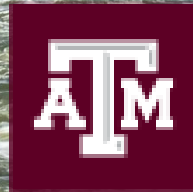


Long-term monitoring efforts supporting science-based management of Galveston Bay

Hui Liu



TEXAS A&M UNIVERSITY
College of Marine Sciences
& Maritime Studies

Outline

- **Why do we need monitoring of the bay?**
- **What is an effective monitoring?**
- **What have we been doing in the bay?**
- **Application and implication**

Why we need monitoring of Texas estuaries



- Galveston Bay has experienced natural disasters (e.g., hurricanes and droughts) and man-made disasters (e.g., oil spills, pollutions etc.).
- Assessing impacts of these disturbances is challenging.
- Effective monitoring has been proven a meaningful tool for post-disaster assessment and restoration efforts.

Urgent status for Texas estuaries

Texas, and most of the western US, is suffering a severe water crisis because of ongoing drought, changing weather patterns, increased water demand, and depleted surface and ground water resources.



DONATE

School Ratings

Big Bend

THC Ban

U.S. Senate Polls

TribFest 2026

Texas is running out of water. Here's why and what state leaders plan to do about it.

The state's water supply faces numerous threats. And by one estimate, the state's municipal supply will not meet demand by 2030 if there's a severe drought and no water solutions are implemented.

BY [ALEJANDRA MARTINEZ](#), [JAYME LOZANO CARVER](#), GRAPHICS BY [CARLA ASTUDILLO](#) AND
GRAPHICS BY [YURIKO SCHUMACHER](#)

REPUBLIC [↗](#) SHARE

MARCH 13, 2025, 1:01 P.M. CENTRAL UPDATED MARCH 13, 2025, 1:01 P.M. CENTRAL



State Needs:

a critical need to increase water development projects to support current and future industrial and municipal needs.

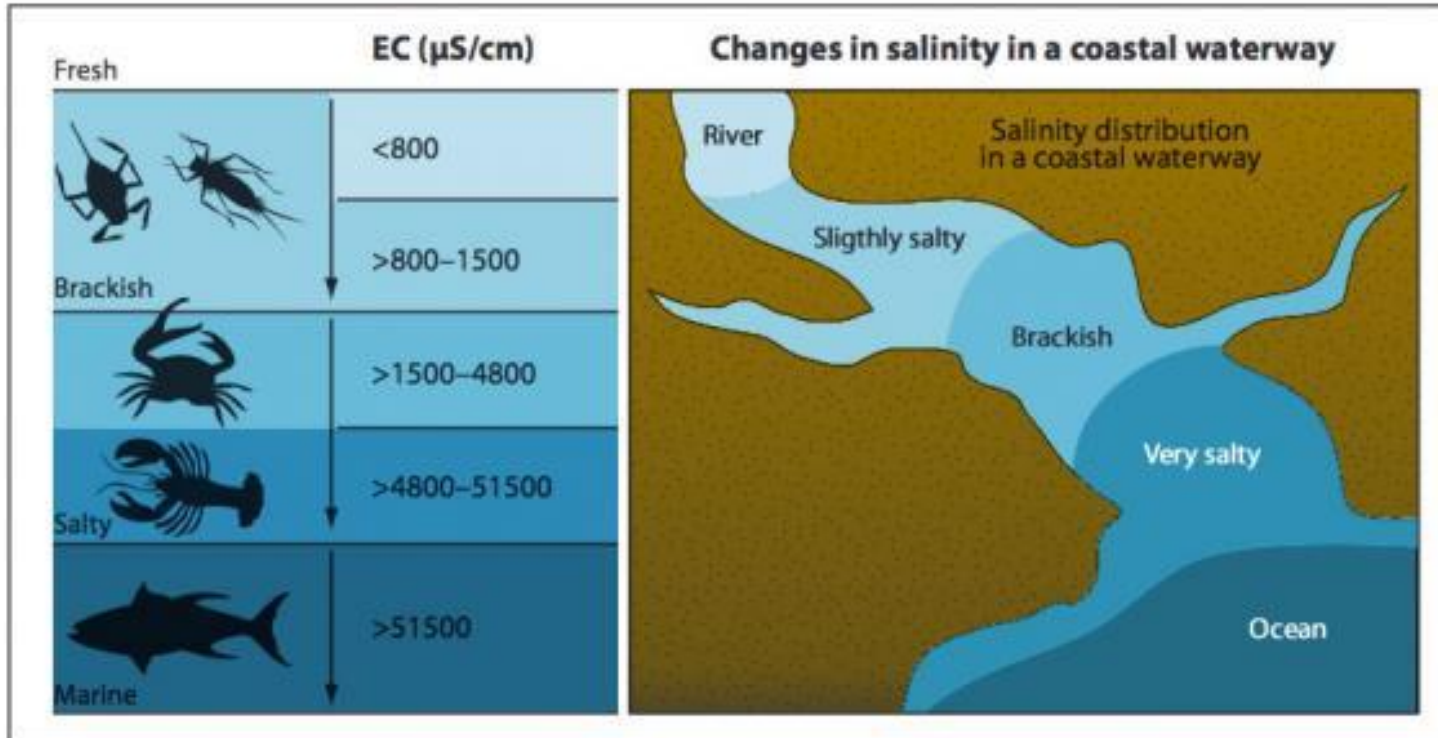
What effective monitoring should be

- Focusing on sensitive indicators (e.g., environmental and biological)
- Conducting consistently in space (fixed sites) with broad coverage of the bay
- Conducting consistently in time (biweekly, monthly, etc.)
- Sufficient details on taxon levels (species/genus, not bulk samples etc.)
- Standard protocols for sample collection and sample processing
- Maintaining the monitoring as long as possible to generate valuable time series data

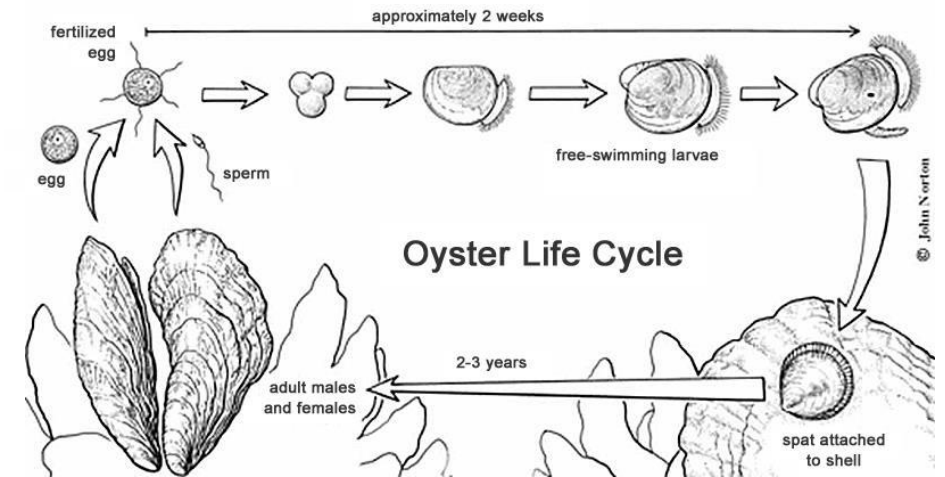
Key species in estuaries and salinity

with focuses on Zooplankton and oyster larvae

Salinity in estuaries



Source: Adapted from Oz Estuaries – Changes in salinity in an estuary



Current lack of zooplankton and oyster larvae in Galveston Bay

312 Zooplankton

313 Zooplankton are microscopic drifting animals that feed on phytoplankton or smaller zooplankton and are
314 conduits of energy transformation from primary producers to higher levels of the bay foodweb.
315 Zooplankton are poikilothermic (having a variable body temperature similar to the temperature of their
316 external environment) and short-lived and are subject to ocean conditions and circulation patterns (Liu et
317 al. 2017). Zooplankton communities in the Northwestern Gulf of Mexico are dominated by copepods, but
318 also consist of larvaceans and various meroplanktonic larvae (Liu et al. 2017). Large increases in
319 zooplankton populations are often observed after extensive flushing of estuaries from high river runoff
320 (Buskey 1989). Galveston Bay may have lower zooplankton abundance than many other Texas estuaries
321 (Buskey and Schmidt 1992), with a typical range for Trinity Bay of 1,200 to 16,000 zooplankton per cubic
322 meter of water. Buskey (1993) reported a mean abundance of mesozooplankton in Nueces Bay of 6,100 per
323 m³ in daytime samples.

324 In a recent study, Liu et al. (2017) analyzed zooplankton samples collected from six stations in Galveston
325 Bay in 2008 and 2009. Samples were dominated by copepods (*Acartia tonsa*, *Oithona* sp. and *Parvocalanus* sp.)
326 and zooplankton nauplii. Zooplankton abundance was greatest in upper reaches of Galveston Bay near
327 riverine inputs (58.5 ± 38.89 to 96.52 ± 33.7 individuals per liter), while zooplankton diversity was greatest
328 near Bolivar Roads. Zooplankton diversity was found to be significantly correlated with salinity ($r=0.53$,
329 $p<0.001$). Zooplankton abundance was significantly correlated with temperature ($r=0.46$, $p<0.001$).

330 Benthic Organisms

331 *Benthos* refers to organisms that live in, on, or near the bay bottom, including plants, invertebrates, and
332 fishes of all sizes. Benthic organisms are an important component of the estuarine food web. Fish including

Current Status: pelagic larvae remain poorly understood for better restoration of oyster fisheries.

STATE OF THE BAY
A Characterization of the Galveston Bay Ecosystem

Welcome Overview Water, Sediment, and Health Living Resources Data, Maps, and Stories Search

Welcome to State of the Bay

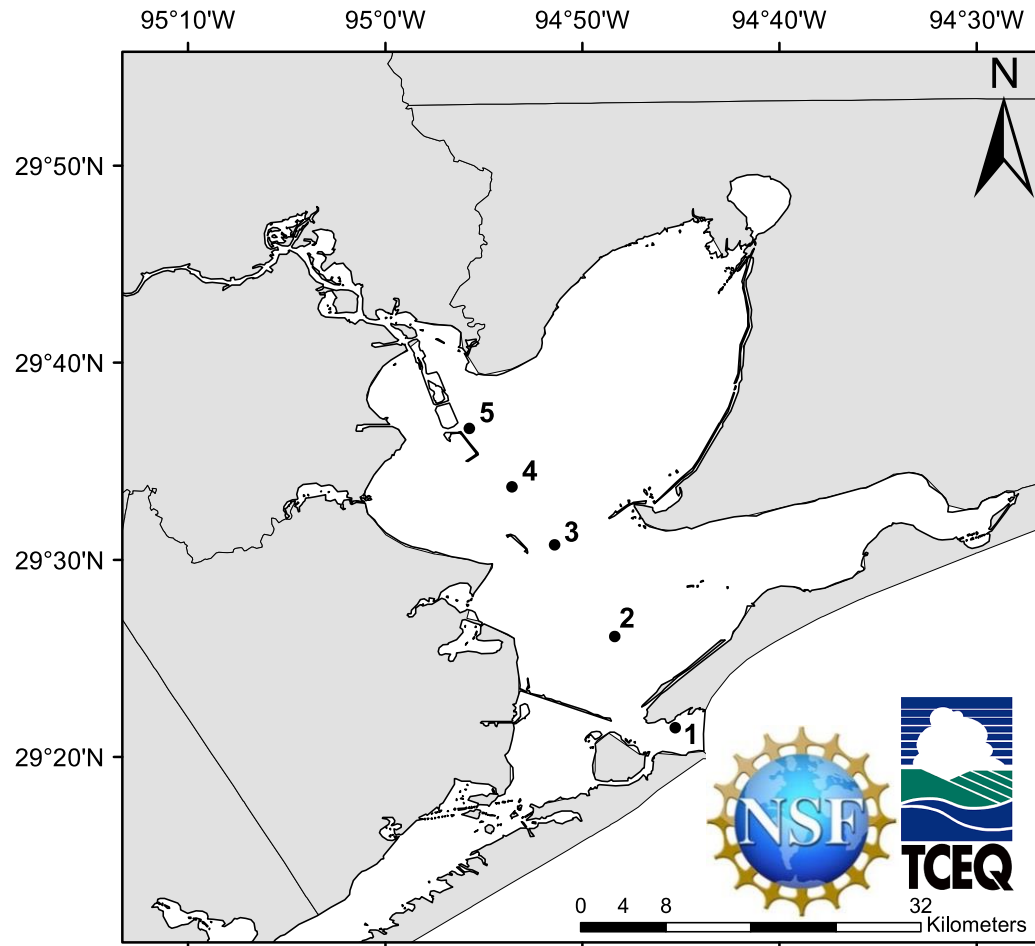
The State of the Bay, 4th Edition (State of the Bay) is sponsored by Texas Commission on Environmental Quality's (TCEQ) Galveston Bay Estuary Program (GBEP) as a resource for historical context and up-to-date analysis of the conditions in and around Galveston Bay. The State of the Bay includes analysis based on datasets available through December 2017. In some cases, included datasets may be older due to quality assurance review processes and/or data availability at the time of analysis. It is reviewed and created through the collaboration and support of stakeholders and partners who are the experts in their fields working on, in and around Galveston Bay (Figure 1). The goal of the State of the Bay is to summarize information that will facilitate and improve management of Galveston Bay through the [Galveston Bay Plan](#).

The State of the Bay website is a reference for scientists, managers, and decision makers that combines a legacy of scientific monitoring and analysis with current data analysis, visualization tools, maps, success stories, and a database of GBEP supported projects. Each section includes an in-depth discussion of current trends and historical context and is color coded to illustrate how the information supports the four priorities of the 2018 Galveston Bay Plan, GBEP's comprehensive conservation and management plan. State of the Bay color key:

Ensure Safe Human and Aquatic Life Use Engage Communities Protect and Sustain Living Resources Inform Science-Based Decision Making

Maps and select graph figures featured in the text of each section are available in an interactive [Map Gallery and Data](#)

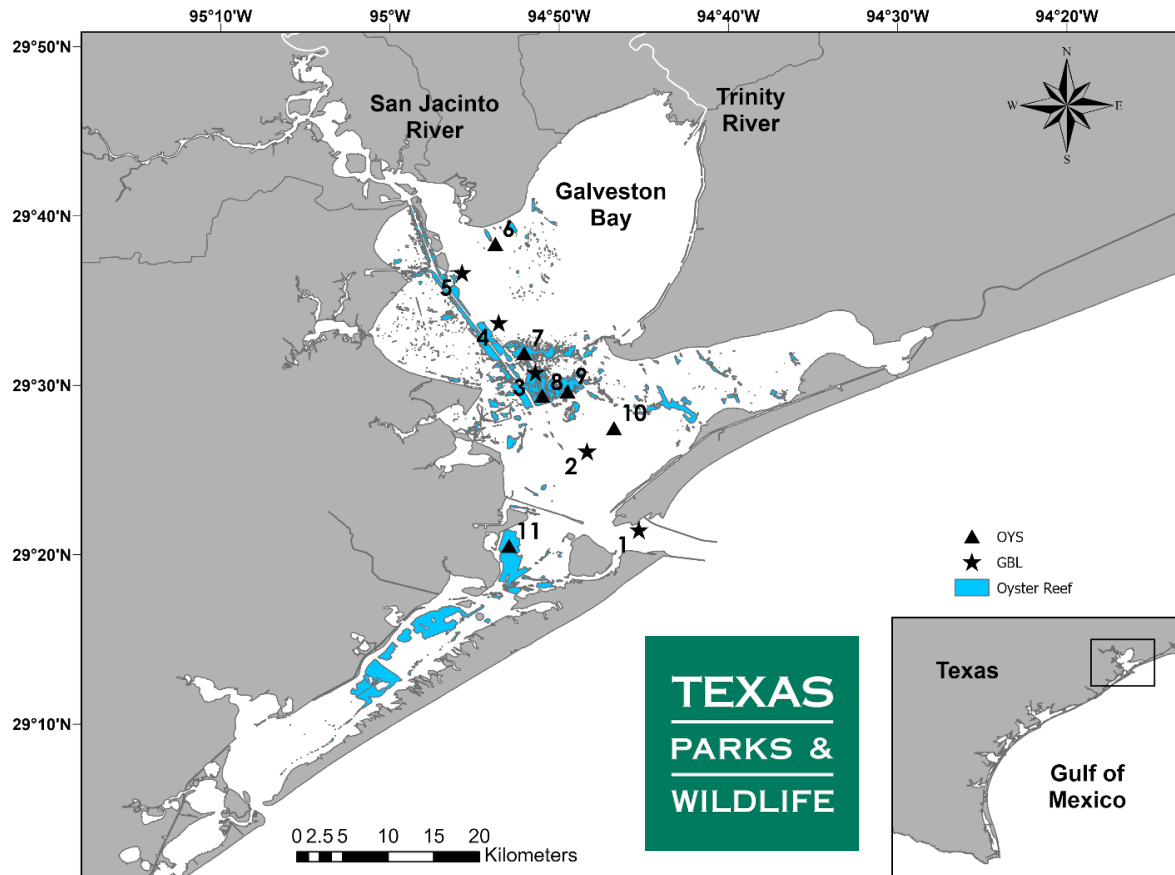
What we have done on zooplankton



- Monthly sampling zooplankton September 2017 – October 2018 (NSF), September 2022-March 2026 (TCEQ),
- Zooplankton (202µm and 100µm nets)
- Salinity
- Temperature
- Chlorophyll
- pH
- DO



Recent monitoring project on pelagic oyster larvae

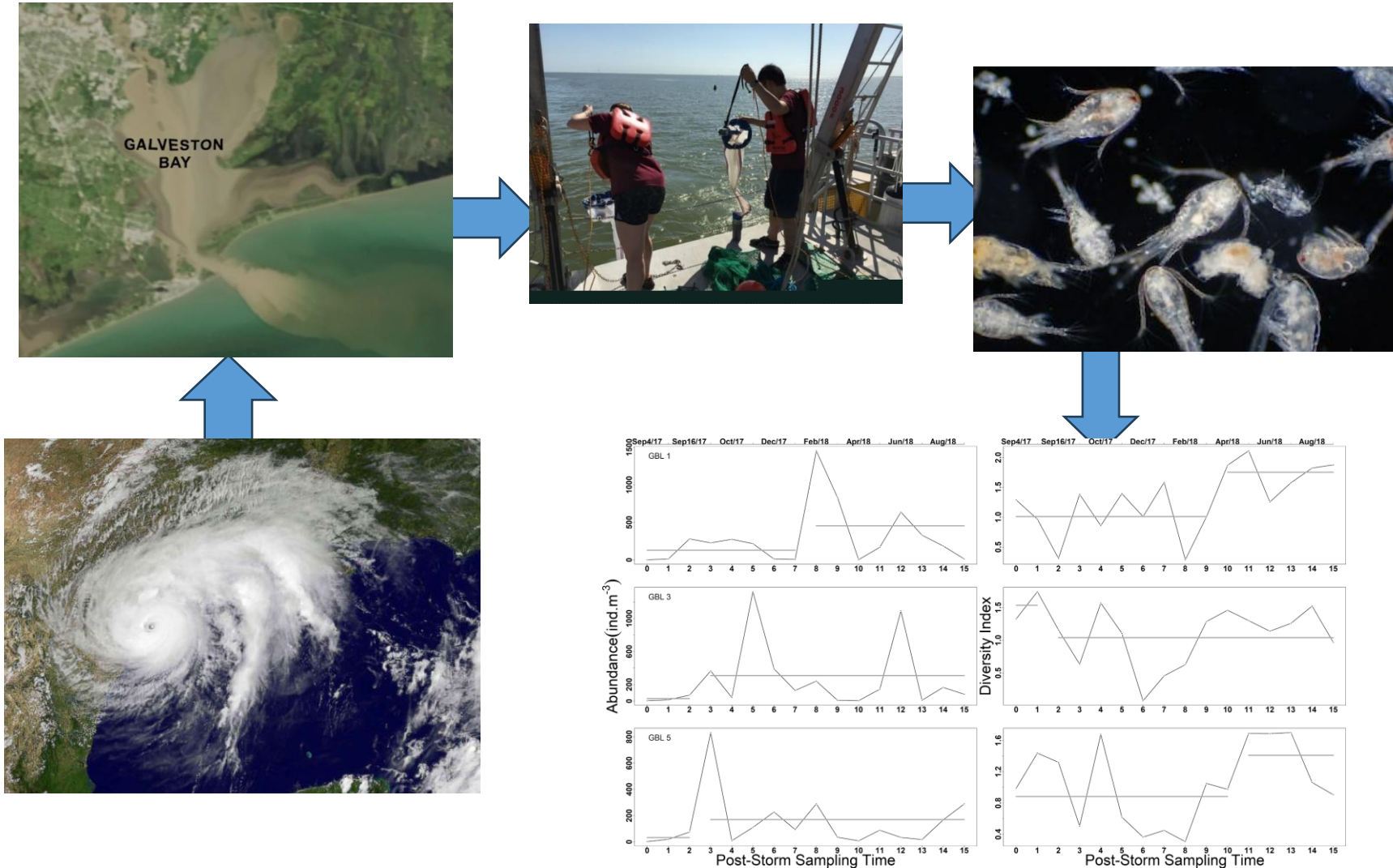


- Monthly sampling zooplankton May –October in 2022, 2023 and 2024 (TPWD)
- Zooplankton (100µm nets)
- Salinity
- Temperature
- Chlorophyll
- pH
- DO



Application and Implication

Disasters, Indicators, Data Analysis and Assessment



Informing Agencies and Stakeholders

- Near-term changes in zooplankton communities were mainly caused by massive flooding.
- Spatial zooplankton ordinations disclosed long-term hurricane impacts to the bay.
- Floods were more harmful than storm surge with ecosystem implications to estuaries.

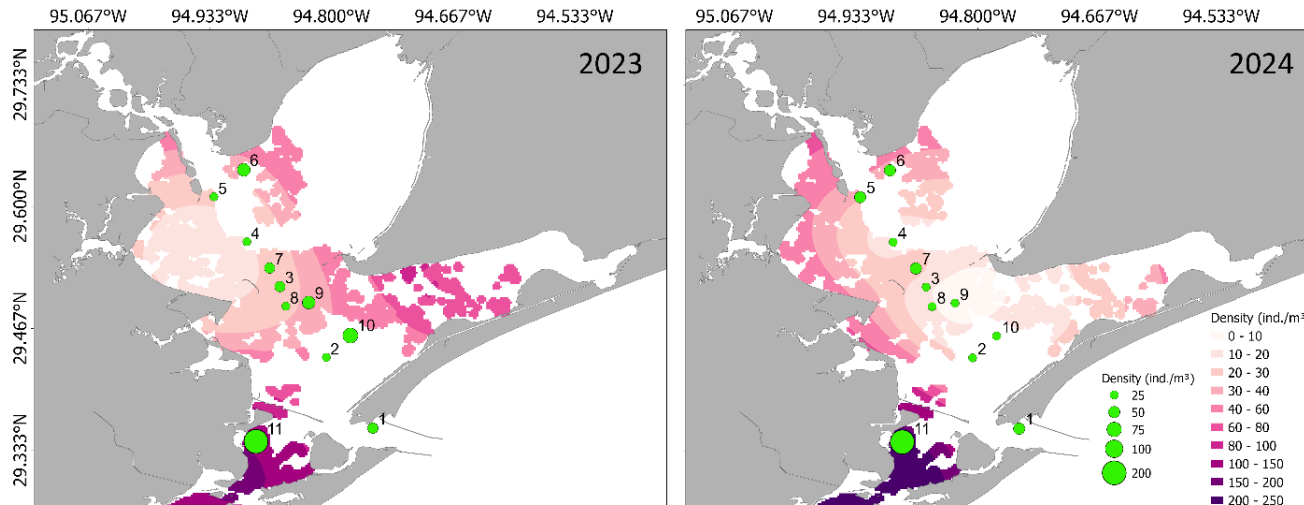
Liu et al. 2021

Application and Implication

Exploration of “Sources” and “Sinks” of larval oysters supporting oyster restoration

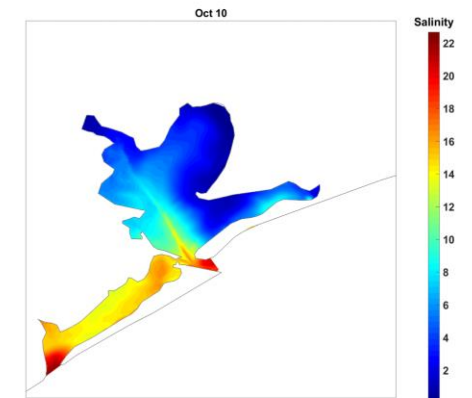
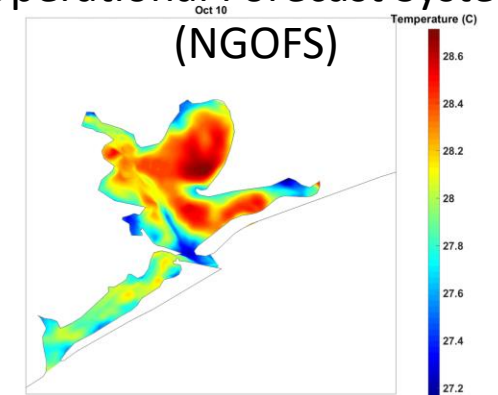
Useful to Agencies and Stakeholders

1. **When** larvae reach their highest density and **How** their densities are related to environmental conditions.
2. **Where** potential oyster sanctuaries could serve as sources of a consistent supply of pelagic larvae.
3. **What** the success of restoration projects would allow for greater confidence in selecting restoration locations.



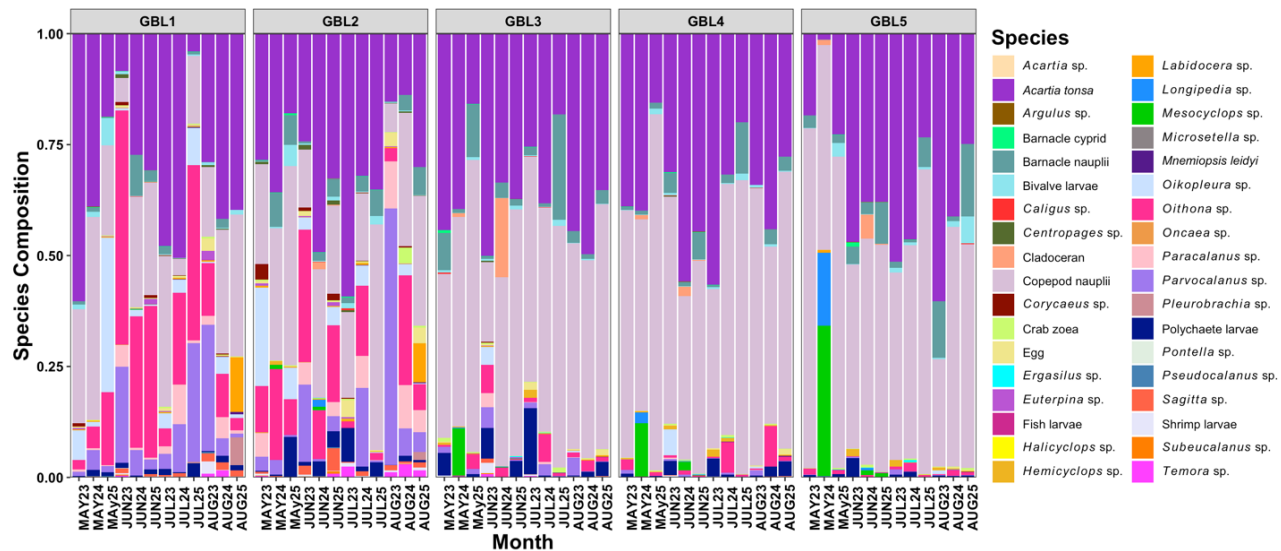
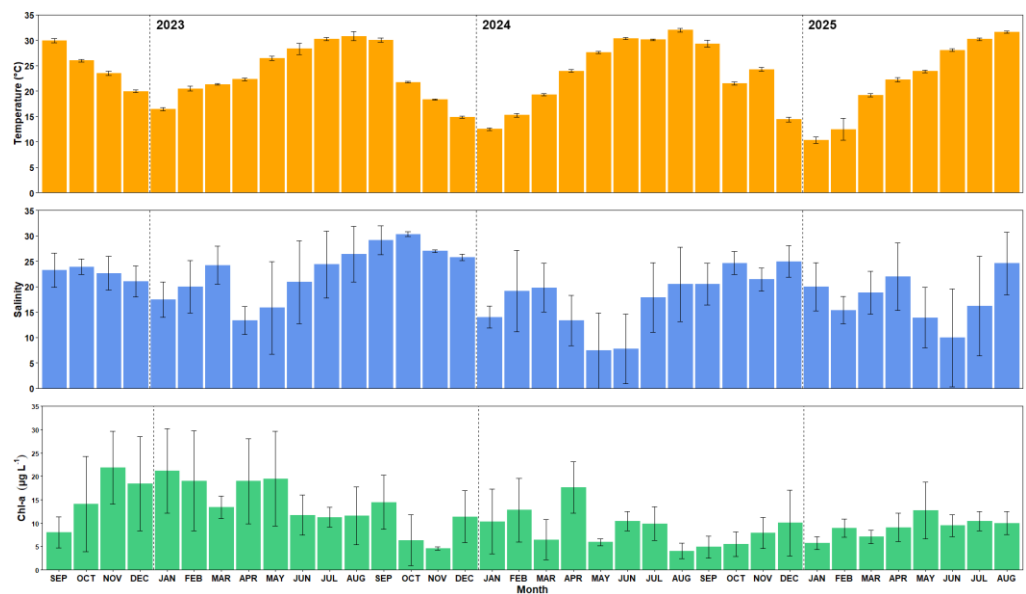
Liu et al. 2025

Northern Gulf of Mexico Operational Forecast System (NGOFS)



- Daily temperature and salinity

Recent outcomes contributing to State of the Bay



Lin et al. in review

Monitoring Ecosystem Indicators for Science-Based Restoration and Enhancement of Pelagic Habitats of Galveston Bay

Final Report



By Hui Liu
Texas A&M University at Galveston
Submitted to Texas Commission on Environmental Quality
January 2026
Contract No. 582-23-40251



Promotion of Galveston Bay Ecosystems in Sciences

IR Inter-Research
Science Publisher

Marine Ecology Progress Series
Volume 756:31–49

Published March 13, 2025
<https://doi.org/10.3354/meps14805>



Modeling larval recruitment dynamics of eastern oysters *Crassostrea virginica* with implications for restoration and management of oyster fisheries

Chengxue Li^{1,2,*}, Hui Liu¹

¹Department of Marine Biology, Texas A&M University at Galveston, Galveston, Texas 77553, USA

²Present address: NOAA Northeast Fisheries Science Center, Woods Hole, Massachusetts 02543, USA

ABSTRACT: Increasing attention has been devoted to understanding the responses of oyster populations to natural disasters such as hurricanes. In particular, the recruitment of planktonic oyster larvae is crucial to the recovery and sustainability of oyster populations and, by extension, oyster

Journal of Coastal Research	33	5	1038–1050	Coconut Creek, Florida	September 2017
-----------------------------	----	---	-----------	------------------------	----------------

Mesozooplankton Dynamics in Relation to Environmental Factors and Juvenile Fish in a Subtropical Estuary of the Gulf of Mexico

Hui Liu^{†*}, Xinsheng Zhang[‡], Qing Yang[§], Tao Zuo^{§§}, and Antonietta Quigg^{†,††}

[†]Department of Marine Biology
Texas A&M University at Galveston
Galveston, TX 77553, U.S.A.

[§]National Marine Environmental Monitoring Center

[‡]NOAA/National Marine Fisheries Service
Southeast Fisheries Science Center
Panama City, FL 32408, U.S.A.

^{††}Department of Oceanography



www.cerf-jcr.org

Journal of Sea Research 208 (2025) 102628



ELSEVIER

Contents lists available at ScienceDirect

Journal of Sea Research

journal homepage: www.elsevier.com/locate/seares



Exploration of enigmatic pelagic larval oysters (*Crassostrea virginica*) fostering estuarine restoration of oyster fisheries

Hui Liu^{a,*}, Bailey Lin^a, Christine C. Jensen^b, Jaime R. Alvarado-Bremer^a, Hongsheng Bi^c, Zhixuan Song^a, Chengxue Li^{d,f}, Xinping Hu^e

^a Department of Marine Biology, Texas A&M University at Galveston, Galveston, TX 77553, USA

^b Texas Parks & Wildlife Division, Coastal Fisheries Field Office, Dickinson, TX 77539, USA

^c University of Maryland Center for Environmental Science, Solomons, MD 20688, USA

^d National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA 02543, USA

^e Marine Science Institute, The University of Texas at Austin, Port Aransas, TX 78373, USA

^f School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY 11794, USA

Ecological Indicators 123 (2021) 107327

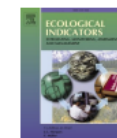


ELSEVIER

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind



Detection of time-varying pulsed event effects on estuarine pelagic communities with ecological indicators after catastrophic hurricanes

Hui Liu^{a,*}, Jillian Gilmartin^a, Chengxue Li^a, Kaizhi Li^b

^a Department of Marine Biology, Texas A&M University at Galveston, Galveston, TX 77553, USA

^b Key Laboratory of Tropical Marine Bio-resources and Ecology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou 510301, China

Thank You

Hui Liu

liuh@tamu.edu

(409)740-4716

