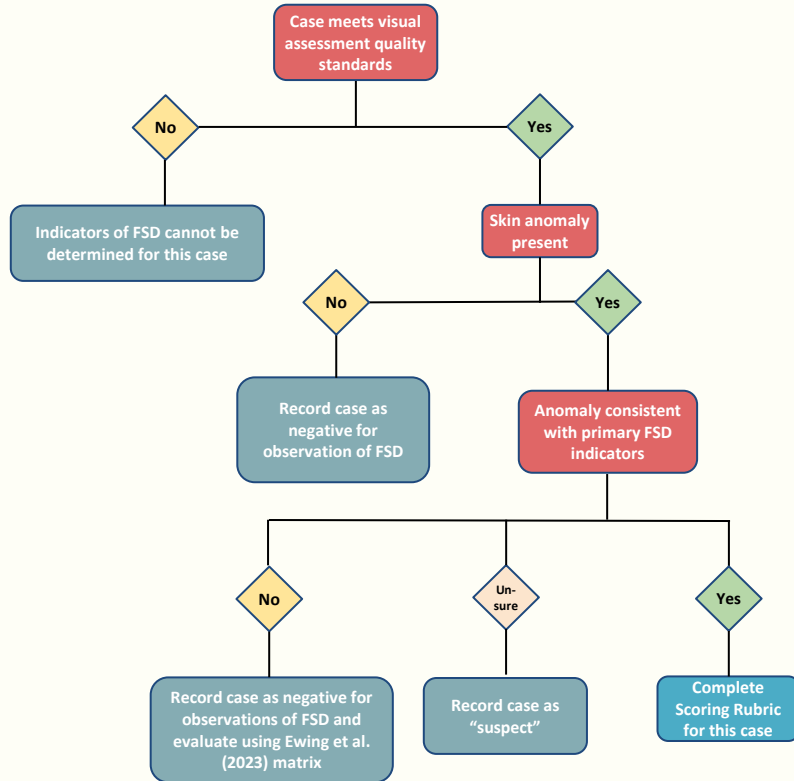
## Photo Analysis

Dolphin FRESH Protocol

The FRESH Screening Decision Tree

FRESH Scoring Rubric

# Methodology - FRESH Screening Decision Tree



Outlines the criteria each case must satisfy prior to application of the FRESH Scoring Rubric.

Positive cases are then evaluated for FSD indicators (overgrowth, target -like lesions, and light discoloration) utilizing the FRESH Scoring Rubric ( Fazioli et al., in press ).

Fazioli, K. L., Toms, C., Takeshita, R., Quackenbush, A., Greig, D., Rowles, T., ... & Mintzer, V. The Dolphin FRESH Protocol: visual Freshwater-Related Evaluation of Skin Health in free-ranging bottlenose dolphins (*Tursiops spp.*). *Frontiers in Marine Science*, 13 , 1743541.

# Preliminary Results - Screening



**47**

**DOLPHINS**



**2,535**

**PHOTOGRAPHS  
SCREENED**



**966**

**CASES**

No. of Images Screened	No. of Cases Evaluated	No. of Cases that <u>Met</u> Visual Assessment Standards	No. of Cases Negative for FSD	No. of Cases Suspect for FSD	No. of Cases Positive for FSD
2,535	966	595	114	243 Range (0-13 cases)	238 Range (0-22 cases)

# Preliminary Results - Overgrowth

One individual (#85; 2.13% of individuals) was observed to have overgrowth lesions, co-occurring with target-like and light discoloration lesions, on two different occasions.



6/7/2016  
Case Score: 14



10/9/2019  
Case Score: 10

# Preliminary Results - Target-like Lesions

17 individuals (36.17%) were observed with target-like lesions, co-occurring with light discoloration, on at least one occurrence.



Animal 1  
6/6/2016  
Case Score: 13



Animal 85  
05/04/2015  
Case Score: 10

# Preliminary Results - Light Discoloration

23 individuals (48.94%) were observed with only light discoloration lesions on at least one occurrence.



Animal 48  
6/27/2016  
Case Score: 7



Animal 75  
05/08/2018  
Case Score: 1

# Preliminary Results - Severity Classes

LOW (1- 5)	MEDIUM (6- 12)	HIGH (>12)
<b>133 (55.88%)</b>	<b>102 (42.86%)</b>	<b>3 (1.26%)</b>

# Example #85 - Severity Classes



Low Severity

8/26/2015  
Case Score: 3



High Severity

6/7/2016  
Case Score: 14



Medium Severity

9/5/2017  
Case Score: 6

# Preliminary Results - Salinity v. Case Score

## Strong negative relationship between salinity and case score

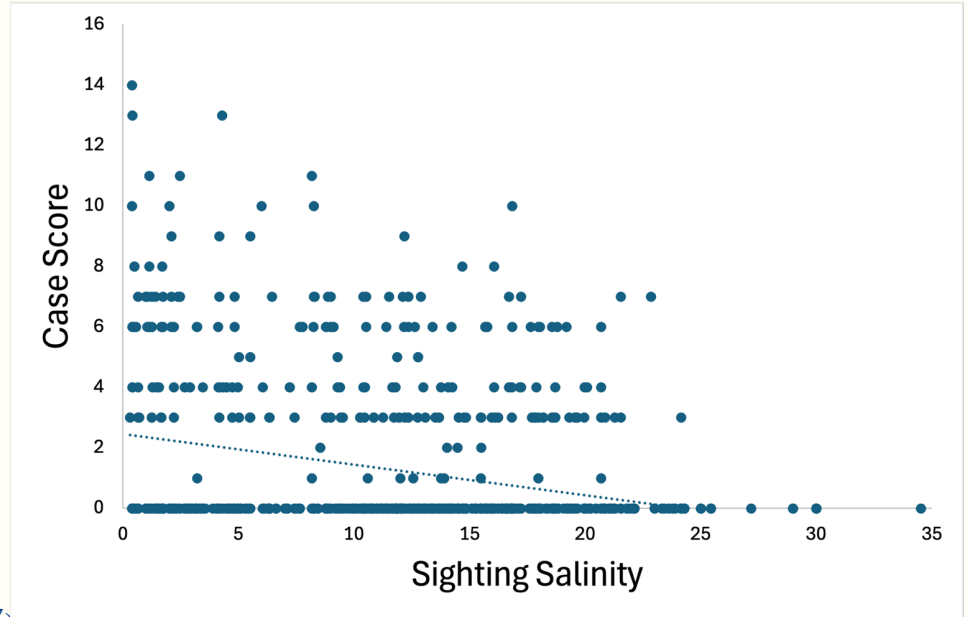
- Higher salinity → Lower case score
- Spearman's  $\rho = -0.40$  ( $n = 324$ ,  $p = 3.66e^{-14}$ )

## Odds of higher case score drop with increasing salinity

- OR = 0.88 (95% CI: 0.85–0.91;  $p = 1.08e^{-13}$ )

## Repeated -sighting models confirm the pattern

- Higher salinity reduces odds of any lesion being present
- OR = 0.86 (95% CI: 0.817–0.915;  $p = 4.20e^{-7}$ )



Plot of case score against sighting salinity; the trendline shows the negative relationship between salinity and case score.

# Key Takeaway & Next Steps

Increased presence of lesions and severity are associated with lower salinities.

- 1 Complete evaluation of all 126 individuals and integrate salinity/water -quality data.
- 2 Assess lesion progression and identify thresholds linked to freshwater exposure.
- 3 Relate case scores to sighting locations, movements, and distribution shifts.
- 4 Develop materials to support community outreach on environmental impacts.

# Acknowledgements

Members of the GDRP (both past and present)

All authors & contributors of the Dolphin FRESH Protocol

Dr. Paul Pennington (NOAA's NCCOS) - statistical expertise

All data was collected under NOAA MMPA Scientific Research Permit #18881



# Questions?

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*Fazioli, K. L., Toms, C., Takeshita, R., Quackenbush, A., Greig, D., Rowles, T., ... & Mintzer, V. The Dolphin FRESH Protocol: visual Freshwater -Related Evaluation of Skin Health in free -ranging bottlenose dolphins (Tursiops spp.). Frontiers in Marine Science, 13, 1743541.*



# Galveston Bay's Urban Bottlenose Dolphins

Updates on Residency and Threat Evaluation



**GALVESTON BAY**  
FOUNDATION



Environmental Institute of Houston



University of Houston  
Clear Lake

Melanie Rogers, Sherah McDaniel, Alyssa Quackenbush, Kristi Fazioli, Vanessa Mintzer



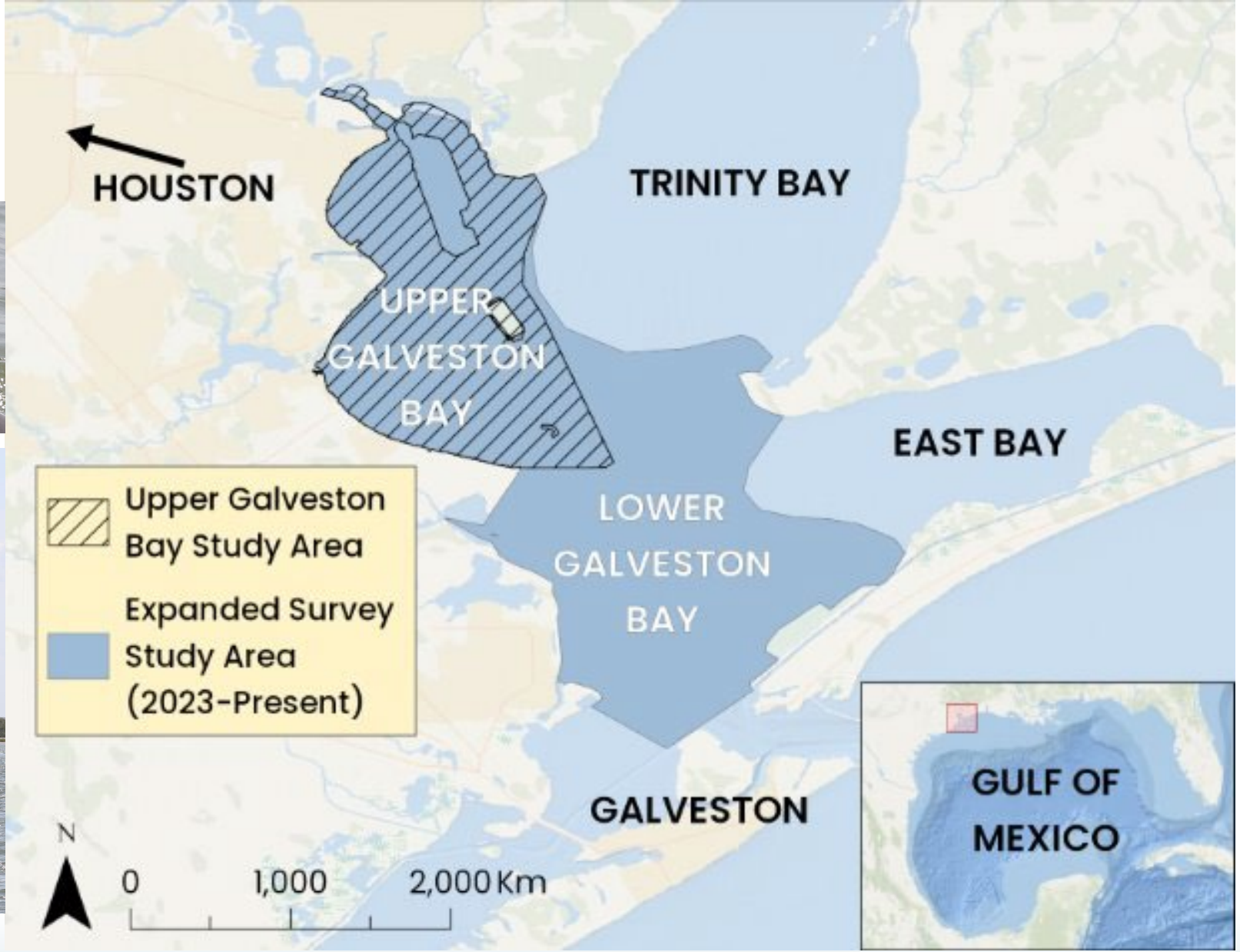
# Our Mission

Our mission is to better understand the bottlenose dolphins that live in the highly industrialized Galveston Bay estuary. We study the ecology, behavior, and health of this population and raise public awareness about dolphins.



# Population Monitoring

## Photo-identification



- 396 surveys; 29,511 km surveyed; 17,726 dolphins sighted
- >1000 distinct individuals cataloged
- 91 biopsy samples collected
- 112 land-based observation shifts
- Seasonal changes in distribution within bay
- Seasonal movement into bay (transient individuals)
- Foraging Ecology
- Freshwater Exposure

• ~200 individuals with high site fidelity to upper bay => "residents"



# GDRP Dolphin Sightings

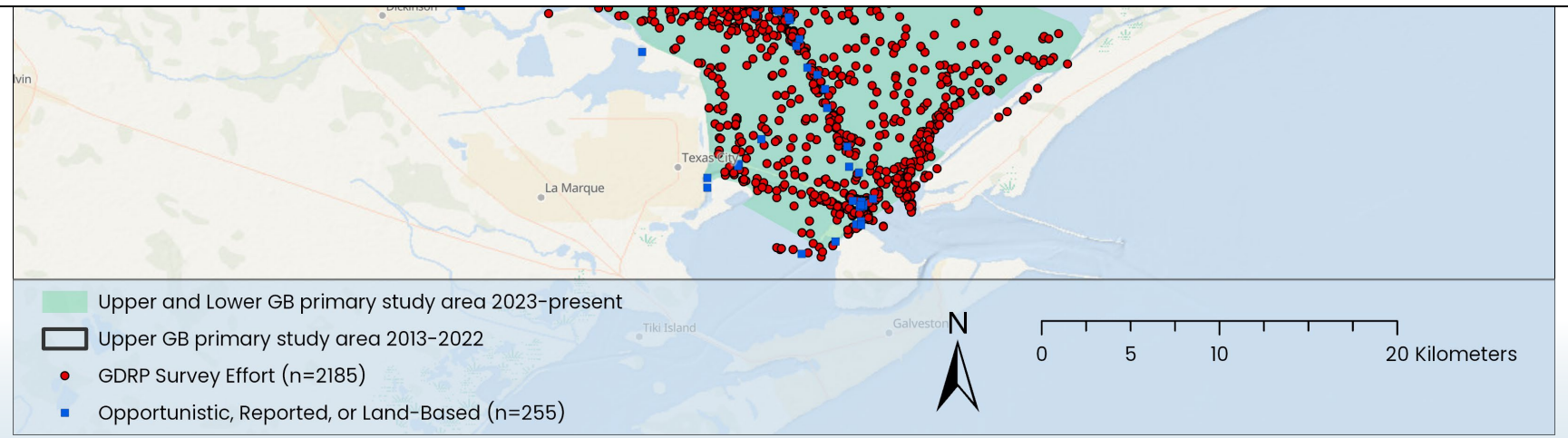
Galveston Bay, Inshore of the ICW; Aug 2013 - Dec 2025



McDaniel, S. (2022). Foraging ecology of bottlenose dolphins (*Tursiops truncatus*) in Galveston Bay, Texas. M.S. Thesis. University of Houston-Clear Lake, Houston, TX.

Mintzer, V. J. & K. L. Fazioli (2021). Salinity and Water Temperature as Predictors of Bottlenose Dolphin (*Tursiops truncatus*) Encounter Rates in Upper Galveston Bay, Texas. *Frontiers in Marine Science* 8(1627). <https://doi.org/10.3389/fmars.2021.754686>

Fazioli, K. & Mintzer, V. (2020). Short-term Effects of Hurricane Harvey on Bottlenose Dolphins (*Tursiops truncatus*) in Upper Galveston Bay, TX. *Estuaries and Coasts* 43: 1013-1031. <https://doi.org/10.1007/s12237-020-00751-y>



# Site Fidelity Upper Galveston Bay

*Site Fidelity = tendency for an animal to reuse and return to an area*

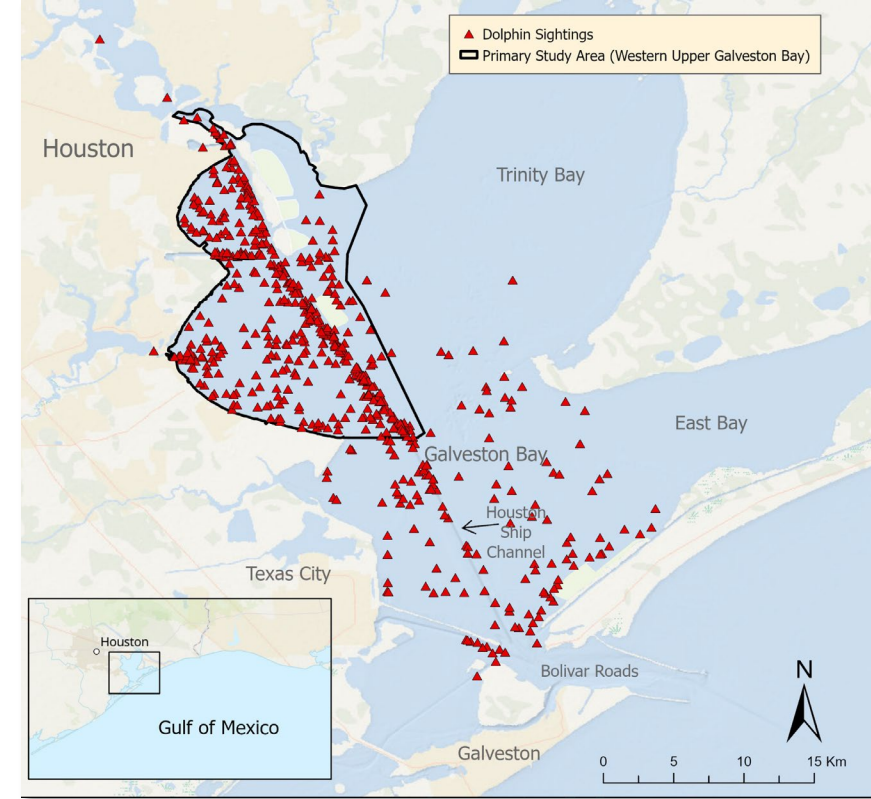
- Are there groups within the population with varying affinity to UGB?
- Is there a resident population of dolphins within UGB?

## Sighting Histories (2016-2019), 442 individuals

**Occurrence** -monthly sighting rate, indicating how frequently individuals use the study area.

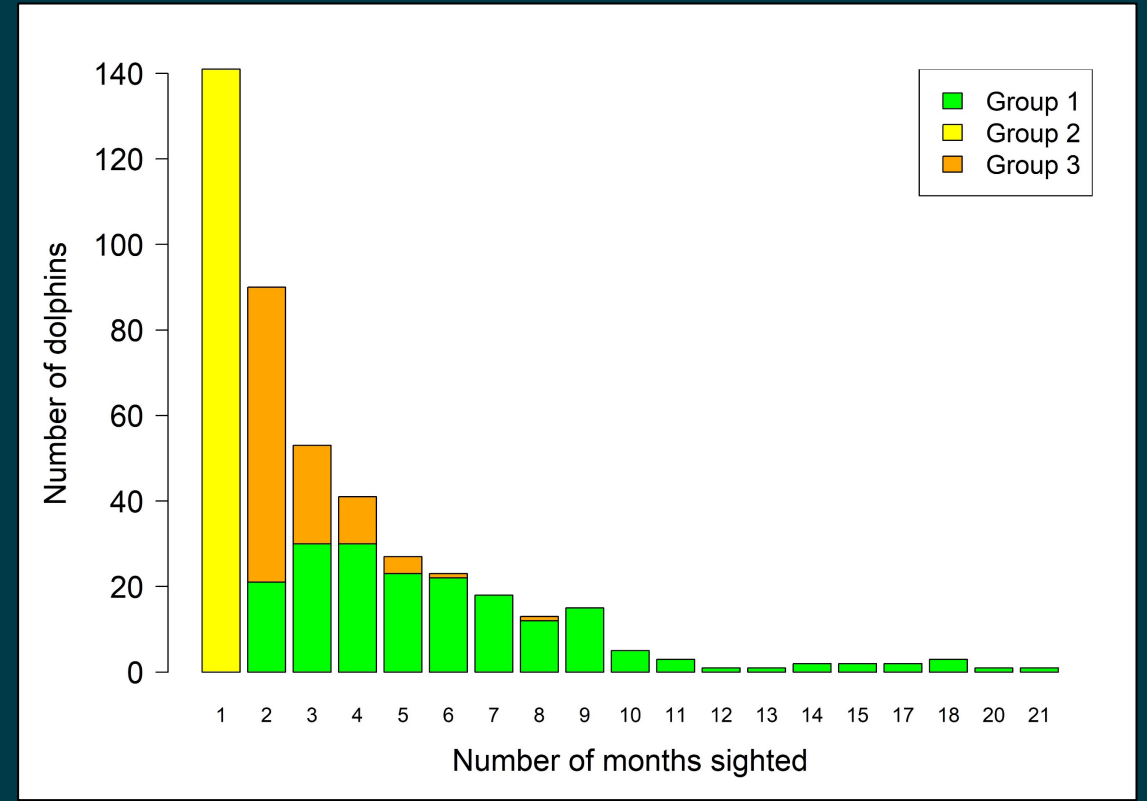
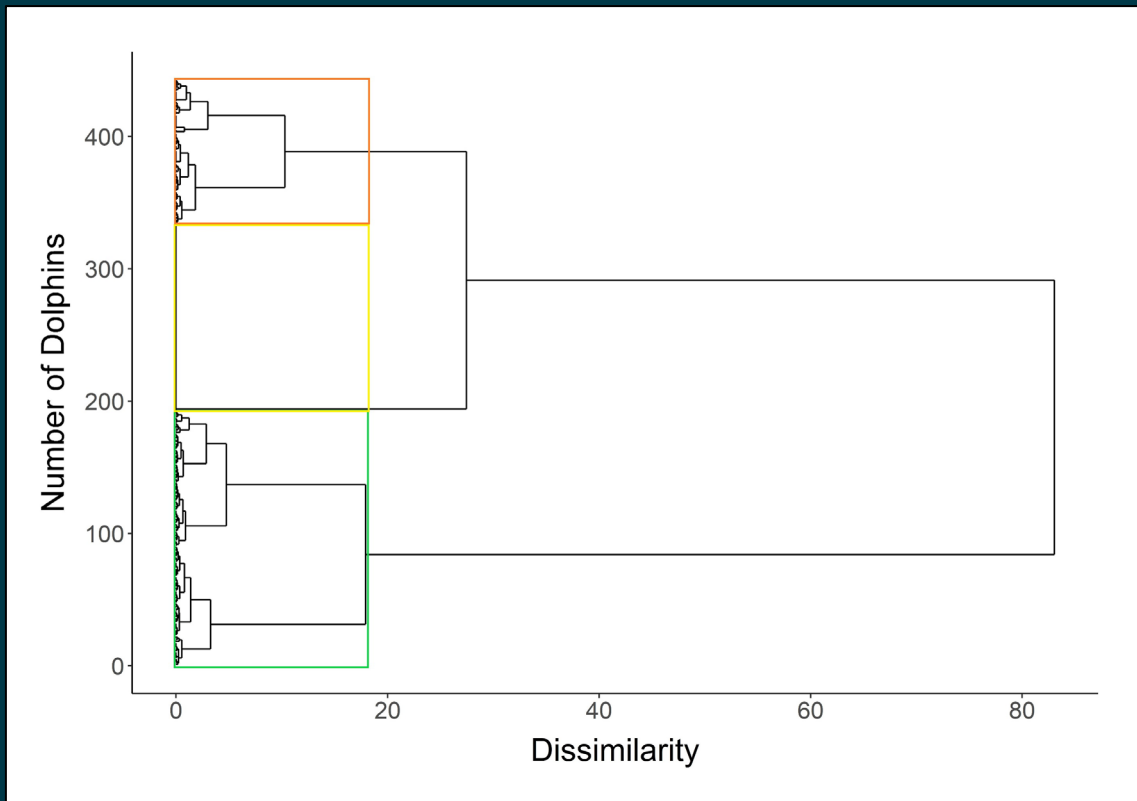
**Permanence** - indicates the total length of time an individual is known to have used the area

**Periodicity** - reoccurrence rate that can facilitate the comparison of individuals sighted over different time periods



CATALOGID	1	2	4	5	6
Jan (2016)	0	0	0	0	0
Feb (2016)	1	0	0	0	1
Mar (2016)	0	0	0	0	0
Apr (2016)	0	0	0	1	1
May (2016)	0	0	0	0	1
Jun (2016)	1	0	0	0	1
Jul (2016)	1	0	0	0	1
Aug (2016)	1	0	0	0	0
Sep (2016)	0	0	0	0	1
Oct (2016)	1	0	1	0	0





**Group 1 (n=192, 43%)**

Year-round residents

Seasonal recurring residents

**Group 2 (n=141, 32%)**

Transients/one-time

visitors

**Group 3 (n=109, 25%)**

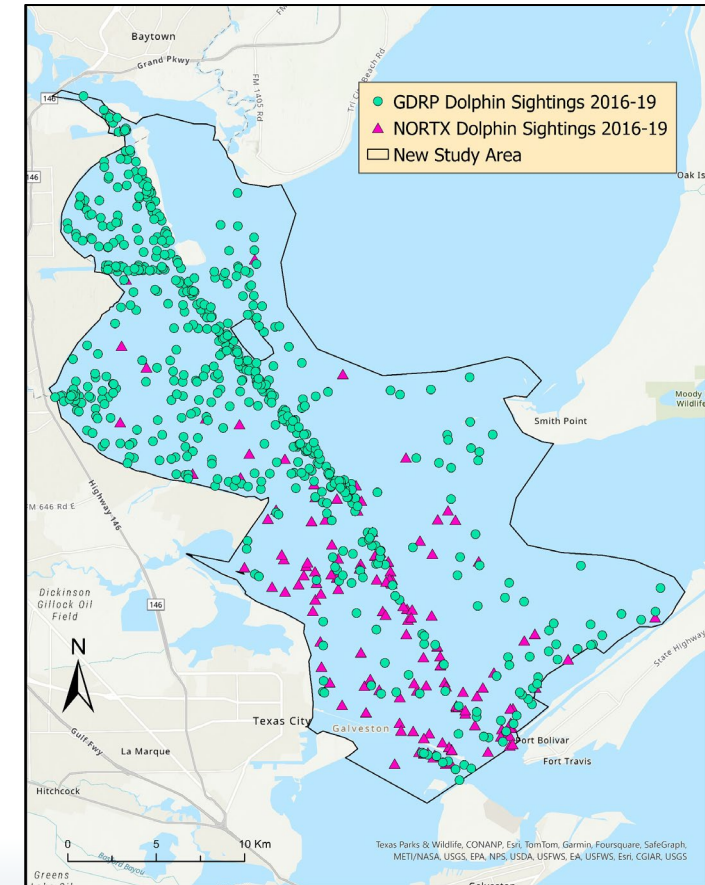
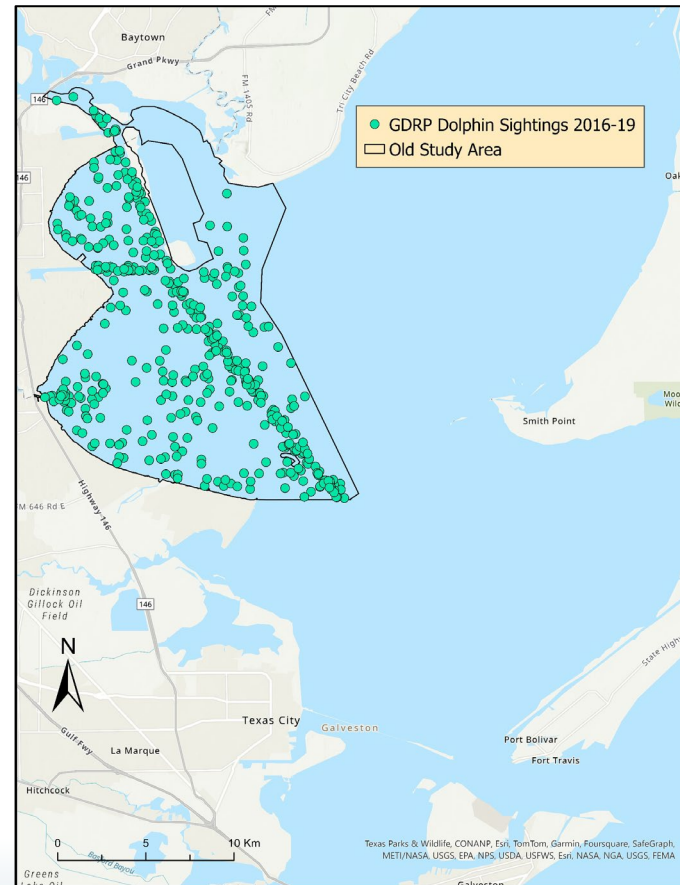
Short-term users



Mintzer, V. J., Quackenbush, A., & Fazioli, K. L. (2023). Site fidelity of common bottlenose dolphins (*Tursiops truncatus*) in a highly industrialized area of the Galveston Bay estuary. *Marine Mammal Science*, 1– 18.

Some individuals may have affinities for different parts of the bay – potentially related to sex, life stage; maternal range (natal philopatry) or social networks

**Next step – Include collaborative data to expand the study area**





**The Gulf of Mexico Dolphin Identification System**



# Human Interaction

- Dolphins are found in high density in the Houston Ship Channel
- Interacting with a human platform (boat, buoy, dock, fishing gear, etc.) in **51%** of sightings (2014-2025)
- **24%** specifically interacting with Trawlers



NMFS Permit#1888



# Trawler Foraging

Upper Bay only (2015-2017)

69% of observed foraging behavior occurs in association with a shrimp trawler

Entire Study area (2014-2025)

45% of observed foraging behavior occurs in association with a shrimp trawler

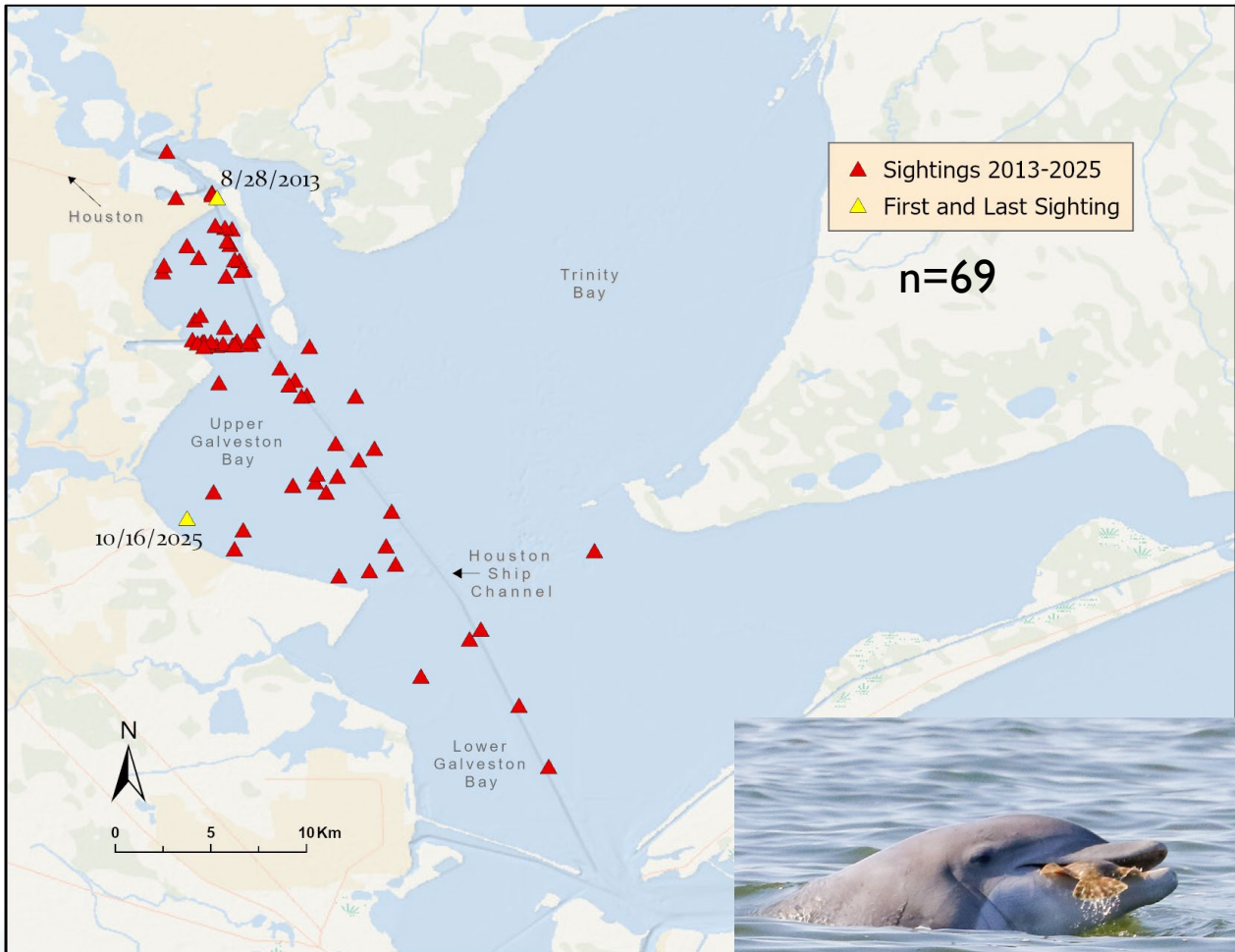
**How many residents have been seen foraging associated with a trawler?**

- 162 High site fidelity individuals (Group I) sighted at least 9 times

**ALL of them**



# Residency, ranging patterns and life history data bring context and meaning to other projects



## ID #1 (“Squirt”) - Male

2013 First Sighting ~Age 4

2016 Biopsy sample ~Age 8

$\Sigma 45\text{PCBs} = 110,714 \text{ ng/g lipid}$

Formed alliance with ID #81

2017 Biopsy sample ~Age 9

$\Sigma 45\text{PCBs} = 141,666 \text{ ng/g lipid}$

2021 Alliance partner disappeared

2026 ~Age 17



[www.galvestonbaydolphin.org](http://www.galvestonbaydolphin.org)



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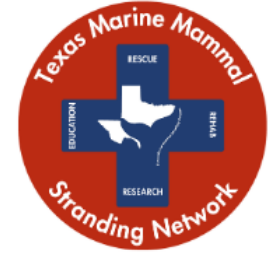
SARASOTA DOLPHIN  
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PROTECT TODAY. PRESERVE TOMORROW.

Galveston Bay's Urban Bottlenose Dolphins

# **Common bottlenose dolphins (*Tursiops truncatus*) as bioindicators of inorganic chemical pollution along the Galveston Coast**

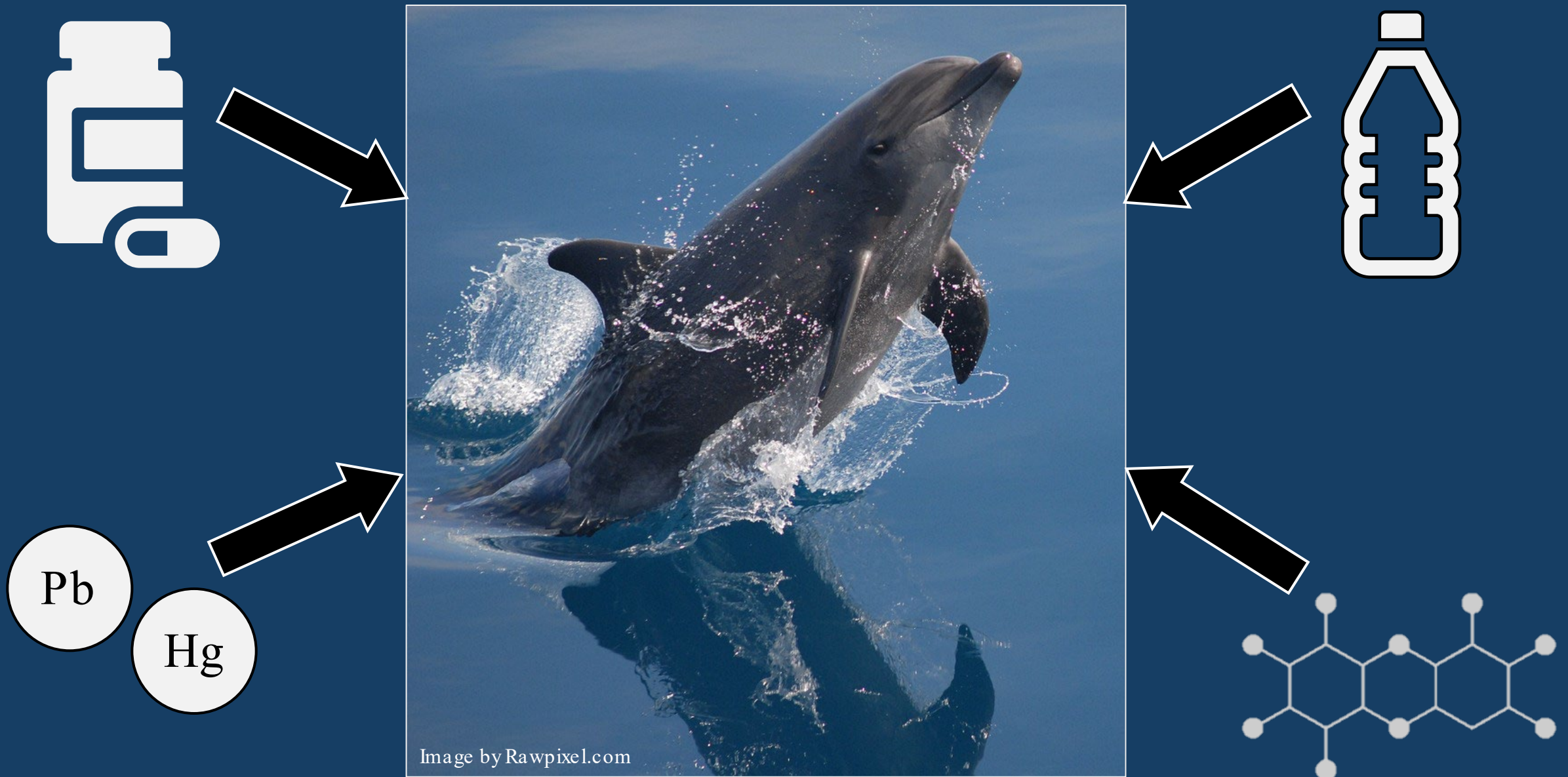
Madison Hallmark<sup>1</sup>, Kyra Kaiser<sup>1</sup>, Jamie Larson<sup>1</sup>, Heidi Whitehead<sup>2</sup>, Ioana E. Pavel<sup>1</sup>, and Dara N. Orbach<sup>1</sup>

<sup>1</sup>Department of Life Science- Texas A&M University – Corpus Christi, Texas

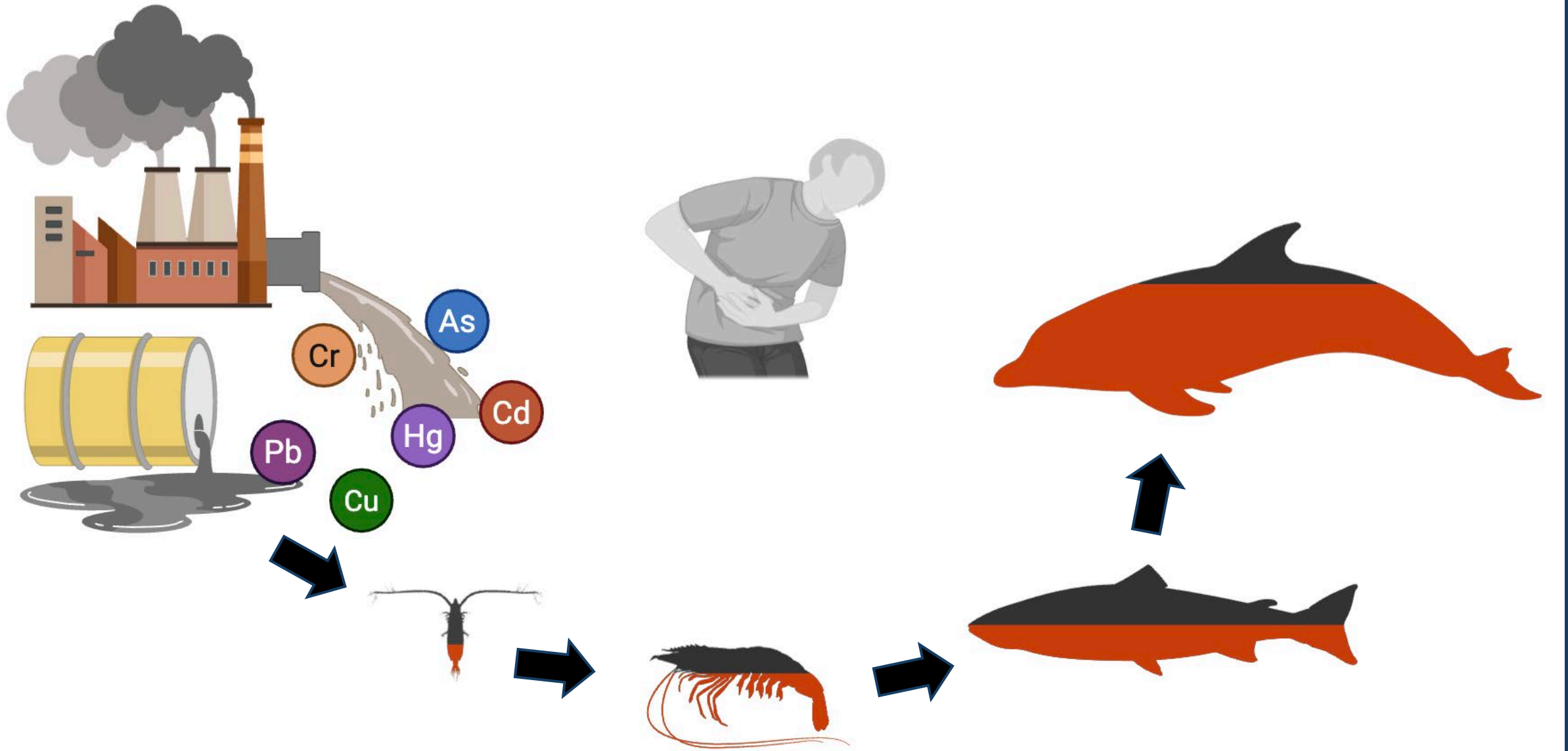
<sup>2</sup>Texas Marine Mammal Stranding Network, Galveston, Texas



# Dolphins as Bioindicators



# Contaminant Exposure



# Galveston Bay & Coastline



Image by James Dillard



Image by JRH Engineering

# U.S. Environmental Protection Agency

## EPA National Primary Drinking Water Regulations

<i>Contaminant</i>	<b>MCLG</b> ( $\mu\text{g L}^{-1}$ )	<b>MCL</b> ( $\mu\text{g L}^{-1}$ )	<b>Human Health Impacts</b>
<i>Antimony (Sb)</i>	6	6	Increase blood cholesterol
<i>Arsenic (As)</i>	0	10	Increase risk of cancer
<i>Barium (Ba)</i>	2000	2000	Increase blood pressure
<i>Beryllium (Be)</i>	4	4	Intestinal lesions
<i>Cadmium (Cd)</i>	5	5	Kidney damage
<i>Chromium (Cr)</i>	100	100	Allergic dermatitis
<i>Copper (Cu)</i>	1300	1300	Liver or kidney damage
<i>Lead (Pb)</i>	0	10	Neurological issues
<i>Mercury (Hg)</i>	2	2	Kidney damage
<i>Selenium (Se)</i>	50	50	Circulatory issues
<i>Thallium (Tl)</i>	0.5	2	Kidney, Intestinal, or liver issues

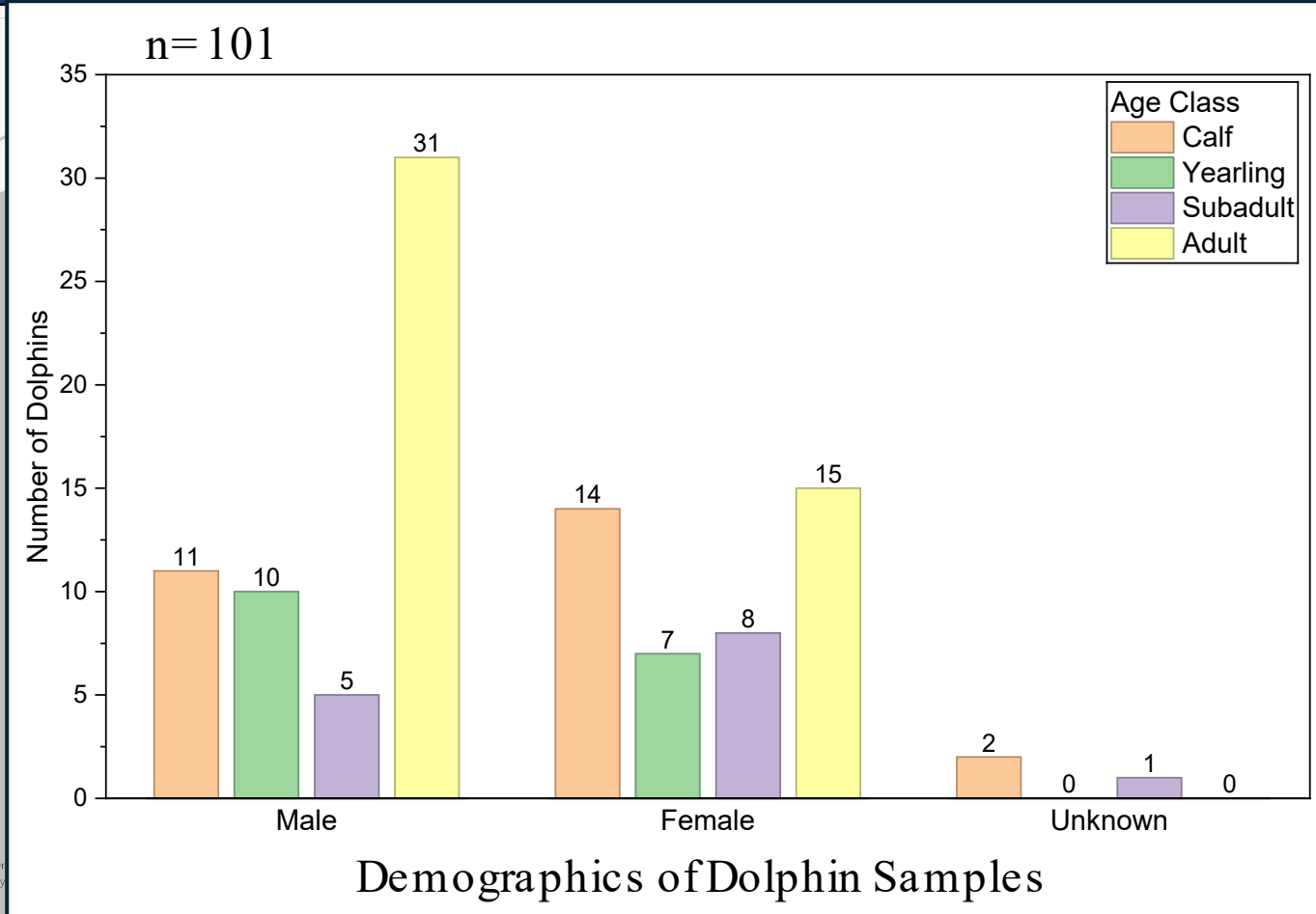
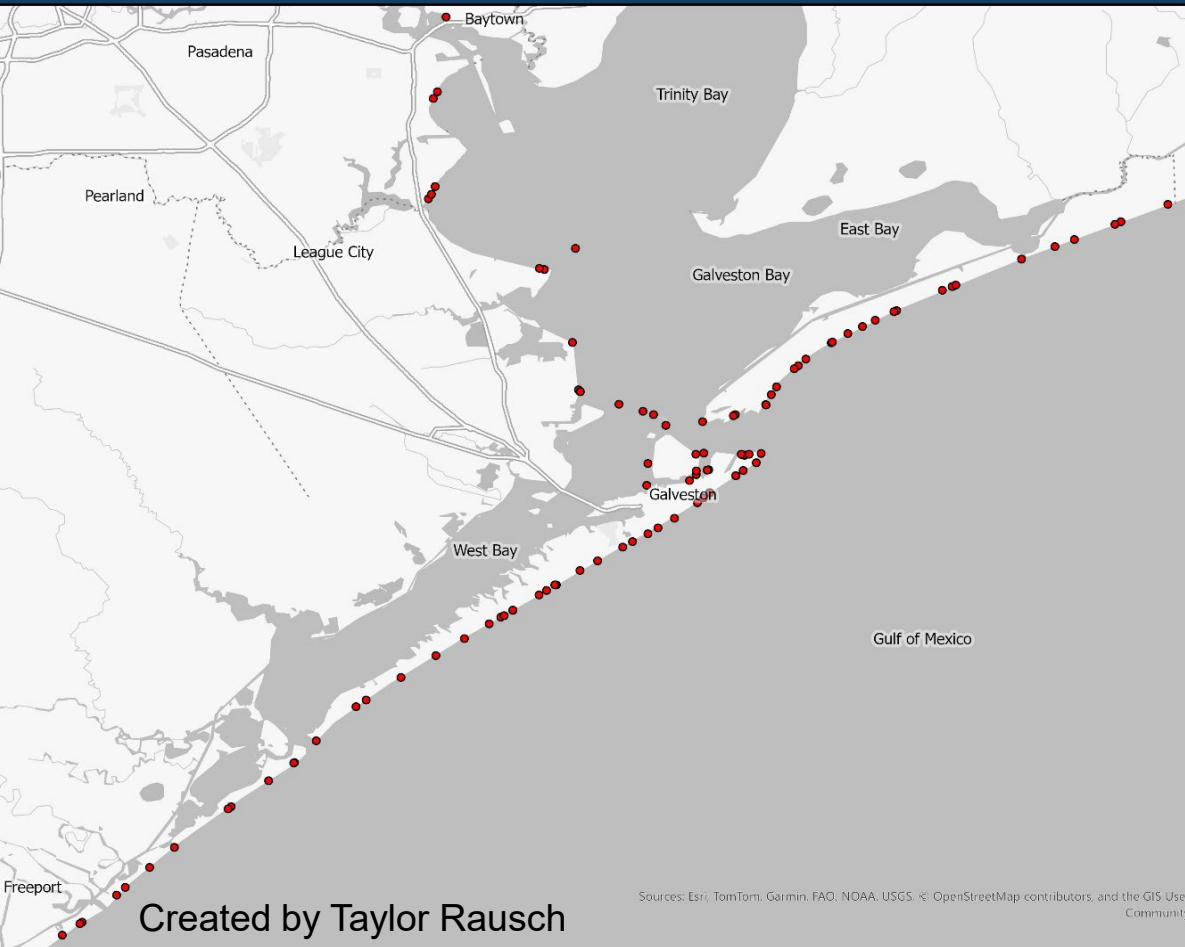


MCGL– Maximum Contamination Level Goal  
MCL– Maximum Contamination Level

## Research Goal

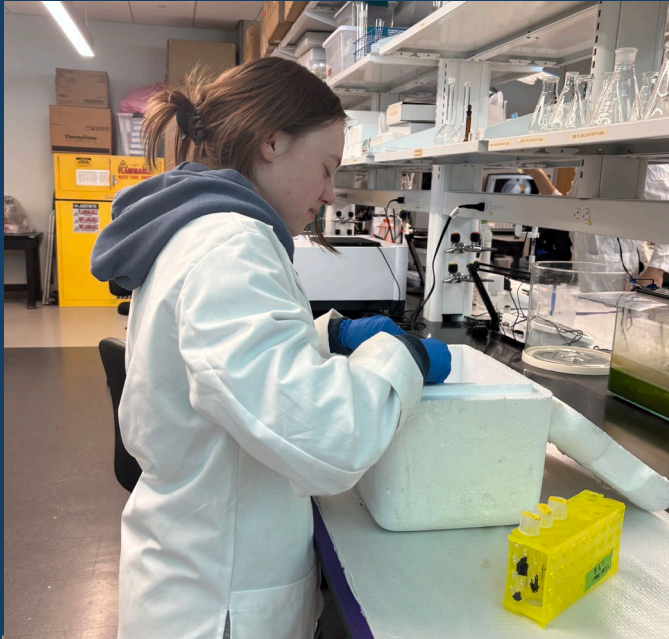
- **Detect and quantify** bioaccumulation of inorganic chemical pollutants in skin of post-mortem dolphins (n = 104) recovered along the upper Texas coast.

# Sample Collection



# Sample Preparation

Skin Extraction



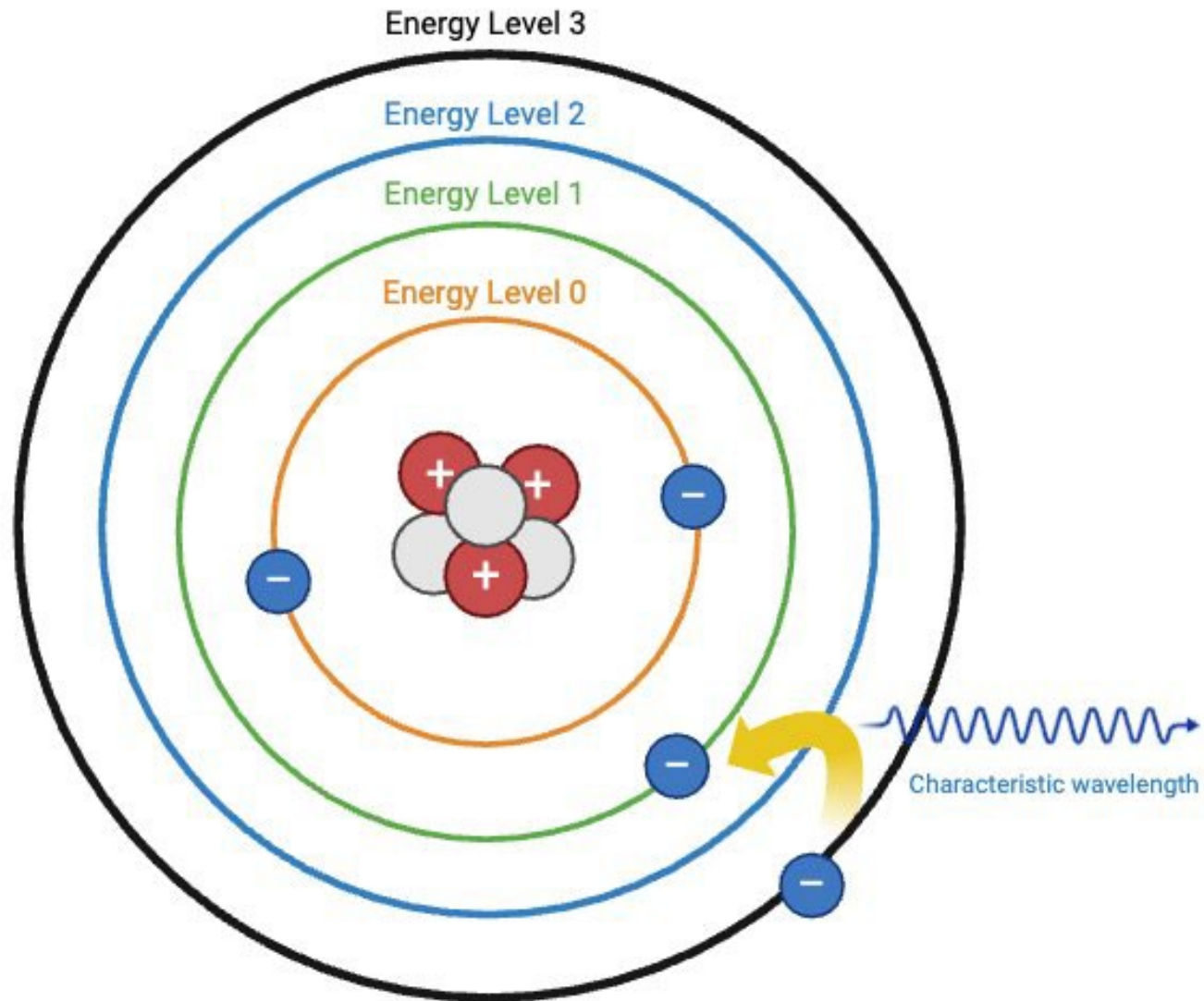
Dehydration



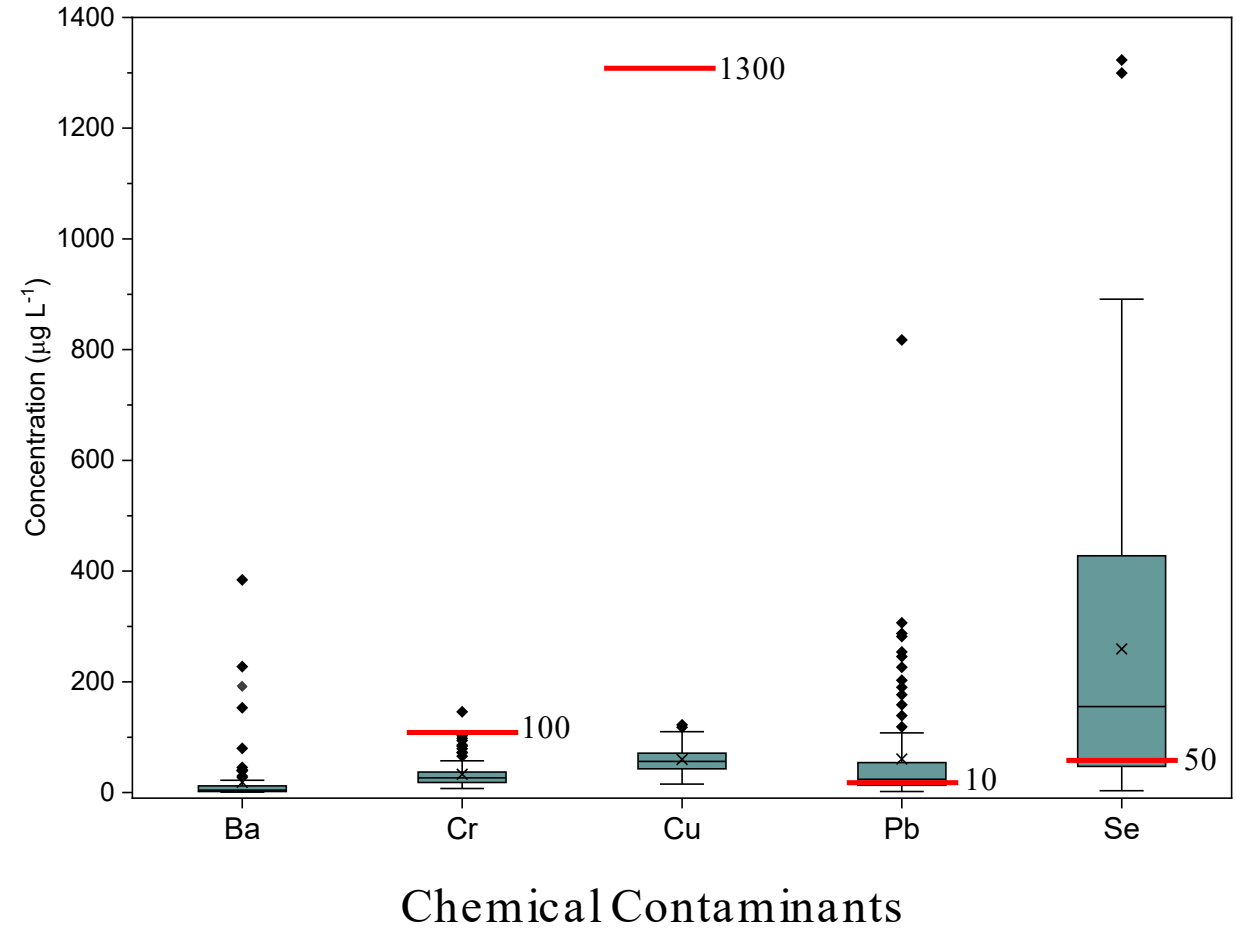
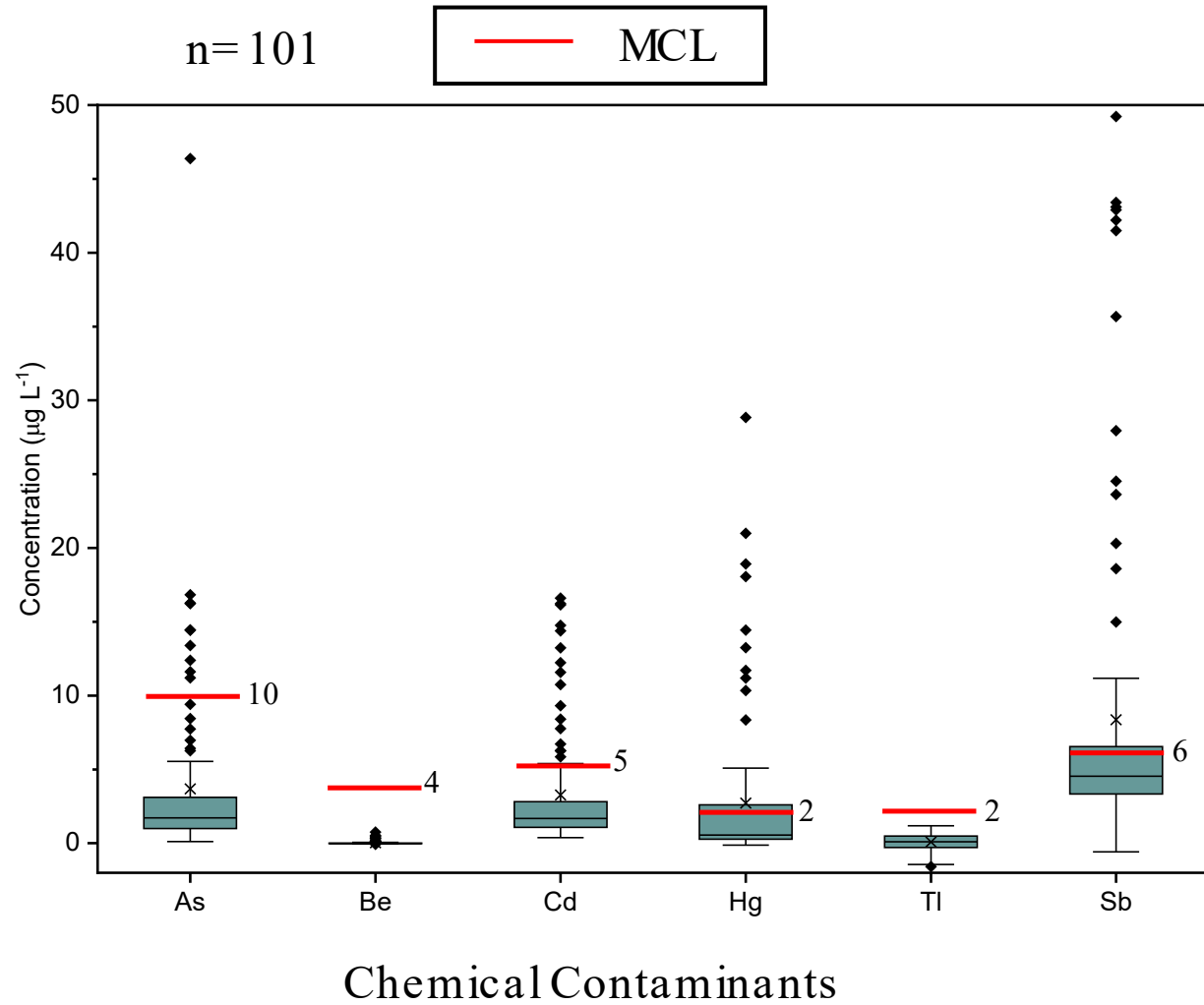
Closed Vessel Acid Digestion & Dilution



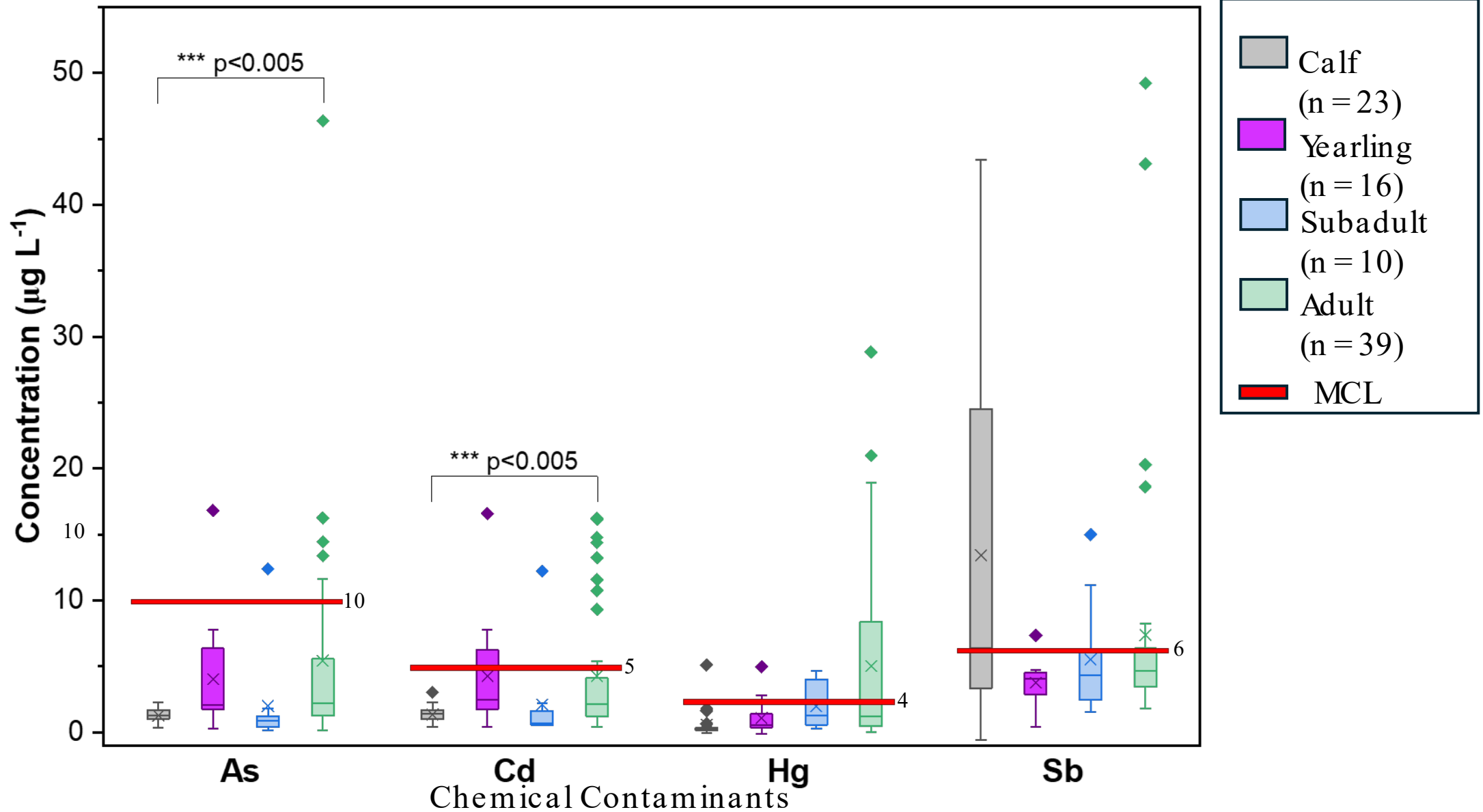
# Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES)



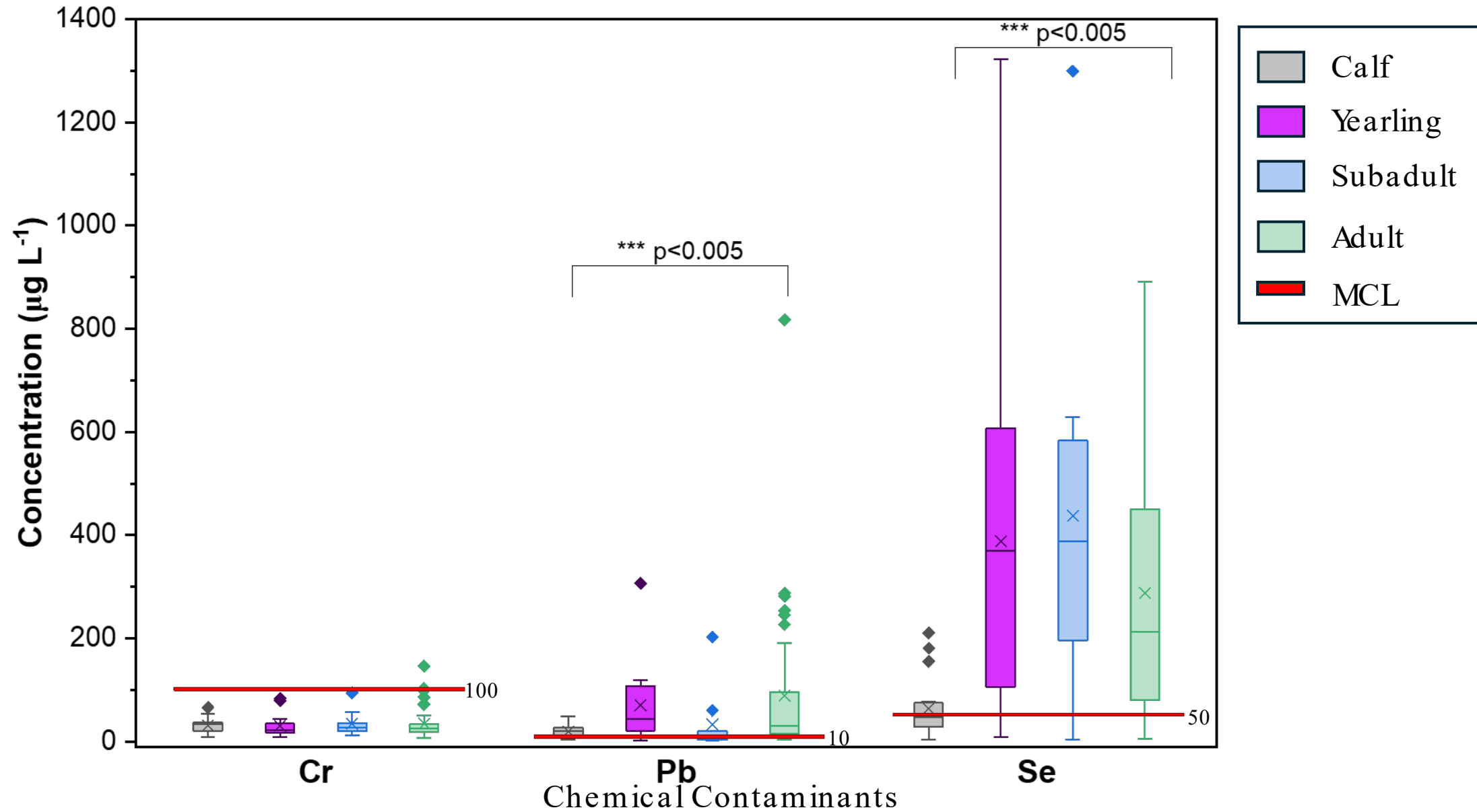
# Results



# Results



# Results

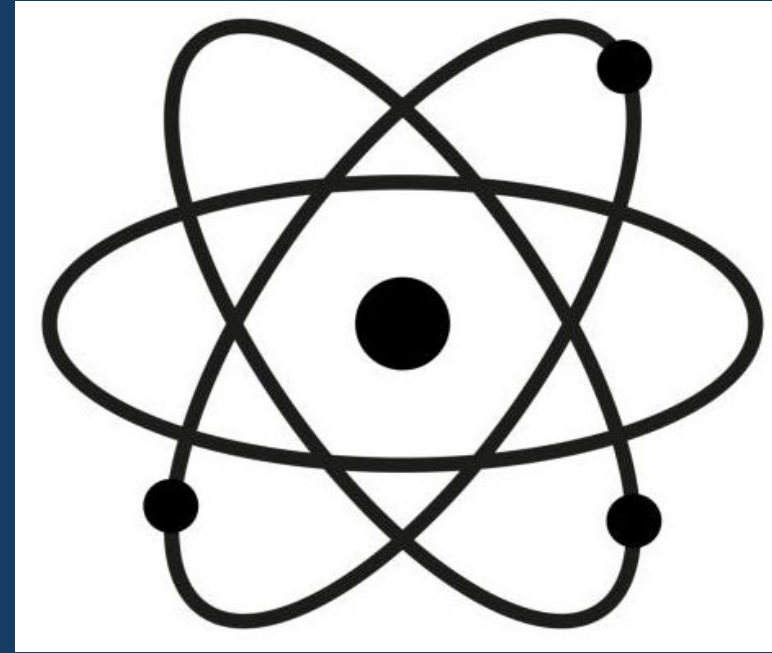
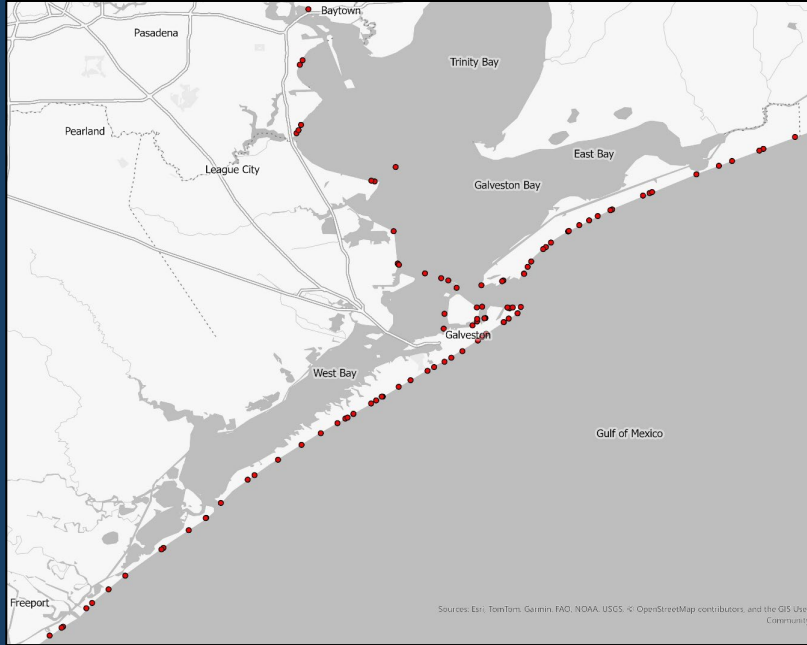


# Summary

<i>Contaminant</i>	<b>MCLG</b> ( $\mu\text{g L}^{-1}$ )	<b>MCL</b> ( $\mu\text{g L}^{-1}$ )	<b>Human Health Impacts</b>
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<i>Thallium (Tl)</i>	0.5	2	Kidney, Intestinal, or liver issues

Contaminants of concern

# Future Directions



**GALVESTON BAY**  
**DOLPHIN RESEARCH PROGRAM**  
AN ENVIRONMENTAL INSTITUTE OF HOUSTON  
AND GALVESTON BAY FOUNDATION PROGRAM



# Acknowledgements

- Dr. Pavel's lab
- Taylor Rausch



# External Calibration Curve

## Group 1

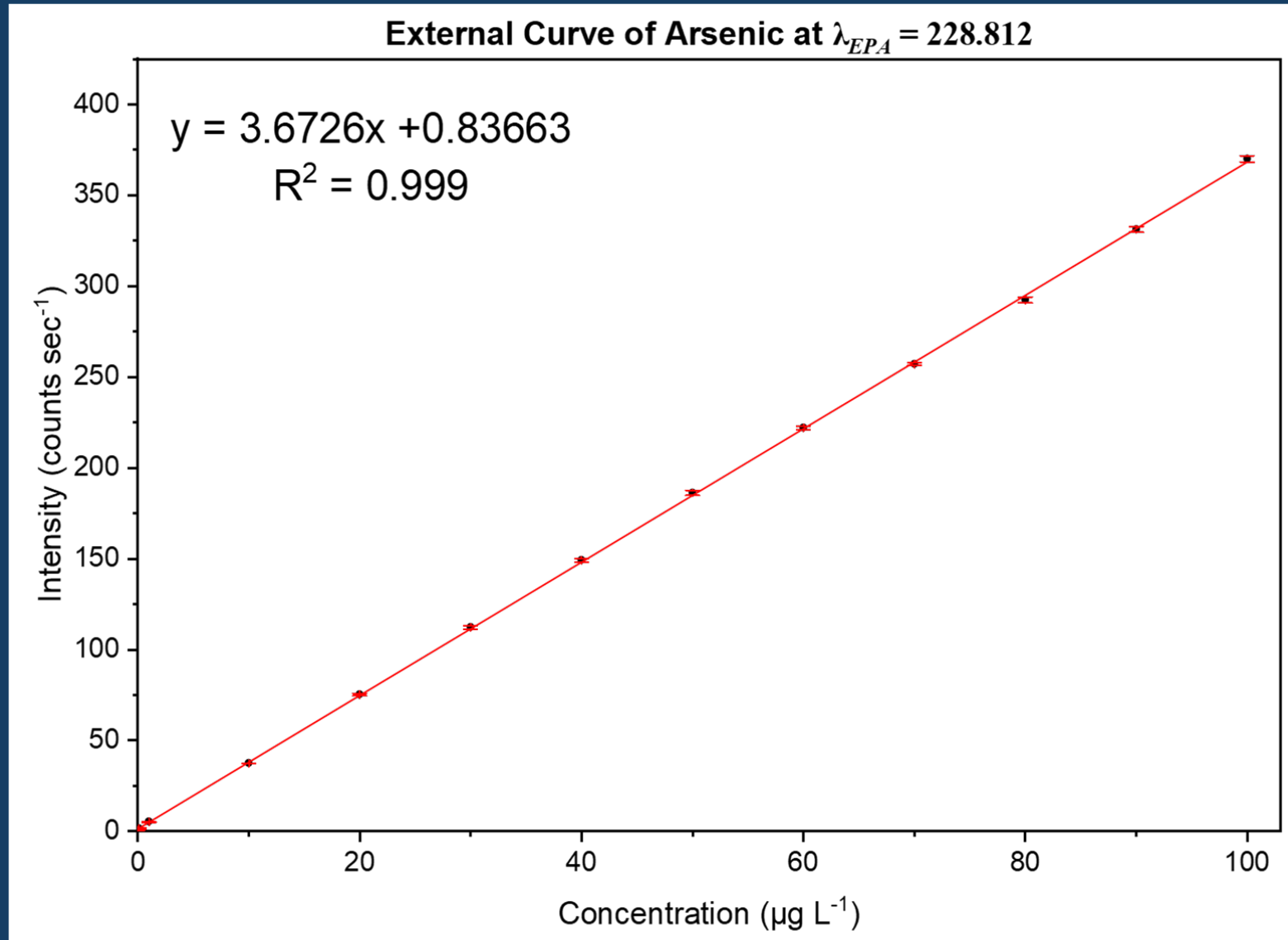
- As, Ba, Cd, Cu, Sb, Se

## Group 2

- Cr, Hg

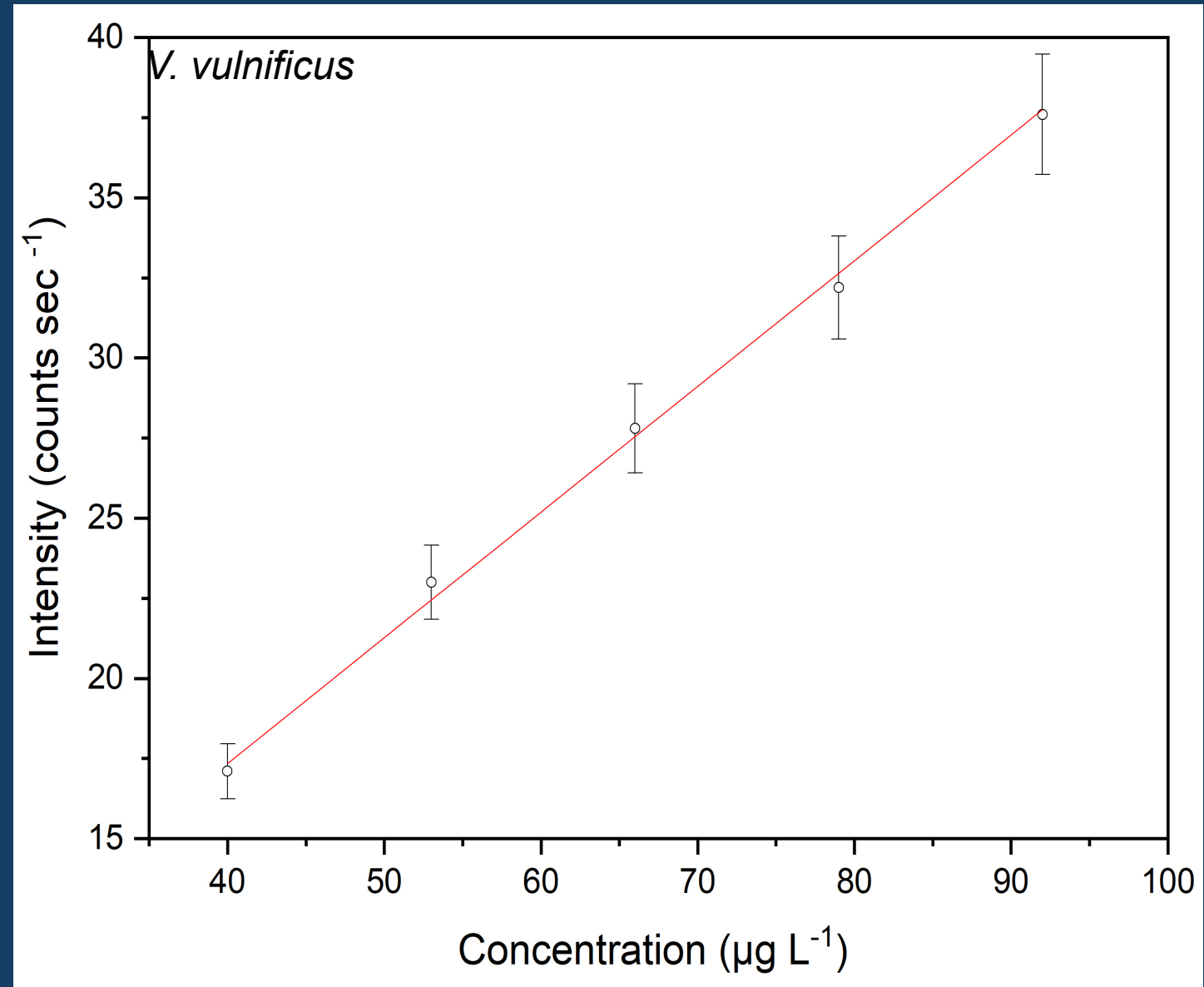
## Group 3

- Be, Pb, Tl

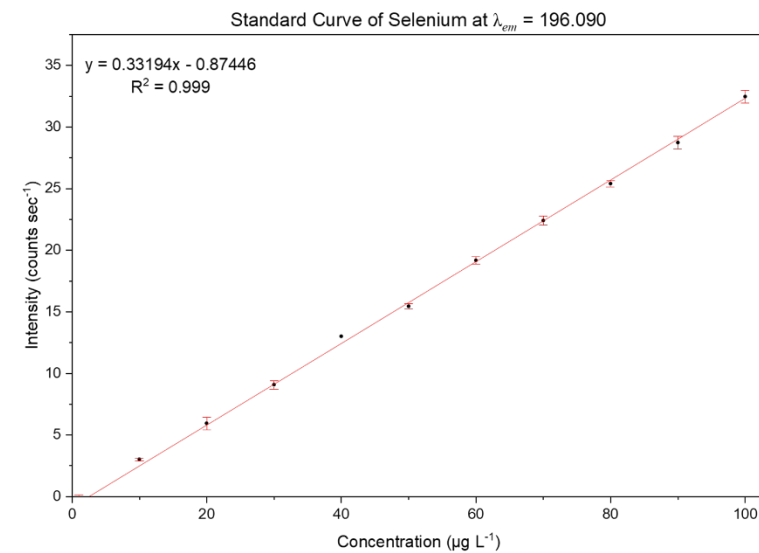
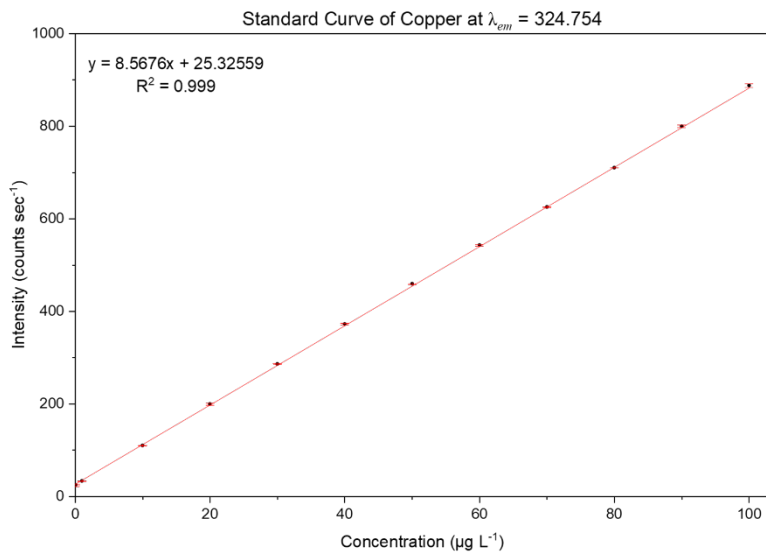
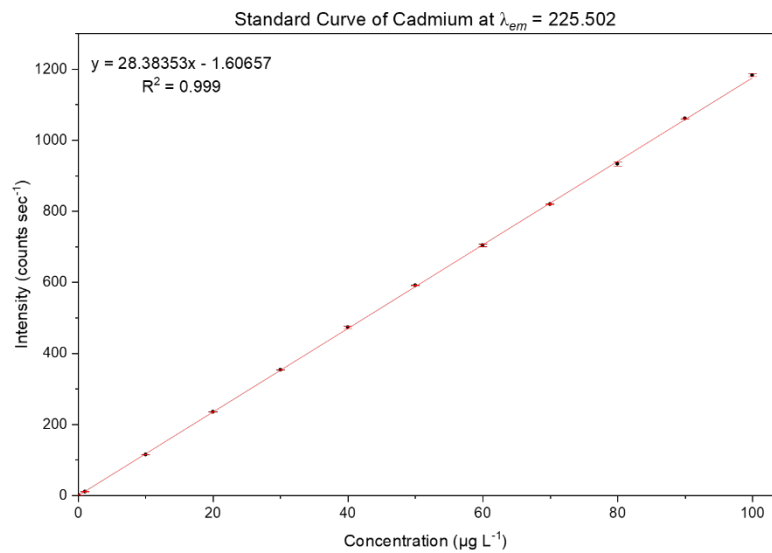
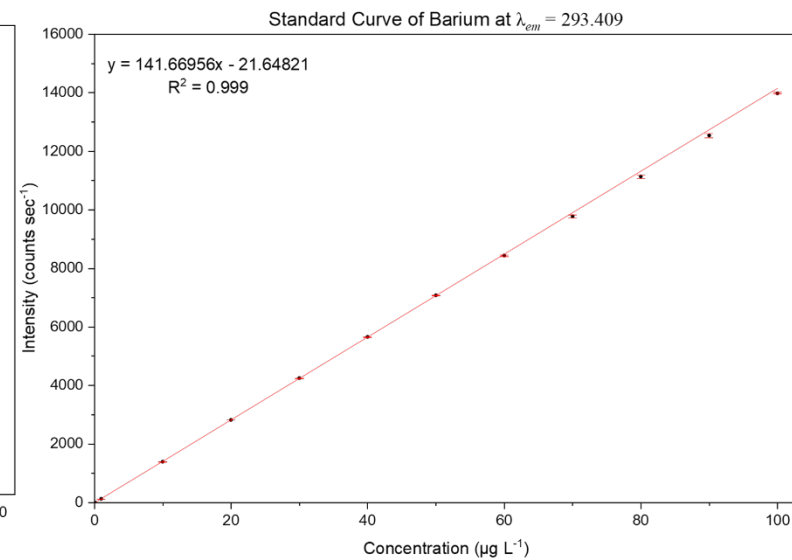
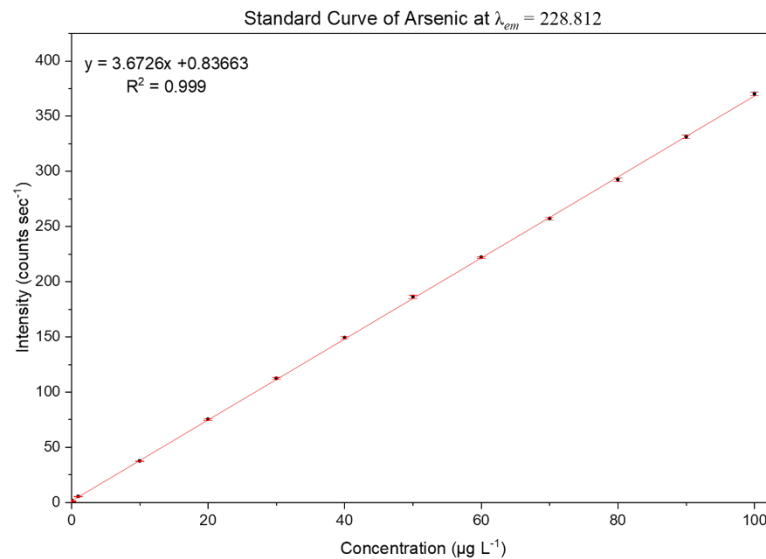
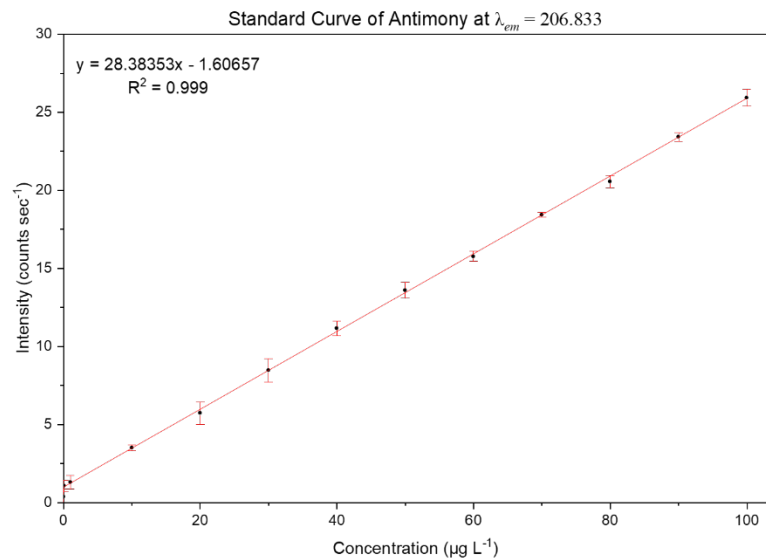


# Method Validation

- Linear dynamic range
- 4 laboratory blanks
- Standard addition method
- Quality control sample

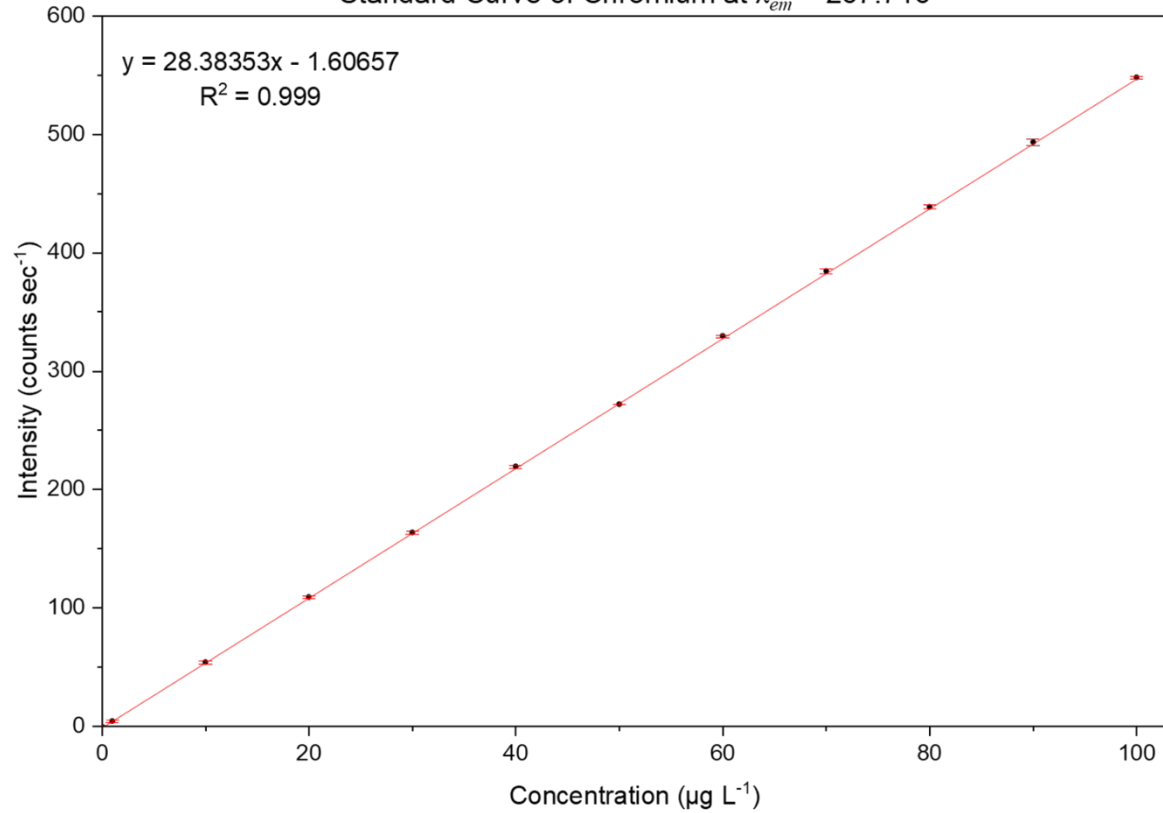


# Supplementary

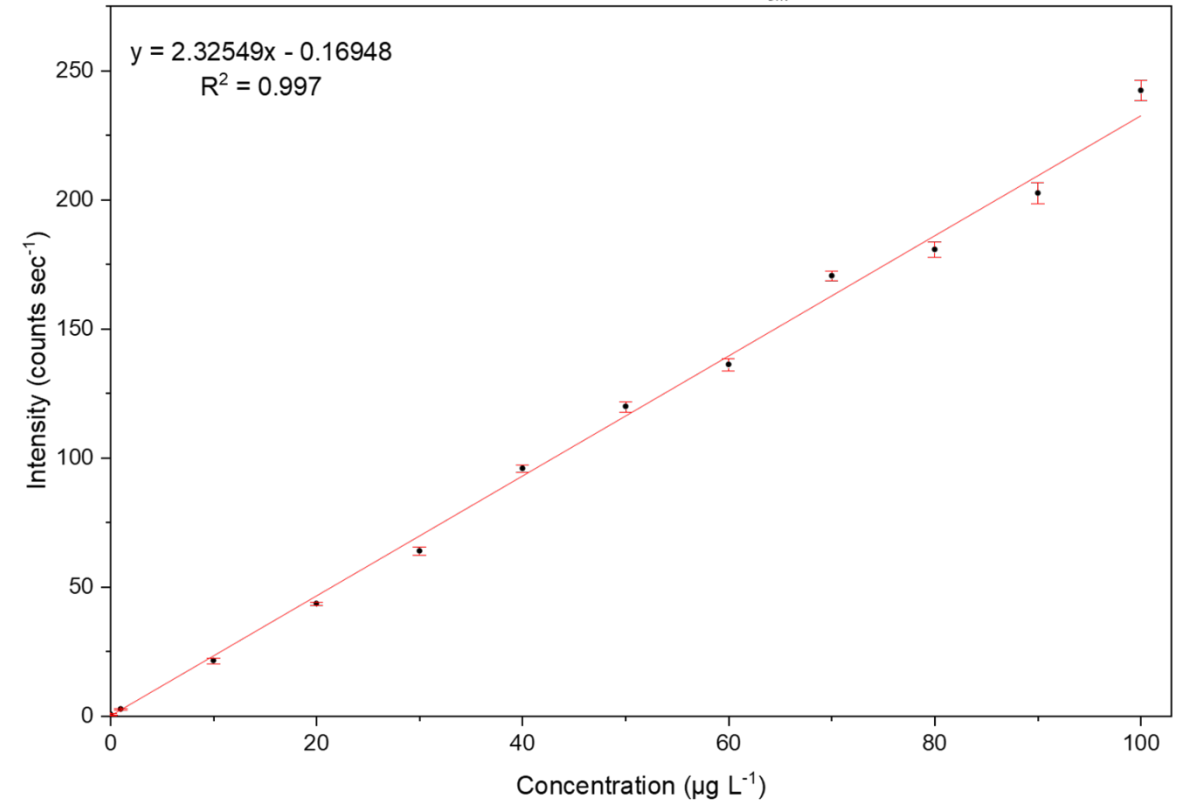


# Supplementary

Standard Curve of Chromium at  $\lambda_{em} = 267.716$

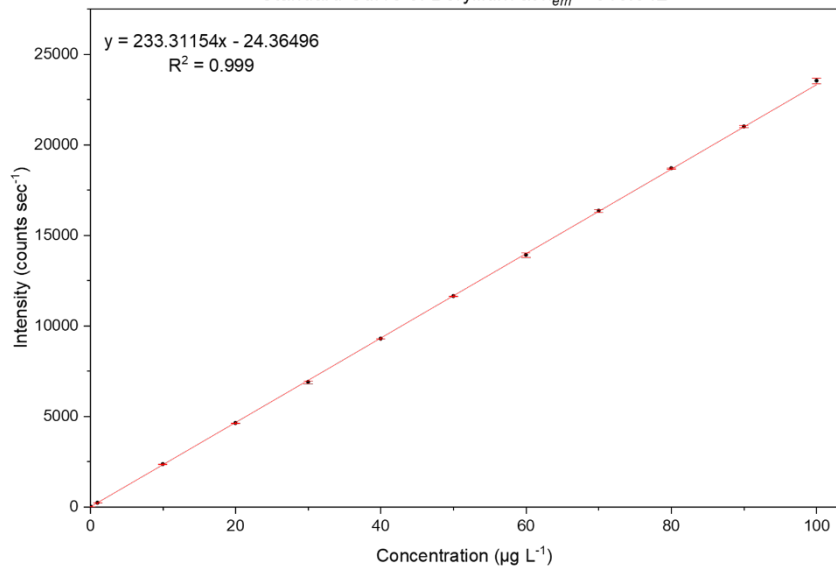


Standard Curve of Mercury at  $\lambda_{em} = 194.227$

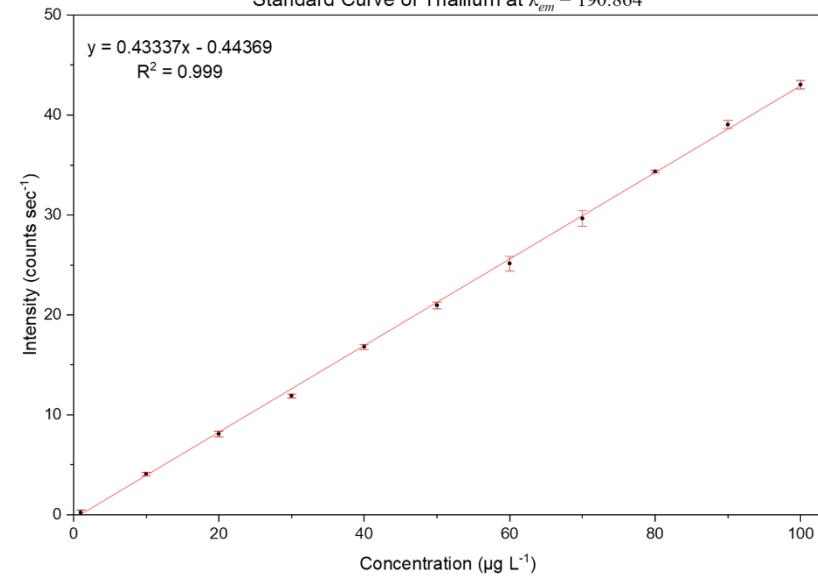


# Supplementary

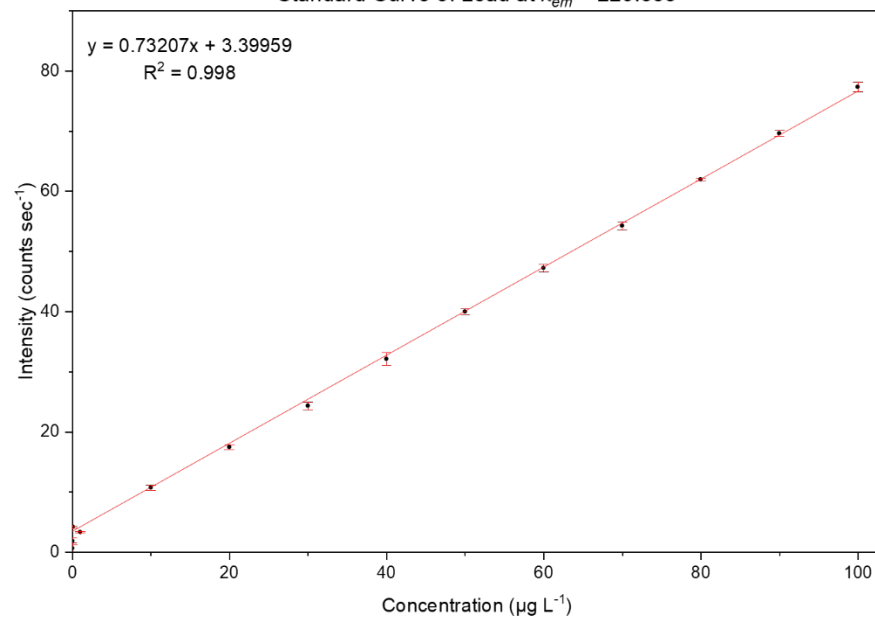
Standard Curve of Beryllium at  $\lambda_{em} = 313.042$



Standard Curve of Thallium at  $\lambda_{em} = 190.864$

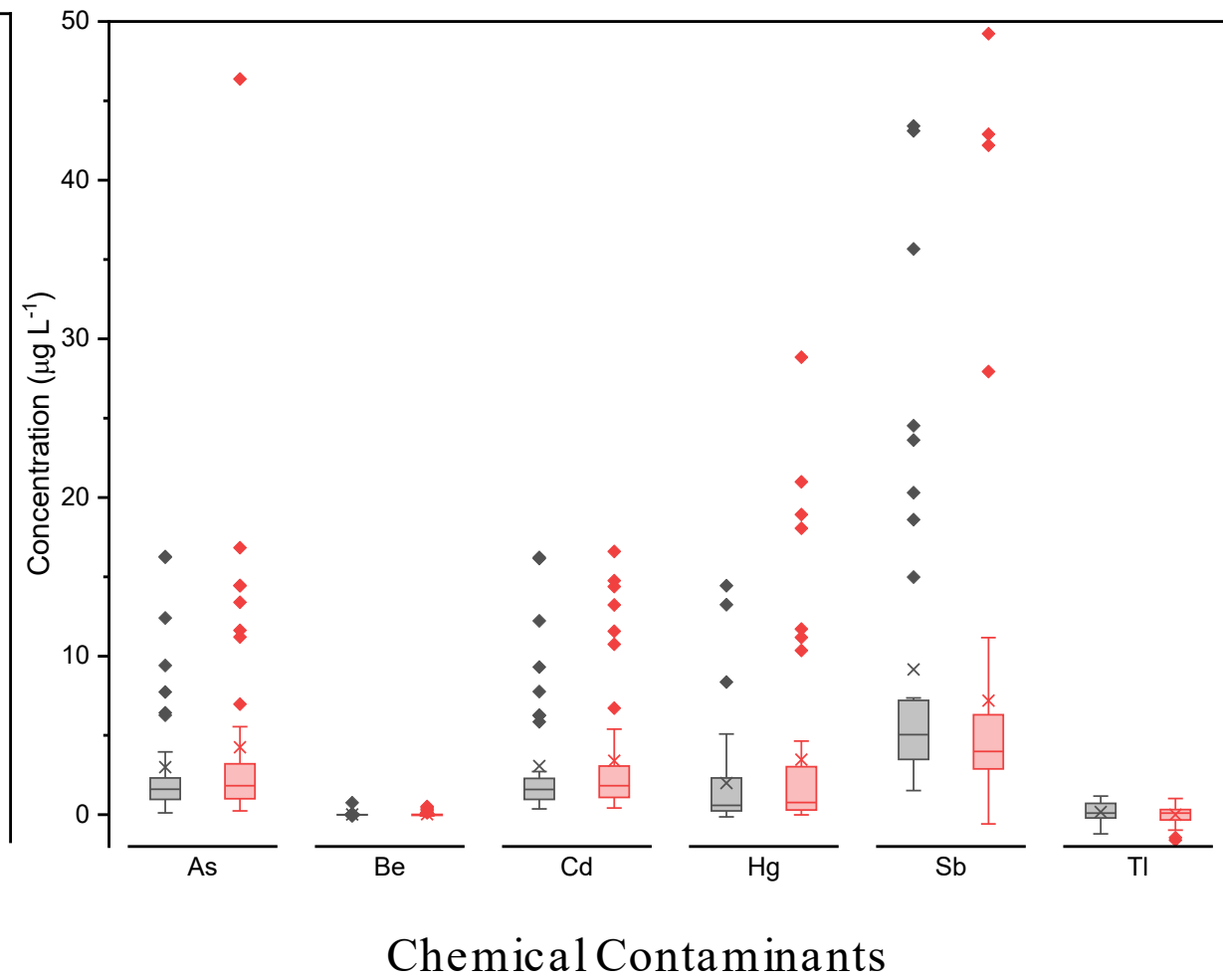
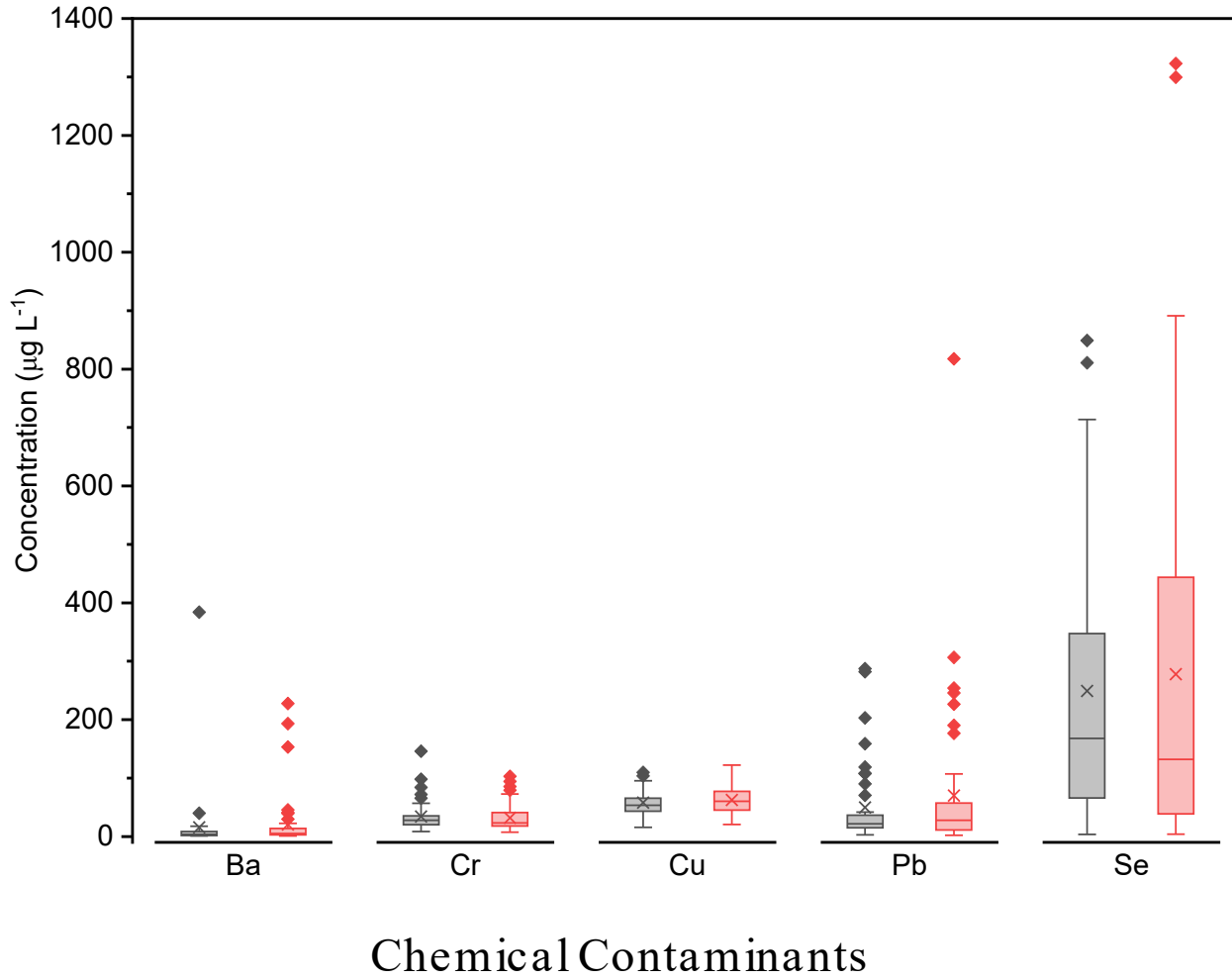


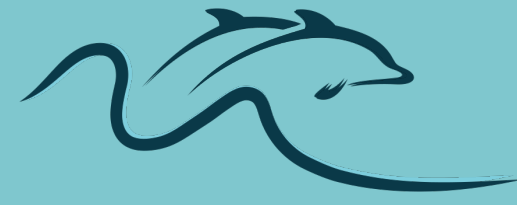
Standard Curve of Lead at  $\lambda_{em} = 220.353$



# Results

Female (n = 41)    Male (n = 60)



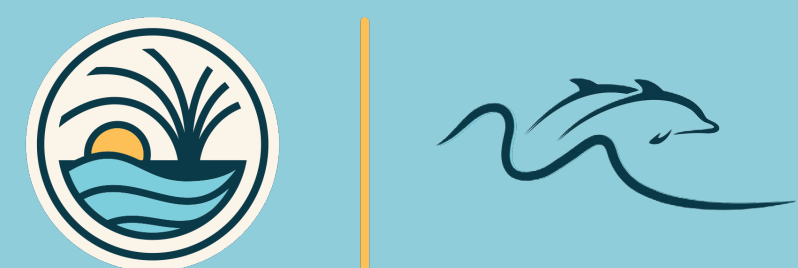
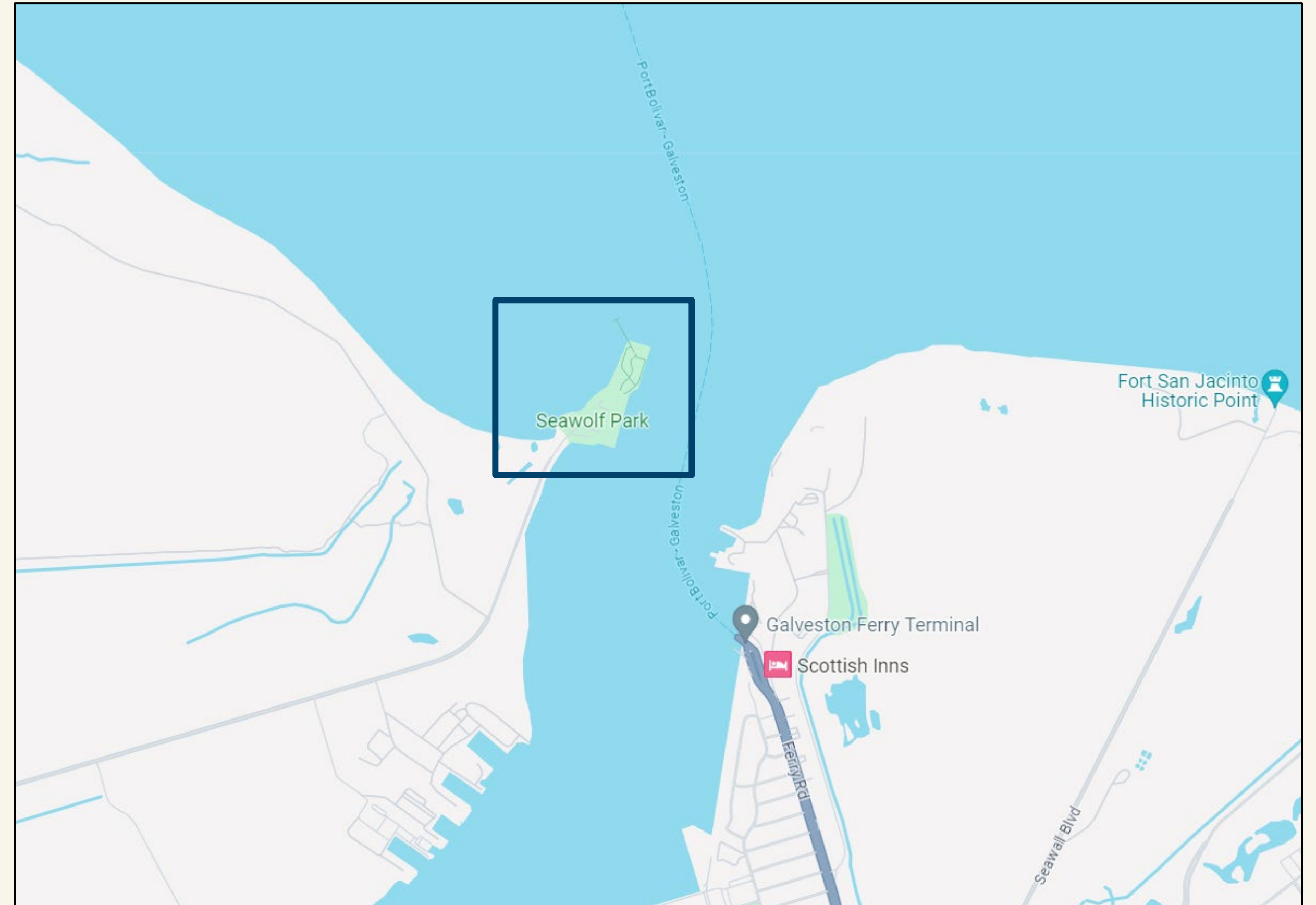


**GALVESTON BAY**  
DOLPHIN RESEARCH PROGRAM

Land-based dolphin surveys  
conducted by citizen scientists:  
What we have learned about  
dolphin-fisher interactions at  
Sea wolf Park

*Alyssa Quackenbush, Kristi Fazioli, Elisa O'Neal,  
Sherah McDaniel, & Vanessa Mintzer*

# Seawolf Park, Galveston Island



# Why Sea wolf Park?



Fishing line debris



Educate



Popular fishing spot



Dolphins "patrol" fishers

Sea wolf Park Station



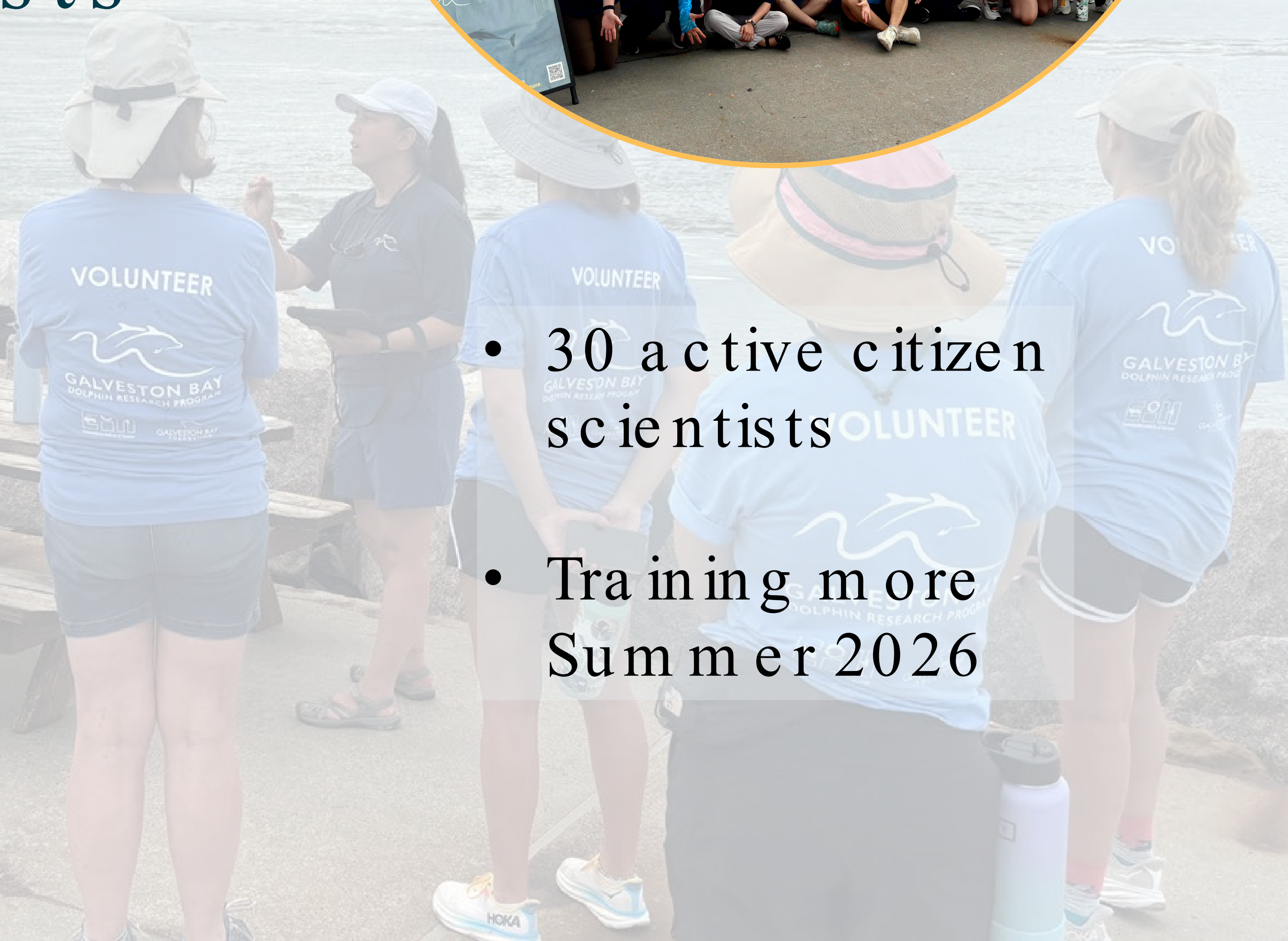
Community involvement



# Sea wolf Station Volunteer Citizen Scientists



- 30 active citizen scientists
- Training more Summer 2026



# Objectives



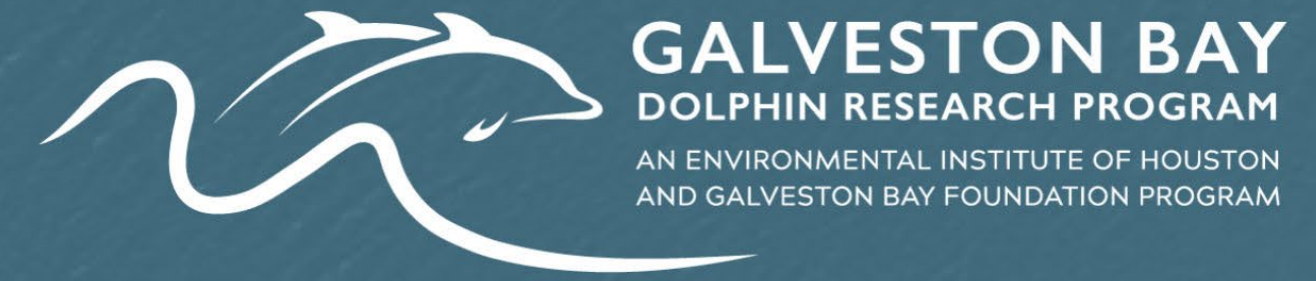
1. Observe how dolphins use the habitat around the park
2. Gather information about threats that affect dolphins
3. Quantify interactions between dolphins and humans



# Methods

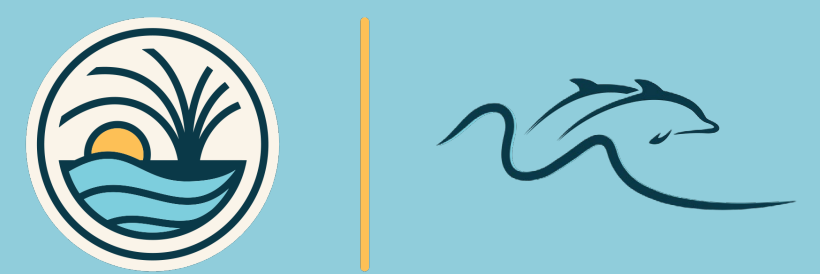
- Photographer & Data Collector look for dolphins
- 2 volunteers collect hourly point sampling data
- Engage with fishers

## Seawolf Park, Galveston TX Land-based dolphin survey station

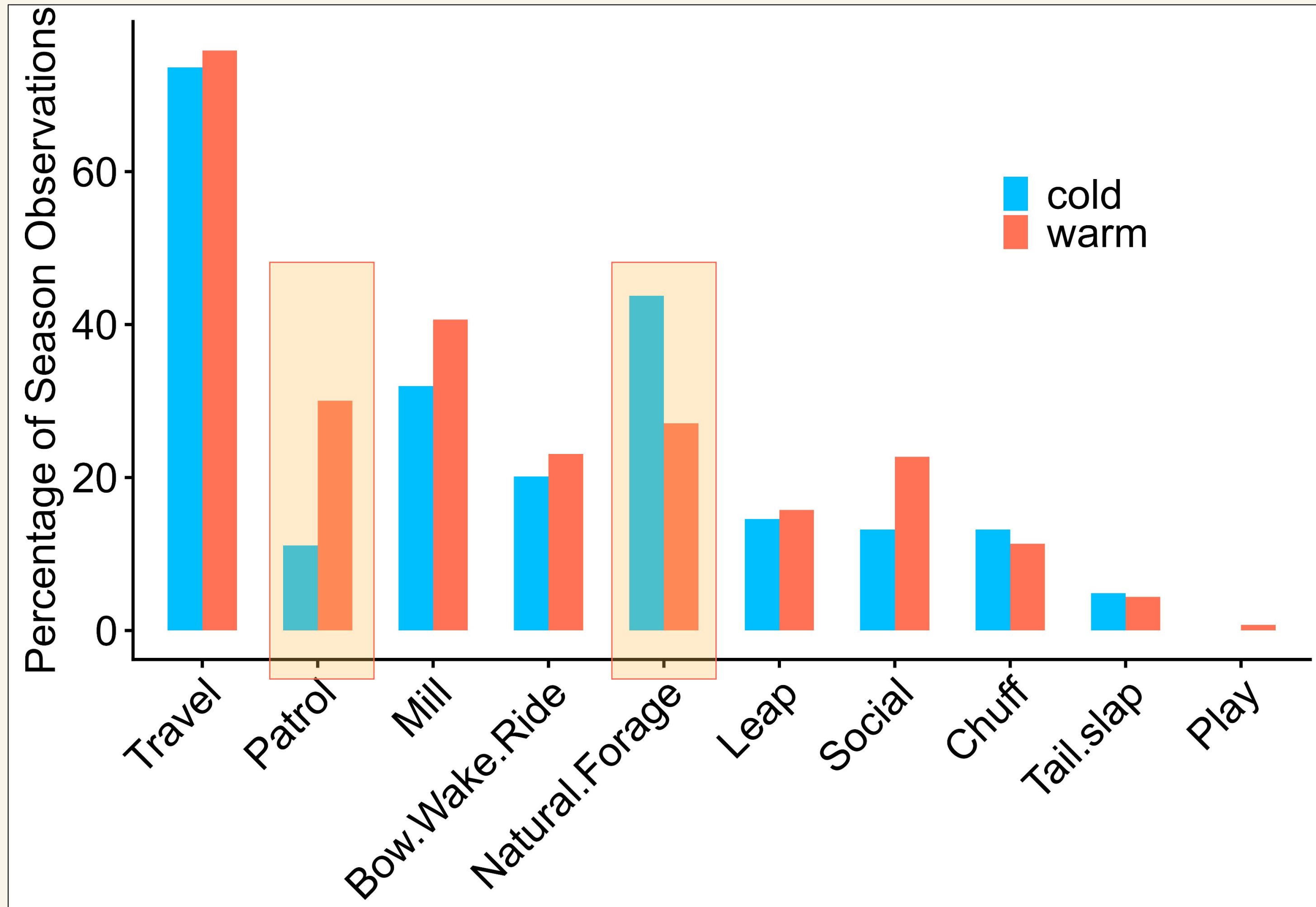




- Completed 113 shifts
- Engaged with 1265 park visitors/ fishers
- 357 hours of survey effort
- Sighted 1492\* total dolphins  
\*not number of individual dolphins



# Dolphin Behaviors

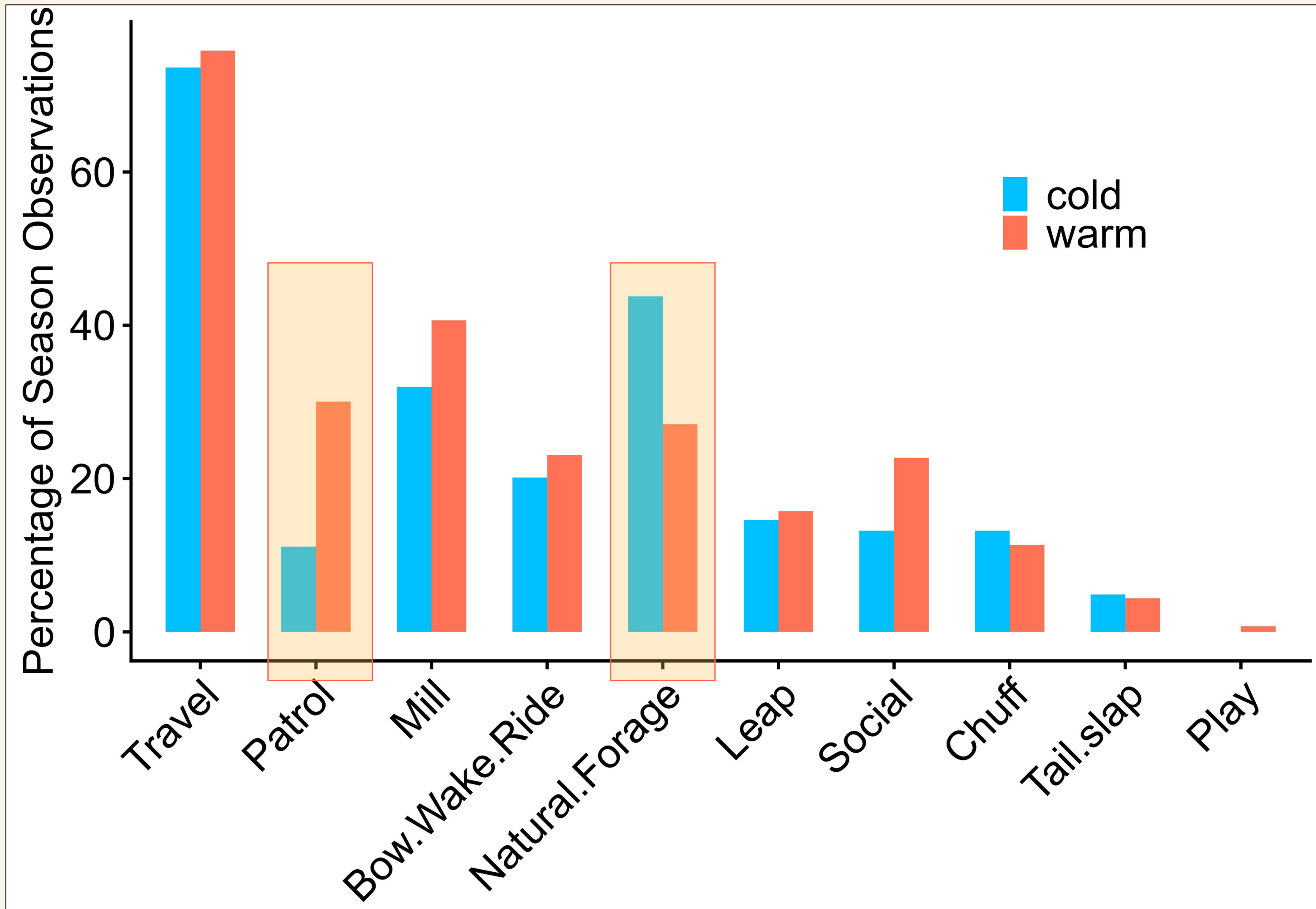


Patrol  
↓  
Depredate



Natural Foraging

# Dolphin Behaviors



If dolphins are present during both seasons, why is their behavior different?

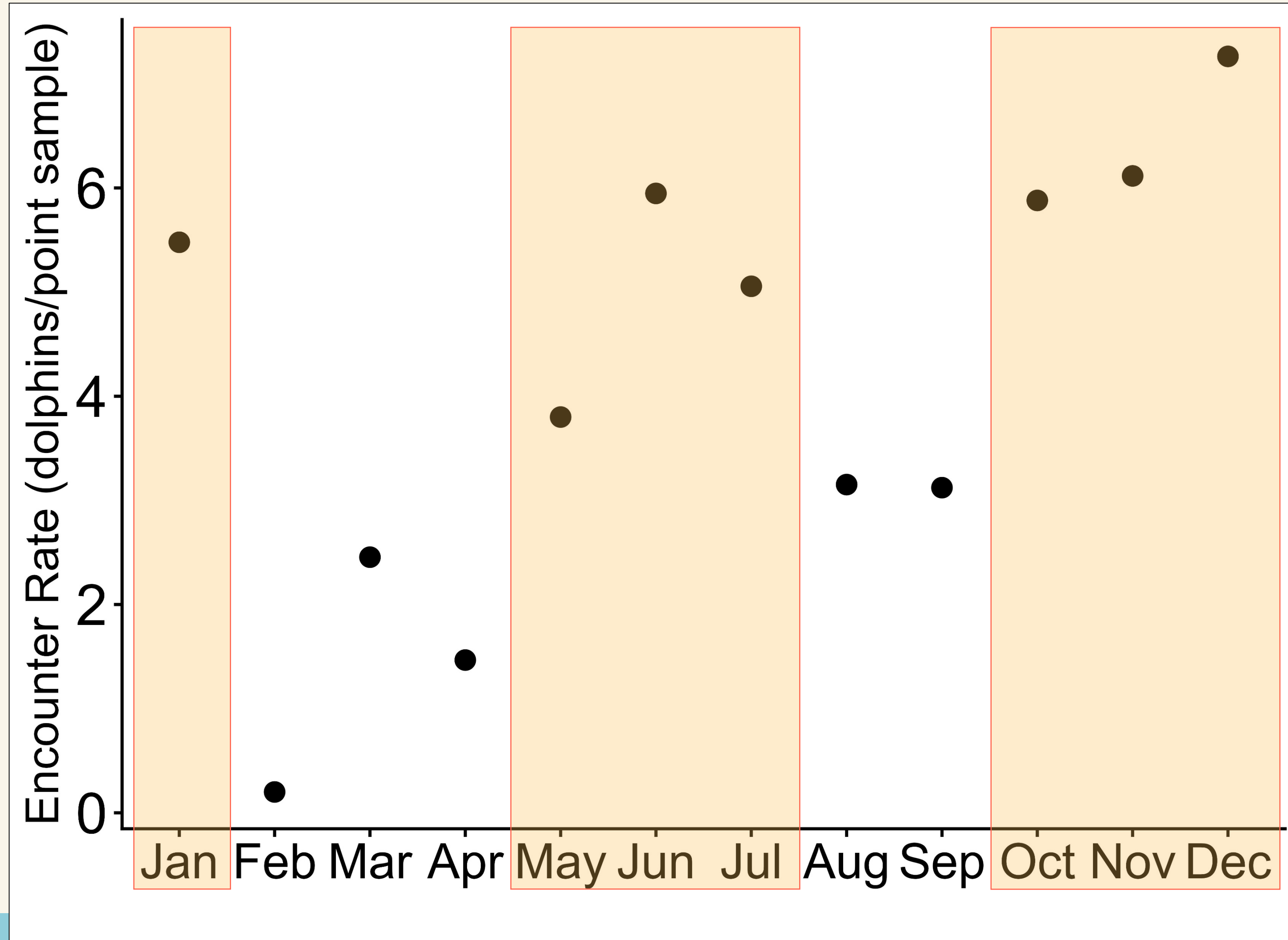
Patrol



Natural Foraging



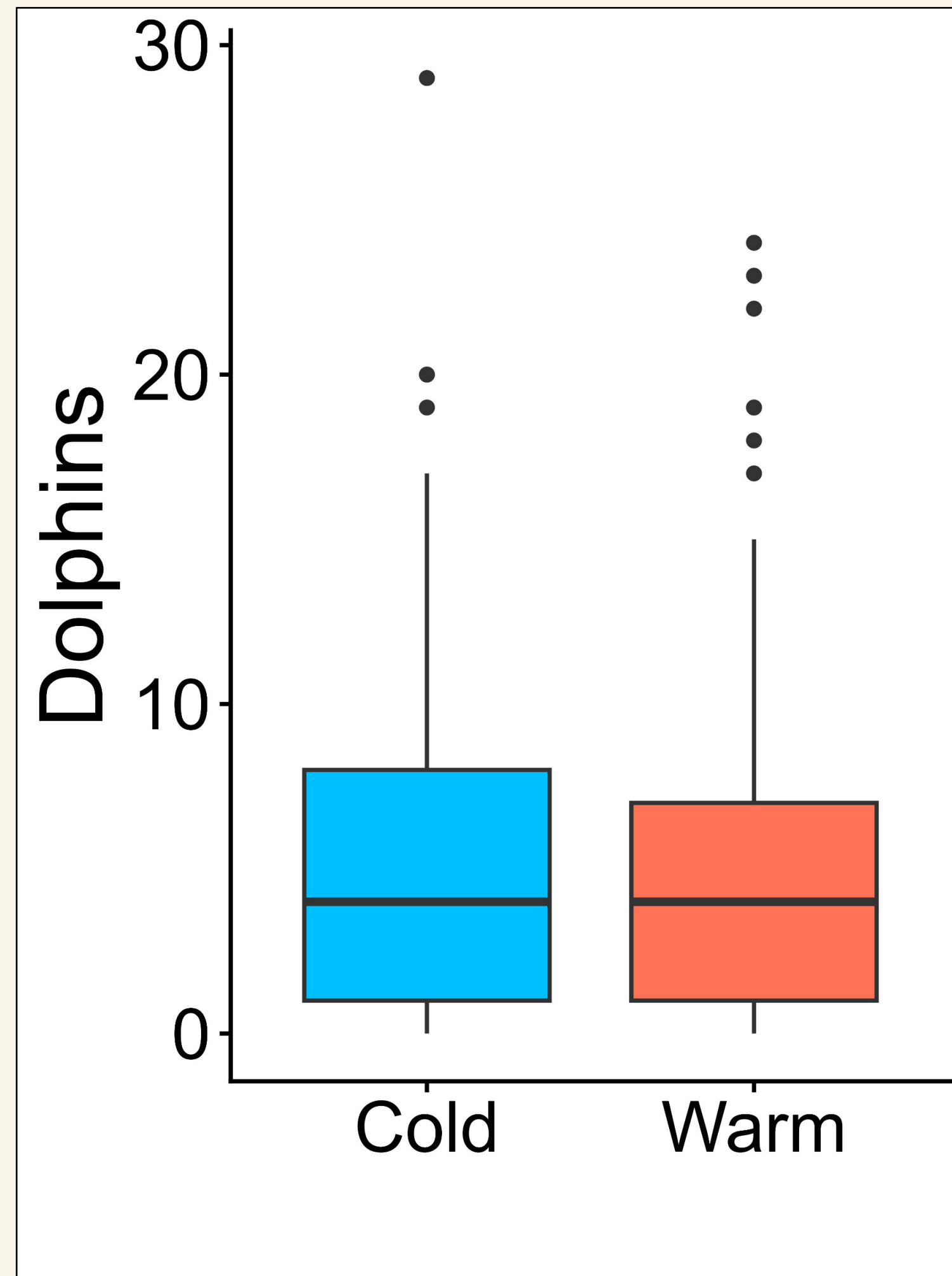
# Dolphin Presence



# Dolphin Presence

No significant  
difference between  
seasons

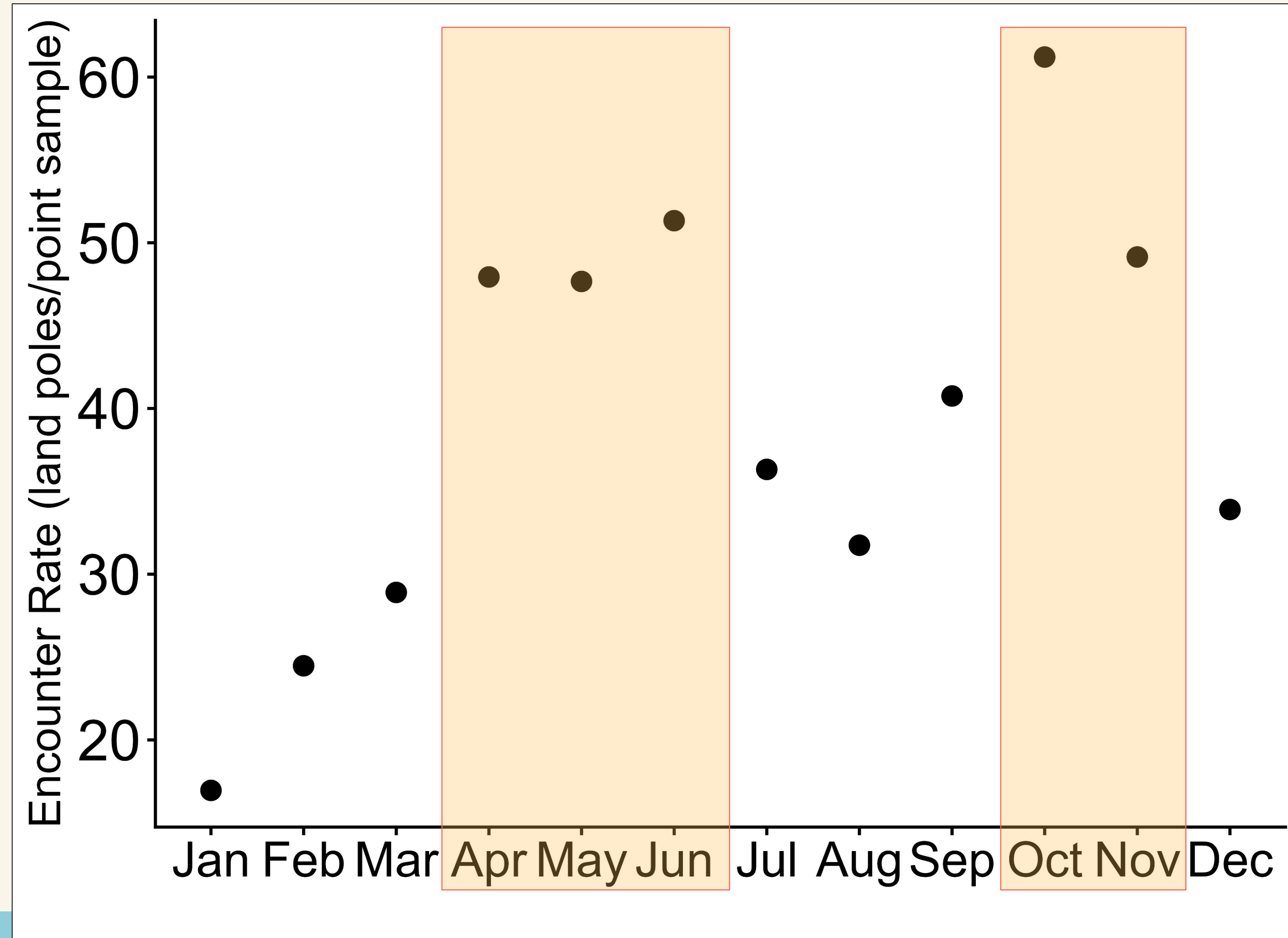
(t-test,  $p > 0.05$ )



Patrolling behavior  
is not related to  
dolphin presence



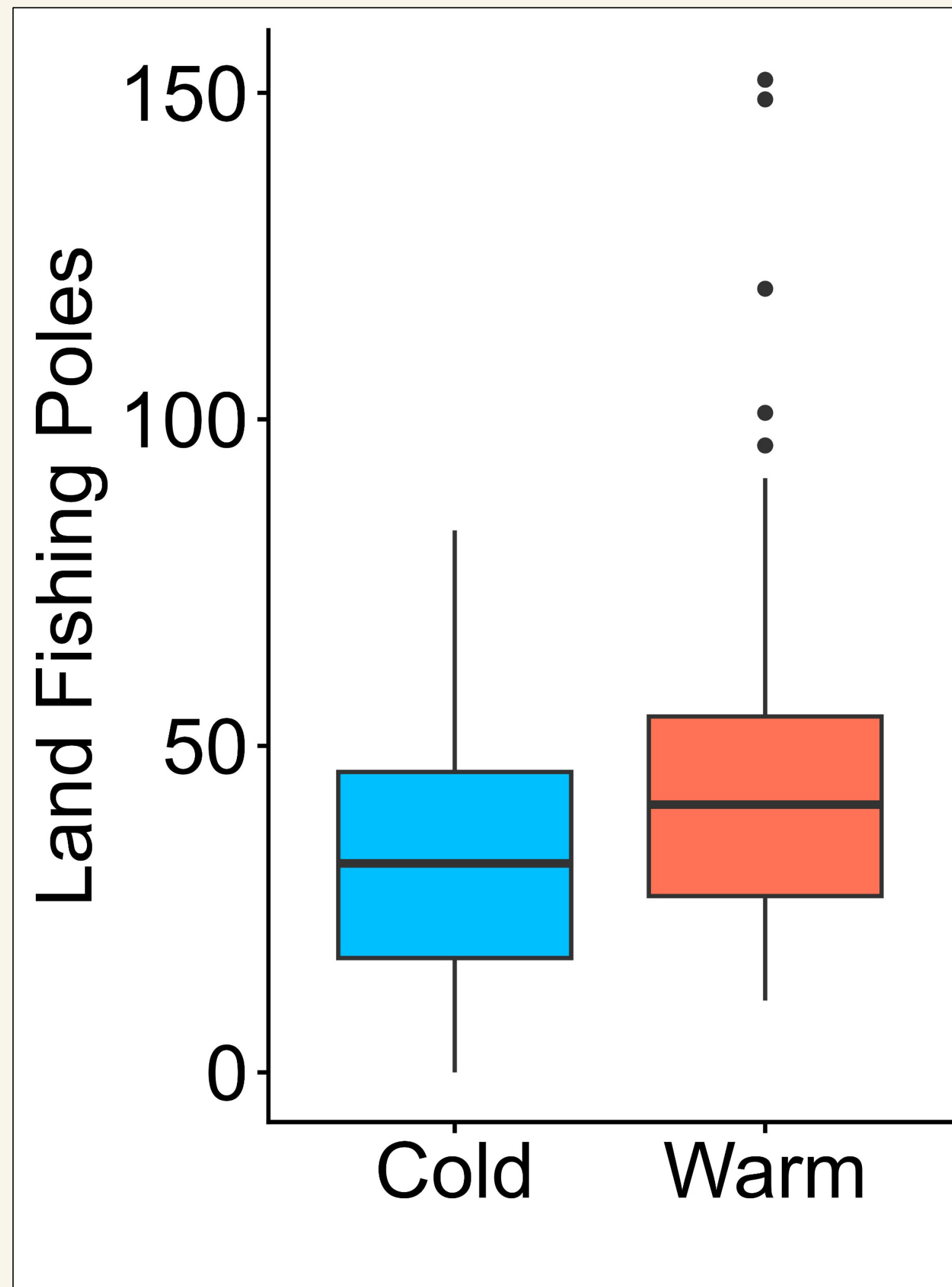
# Fisher Presence



# Fisher Presence

Significantly fewer  
fishers during cold  
season

(t-test,  $p < 0.05$ )

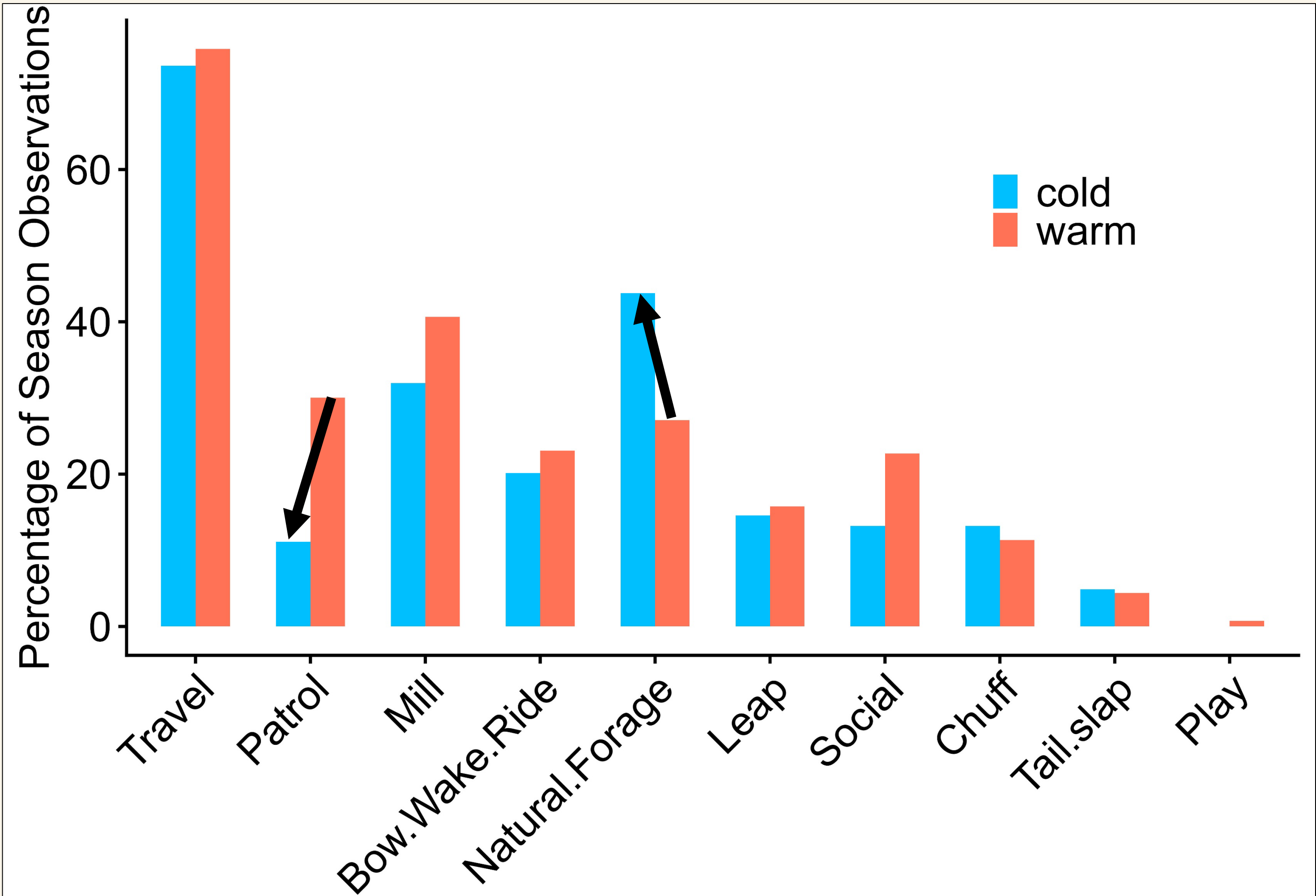


Patrolling behavior  
correlates with fisher  
presence and  
opportunities to patrol



# Dolphin Behaviors

Dolphin foraging behavior changes with fisher presence



# Wild life Entanglements in Galveston Bay



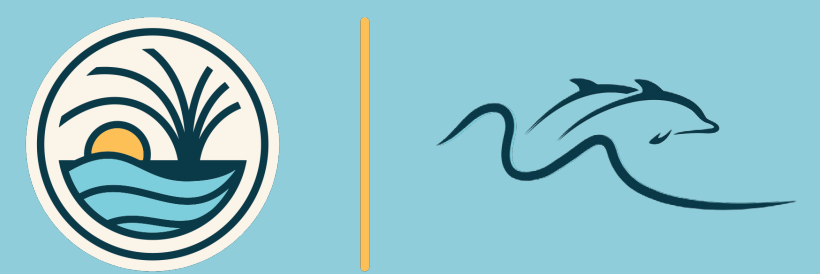


# Monofilament Recycling

Outreach

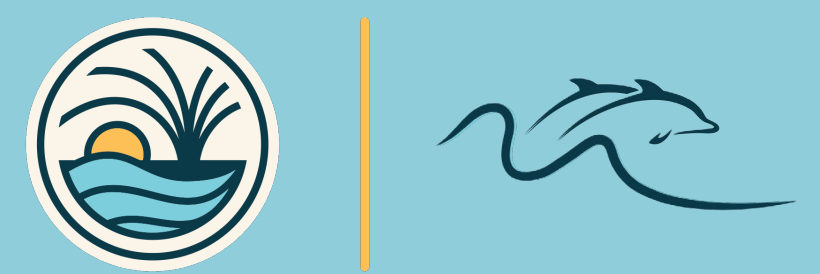
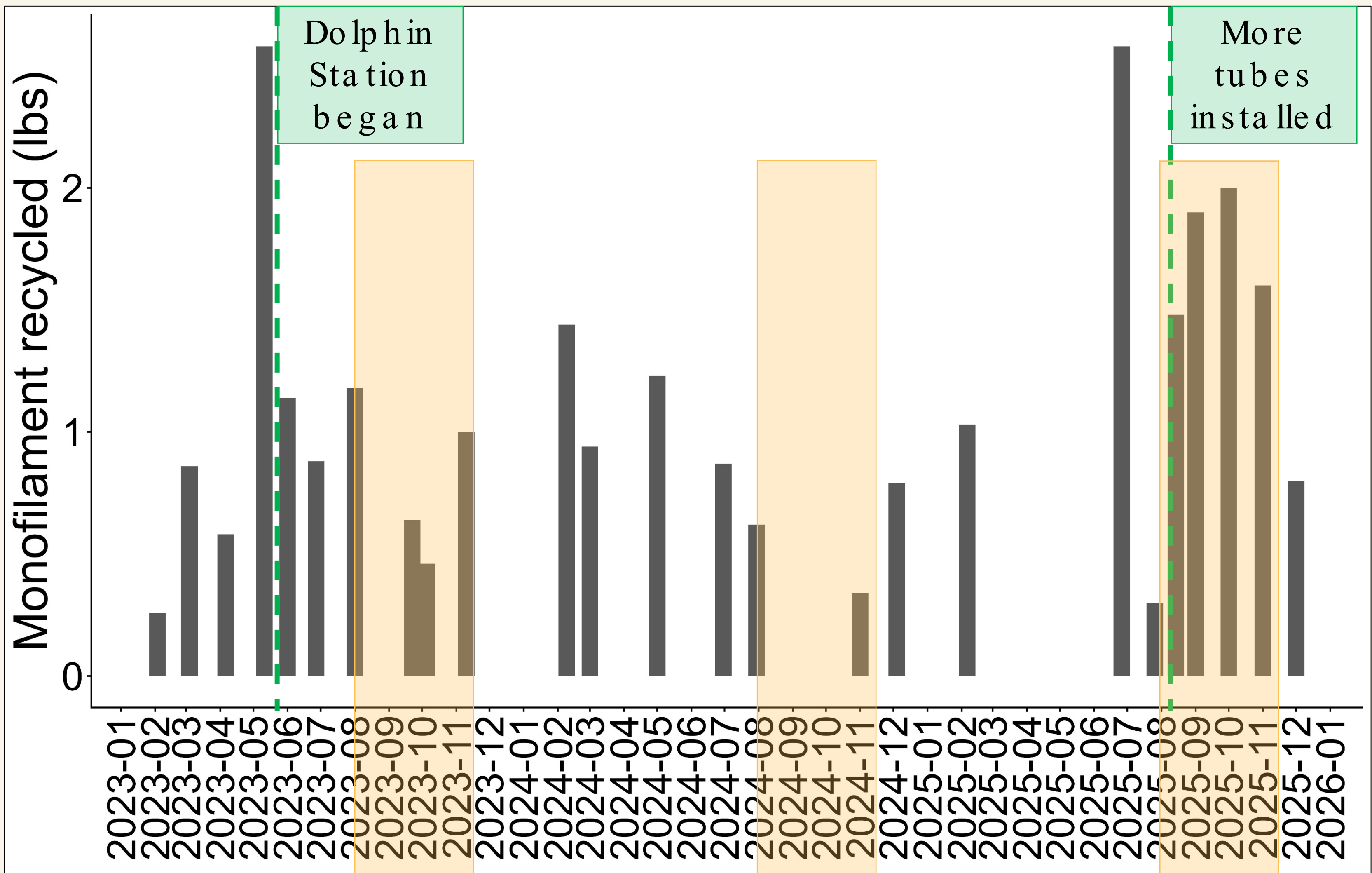


Fishing debris





# Monofilament Recycling

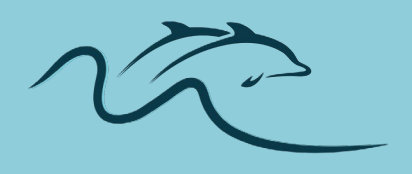
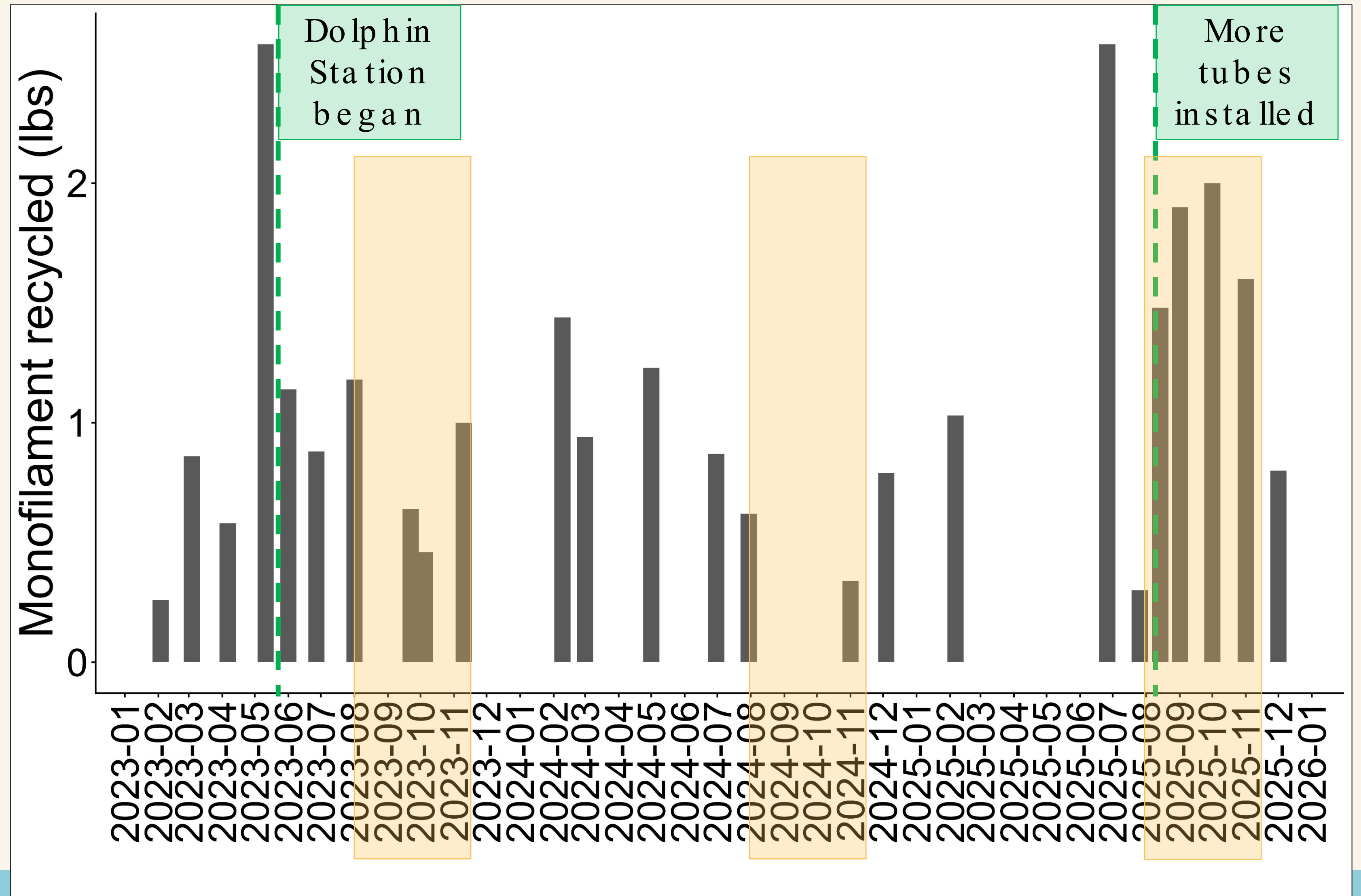




# Monofilament Recycling

Will we see gradual increase in amount recycled due to our presence?

Does the amount recycled correlate to fisher presence?





# Next Steps



1. Long term monitoring
2. Start catalog of individual dolphins at Sea wolf Park and track through time
3. Examine photos for evidence of entanglement



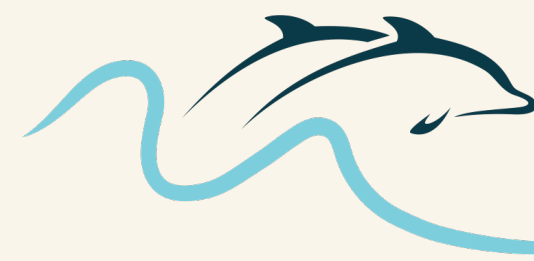
Thank you,  
volunteers!



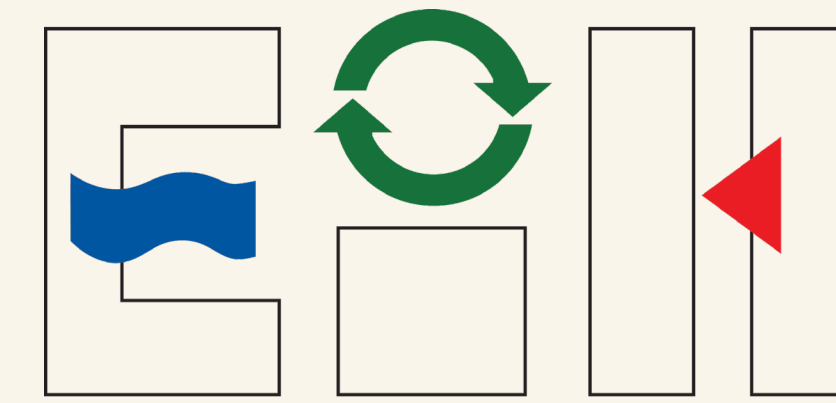


**GALVESTON BAY  
FOUNDATION**

PROTECT TODAY. PRESERVE TOMORROW.



**GALVESTON BAY  
DOLPHIN RESEARCH PROGRAM**



Environmental Institute of Houston

**UHCL**

University of Houston  
Clear Lake



**PORT HOUSTON**



Thank you!



[galvestonbaydolphin.org](http://galvestonbaydolphin.org)

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