Post-Channel Widening Water Quality Monitoring at Bahia Grande, Cameron County, Texas

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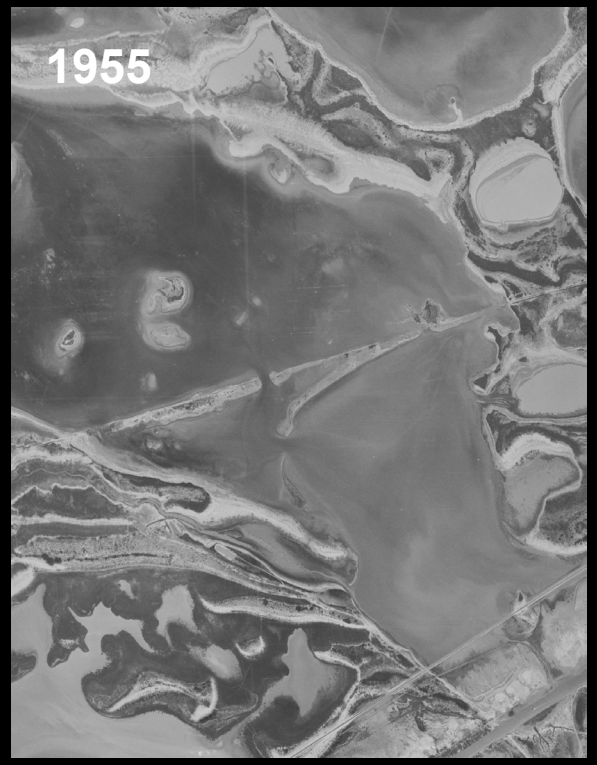
Laguna Madre
Laguna Larga
Little Laguna Madre
Bahia Grande (North)
Bahia Grande (South)
Brownsville Ship Channel
South Bay
Google Earth
Image © 2024 Airbus
3 mi
N

Hypersalinity

- High surface area to volume ratio (< 0.8 m depth over 6,500 acres)
- Low tidal exchange / circulation (or single inlet, lack of flow-through)
- Low average yearly rainfall (27 in)
- High temperatures (average highs of 27°C)
- Predominate SE-SSE wind direction (10-25 mph day; 4-10 mph night)
- Barriers to water flow (e.g., abandoned railroad causeway)



Hydrologic Modifications Timeline

- **2005 - 2007**:

Initial reflooding via pilot (experimental) channel (15 ft wide by 3 ft depth), tidal exchange <1% (0.6%), extreme hypersalinity throughout

- **2008 - 2021**:

Bridge over the pilot channel (2008), tidal exchange 2% (2008) increasing to 10% (2011) due to natural opening, moderate salinity in the southern compartment, extreme hypersalinity persists in the northern compartment.

Hydrologic Modifications Timeline

- **2022 - present**:

Widening of the inlet channel to 150 ft wide by 15 ft deep, tidal exchange 22% total water volume

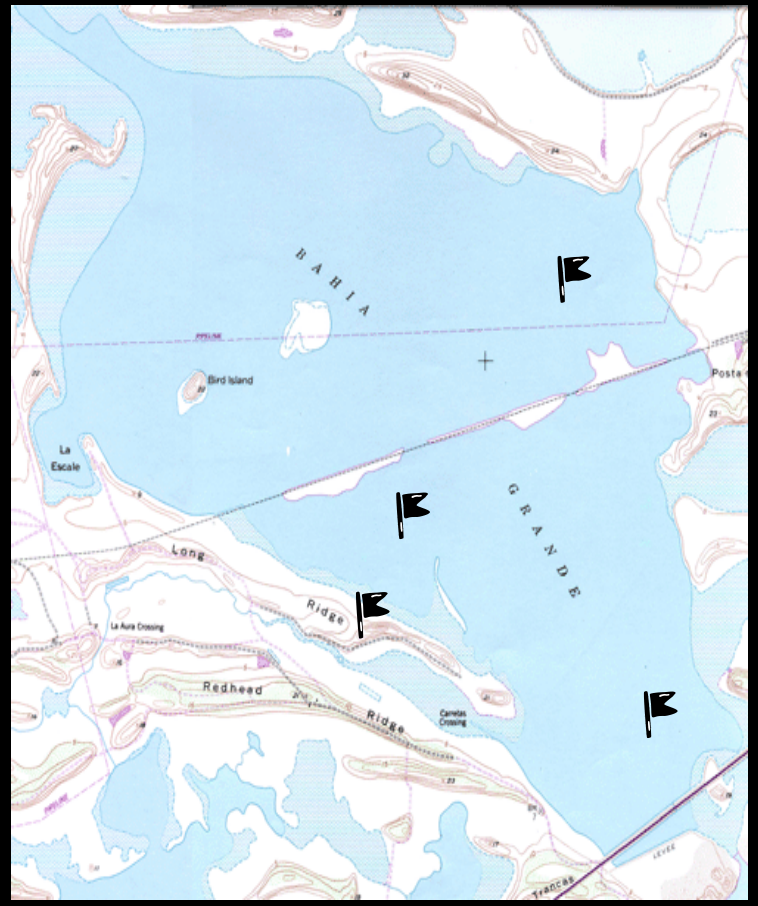
Objectives

<u>Monitoring Program</u> (2005-2009; 2011-2013; 2017-2019; 2021 - present):

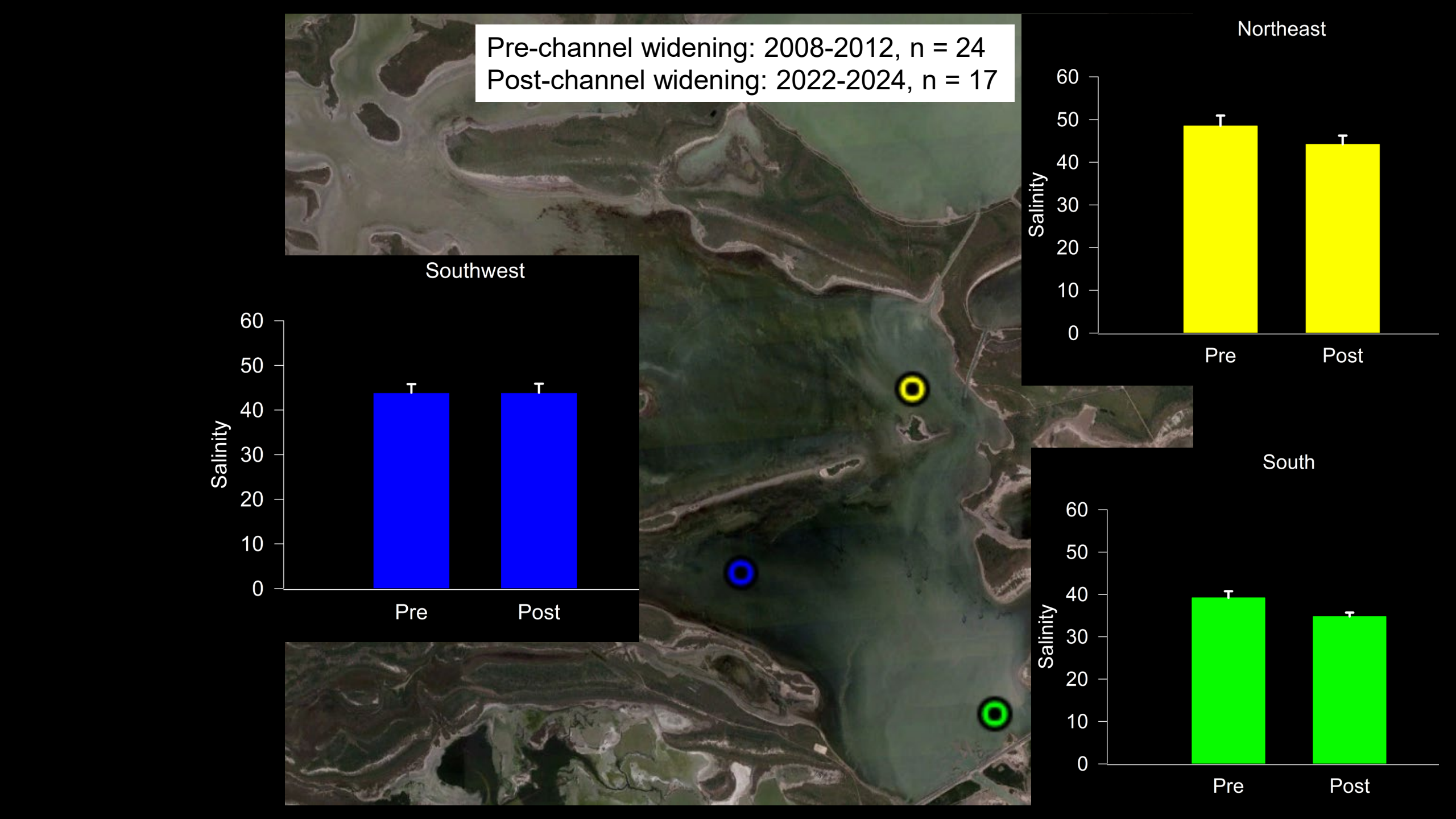
To monitor the changes in the water quality and biotic templates response to the physical modifications (e.g., channel construction / widening)

- **Benthic Community Monitoring (2006 – present):**
- **Nekton community monitoring (2006-2009; USFWS assumed in 2017):**
- **Water Quality monitoring (2006 – present):**
    1. **Temporal Monitoring (*permanent WQ stations)***
    2. **Temporal/Spatial Monitoring (*associated with biological monitoring*)**
    3. **Spatial Monitoring (*71 station sampling grid*)**

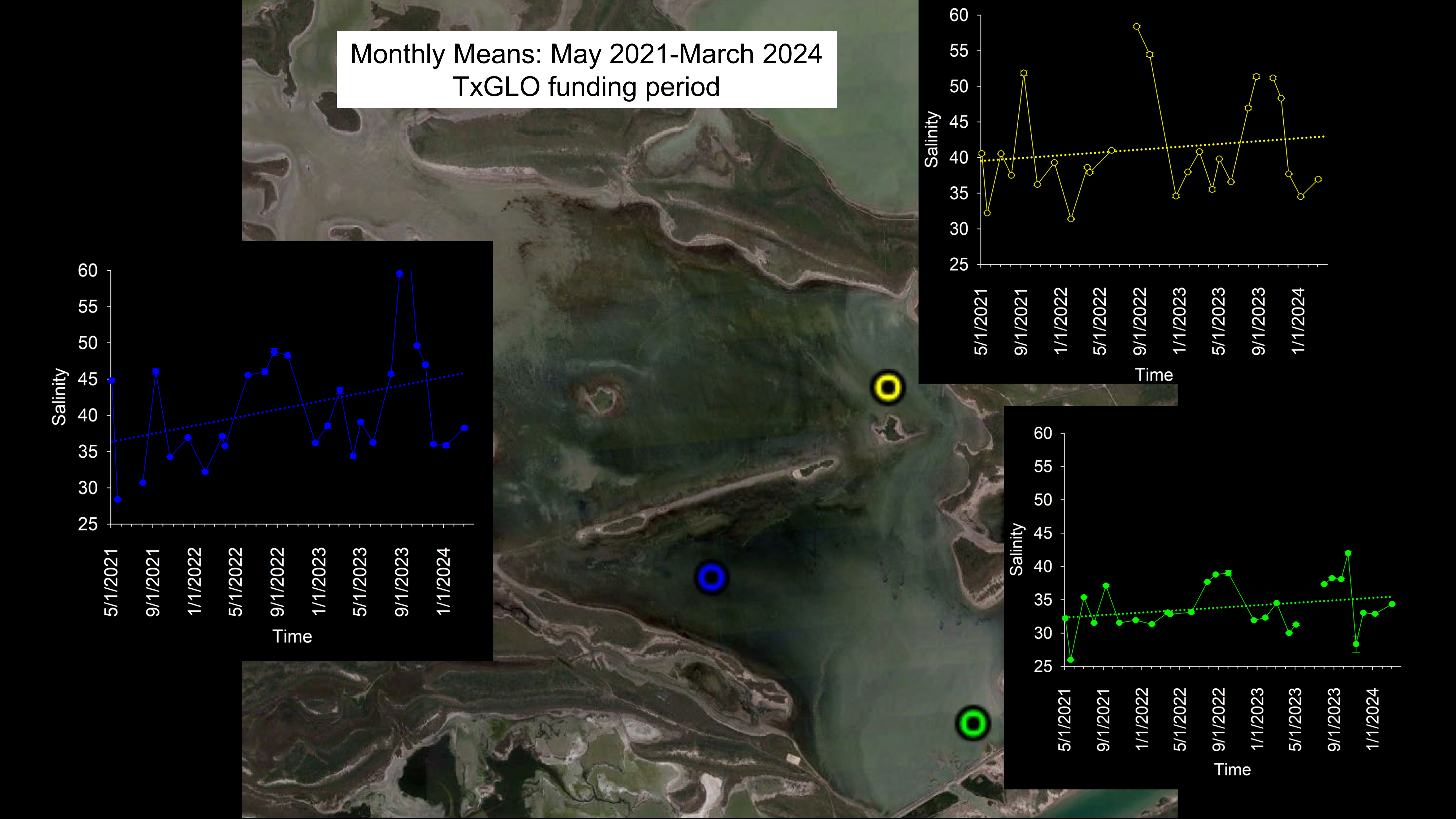
Temporal Water Quality Monitoring



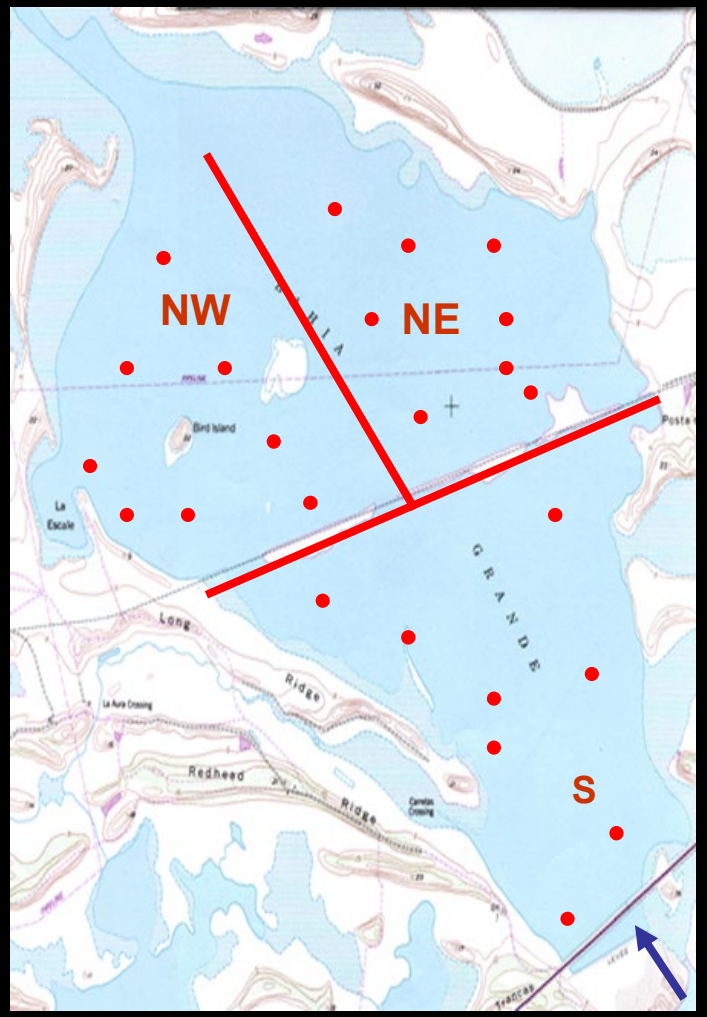
- Water Temperature
- Salinity
- pH
- Dissolved Oxygen
- Depth
- Barometric Pressure
- Air Temperature
- Wind Speed/Direction


Pre-channel widening: 2008-2012, n = 24
Post-channel widening: 2022-2024, n = 17
Northeast
Salinity
60
50
40
30
20
10
0
Pre
Post
Southwest
Salinity
60
50
40
30
20
10
0
Pre
Post
South
Salinity
60
50
40
30
20
10
0
Pre
Post

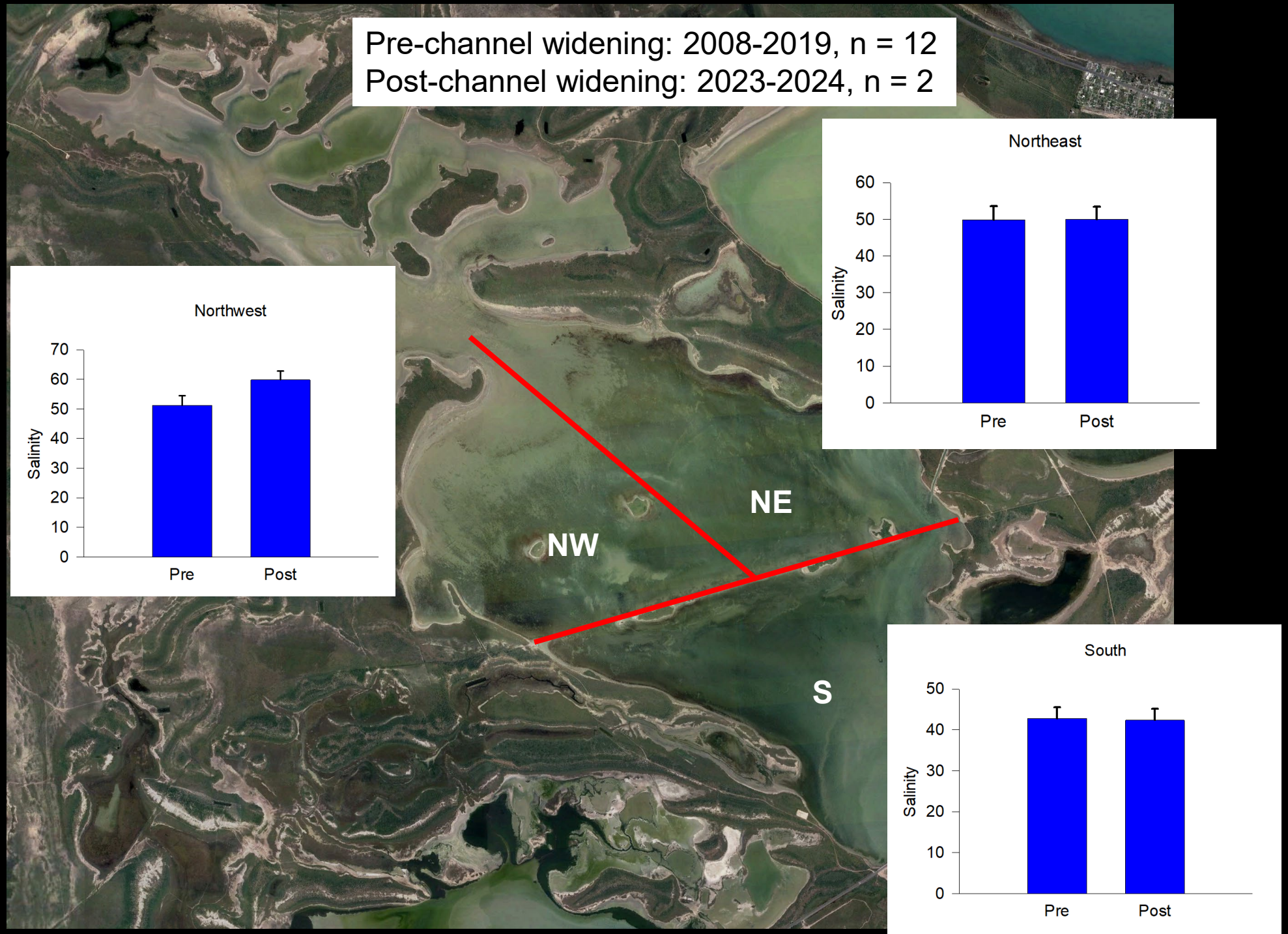
Monthly Means: May 2021-March 2024
TxGLO funding period



Temporal/Spatial Monitoring



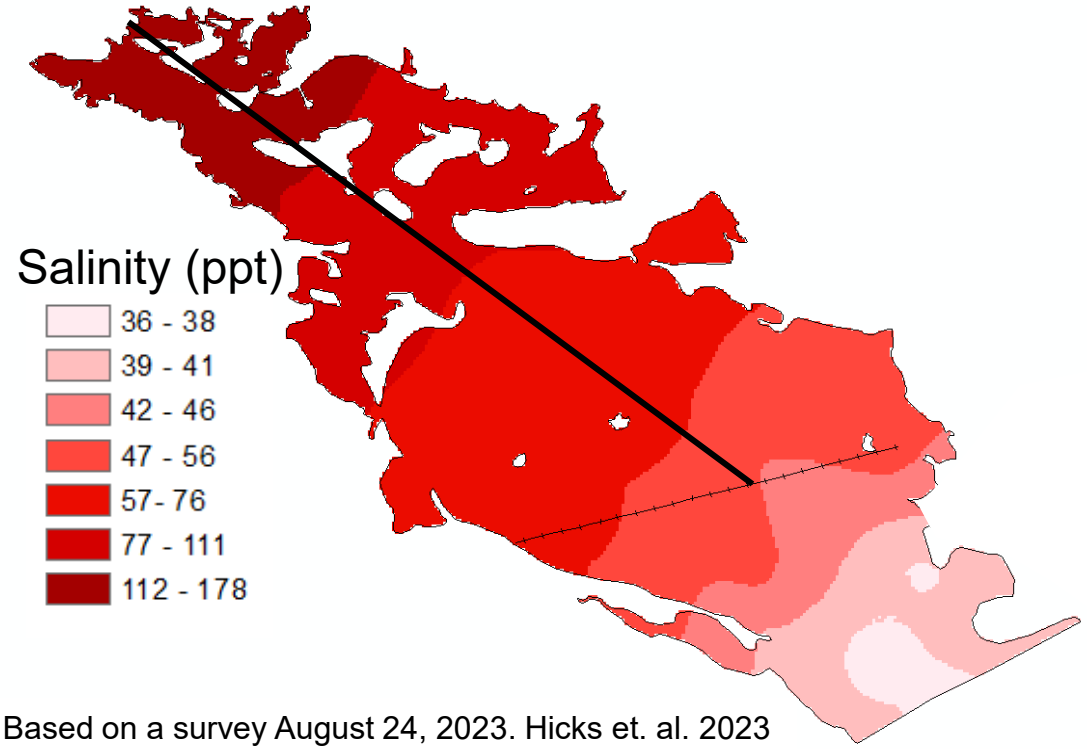
- Program began in 2005
- 24 Sampling sites
- Randomly generated
- Water Quality (grab samples) in conjunction with benthic sampling


Pre-channel widening: 2008-2019, n = 12
Post-channel widening: 2023-2024, n = 2
Northwest
Salinity
70
60
50
40
30
20
10
0
Pre
Post
Northeast
Salinity
60
50
40
30
20
10
0
Pre
Post
South
Salinity
50
40
30
20
10
0
Pre
Post
NW
NE
S

Spatial Water Quality Monitoring

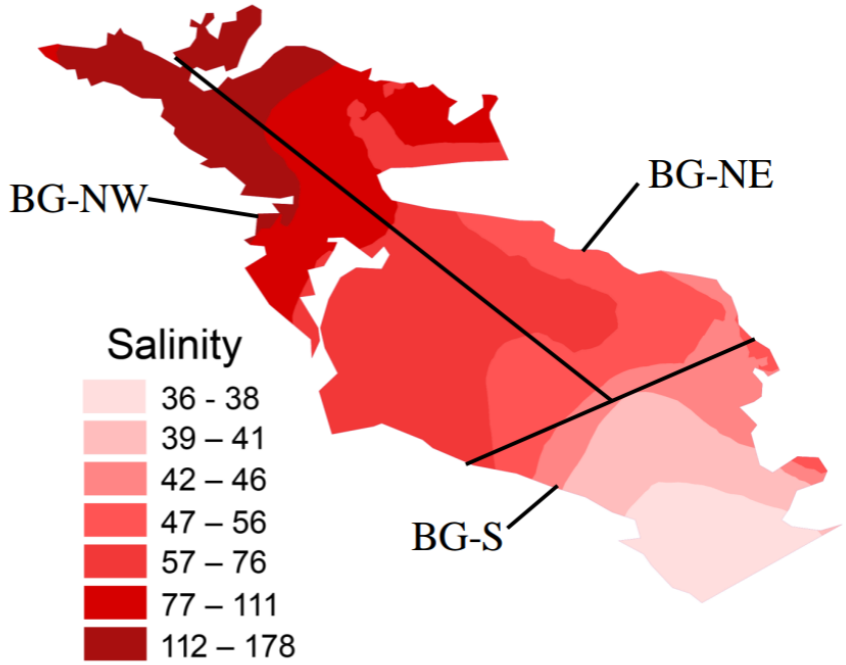
- Survey occurs under typical conditions
- 71 sites (34 southern, 37 northern)
- Hydrolab Compact DS5
- ArcGIS (Kriging tool)

Salinity Distribution



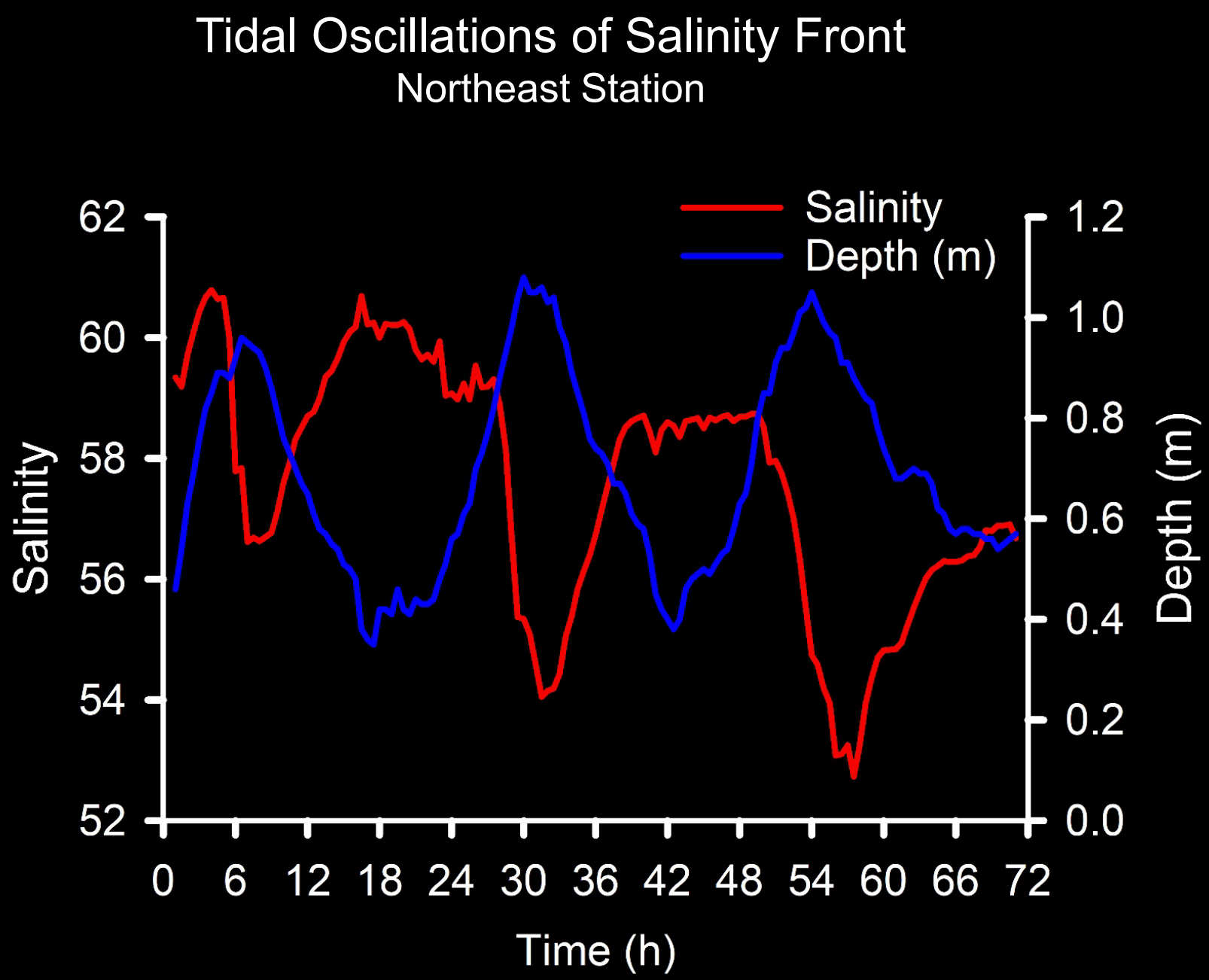
Based on a survey August 24, 2023. Hicks et. al. 2023

Average Salinities*:
BG-S: 40 ppt
BG-NE: 68 ppt
BG-NW: 80 ppt

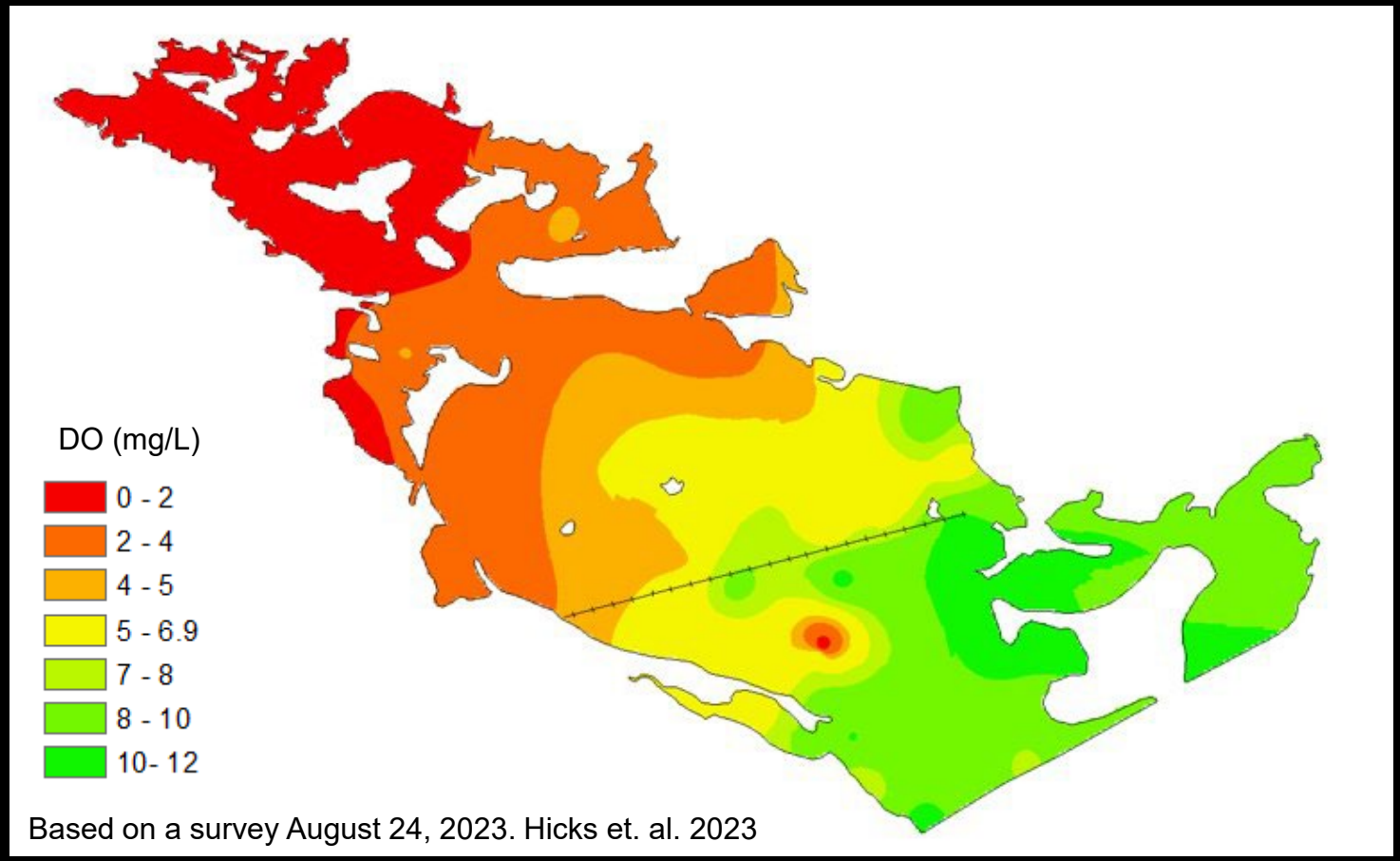


*Based on a survey July 23,2019

Eckert & Hicks, 2019

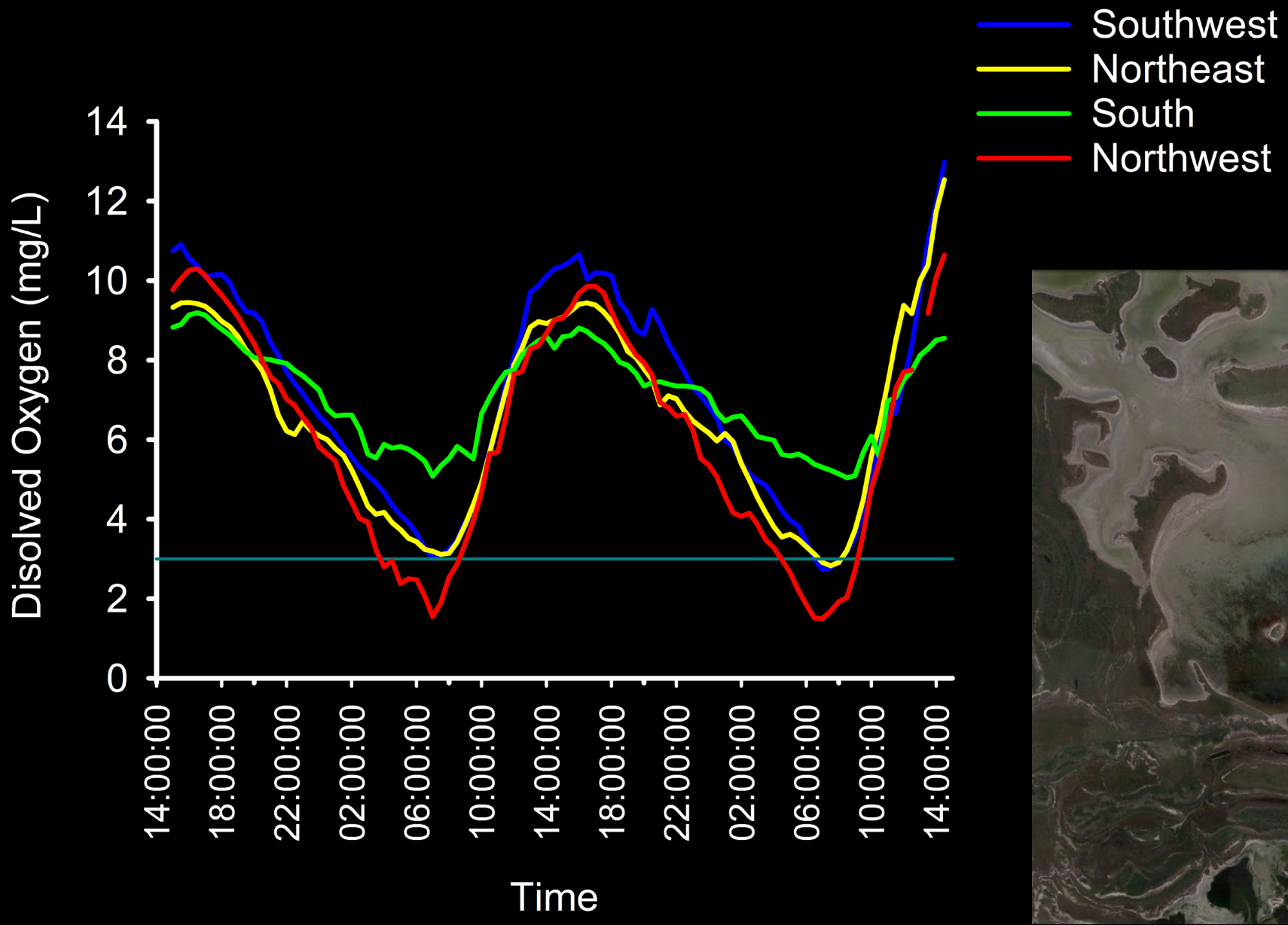

Tidal Oscillations of Salinity Front
Northeast Station
Salinity
Depth (m)
62
60
58
56
54
52
Salinity
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Depth (m)
0
6
12
18
24
30
36
42
48
54
60
66
72
Time (h)

Dissolved Oxygen Distribution



Based on a survey August 24, 2023. Hicks et. al. 2023

Diurnal Oxygen Cycles

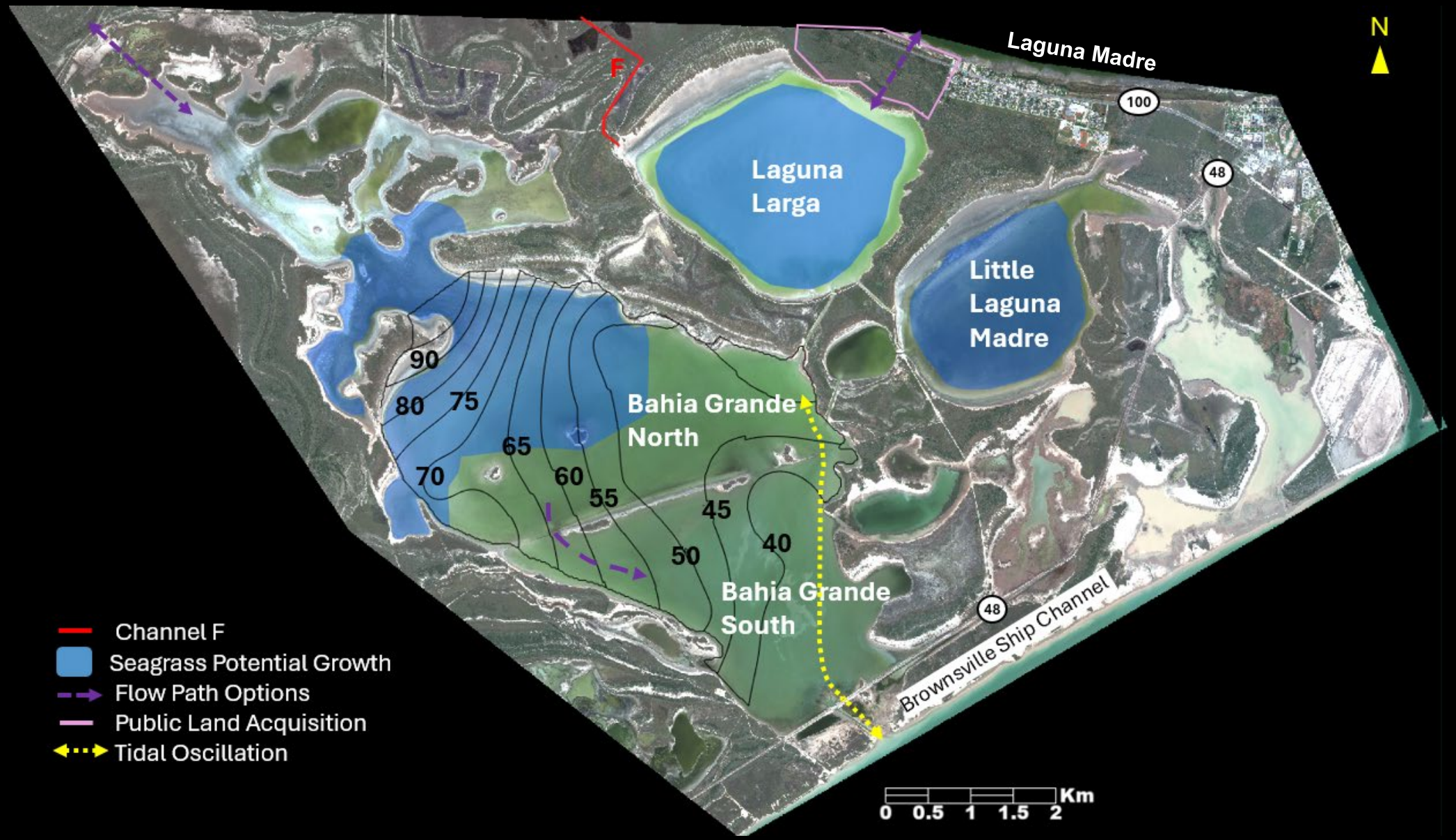


Seagrass Distribution Map

Bare/Sparse: 54%
Dense: 28%
Moderate: 18%

Conclusions

- Salinity distribution is largely unchanged
- Tidal exchange is controlling salinity in the southern compartment; Meteorological processes (precipitation and evaporation) are controlling salinity in the northern compartment and connected lagoons
- The southern compartment is at a suitable endpoint for the restoration
- Further manipulations and enhancement actions could result in an additional >4,000 acres of seagrass habitat (>32% increase)
- A basin-wide hydrologic model would be required to guide further modifications


N
Laguna Madre
F
Laguna Larga
Little Laguna Madre
100
48
90
80
75
70
65
60
55
50
45
40
Bahia Grande North
Bahia Grande South
48
Brownsville Ship Channel
Channel F
Seagrass Potential Growth
Flow Path Options
Public Land Acquisition
Tidal Oscillation
0 0.5 1 1.5 2 Km

Acknowledgements

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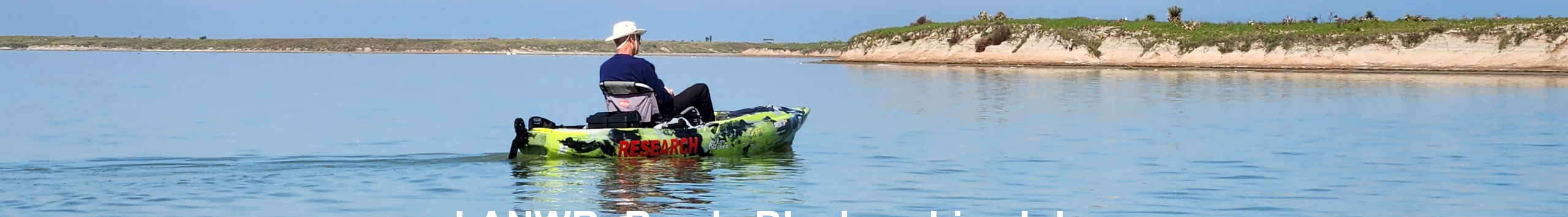
- Texas Sea Grant
- Cameron County
- Texas General Land Office (GLO)

Acknowledgements

People



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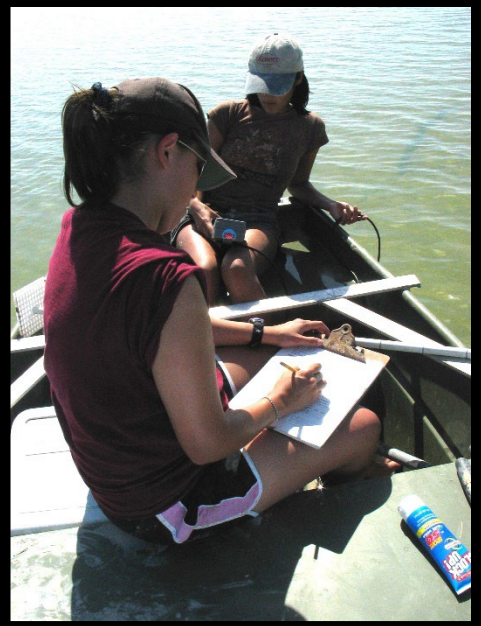

The University of Texas Rio Grande Valley

Graduate Student Thesis Projects

Erika M. Cornejo (Advisor: D. Hicks). Fish Assemblage Dynamics in the Re-flooded Bahia Grande (M.S. thesis, UTB, 2009).

Claudia Tamez (Advisor: D. Hicks). Gauging wetland restoration status using benthic-based structural and functional metrics (M.S. thesis, UTB, 2014).

Mario Marquez (Advisor: A. Fierro). Decomposition patterns and nitrogen dynamics of black mangrove (*Avicennia germinans*) leaf litter in disturbed estuaries linked to the Lower Laguna Madre, Texas (M.S. thesis, UTB, 2014).

Crystal Martinez (Advisor: A. Fierro). *Balanus eburneus* (Crustacea: Cirripedia) as a potential indicator of estuarine system recovery in south Texas: a study of recruitment, growth and stable isotopes (M.S. thesis, UTB, 2015).

Monica Delgado (Advisor: C. Cintra).Decomposition and nitrogen dynamics of turtle grass (*Thalassia testudinum*) in a subtropical estuarine system (M.S. thesis, UTB, 2015).

Leticia Contreras (Advisor: A. Fierro). Decomposition of black mangrove (*Avicennia germinans*) leaf litter: calibrating estuarine indicators of functional recovery (M.S. thesis, UTB, 2017).

Catherine Eckert (Advisor: D. Hicks). Assessing the rehabilitation status of the reflooded Bahia Grande, Texas based on trace gas fluxes, benthic macroinvertebrates, and fish community data along salinity and seagrass gradients (M.S. thesis, UTRGV, 2019).