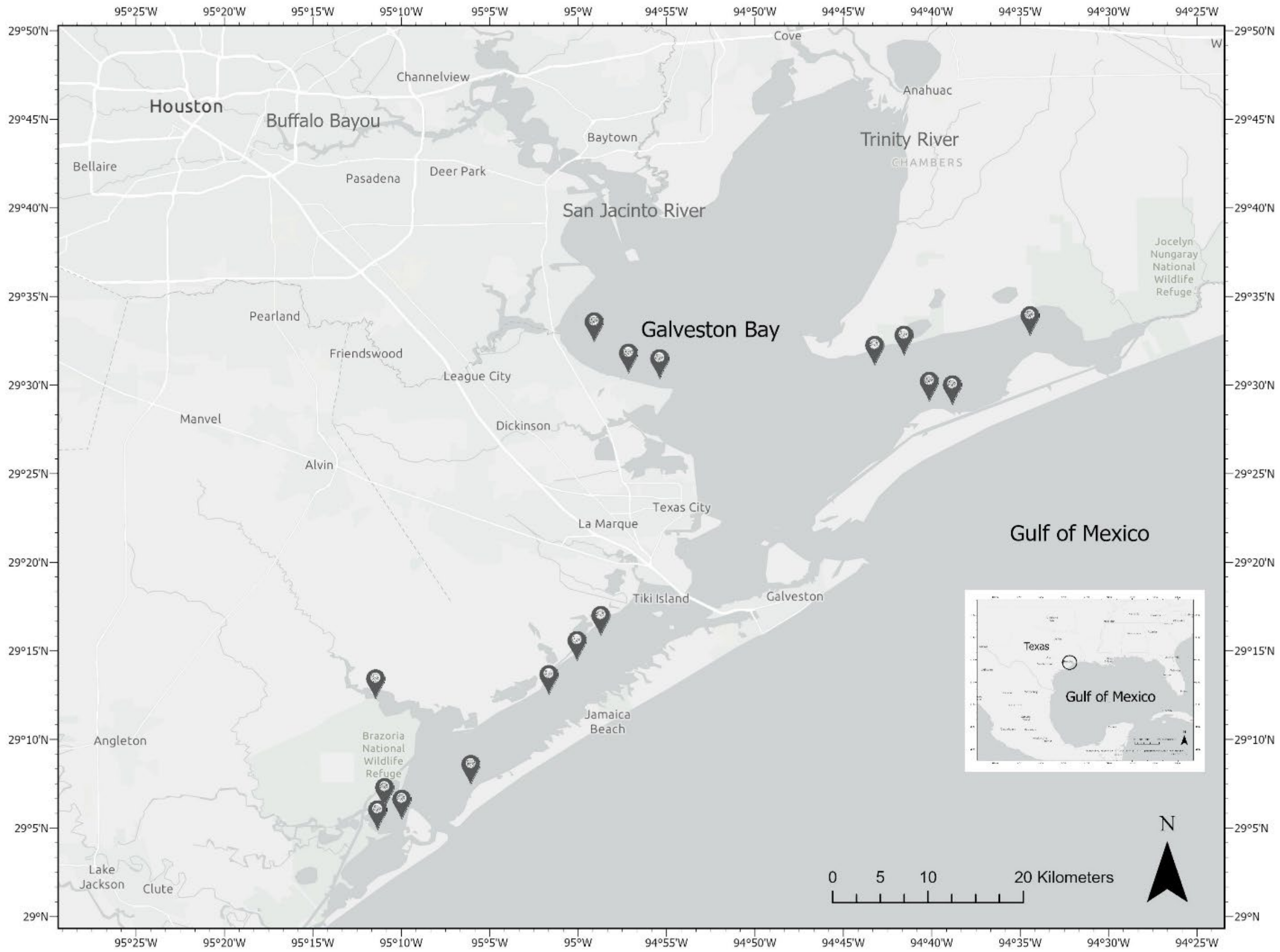
1. Introduction

Introduction

- **Gulf of Mexico** contributes to **30% of oil** and **10% of U.S. natural gas** productions.
- Galveston Bay
  - Home to **Houston**
  - **Petrochemical/industrial** hub
  - **Fisheries** industry
- Leads to accumulation of
  - Oil derived polycyclic aromatic hydrocarbons (**PAHs**)
  - ‘Legacy’ industrial pollution polychlorinated biphenyls (**PCBs**)
  - Petrochemical products such as **plastics**



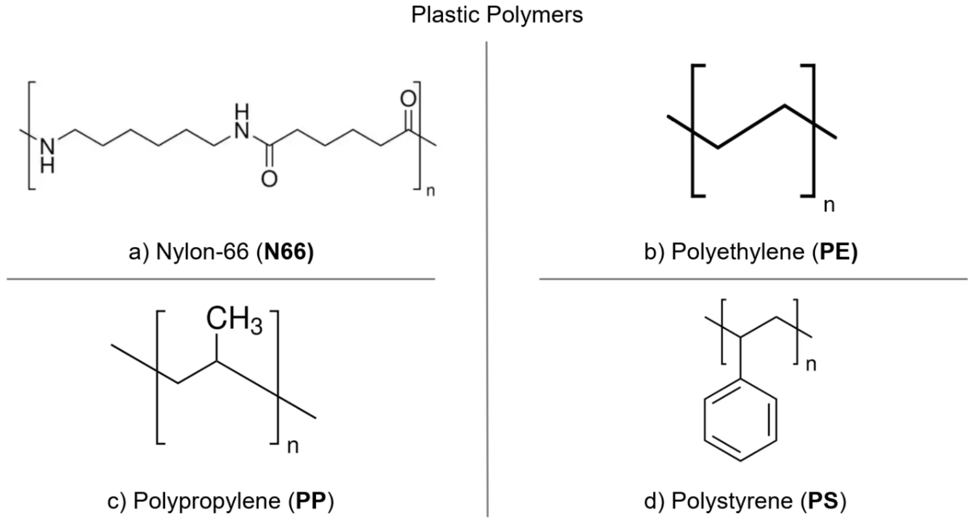
Objective

- Quantify pollutant body-burdens:
  - Persistent pollutants: **PAHs & PCBs**
  - Emerging pollutants: **Nano-microplastics (NMPs)**
    In **oysters** and **fish** from Galveston Bay

- Compare with **historical data (1970s-date)**: PAHs & PCBs in biota, surface waters, and sediments

- Hypothesis:
  - **Current pollutant levels > historic levels** due to industrialization & urbanization.

Biota and Pollutants



Poll

- **14**
- **28**

- **12 Microplastics**
  - polyethylene (PE), polypropylene (PP), polystyrene (PS), styrene butadiene rubber (SBR), polyvinyl chloride (PVC), polyamide N-6 (PA), nylon-66 (N66), polycarbonate (PC), polyurythane (PU), poly (methyl methacrylate) (PMMA), polyethylene terephthalate (PET) and Acrylonitrile butadiene styrene (ABS).

https://fishspecies.dnrec.delaware.gov/FishSpecies.aspx?habitat=2&species=150

https://deq.nc.gov/about/divisions/marine-fisheries/public-information-and-education/species/spotted-seatrout

Eastern Oyster | NOAA Fisheries

2. Methods

PAH-PCB GCMS Quantification

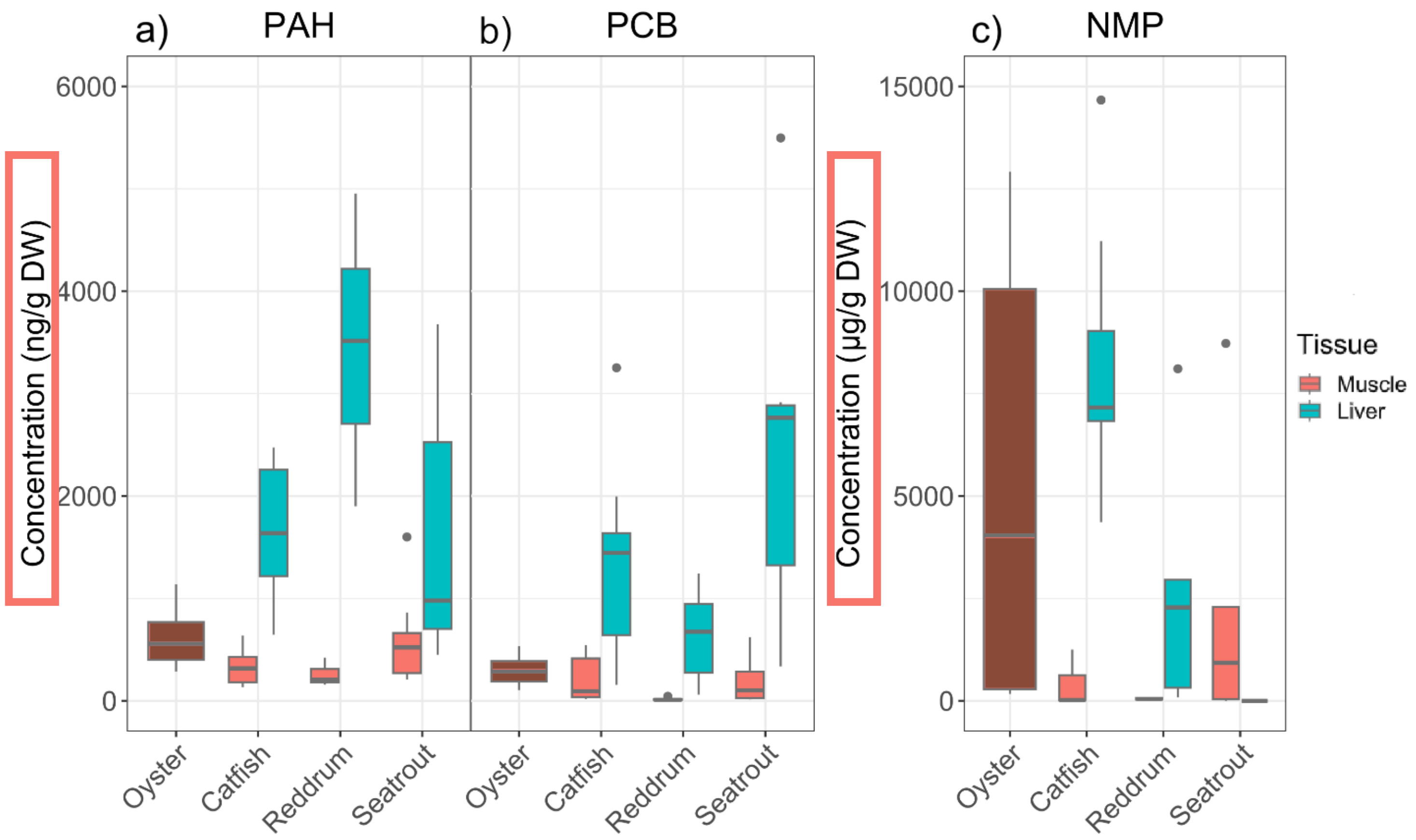
NMPs Py-GCMS Quantification

Published Method
(Gahn et.al., 2025)

3. Results

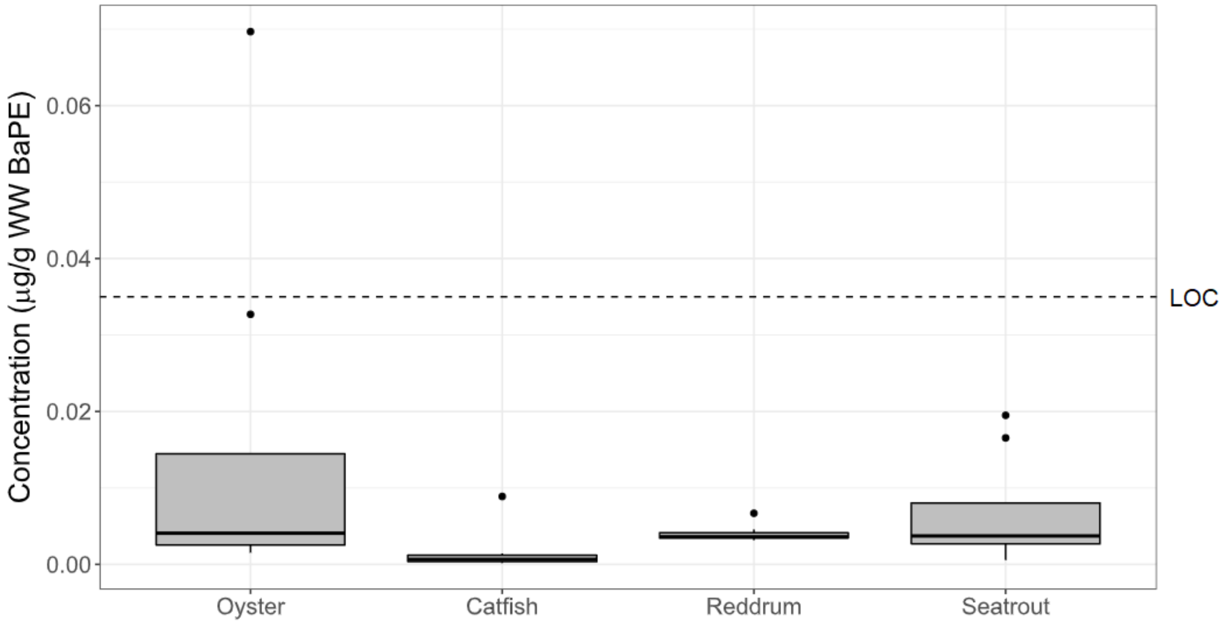
Pollutant Body-burdens

- **NMPs 3-4 order** of magnitude higher than **PAHs and PCBs**
- Oyster had ~2.4× to 279× **higher** contaminant levels than fish muscle.
- Fish livers had ~3× to 42× **higher** contaminant levels than muscle.



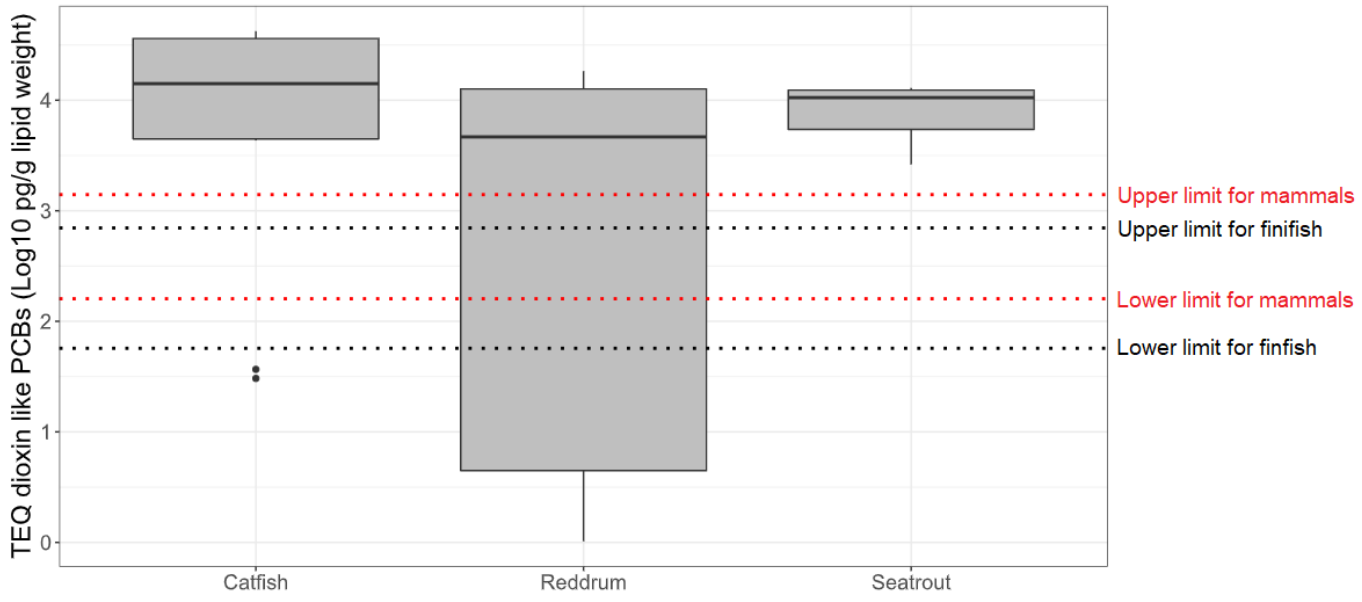
Relative Abundance of **PAHs**

- **Petrogenic dominant**
- Muscle
  - **LMW: ACE & PHE** dominant (20–35%), **FLU** in red drum, seatrout, oysters (10–15%)
  - **HMW: BkF** in red drum (~25%)
- Liver
  - **LMW:FLU** dominant (up to 50%), **ACE** in catfish (~25%)
  - **HMW: BaP** in seatrout (~25%), **IcdP** in red drum (~50%)
- **No risk of cancer** detected for human consumption



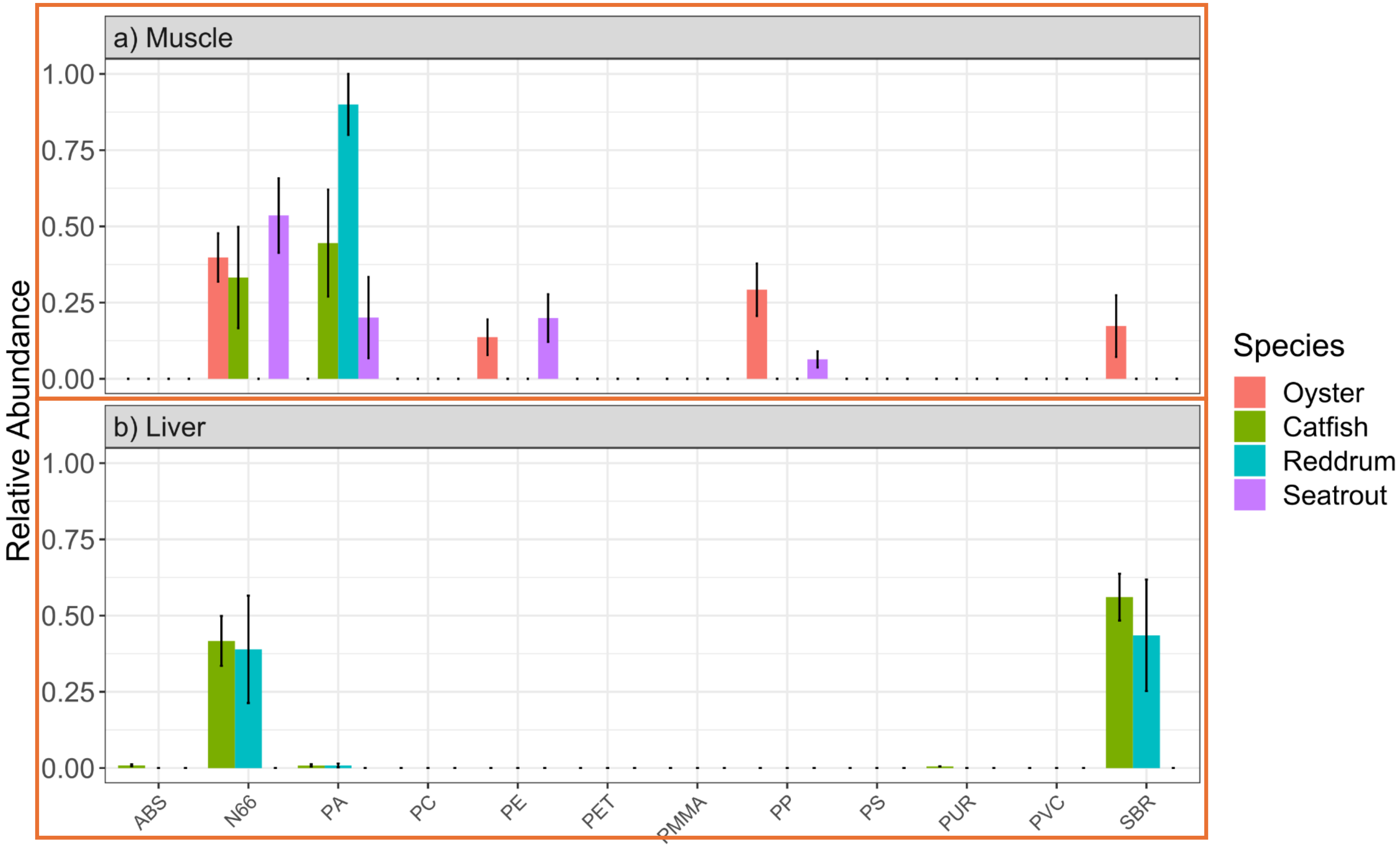
Relative Abundance of **PCBs**

- Muscle
  - **NDL-PCBs: PCB 52** dominant in red drum (~75%) and seatrout (~30%), **PCB 128** in oysters (~50%) and seatrout (~25%), **PCB 138** (22%) and **PCB 153** (18%) in catfish
- Liver
  - **NDL-PCBs: PCB 128** in seatrout (~25%)
  - **DL-PCBs: PCB 126** dominant in catfish (50%), red drum (38%), seatrout (~25%)



Relative Abundance of **NMPs**

- Dominant in **Nylon, tire & single use plastic**
- Muscle
  - **PA**: 23–45% in catfish & seatrout; up to 88% in red drum
  - **N66**: 30–55% in oysters, catfish, seatrout
  - Others
    - **PE**: 13% (oyster), 19% (seatrout)
    - **PP**: up to 31% (oyster)
    - **SBR**: up to 19% (oyster)
- Liver
  - **N66**: 39% (catfish), 37% (red drum)
  - **SBR**: 57% (catfish), 39% (red drum)



Average Daily intake (ADI) of Plastics

- Assuming 70kg adult consuming 30g fish/oyster per day,
- **Seatrout**: 443.9 mg/kg/year → **31 g plastics/year**
- **Oysters**: 309.98 mg/kg/year → **21 g plastics/year**
- **Plastic credit card ≈ 6 g**
  - **<~2% bioaccumulate = 0.42 g**
  - **~90% depuration** in clean water (7 days)
  - **Toxicity** needs to be studied

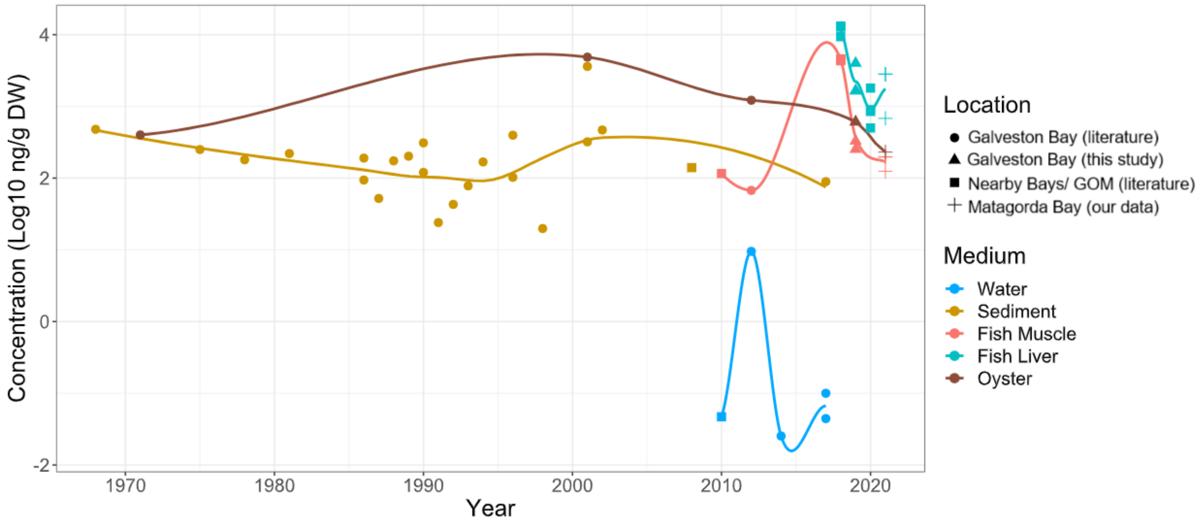
	ADI (min - max) (mg NMPs/Kg body weight/day)	Yearly Intake (min - max) (mg NMPs/Kg body weight/year)
Oysters	0.85 (0.01 – 4.80)	309.98 (4.45 – 1752.60)
Catfish	0.03 (0 - 0.12)	9.64 (0 – 42.58)
Reddrum	0 (0 - 0.01)	1.47 (0 – 2.69)
Seatrout	1.22 (0 – 4.83)	443.90 (0.01 – 1763.93)

Current vs Historic Levels

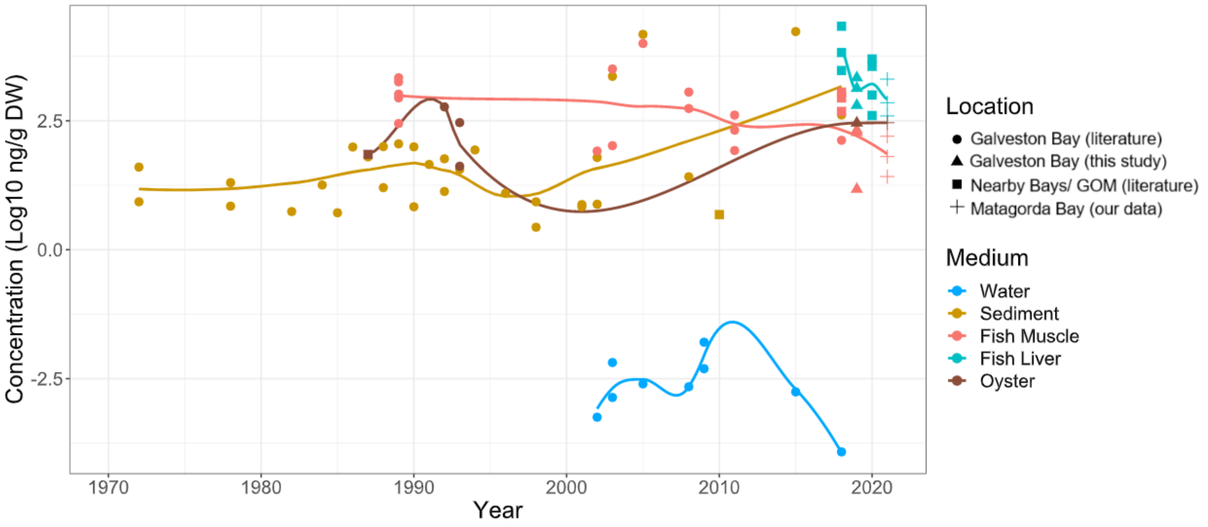
- **Historic PAHs**
  - Water < Sediment < Fish Muscle < Oysters < Fish Liver
- **Historic PCBs**
  - Water < Sediment < Oysters < Fish Muscle < Fish Liver
- **Historic NMPs**
  - Water < Sediment < Fish Muscle < Fish Liver < Oysters
- **No significant change** in PAHs & PCBs **from historic levels.**

Current vs Historic Trends

PAH



PCB



Conclusion

- **PAHs sources: Petrogenic** → linked to urban/petrochemical activity.
- Presence of **toxic BaP and PCB-126** in **Liver** is concerning.
- **No change in PAHs & PCBs from historic levels.**
  - Water<Sediment<Fish Muscle<Oysters<Fish Liver

- **NMP** dominant in **Nylon, tire** & **single use plastic** → reflect industrial/urban inputs.
- **Sparse historical data for NMPs** → trend assessment difficult.
- Future **monitoring should prioritize NMPs** and legacy pollutants for risk mitigation.
- **Toxicity of NMPs** need to be studied.

- *Need for **awareness** for **accountability at the personal and industrial level** to protect **Galveston Bay** seafood resources.*

Acknowledgements

- **Advisors**
  - Dr. David Hala
  - Dr. Karl Kaiser
  - Dr. Lene Petersen
  - Dr. David Wells
  - Dr. Antonietta Quigg
- **Student Researchers**
  - Bryan Gahn
  - Marcus Wharton, MS
- **Funding**

USCRP
US COASTAL RESEARCH PROGRAM

MATAGORDA BAY
MITIGATION TRUST

References

- Bacosa, H. P., Steichen, J., Kamalanathan, M., Windham, R., Lubguban, A., Labonté, J. M., Kaiser, K., Hala, D., Santschi, P. H., & Quigg, A. (2020). Polycyclic aromatic hydrocarbons (PAHs) and putative PAH-degrading bacteria in Galveston Bay, TX (USA), following Hurricane Harvey (2017). *Environmental Science and Pollution Research*, *27*(28), 34987-34999.
- Howell, N. L., Lakshmanan, D., Rifai, H. S., & Koenig, L. (2011). PCB dry and wet weather concentration and load comparisons in Houston-area urban channels. *Science of The Total Environment*, *409*(10), 1867–1888.
- Oakley, J. W., Guillen, G., Steinhaus, J., Cox, E., Sager, M., & Huette, M. (2024). *Microplastics in the Galveston Bay Watershed: The Big Impacts of Tiny Pollution, Final Report*. https://www.uhcl.edu/environmental-institute/research/publications/documents/24-002-microplastics-galveston-bay-watershed-final-report.pdf
- Oziolor, E. M., Apell, J. N., Winfield, Z. C., Back, J. A., Usenko, S., & Matson, C. W. (2018). Polychlorinated biphenyl (PCB) contamination in Galveston Bay, Texas: Comparing concentrations and profiles in sediments, passive samplers, and fish. *Environmental pollution*, *236*, 609-618.
- Ribeiro, F., Okoffo, E. D., O'Brien, J. W., Fraissinet-Tachet, S., O'Brien, S., Gallen, M., Samanipour, S., Kaserzon, S., Mueller, J. F., & Galloway, T. (2020). Quantitative analysis of selected plastics in high-commercial-value Australian seafood by pyrolysis gas chromatography mass spectrometry. *Environmental science & technology*, *54*(15), 9408-9417.
- Santschi, P. H., Presley, B. J., Wade, T. L., Garcia-Romero, B., & Baskaran, M. (2001). Historical contamination of PAHs, PCBs, DDTs, and heavy metals in Mississippi river Delta, Galveston bay and Tampa bay sediment cores. *Marine Environmental Research*, *52*(1), 51-79.

Questions?

Asif Mortuza, **PhD Candidate**

- Texas A&M University at Galveston
- Email: morta02@tamu.edu
- **Graduation: Spring 2026**

Looking for work!

Researchgate Profile

4. Supplementary Materials

PAHs Recoveries

Compound name	% Recovery in biota (n=6)	% Recovery Liquid-liquid extraction (n=3)
Benzo[a]pyrene (BaP)	74.07 ± 0.44	106.07 ± 4.19
Pyrene (PYR)	46.01 ± 9.24	69.13 ± 4.12
PCB 18	69.07 ± 3.88	41.76 ± 6.93
PCB 101	68.5 ± 5.83	128.31 ± 16.99

NMPs Recoveries

Name	% Recovery
Polymethyl methacrylate	48
Polypropylene	**115**
Polyvinyl chloride	91
Polyamide	68
Polycarbonate	219
Nylon-66	**93**
Polyethylene	**113**
Polyethylene terephthalate	223
Acrylonitrile butadiene styrene	150
Polyurythane	14
Polystyrene	120

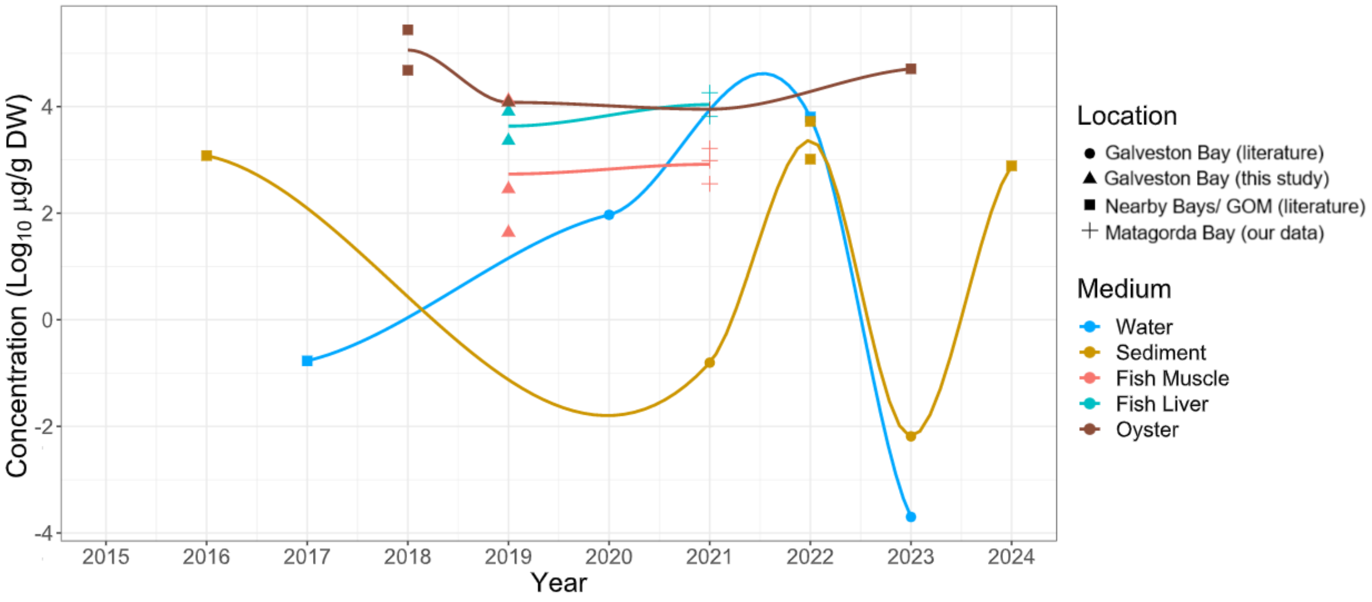
Source of PAHs

- **Petrogenic** dominance
  - Oyster 71%
  - Catfish 67%
  - Red drum 83%
  - Seatrout 57%

Diagnostic Ratios	*Pyrogenic* if*	*Oyster*	*Catfish Muscle*	*Red drum Muscle*	*Seatrout Muscle*
∑LMW/∑HMW	<1	4.91	2.95	1.34	3.54
∑COMB/∑PAH	~1	0.17	0.25	0.43	0.22
FLT/(FLT+PYR)	>0.4	0.00	0.46*	-	1.00*
ANT/(ANT+PHE)	>0.1	0.03	0.08	0.08	0.07
BaA/(BaA+CHR)	>0.2	0.53*	0.70*	0.60*	0.50*
IcdP/(IcdP+BghiP)	>0.2	0.34*	-	0.00	0.34*
PHE/ANT	<10	29.03	12.31	12.22	13.78
Pyrogenic*		29%	33%	17%	43%
Petrogenic		**71%**	**67%**	**83%**	**57%**

Current vs Historic Trends

NMP



Vanessa Mintzer
Kristi Fazioli
Erin Fougeres
Michel Gielazyn
Amie Lund
Brian Quigley
Aaron Roberts
Errol Ronje
Irvin Schultz
Lori Schwacke
Heidi Whitehead
Ryan Takeshita

State of the Bay
February 24, 2026
Galveston, TX

NOAA RESTORE SCIENCE PROGRAM

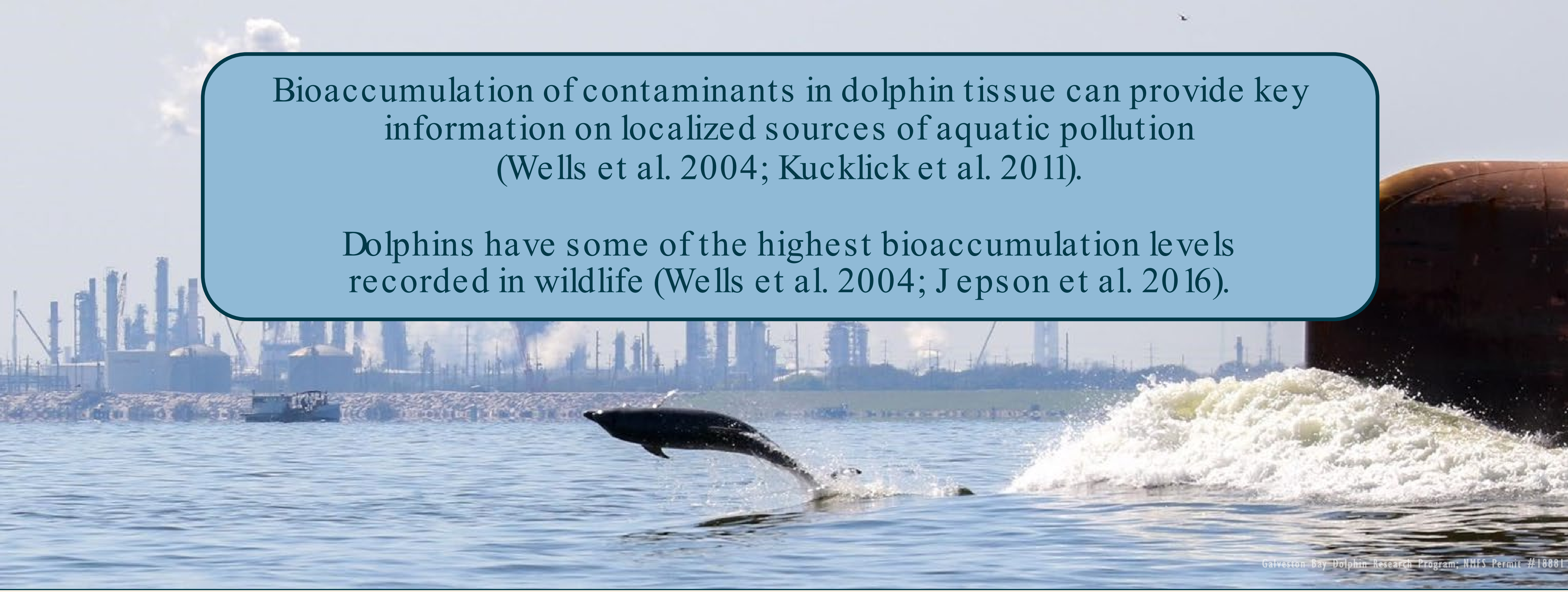
Establishing a research framework and baseline conditions to support assessments of cumulative effects from multiple stressors in Galveston Bay dolphins

NATIONAL MARINE MAMMAL FOUNDATION
Texas Marine Mammal Stranding Network
MARINE MAMMAL COMMISSION
GALVESTON BAY DOLPHIN RESEARCH PROGRAM
GALVESTON BAY FOUNDATION
Environmental Institute of Houston
UNT UNIVERSITY OF NORTH TEXAS
NOAA

Bottlenose dolphins (*Tursiops truncatus*)
are a **sentinel species** for estuarine and human health

Bioaccumulation of contaminants in dolphin tissue can provide key information on localized sources of aquatic pollution (Wells et al. 2004; Kucklick et al. 2011).

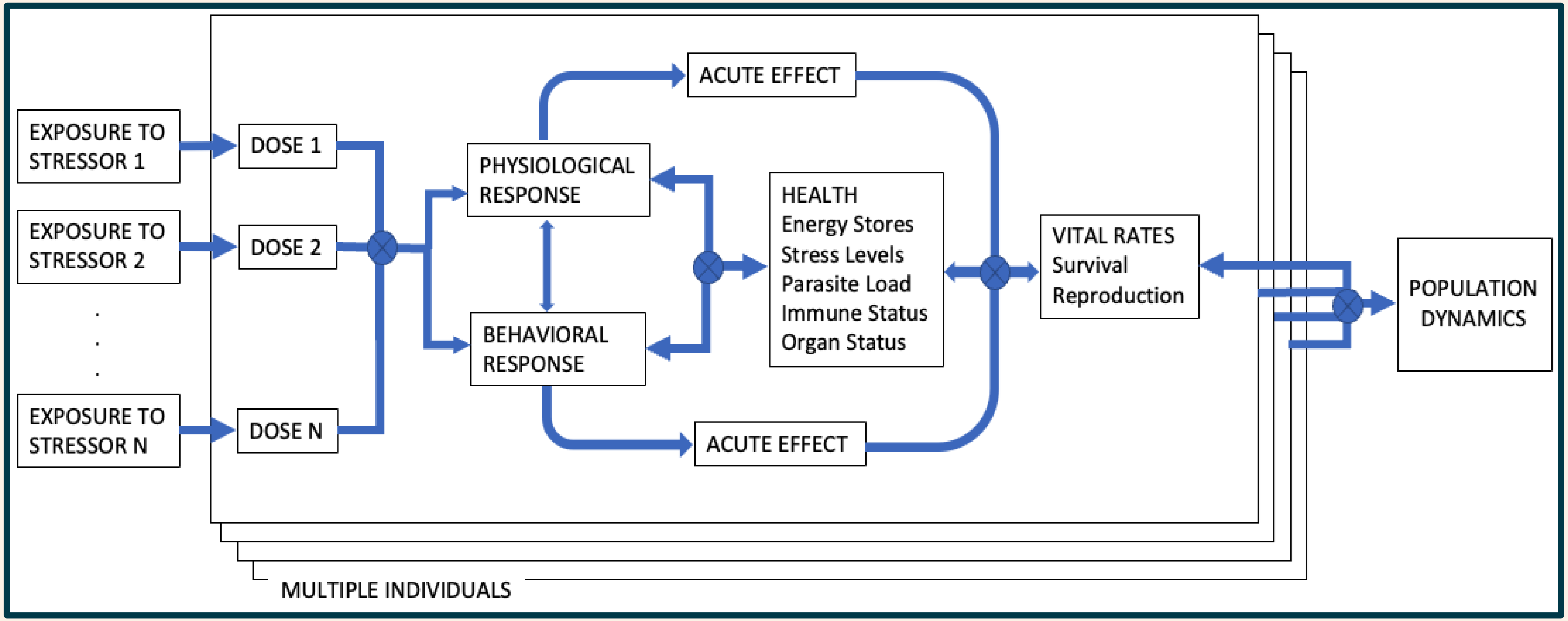
Dolphins have some of the highest bioaccumulation levels recorded in wildlife (Wells et al. 2004; Jepson et al. 2016).



NOAA's DARRP and co-Trustees may decide to pursue NRDAs for Houston-area bottlenose dolphins, including considering how **co-exposures of multiple stressors may have led to cumulative effects**.

A **N**atural **R**esource **D**amage **A**ssessment is a process used to evaluate environmental damage from oil spills or hazardous releases and recover funds to restore natural resources and compensate for lost public use.

Population Consequences of Multiple Stressors (PCoMS)



Model used for our study design

Adapted from National Academies of Sciences, Engineering, and Medicine (NASEM). 2017. Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals. Washington, DC: The National Academies Press. doi: 10.17226/23479. And the PCoMS Working Group supported by the US Office of Naval Research.

Co-production Model for Science

RESTORE SCIENCE PROGRAM

Steps to a Co-Produced Research Project:

1. Scoping

- ☐ **Define the need** — What is the natural resource issue?
- ☐ **Define the problem** — What is the key problem to address?
- ☐ **Define the players** — Who all is involved?
- ☐ **Identify the project goal** — What will this project aim to accomplish?

2. Design

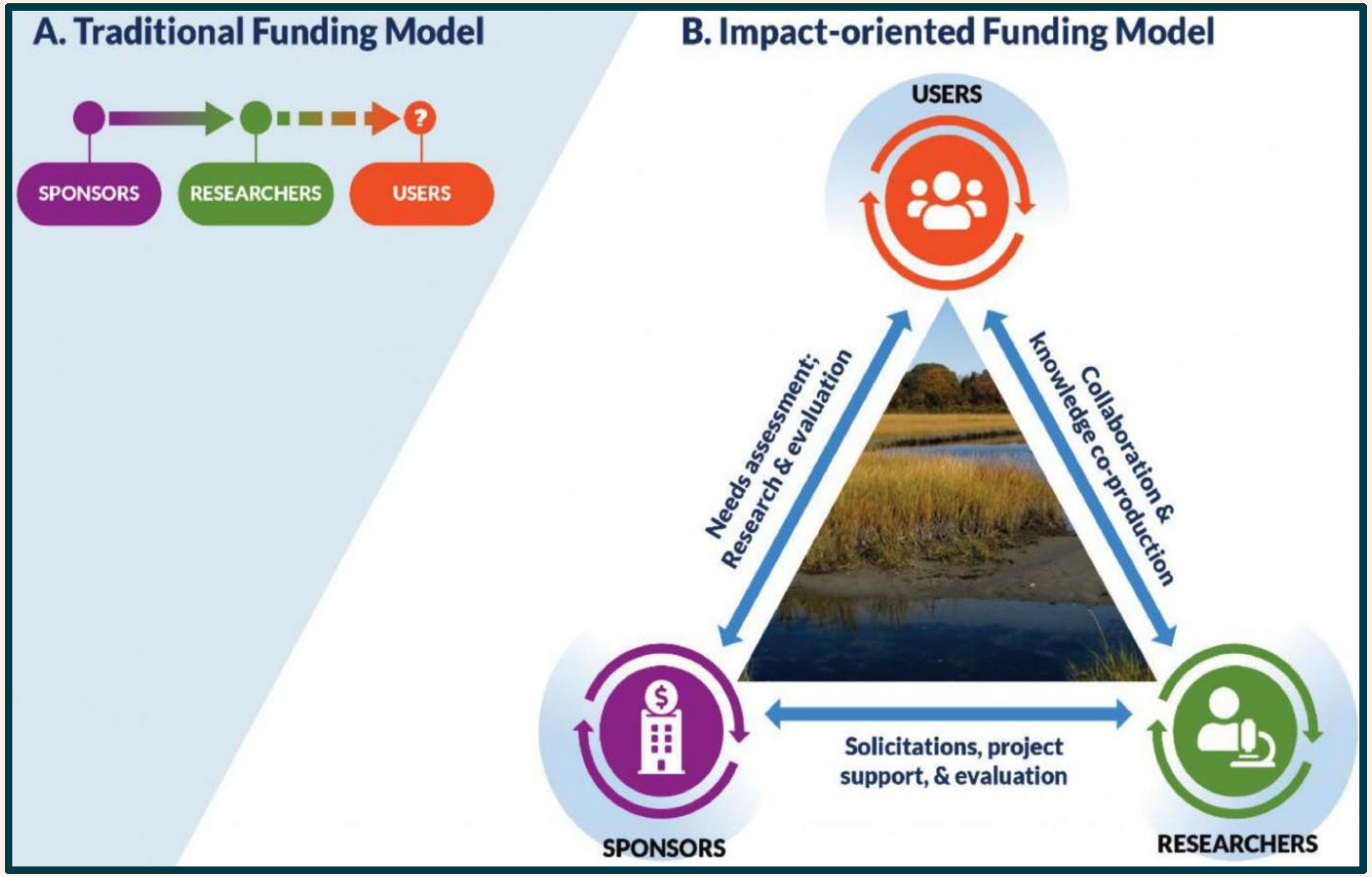
- ☐ **Build the co-production process** — Who needs to be engaged, how, and at what frequency?
- ☐ **Integrate into the research process** — How will these interactions feed into the project?

3. Research & Development

- ☐ **Conduct the research** — Who is doing what, when?
- ☐ **Monitor the process** — What feedback do team members have?
- ☐ **Engage with necessary groups** — What intermediate information should be exchanged?
- ☐ **Iterate as needed** — Does anything need adjusting?

4. Transfer & Application

- ☐ **Design the products** — What do end users need, and in what format?
- ☐ **Transfer the products** — How should information be shared, and with whom?



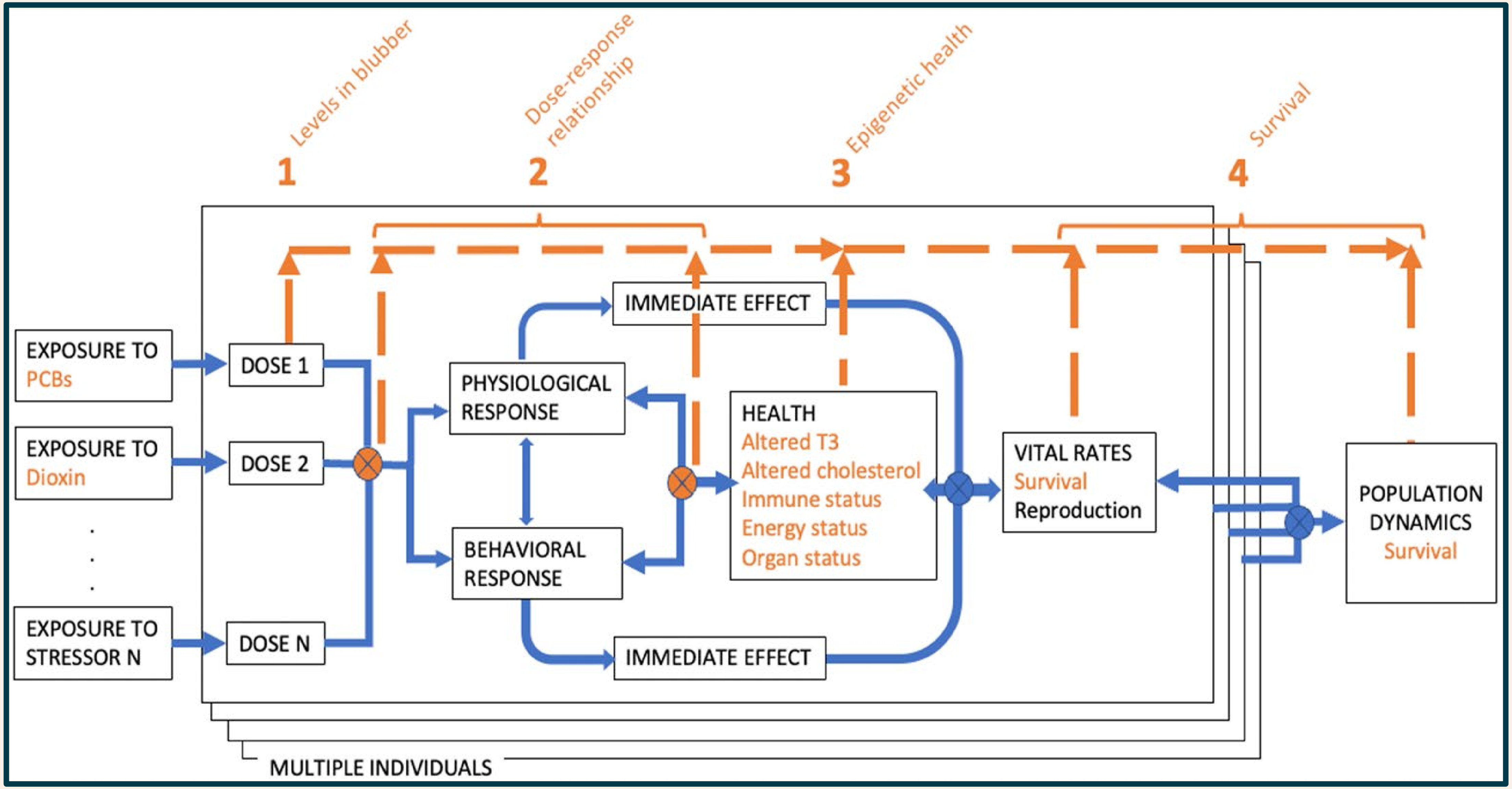
https://restoreactscienceprogram.noaa.gov/co -production-examples-and-tools

Arnott et al. 2020. https://doi.org/10.1016/j.gloenvcha.2019.101979

2022 Scoping Workshop

Project Focus: Houston-area bottlenose dolphins may be **injured by polychlorinated biphenyls (PCBs) and dioxins**, and **co-exposures** of contaminants may lead to **cumulative effects**.

Data gaps for applying the PCoMS framework to Houston-area dolphins



Project Questions and Approaches

1. What are the current levels of PCBs and dioxins in the blubber of Houston area dolphins?

Analytical chemistry

2. Is there any interaction between the toxic effects of dioxins and PCBs, since both can disrupt similar physiological systems?

Laboratory cell-culture exposures

3. Is the health of Houston area dolphins consistent with their chronological age?

Epigenetic analysis

4. What are the survival rates of Houston area dolphins compared to others in the Southeastern US?

CMR surveys and population modeling

Project Timeline (Oct 2023 – Sept 2028)

	FY 24	FY 25	FY 26	FY 27	FY 28
	Year 1	Year 2	Year 3	Year 4	Year 5
New data/sample collection and processing	CMR surveys	Remote biopsy sampling	CMR surveys		CMR surveys
Existing data/sample curation and processing		Previously collected skin/blubber (remote bx + strandings)			
Analyses & Interpretation			Analytical Chemistry / Epigenetics / Cell -line exposure / CMR modeling		
Final touches					Reporting / MS prep / Archiving

Reporting, outreach, and end user engagement throughout the project period

Project Timeline (Oct 2023 – Sept 2028)

	FY 24 Year 1	FY 25 Year 2	FY 26 Year 3	FY 27 Year 4	FY 28 Year 5
New data/sample collection and processing	CMR surveys	Remote biopsy sampling	CMR surveys		CMR surveys
Existing data/sample curation and processing		Previously collected skin/blubber (remote bx + strandings)			
Analyses & Interpretation			Analytical Chemistry / Epigenetics / Cell -line exposure / CMR modeling		
Final touches					Reporting / MS prep / Archiving

Reporting, outreach, and end user engagement throughout the project period

2024 CMR field effort

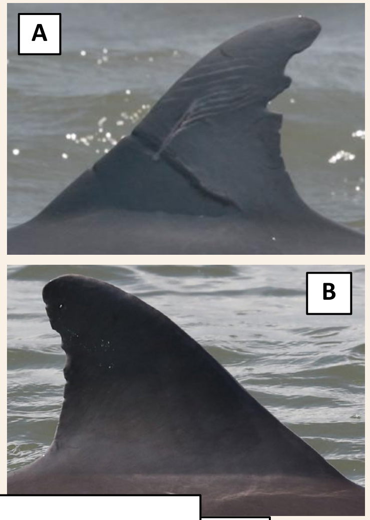
Boat-based photo-ID surveys

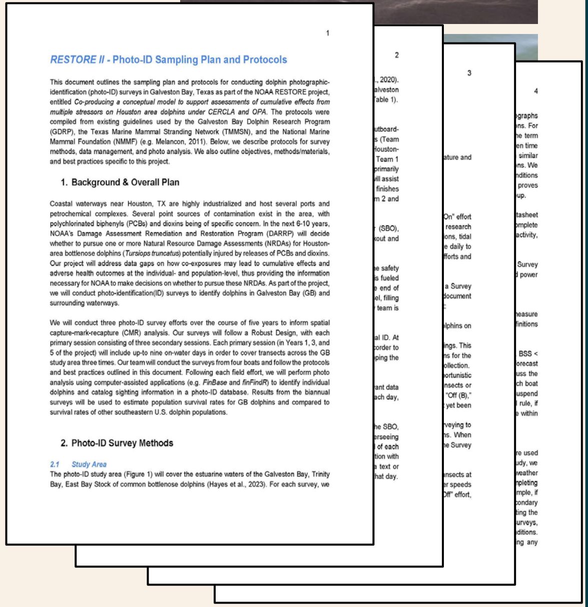
↓

Inform spatial capture-mark recapture (CMR) analyses

↓

Estimate survival rates





1

RESTORE II - Photo-ID Sampling Plan and Protocols

This document outlines the sampling plan and protocols for conducting dolphin photographic-identification (photo-ID) surveys in Galveston Bay, Texas as part of the NOAA RESTORE project, entitled *Co-producing a conceptual model to support assessments of cumulative effects from multiple stressors on Houston area dolphins under CERCLA and OPA*. The protocols were compiled from existing guidelines used by the Galveston Bay Dolphin Research Program (GDRP), the Texas Marine Mammal Stranding Network (TMMSN), and the National Marine Mammal Foundation (NMMF) (e.g. Melancon, 2011). Below, we describe protocols for survey methods, data management, and photo analysis. We also outline objectives, methods/materials, and best practices specific to this project.

1. Background & Overall Plan

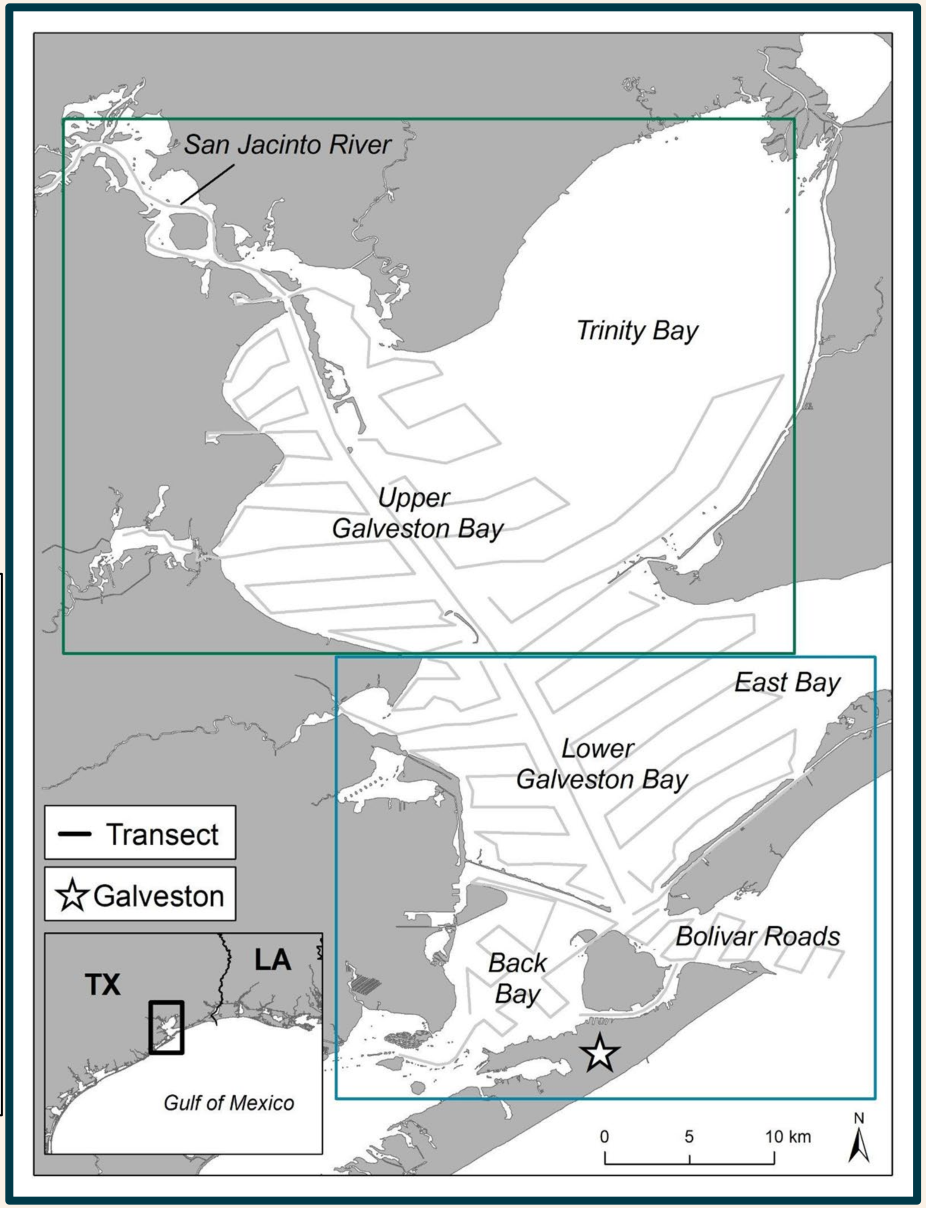
Coastal waterways near Houston, TX are highly industrialized and host several ports and petrochemical complexes. Several point sources of contamination exist in the area, with polychlorinated biphenyls (PCBs) and dioxins being of specific concern. In the next 6-10 years, NOAA's Damage Assessment Remediation and Restoration Program (DARRP) will decide whether to pursue one or more Natural Resource Damage Assessments (NRDAs) for Houston-area bottlenose dolphins (*Tursiops truncatus*) potentially injured by releases of PCBs and dioxins. Our project will address data gaps on how co-exposures may lead to cumulative effects and adverse health outcomes at the individual- and population-level, thus providing the information necessary for NOAA to make decisions on whether to pursue these NRDAs. As part of the project, we will conduct photo-identification(ID) surveys to identify dolphins in Galveston Bay (GB) and surrounding waterways.

We will conduct three photo-ID survey efforts over the course of five years to inform spatial capture-mark-recapture (CMR) analysis. Our surveys will follow a Robust Design, with each primary session consisting of three secondary sessions. Each primary session (in Years 1, 3, and 5 of the project) will include up-to nine on-water days in order to cover transects across the GB study area three times. Our team will conduct the surveys from four boats and follow the protocols and best practices outlined in this document. Following each field effort, we will perform photo analysis using computer-assisted applications (e.g. *FinBase* and *finFindR*) to identify individual dolphins and catalog sighting information in a photo-ID database. Results from the biannual surveys will be used to estimate population survival rates for GB dolphins and compared to survival rates of other southeastern U.S. dolphin populations.

2. Photo-ID Survey Methods

2.1 Study Area

The photo-ID study area (Figure 1) will cover the estuarine waters of the Galveston Bay, Trinity Bay, East Bay Stock of common bottlenose dolphins (Hayes et al., 2023). For each survey, we



NATIONAL MARINE MAMMAL FOUNDATION | Texas Marine Mammal Stranding Network | GALVESTON BAY DOLPHIN RESEARCH PROGRAM | NOAA National Centers for Environmental Information

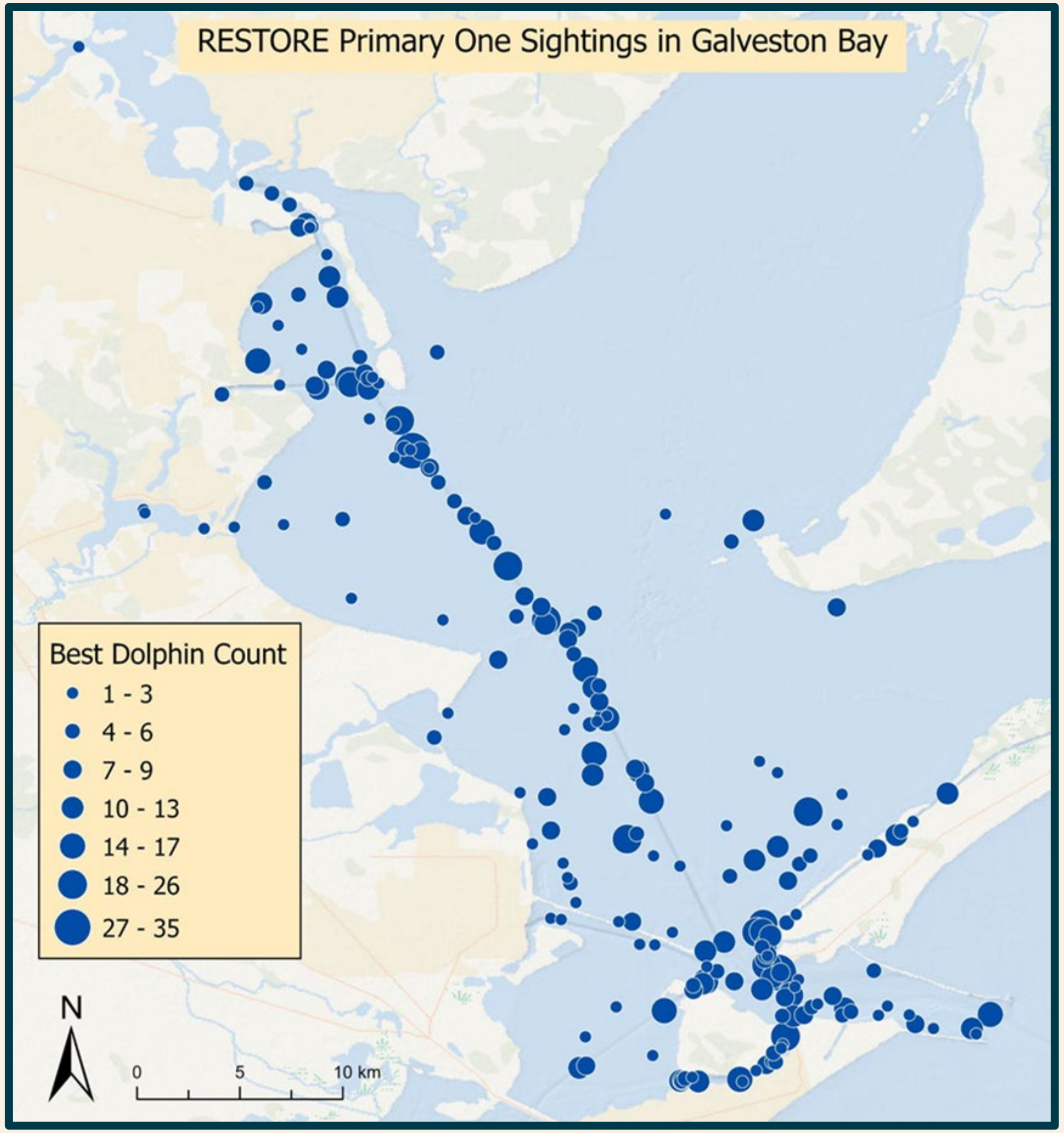
Activities conducted under NOAA MMPA Permit #23203

2024 CMR field effort

Met all survey goals (August 19-20, 2024)

33 surveys; 212hrs; 3009km

199 group sightings; 1473 total dolphins



Activities conducted under NOAA MMPA Permits

2024 CMR field effort

Met all survey goals

33 surveys; 212hrs; 3009km

199 group sightings; 1473 total dolphins

Engaged Local Community

Field Assistant Volunteers

Activities conducted under NOAA MMPA Permit #23203

BACKGROUND | APPROACH | **PROGRESS** | ONWARD

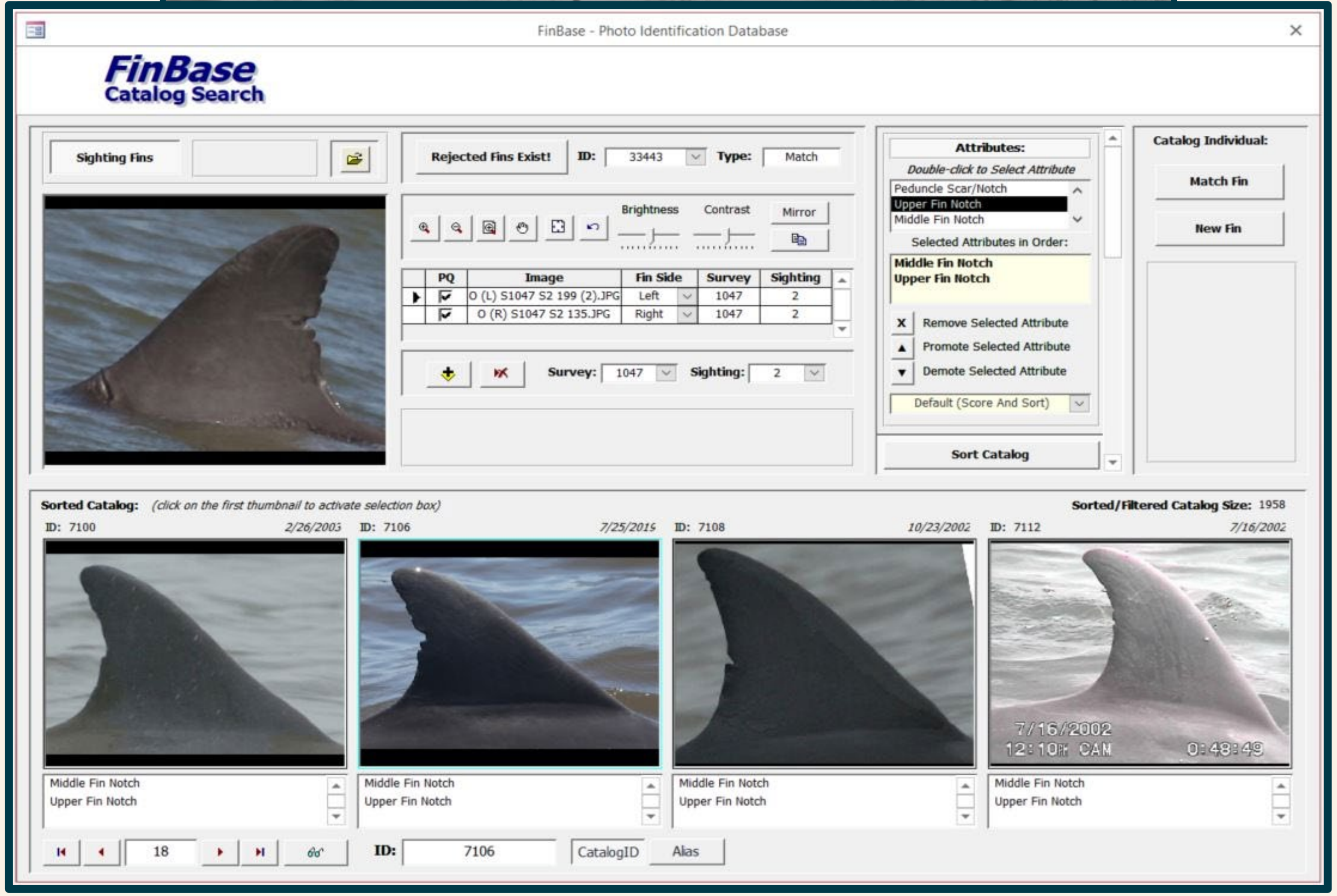
First round of photo analysis

11,997 photos

1,473 dolphins encountered

756 identified

GoMDIS and cross-catalog matching



Galveston Bay Dolphin Research Program · Texas Marine Mammal Stranding Network · NOAA National Centers for Environmental Information · Texas A&M University Galveston Campus

The Gulf of Mexico Dolphin Identification System

Sarasota Dolphin Research Program · Brookfield Zoo Chicago

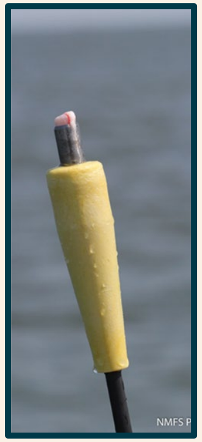
Activities conducted under NOAA MMPA Permits

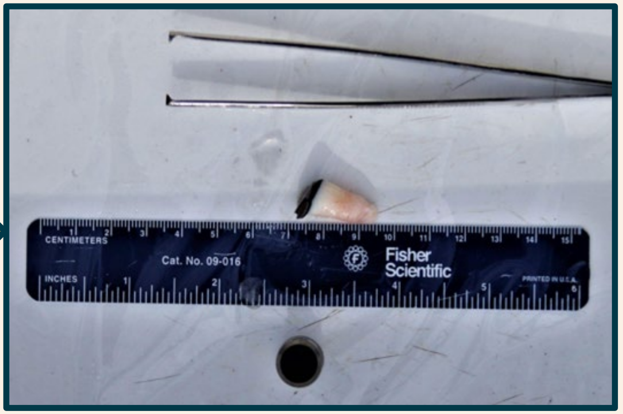
Project Timeline (Oct 2023 – Sept 2028)

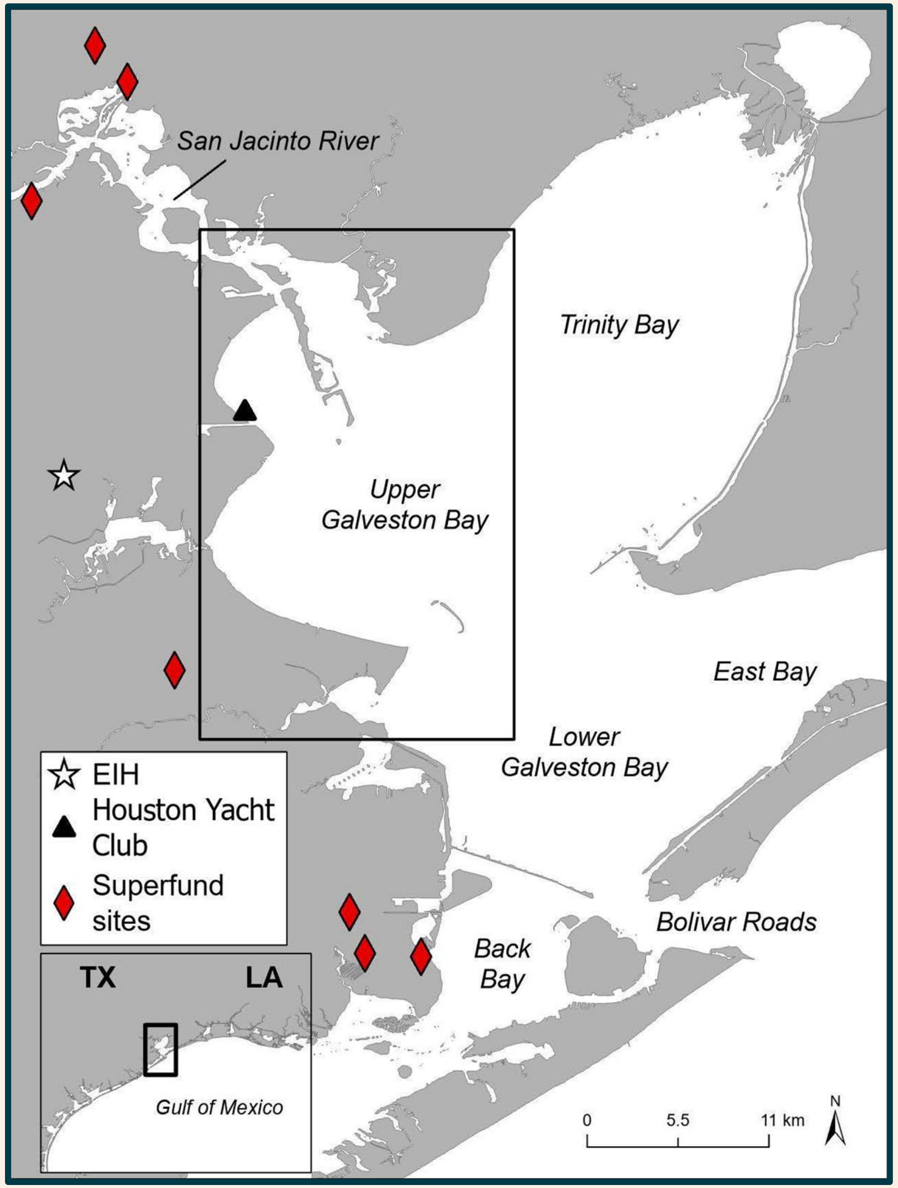
	FY 24	FY 25	FY 26	FY 27	FY 28
	Year 1	Year 2	Year 3	Year 4	Year 5
New data/sample collection and processing	CMR surveys	Remote biopsy sampling	CMR surveys		CMR surveys
Existing data/sample curation and processing		Previously collected skin/blubber (remote bx + strandings)			
Analyses & Interpretation			Analytical Chemistry / Epigenetics / Cell -line exposure / CMR modeling		
Final touches					Reporting / MS prep / Archiving

Reporting, outreach, and end user engagement throughout the project period

2025 Remote Biopsy Sampling







Biopsy operations conducted under authority of NOAA MMPA Permit #28894

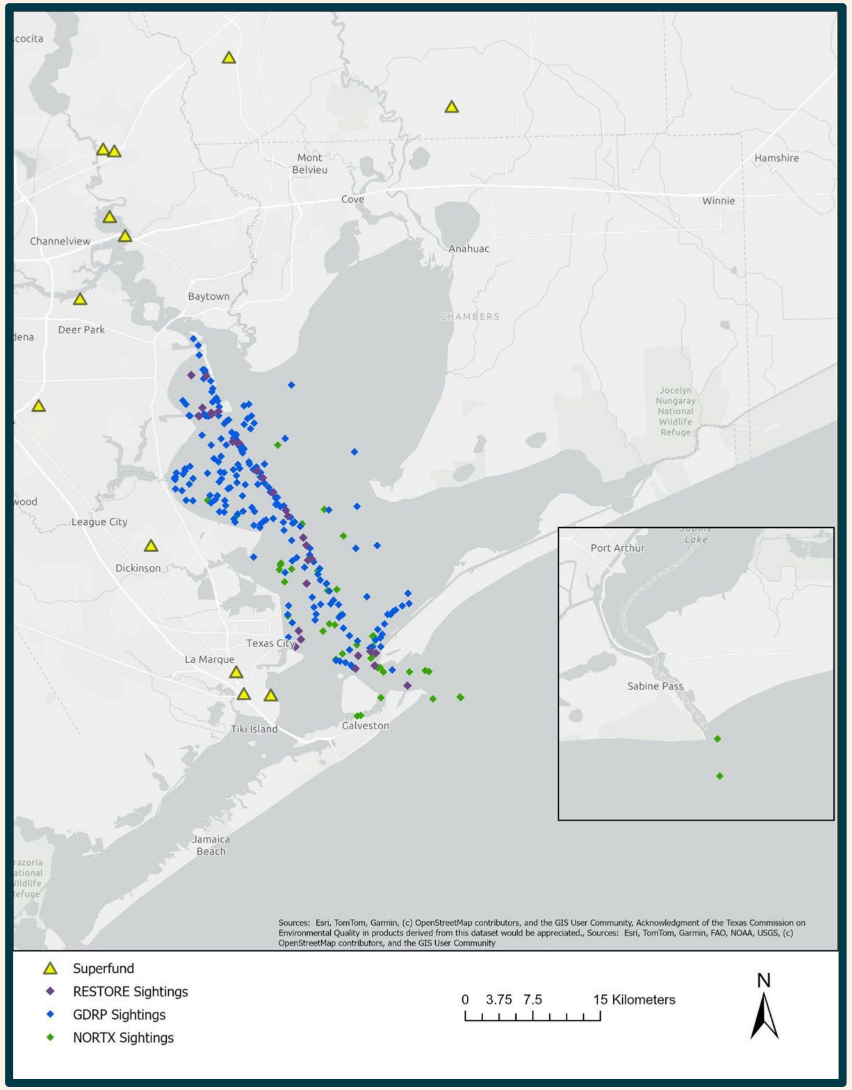
2025 Remote Biopsy Sampling

35 samples
(32 full; 3 partial)

Most were known dolphins

10 dolphins with
10yr+ sighting histories

3 previously sampled
(2015-2018)



Biopsy operations conducted under authority of NOAA MMPA Permit #28894

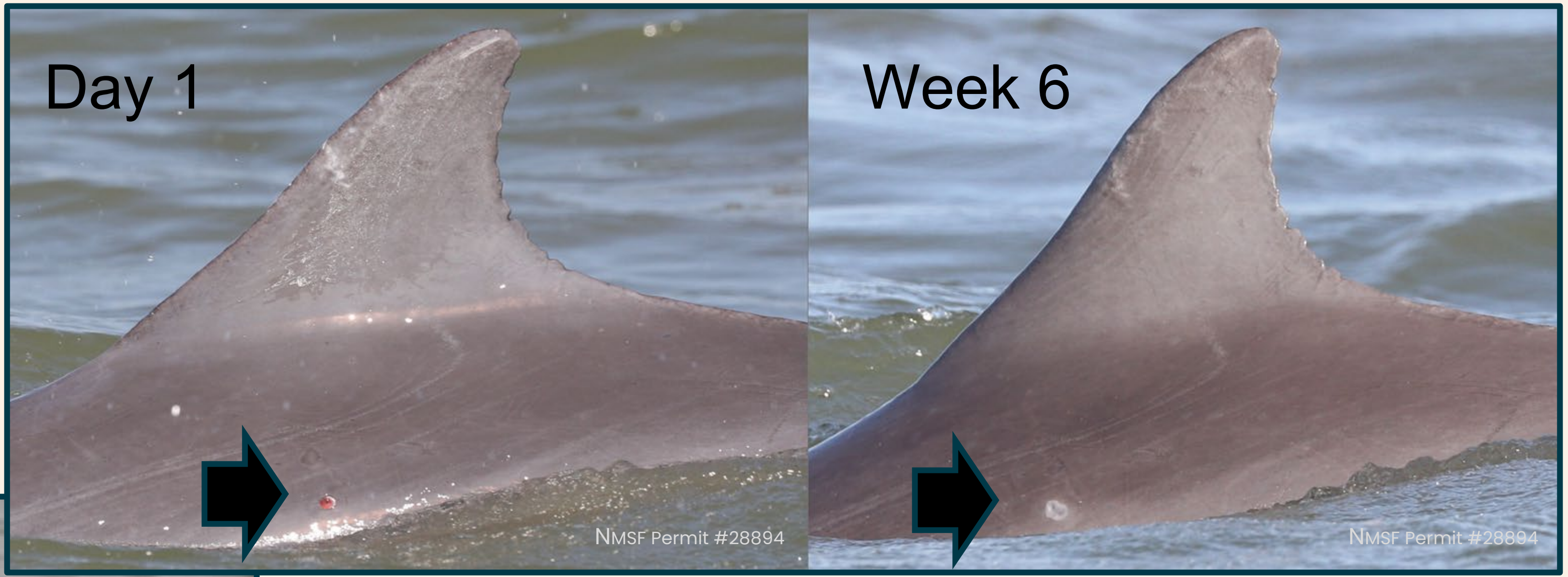
2025 Post-Biopsy Sampling surveys

September- October 2025

40 hours

355km

52 groups sightings



Follow up observations on 19 individuals

Wounds are healing well!

Project Timeline (Oct 2023 – Sept 2028)

	FY 24	***FY 25***	***FY 26***	***FY 27***	***FY 28***
	Year 1	Year 2	Year 3	Year 4	Year 5
New data/sample collection and processing	CMR surveys	Remote biopsy sampling	CMR surveys		CMR surveys
Existing data/sample curation and processing		Previously collected skin/blubber (remote bx + strandings)			
Analyses & Interpretation			Analytical Chemistry / Epigenetics / Cell -line exposure / CMR modeling		
Final touches					Reporting / MS prep / Archiving

Reporting, outreach, and end user engagement throughout the project period

Analyses of Archived Tissue Samples and Long-term Photo-ID

Leveraging over a decade of research in the Bay!

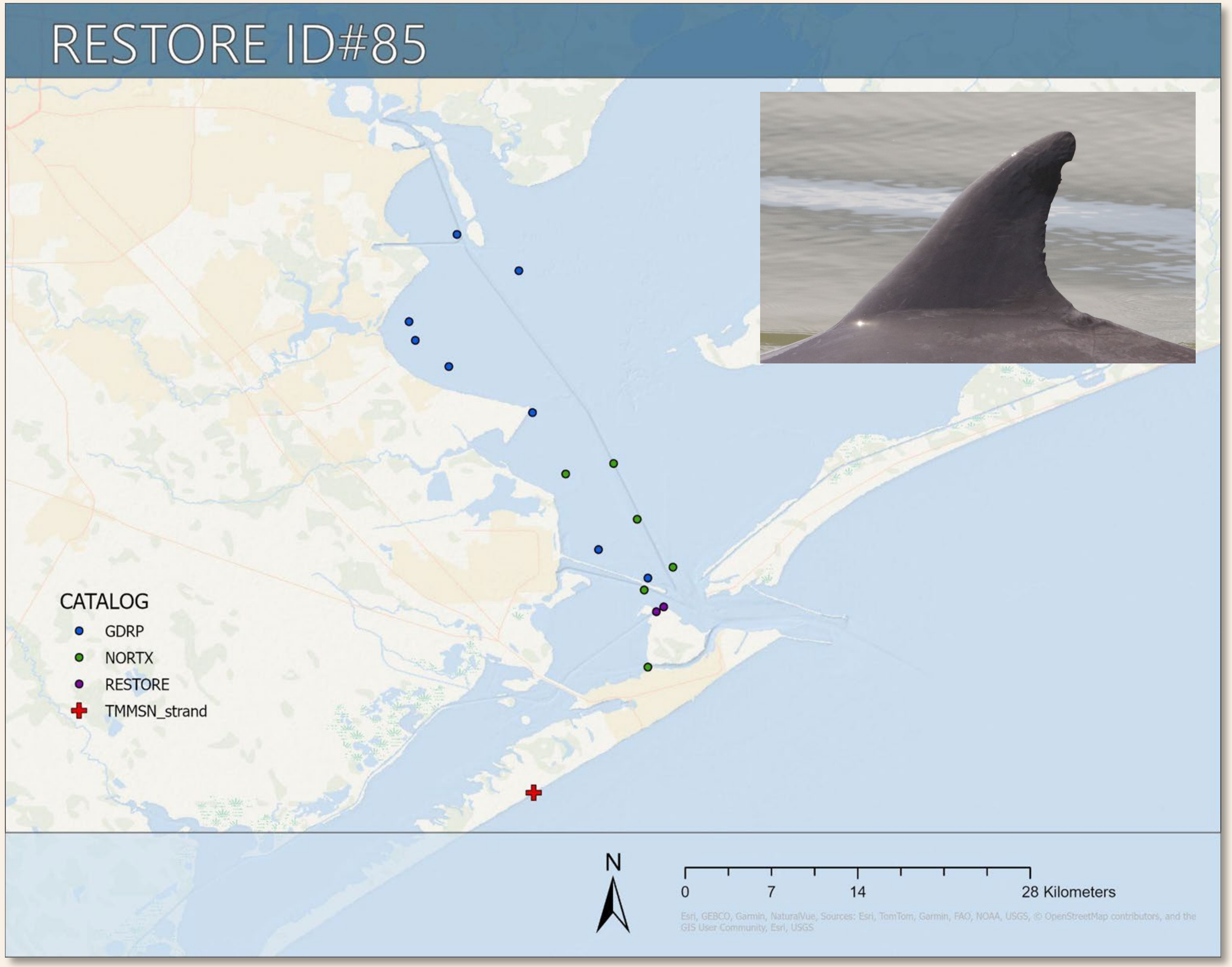
Source	Season	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Remote Biopsy													
	Warm (May-Oct)	13	10	12	13							35	**83**
Stranded													
	Cool (Nov-Apr)		1	2	4	3	1				2	2	**15**
	Warm (May-Oct)		1			1		2					**4**
		13	12	14	17	4	1	2			2	37	**102**

Analyses of Archived Tissue Samples and Long-term Photo-ID

Leveraging over a decade of research in the Bay!

Dolphin R85, Male:

- First sighted in 2016
- Sighted 16times
- Stranded 12/30/2024
- Antemortem vessel strike, eosinophilic bronchopneumonia, verminous gastritis

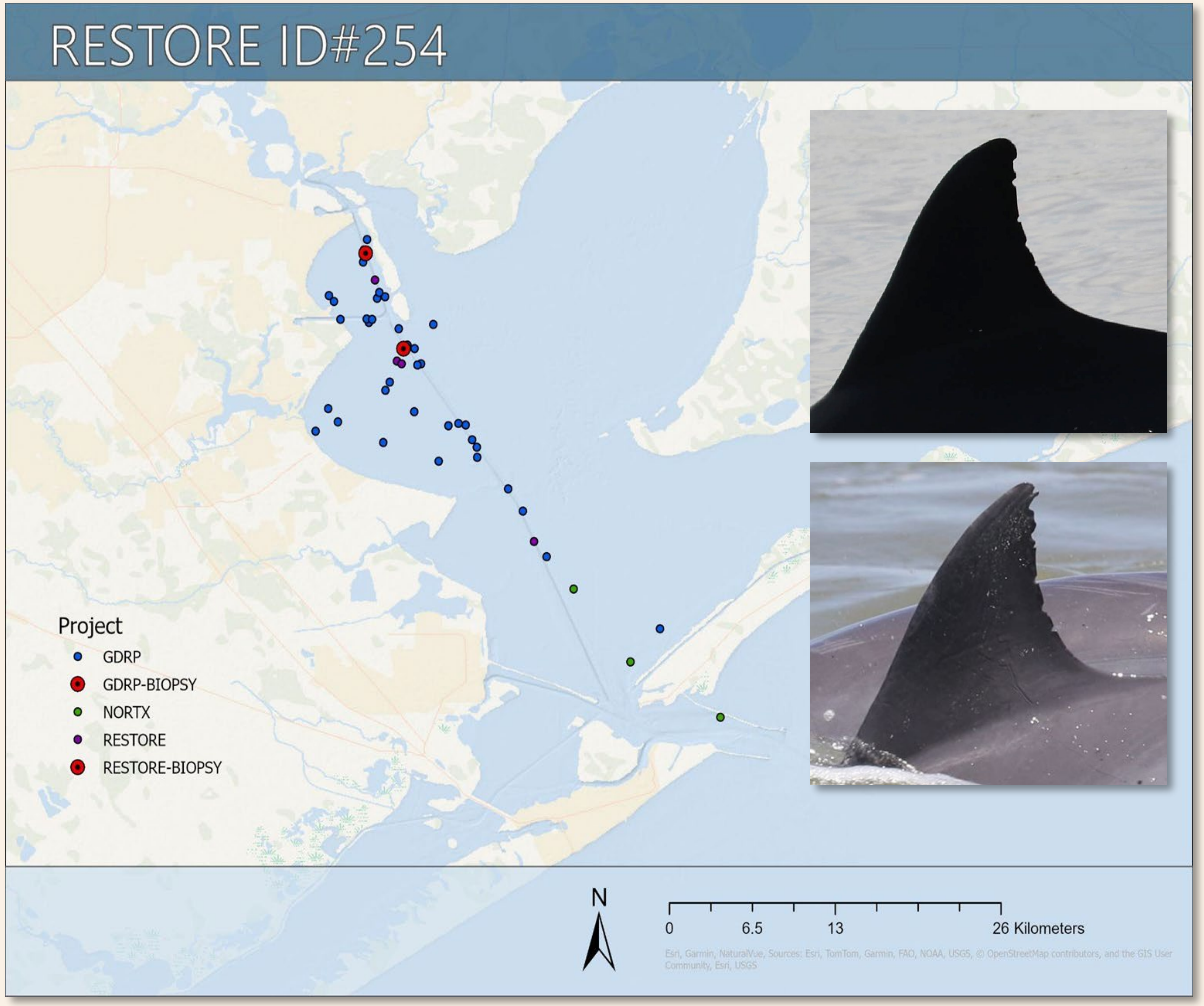


Analyses of Archived Tissue Samples and Long-term Photo-ID

Leveraging over a decade of research in the Bay!

Dolphin R254 (a.k.a. "Jack Henry"), Male:

- First sighted in 2015 as a calf
- Independent from mom in 2016
- Sighted 46+ times
- Long-term monitoring and cross-catalog matching tracked changed fin
- Sampled in 2018 and 2025
- Σ45PCBs = 90322.58 ng/g lipid @ Age 5



Project Timeline (Oct 2023 – Sept 2028)

	Year 1 (*FY 24*)	Year 2 (*FY 25*)	Year 3 (*FY 26*)	Year 4 (*FY 27*)	Year 5 (*FY 28*)
New data/sample collection and processing	CMR surveys	Remote biopsy sampling	CMR surveys		CMR surveys
Existing data/sample curation and processing		Previously collected skin/blubber (remote bx + strandings) (spans Years 2–3)			
Analyses & Interpretation			Analytical Chemistry / Epigenetics / Cell -line exposure / CMR modeling (spans Years 3–5)		
Final touches					Reporting / MS prep / Archiving

Reporting, outreach, and end user engagement throughout the project period

Project Questions and Approaches

1. What are the current levels of PCBs and dioxins in the blubber of Houston area dolphins?

Analytical chemistry

2. Is there any interaction between the toxic effects of dioxins and PCBs, since both can disrupt similar physiological systems?

Laboratory cell-culture exposures

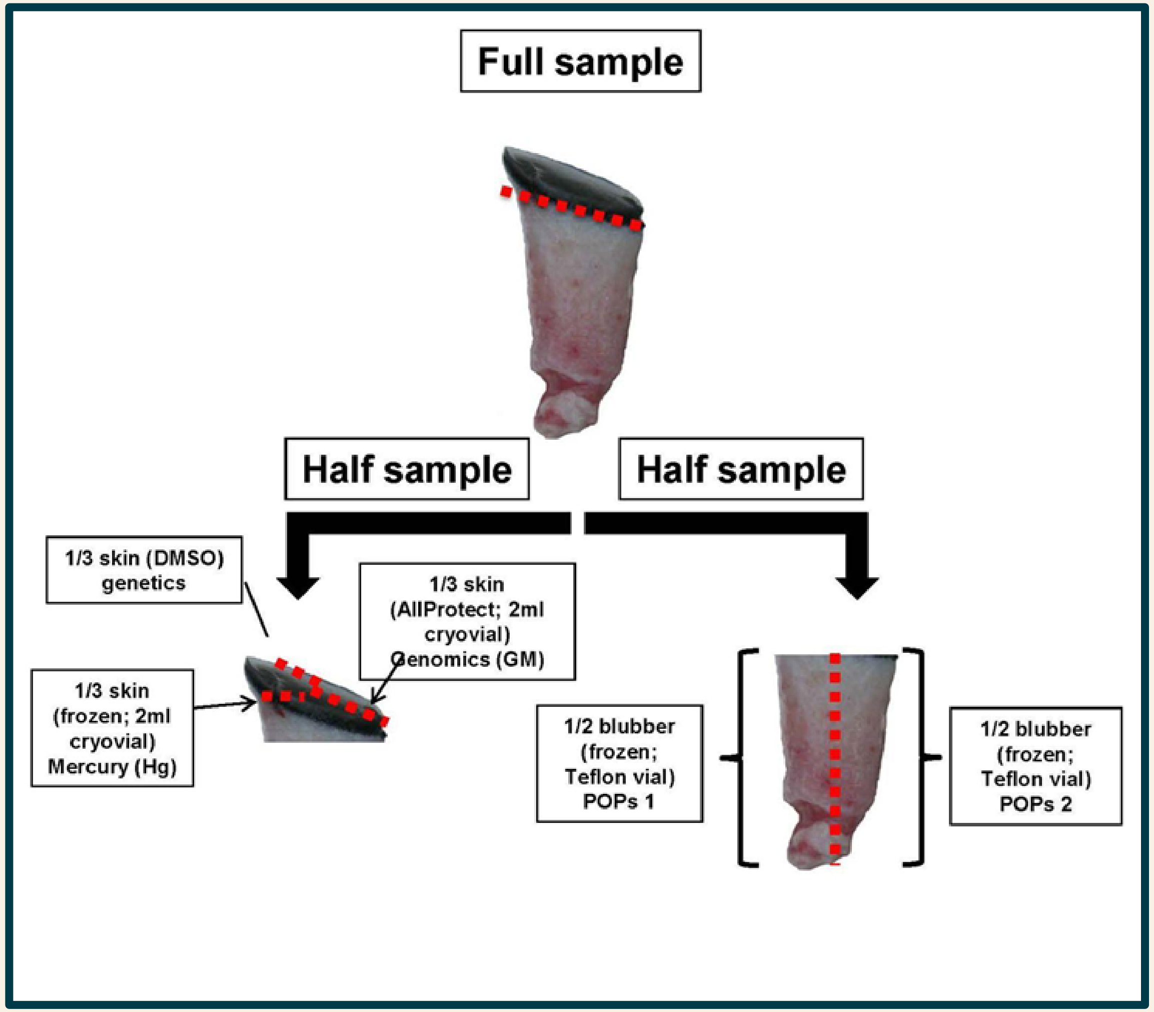
3. Is the health of Houston area dolphins consistent with their chronological age?

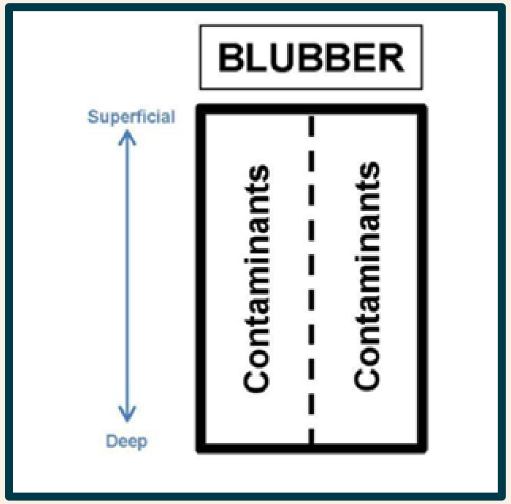
Epigenetic analysis

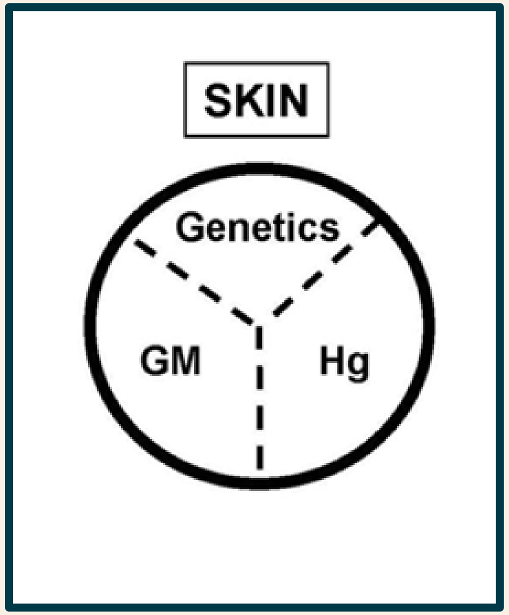
4. What are the survival rates of Houston area dolphins compared to others in the Southeastern US?

CMR surveys and population modeling

1. Subsampling and Laboratory Analyses







½ blubber for PCBs

½ blubber for dioxins

1/3 skin for Epigenetics

1/3 skin for Mercury

TEXAS ENVIRONMENTAL EXCELLENCE AWARDS EST. 1993

GALVESTON BAY ESTUARY PROGRAM

TEXAS A&M UNIVERSITY GALVESTON CAMPUS

1/3 skin will be archived

2. Cell-line exposure experiments

Table 1. Mechanisms and Effects of Thyroid Disruptors[55,60]

Thyroid Disruptors	Mechanism	Effect
Perchlorates, thiocyanate, nitrate, bromates, phthalates	Blocking uptake of iodide into thyroid cell	Decreased synthesis of T3 and T4
Methimazole, amitrole, soy isoflavones, benzophenone 2	Blocking production of TPO in thyroid follicles	Decreased synthesis of T3 and T4
PCBs, pentachlorophenol, flame retardants, phthalates	Competitive binding to thyroid transport protein (TTR)	Possible effect on fetal brain T4 production
Dioxin, PBDE, chlordane	Altering transport across cell membrane	Increased biliary elimination of T3 and T4
Acetochlor (herbicide), PCBs	Enhanced hepatic metabolism	Increased biliary metabolism of T3 and T4
PCBs, triclosan, pentachlorophenol, dioxin, difuran	Inhibition of sulfation	Decreased sulfation of thyroid hormones leading to possible decrease of peripheral T3 synthesis
FD&C red dye #3, PCBs, octyl-methoxycinnamate	Inhibition of deiodinase activity	Decreased peripheral T3 synthesis
PCBs, bisphenol A, hexachlorobenzene, flame retardants	Altering binding to thyroid receptor	Altered thyroid hormone directed gene transcription
DDT, PCBs	Inhibiting TSH receptor	Decreased production of T3 and T4

Patrick (2009) Alternative Medicine Review 14(4)

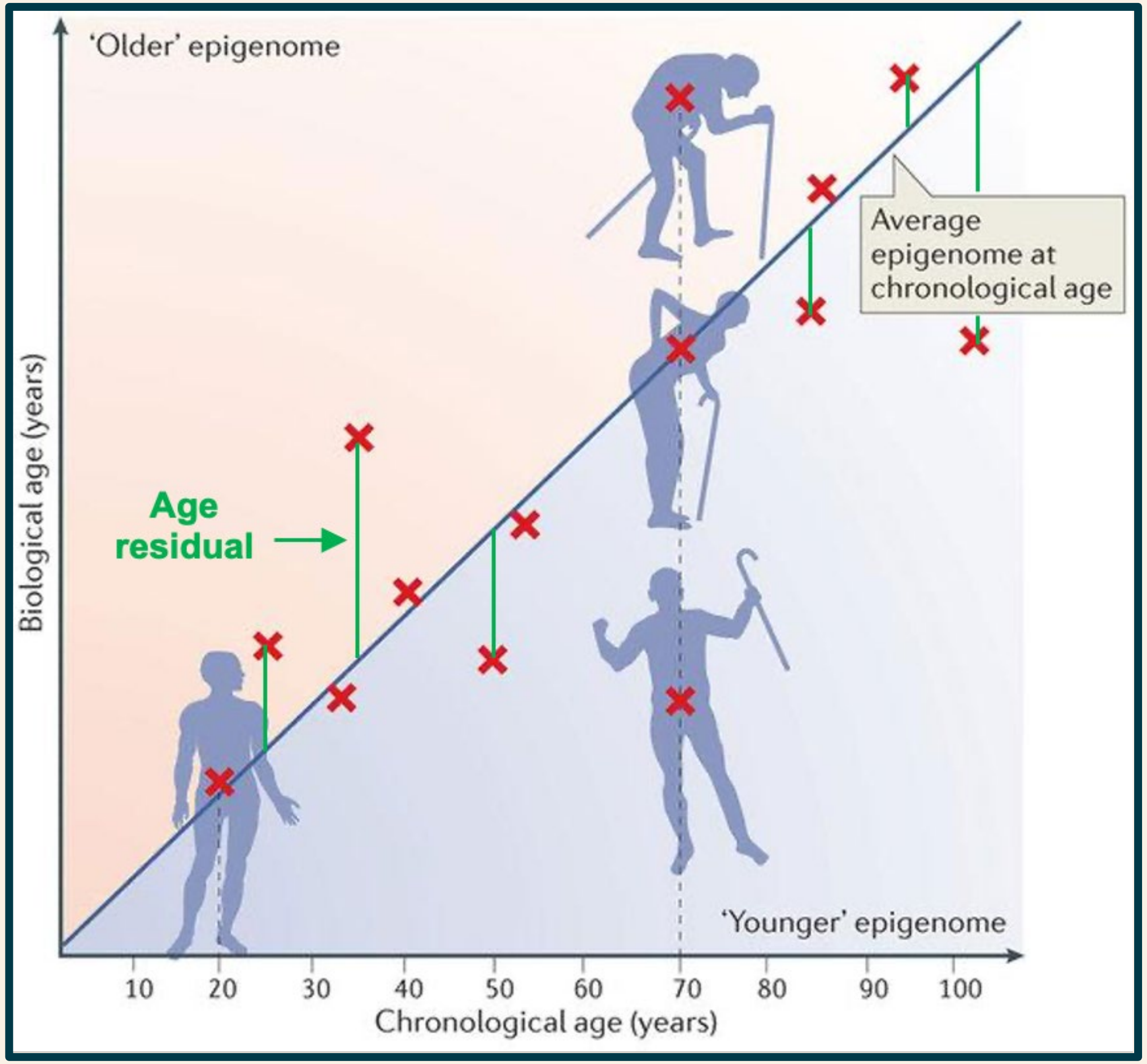
Understand the physiological impacts of dioxins alone, PCBs alone, and both chemicals together

Both PCBs and dioxins disrupt the HPT axis– interaction could be additive, synergistic, or antagonistic

Establish D-R relationships

HPT axis= Hypothalamic-Pituitary-Thyroid axis

3. Evaluating health/fitness using epigenetics



Benayoun (2015) 10.1038/nrm4048

Estimate **chronological age** (based on number of years since birth) and **biological age** (based on health, stress, and lived experience)

If dolphins are exposed to dioxins and PCBs, there will be a **discrepancy between their biological and chronological ages**.

Epigenetics → study of how behaviors and environment affect how your genes work, without altering DNA sequence

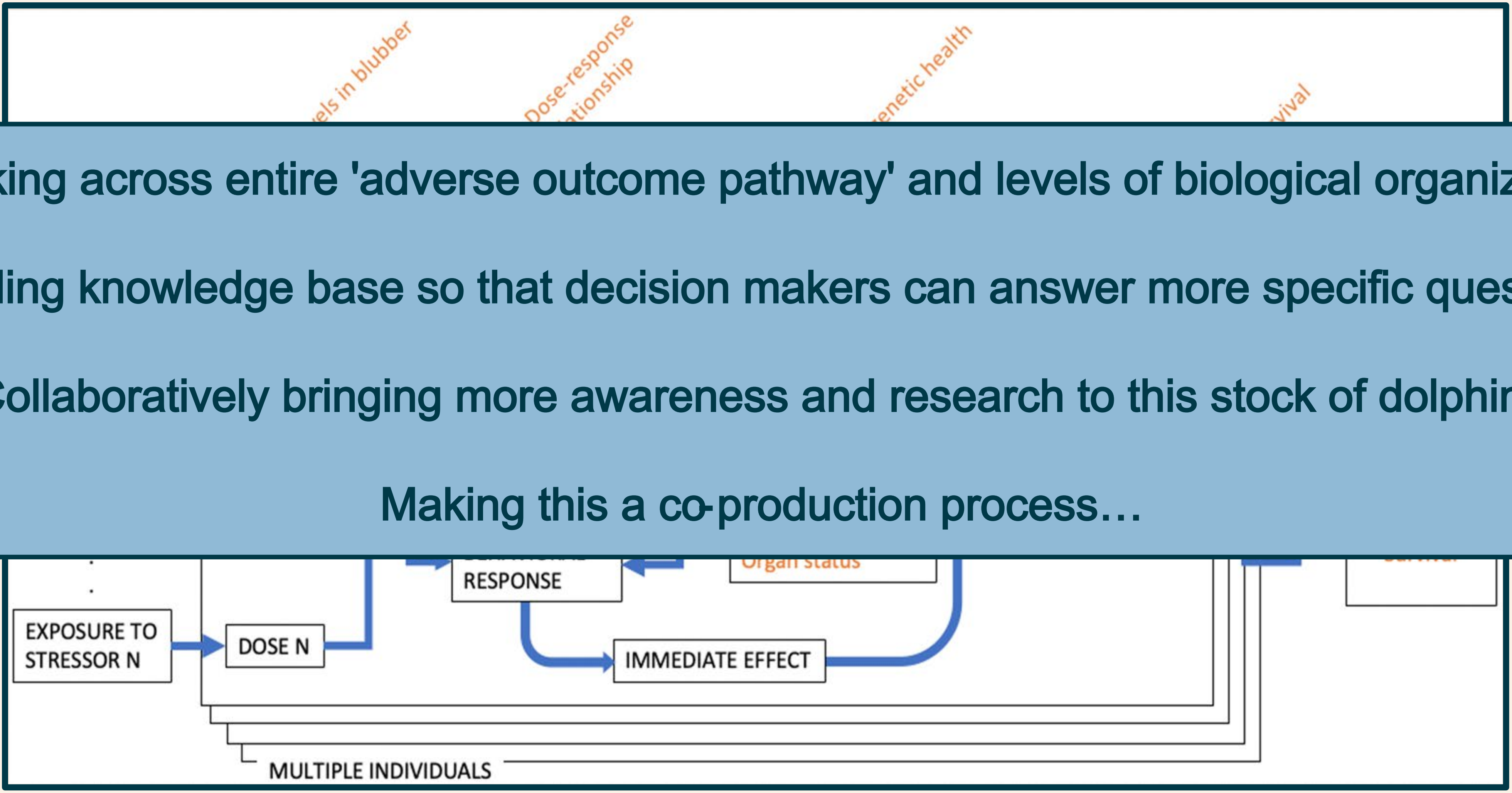
4. Survival Analyses

CMR Surveys in 2026 and 2028

Spatial mark recapture analyses of CMR surveys (OpenSCR)

Application of Barker model to combined long-term/historical datasets

Synthesis: PCoMS Model Development



Working across entire 'adverse outcome pathway' and levels of biological organization

Building knowledge base so that decision makers can answer more specific questions

Collaboratively bringing more awareness and research to this stock of dolphins

Making this a co-production process…

DISCUSSION - STAKEHOLDER ENGAGEMENT

1. What's missing from the study design, analyses, and/or deliverables that would benefit you and other stakeholders?

2. Consider the implications for restoration/conservation. Do you think the project helps identify ways to quantify the benefits/progress of restoration activities?

3. What end products/analyses from the activities we described would be most useful to local and state natural resource managers?

4. Are there any potential collaborators/future applications that we should meet?

5. Are there datasets we should be aware of and integrate into our analyses?

Please tell us what you think!

Thank you for your attention and participation!

vmintzer@galvbay.org
Ryan.Takeshita@mmf.org

RESTORE SCIENCE PROGRAM

UNT UNIVERSITY OF NORTH TEXAS

NATIONAL MARINE MAMMAL FOUNDATION

MARINE MAMMAL COMMISSION

Texas Marine Mammal Stranding Network

Please stay tuned…

GALVESTON BAY FOUNDATION

GALVESTON BAY DOLPHIN RESEARCH PROGRAM

Environmental Institute of Houston

NOAA

Special thanks to Matthew Bowers, Anastasia Konefal, Miranda Madrid, Wayne McFee, and Frank Parker