Impacts of Droughts and Low Flows on Estuarine Health and Productivity

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Drought Impact and Recovery in Texas Estuaries - Jan 2013 – Houston, TX

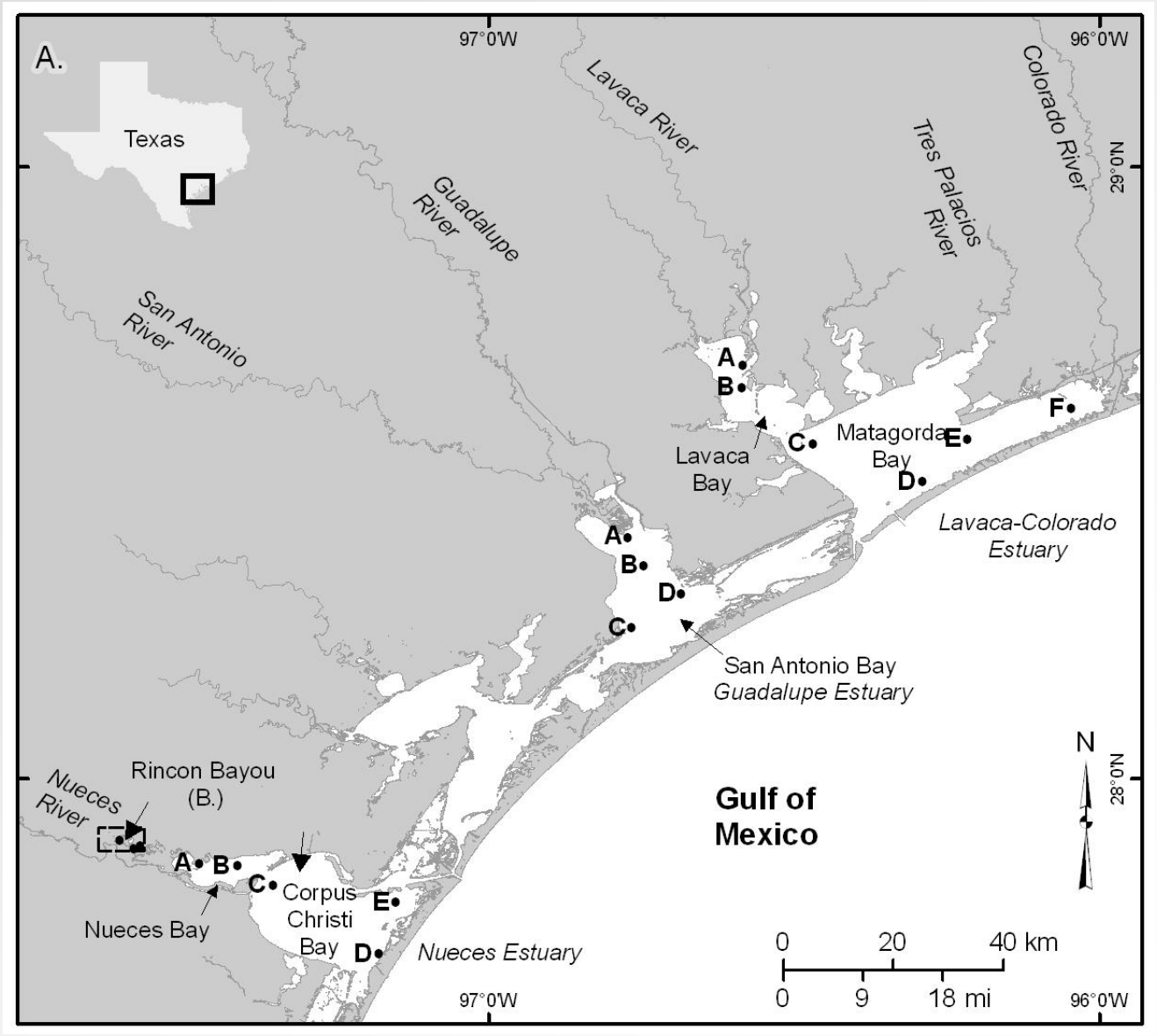
Acknowledgments and Approach

- Commissioned by TWDB
- Project #1100011150
- Final Report October 2012

Texas Water Development Board

- Water planning based on evaluating water availability during low-flow or drought-of-record periods
- Need to identify effects of droughts on benthos
  - Infauna data from TAMUCC Harte Research Inst.
  - Epifauna data from TPWD Coastal Fisheries

Study Area (HRI Long-term Stations)

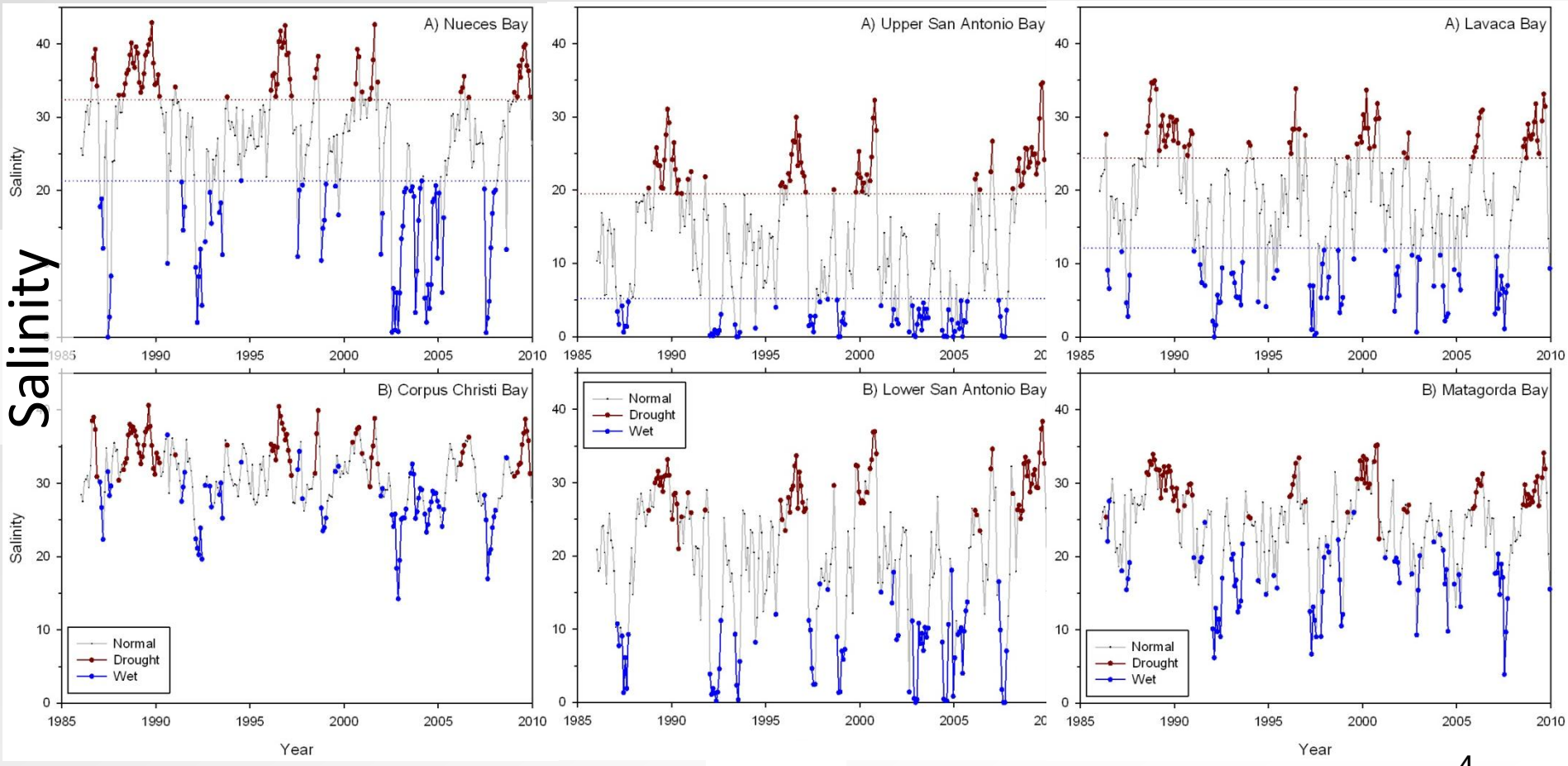


Defining Droughts:

Salinity Quartiles (25%)

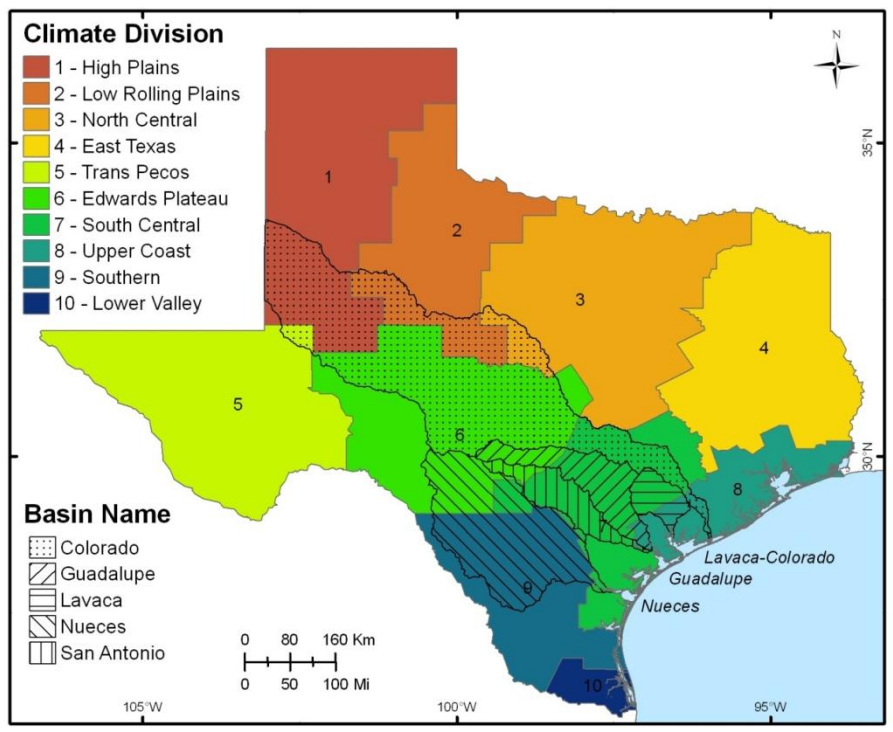
Drought
Normal
Wet

Nueces | Guadalupe | Lavaca-Colorado



Palmer Drought Severity Index

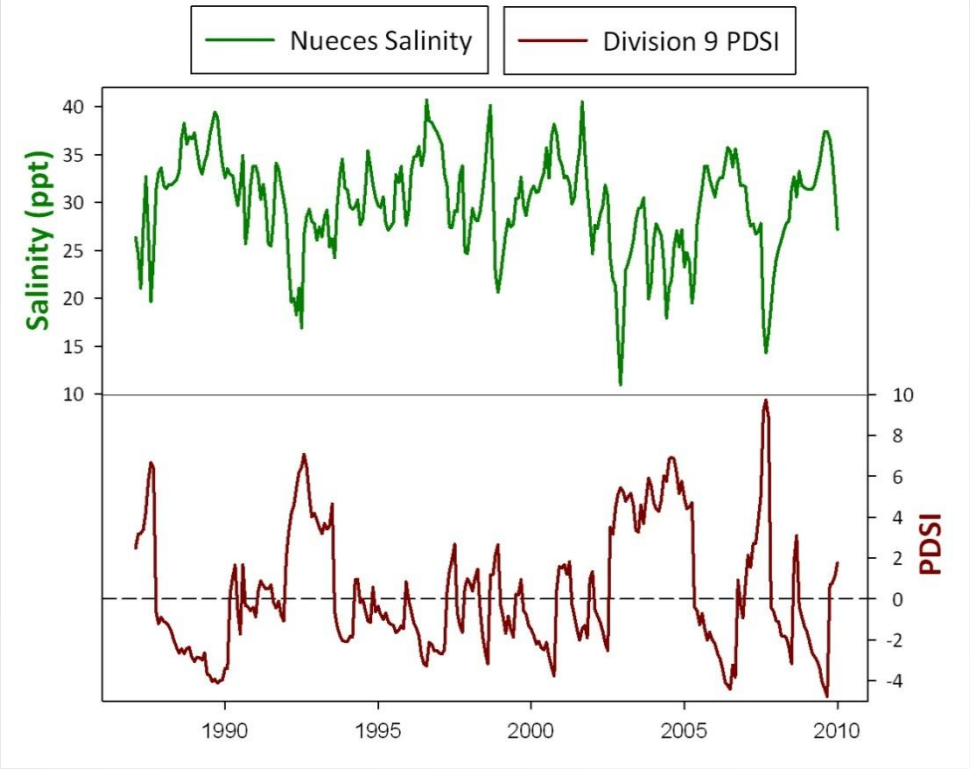
- Uses temperature and precipitation to determine ‘dryness’
- Effective for long-term (several months)
- Based on conditions on land
- Each state split into 10 divisions
- +ve = Wet, -ve = Drought

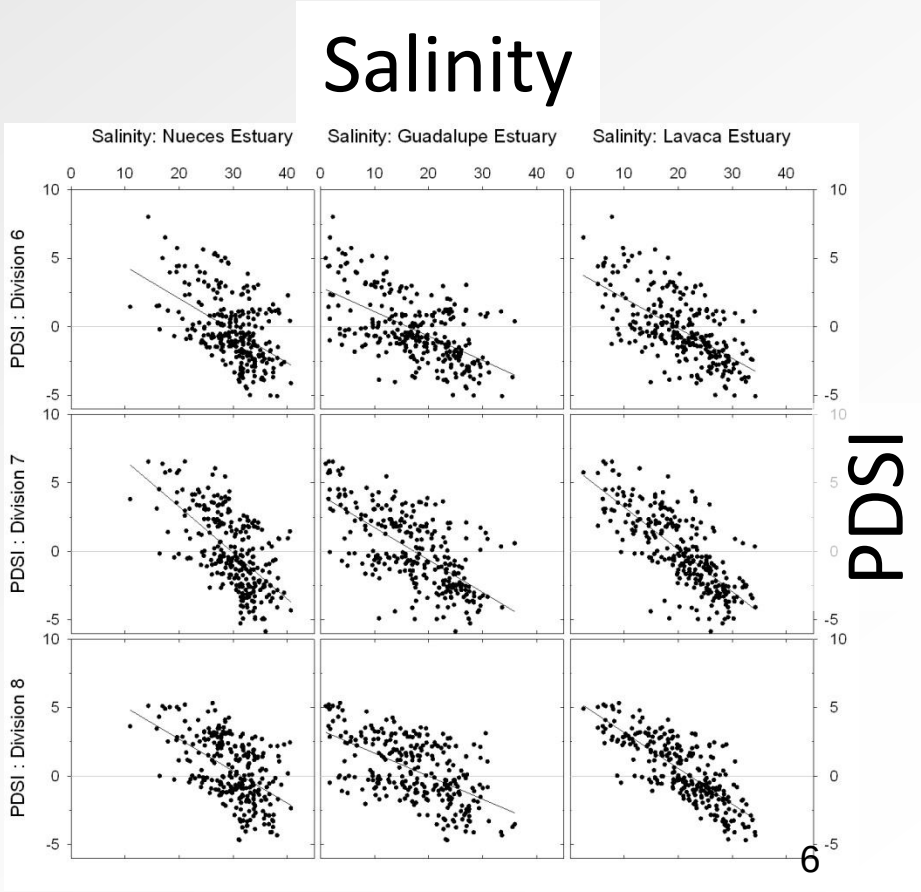


PDSI Value	Class
≥ 4.00	Extremely wet.
3.00 to 3.99	Very wet.
2.00 to 2.99	Moderately wet.
1.00 to 1.99	Slightly wet.
0.50 to 0.99	Incipient wet spell.
0.49 to -0.49	Near normal.
-0.50 to -0.99	Incipient drought.
-1.00 to -1.99	Mild drought.
-2.00 to -2.99	Moderate drought.
-3.00 to -3.99	Severe drought.
≤ -4.00	Extreme drought.

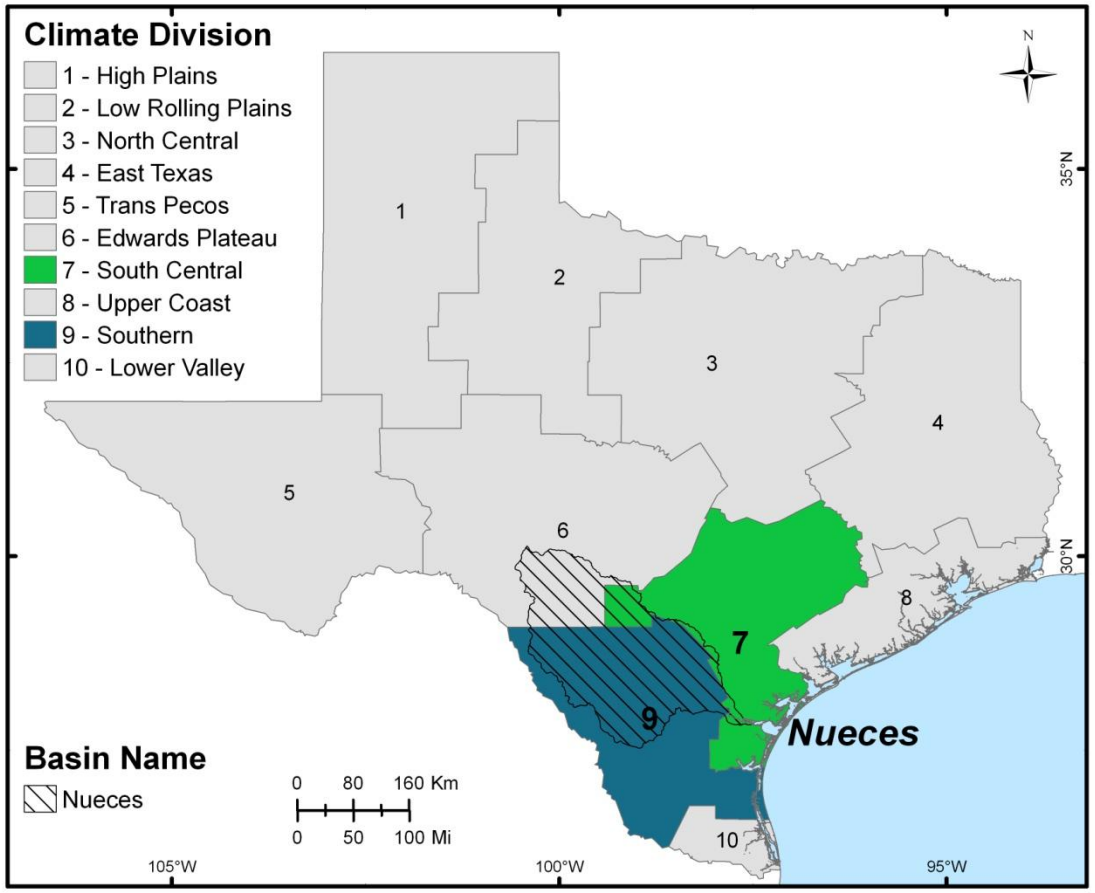
Palmer Drought Severity Index

- High correlations with Estuarine Salinity
- ↑ Salinity = ↓ PDSI (Drought)





Palmer Drought Severity Index – Climate Divisions

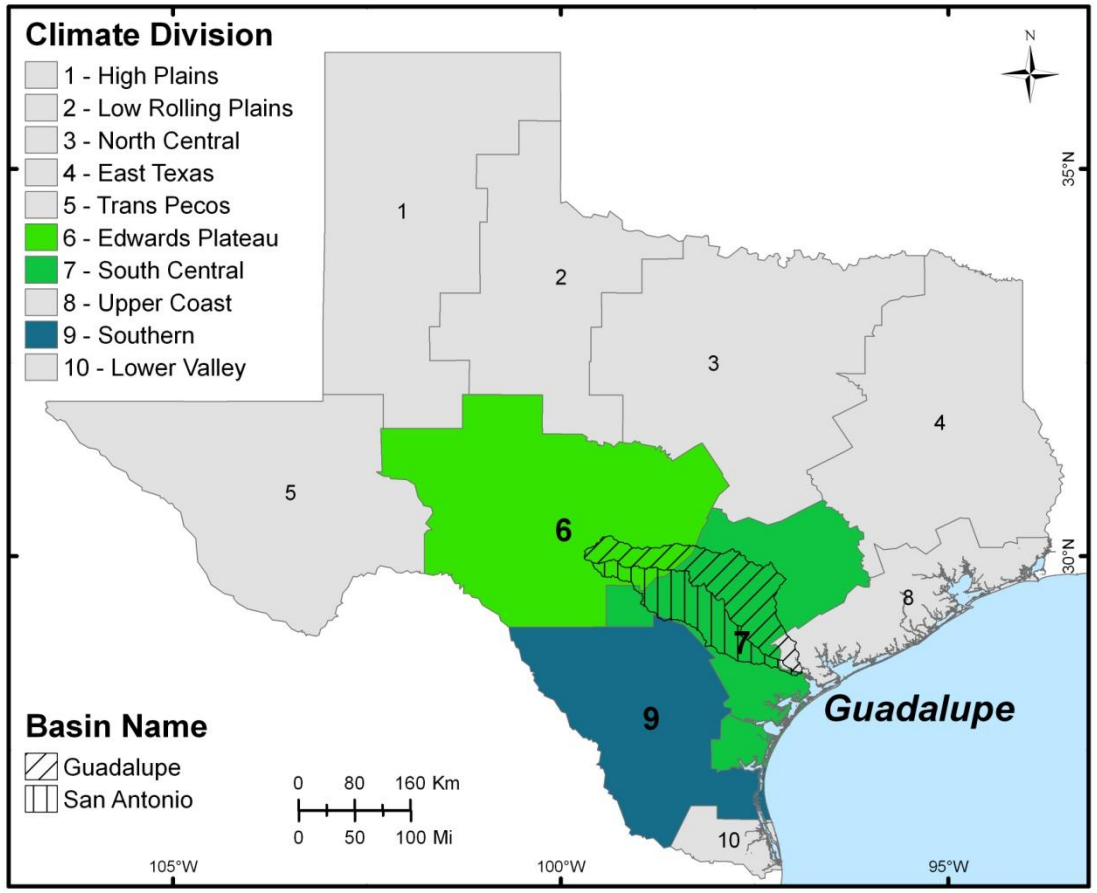


Nueces Estuary

r = -0.8

Regions 9; 7&9

Palmer Drought Severity Index – Climate Divisions

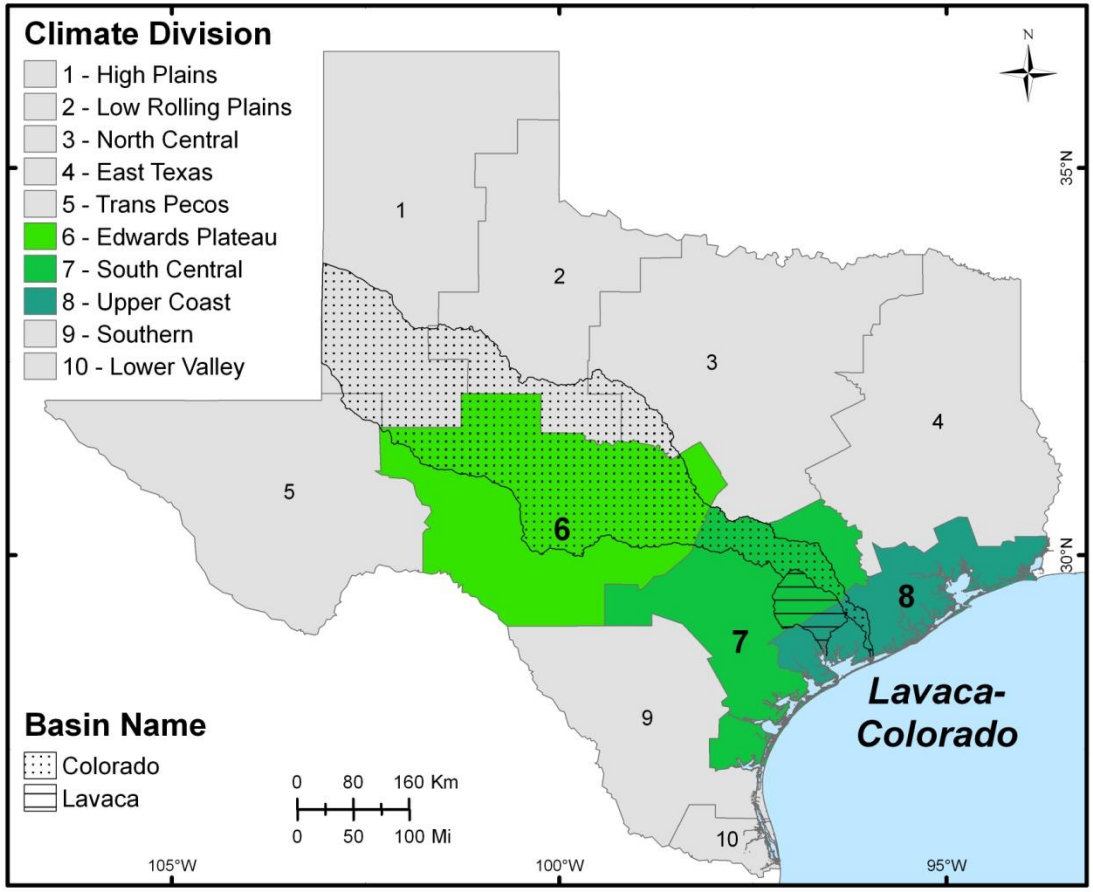


Guadalupe Estuary

r =-0.7

Regions 7&9; 6,7&9

Palmer Drought Severity Index – Climate Divisions



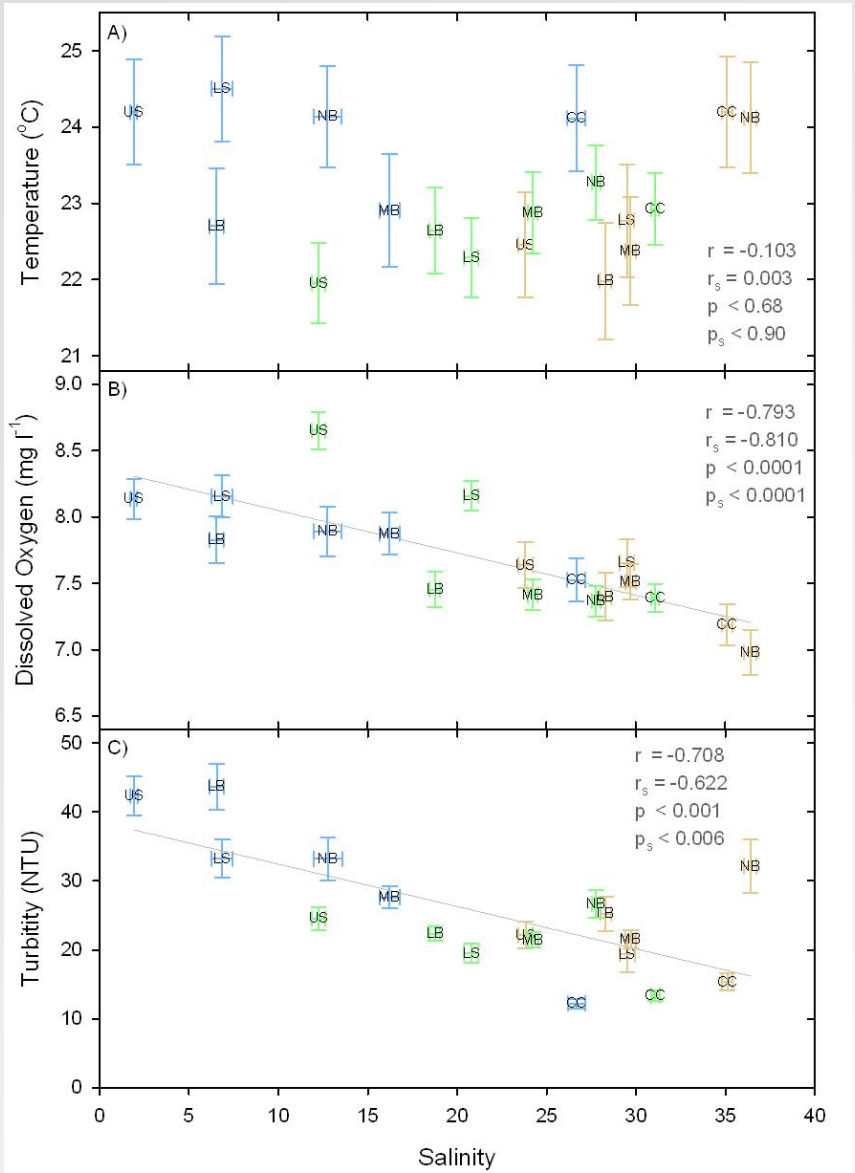
Lavaca-Colorado Estuary

r = -0.8

Regions 7&8; 6,7&8

Effects of Droughts on …

Salinity →



Wet

Normal

Drought

Mean ± Std. Error

Bay Abbreviations:

LB – Lavaca Bay

MB - Matagorda Bay

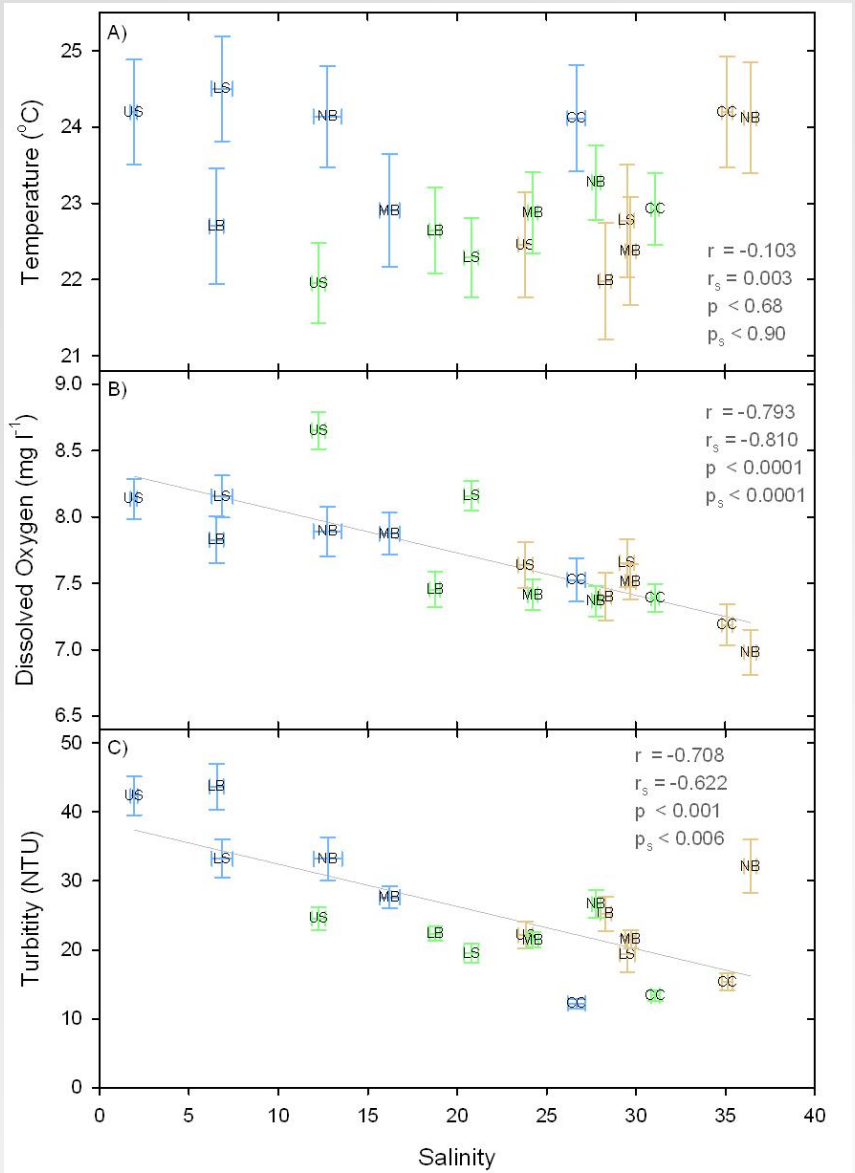
US – Upper San Antonio

LS – Lower San Antonio

NB – Nueces Bay

CC – Corpus Christi Bay

Effects of Droughts on Water Quality

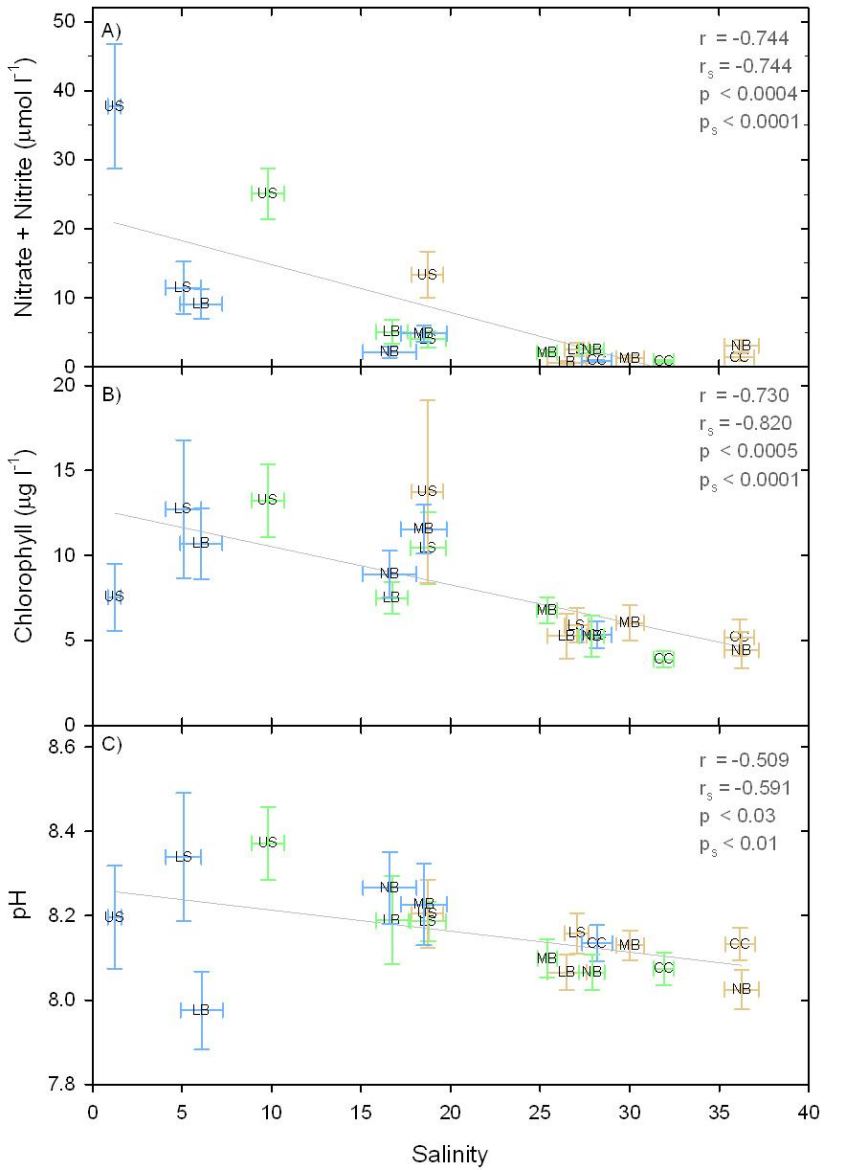


Temperature ⟺

Dissolved Oxygen ↓

Turbidity ↓

Effects of Droughts on Water Quality

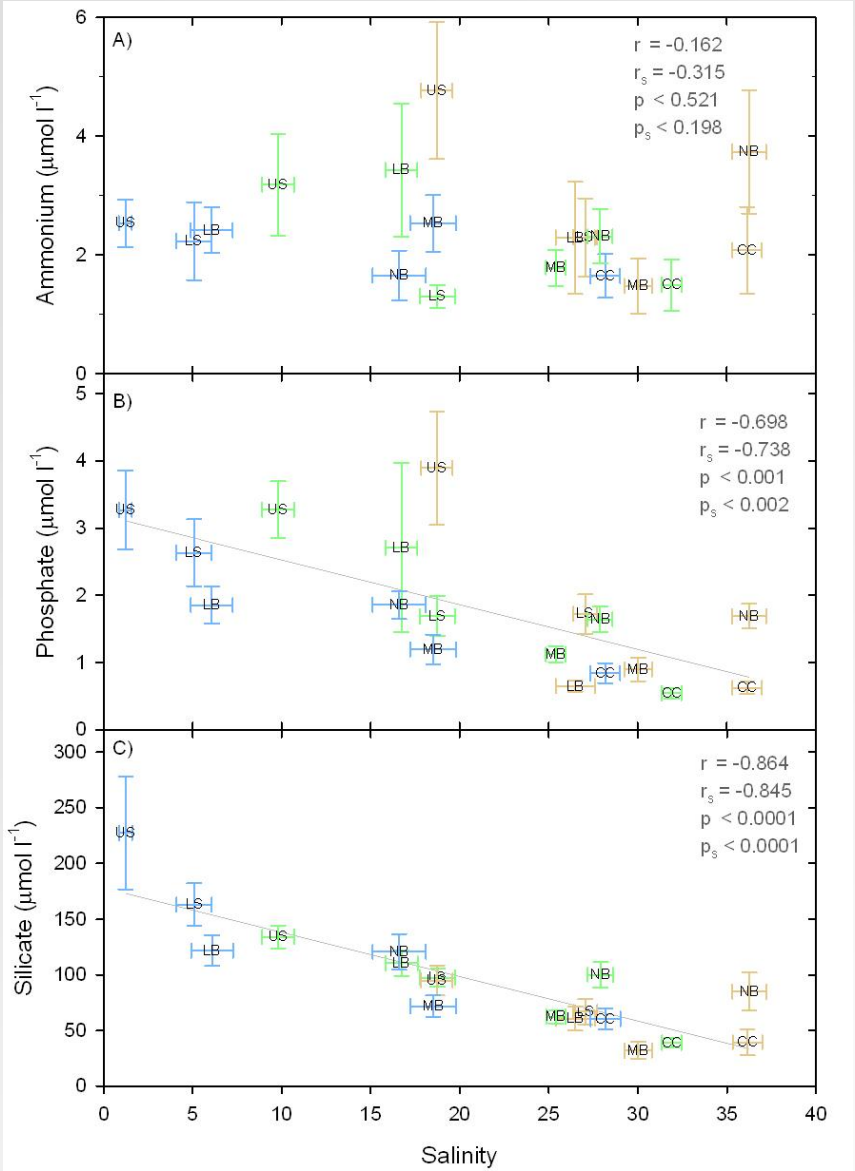


Nitrate + Nitrite ↓

Chlorophyll ↓

pH ↓

Effects of Droughts on Water Quality

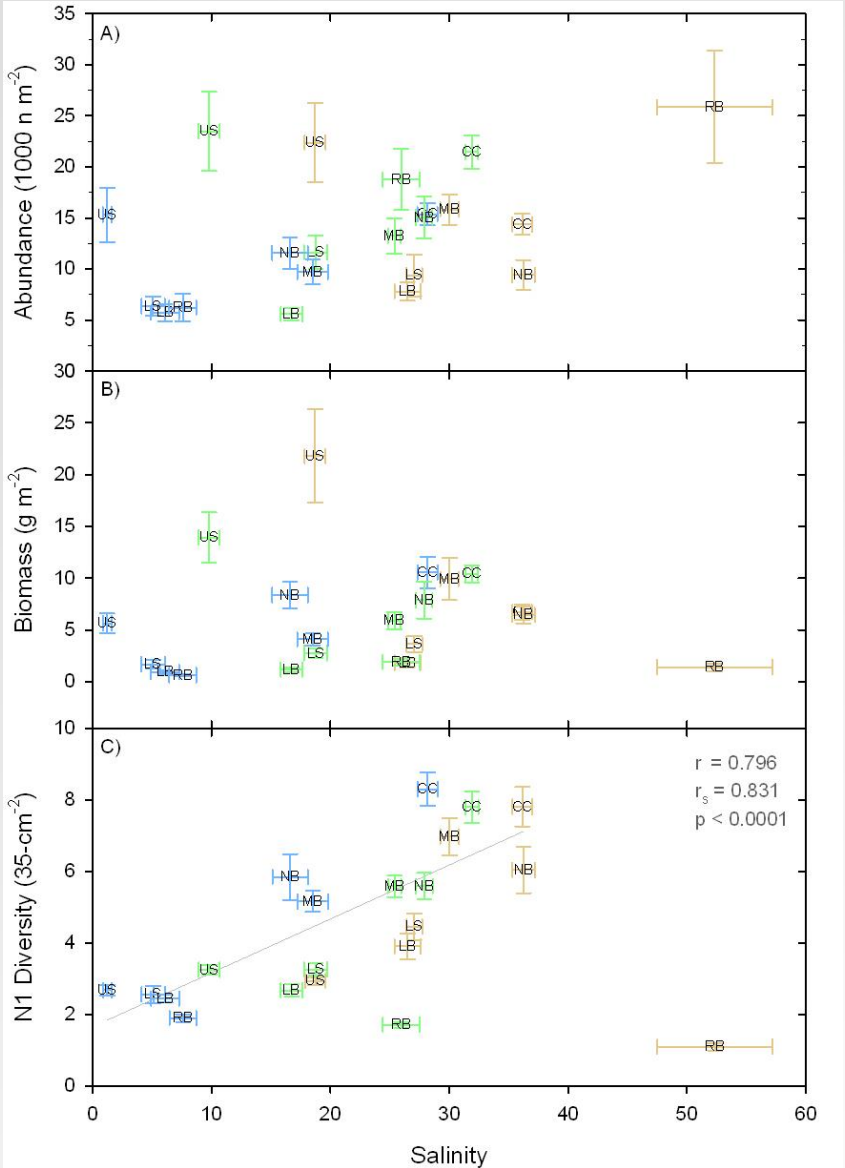


Ammonium ⟺ Non-linear

Phosphate ↓

Silicate ↓

Effects of Droughts on Benthic Macrofauna



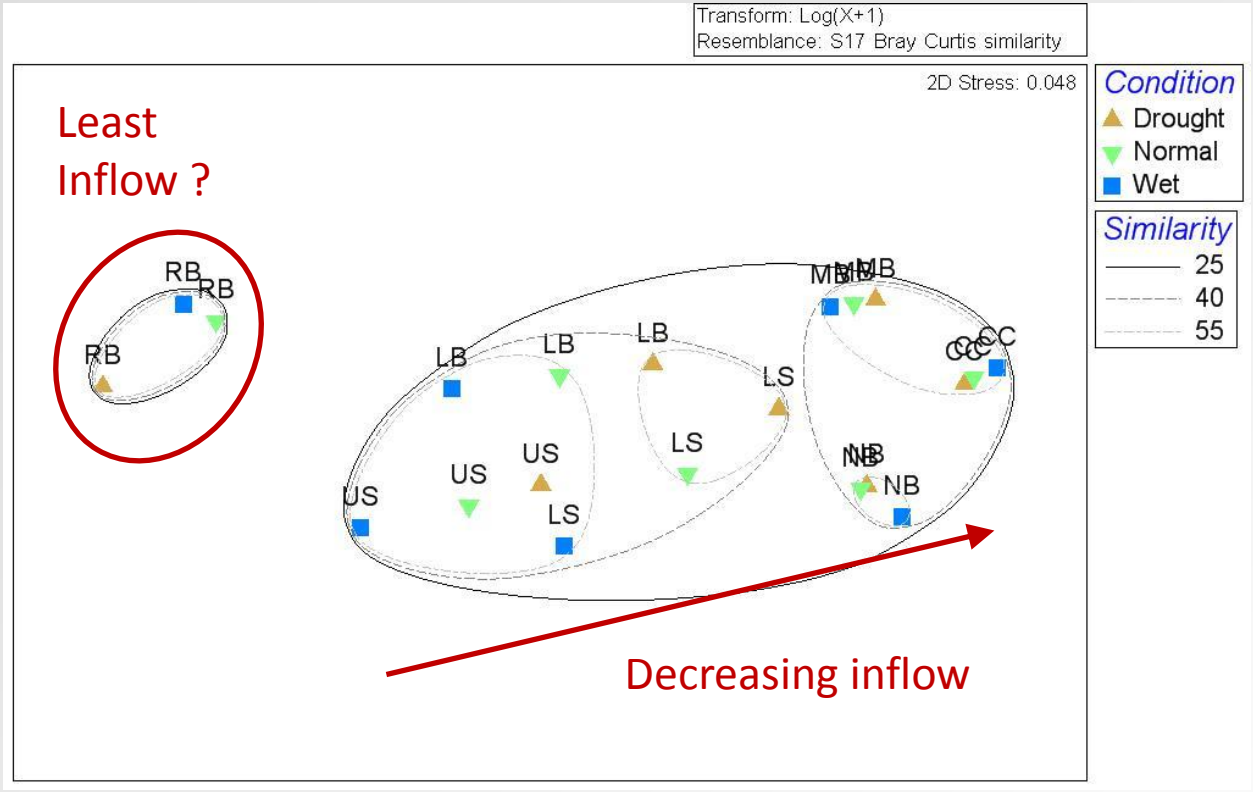
Abundance ⟺

Biomass ⟺

Non-linear

Diversity ⇑

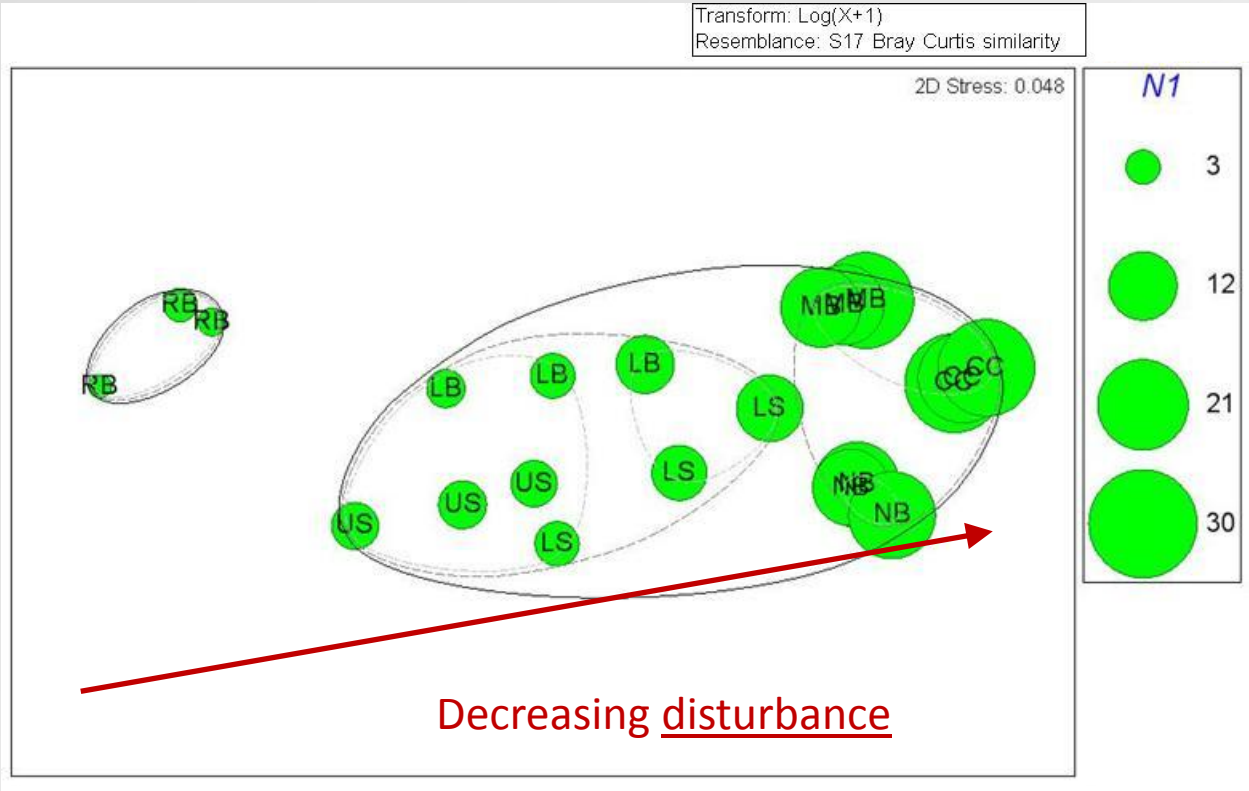
Effects of Droughts on Benthic Macrofauna



Community Composition (MDS)

1. Bays different
2. Consistent shift to right in NE bays and more variability

Effects of Droughts on Benthic Macrofauna

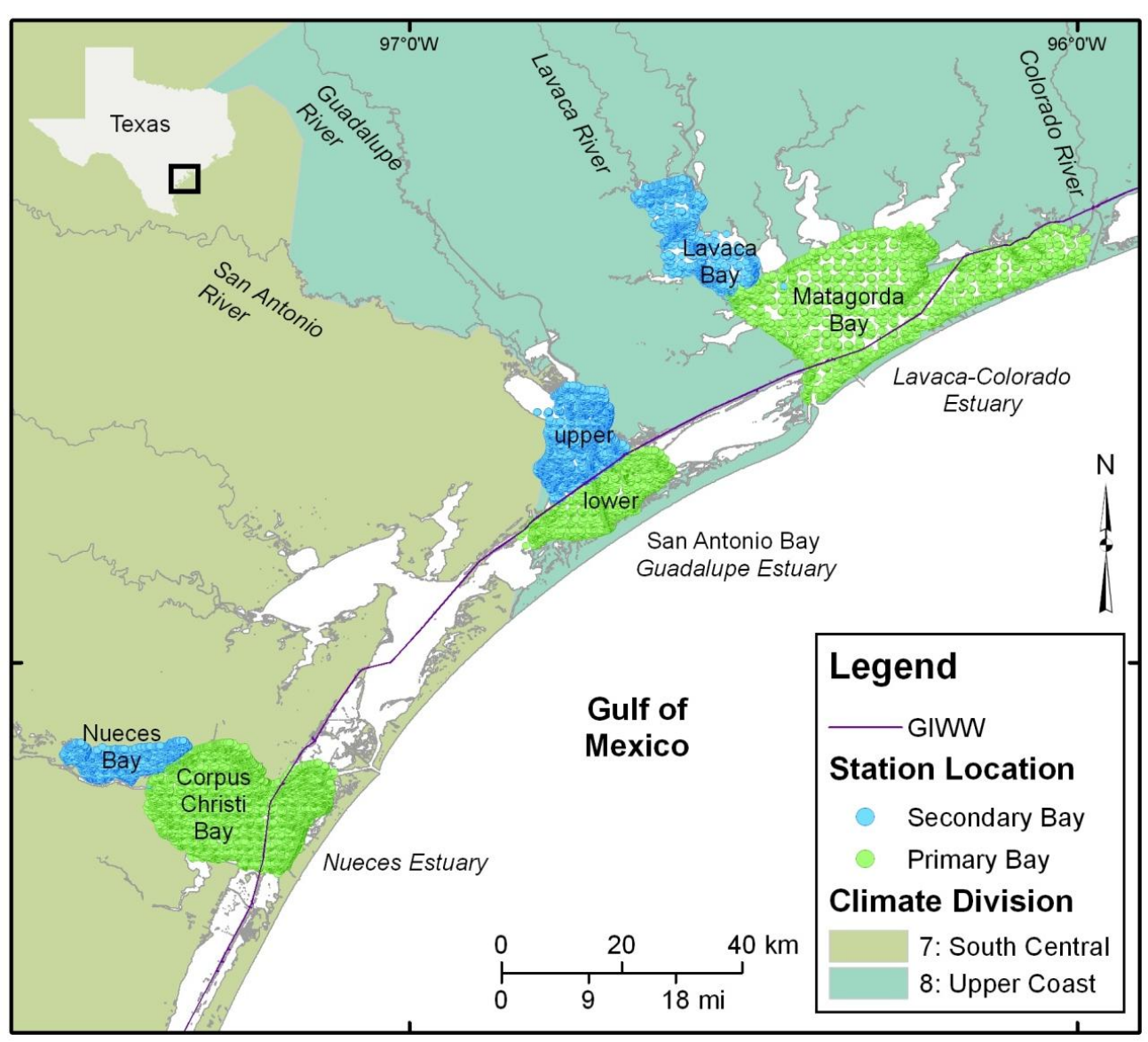


Community Composition (MDS)

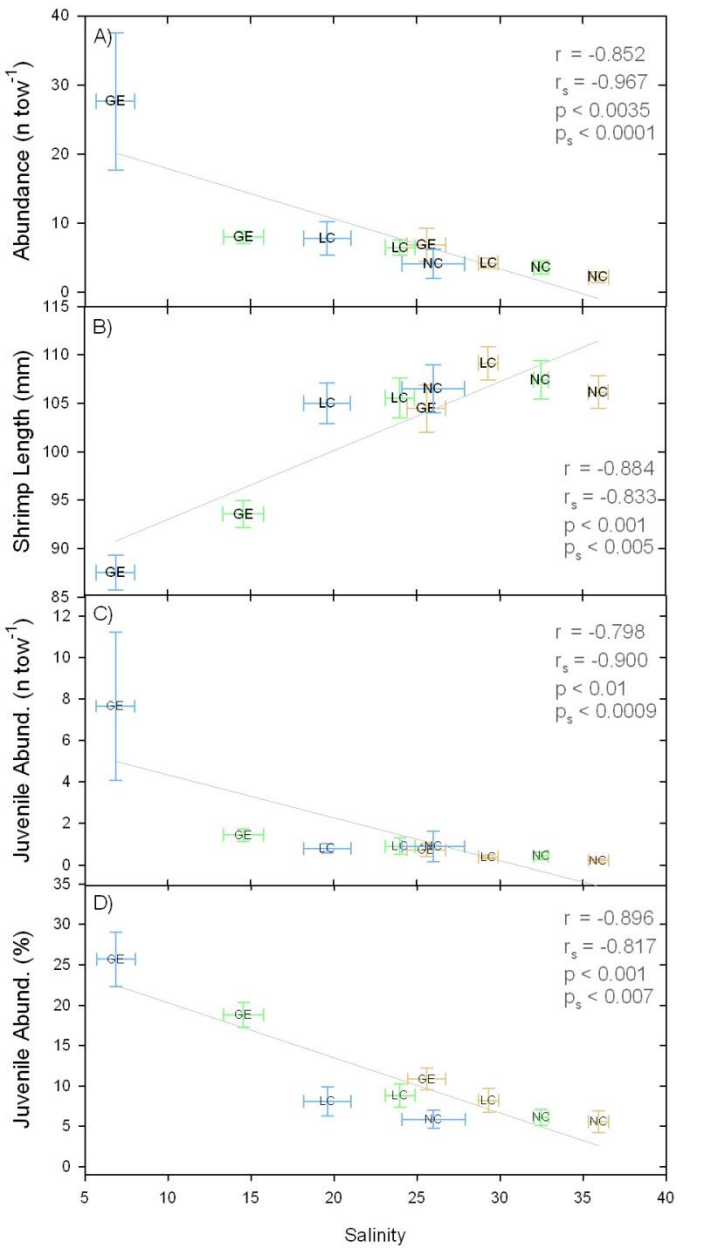
Diversity

1. Increases with less variability

Study Area – TPWD Data



Effects of Droughts on White Shrimp



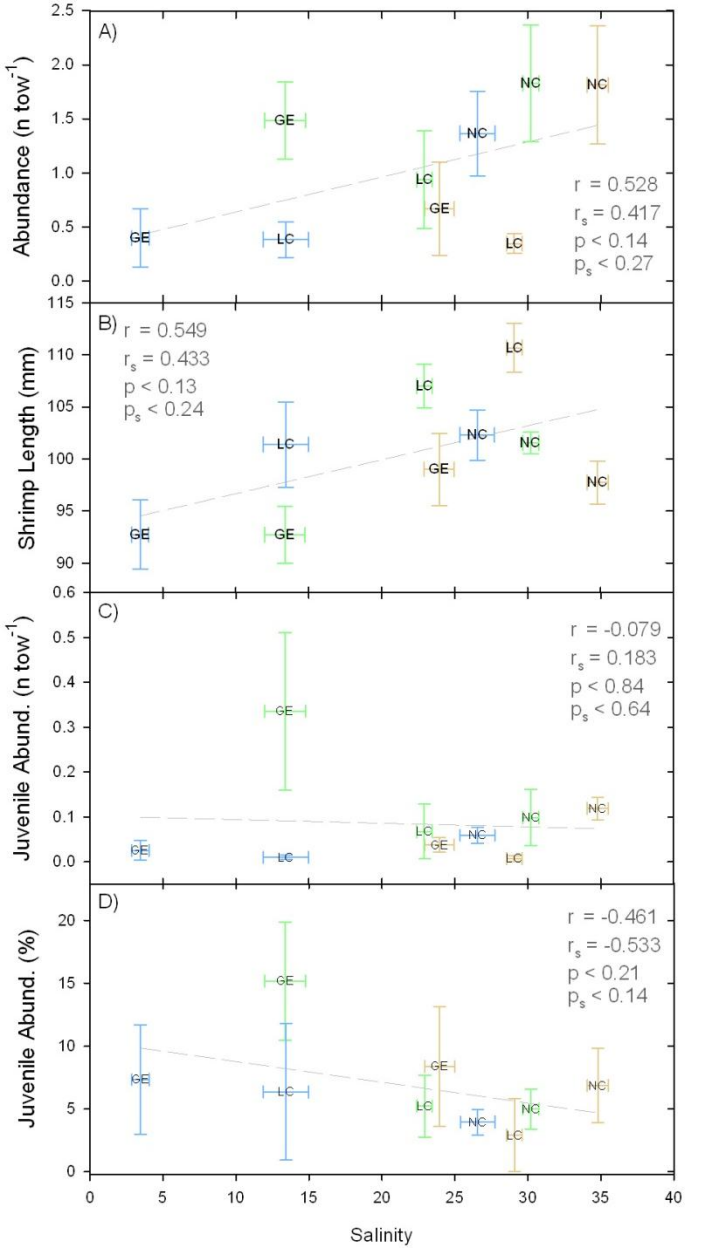
Abundance ↓

Size (length) ↑

Juvenile Abundance ↓

Juvenile % ↓

Effects of Droughts on Brown Shrimp



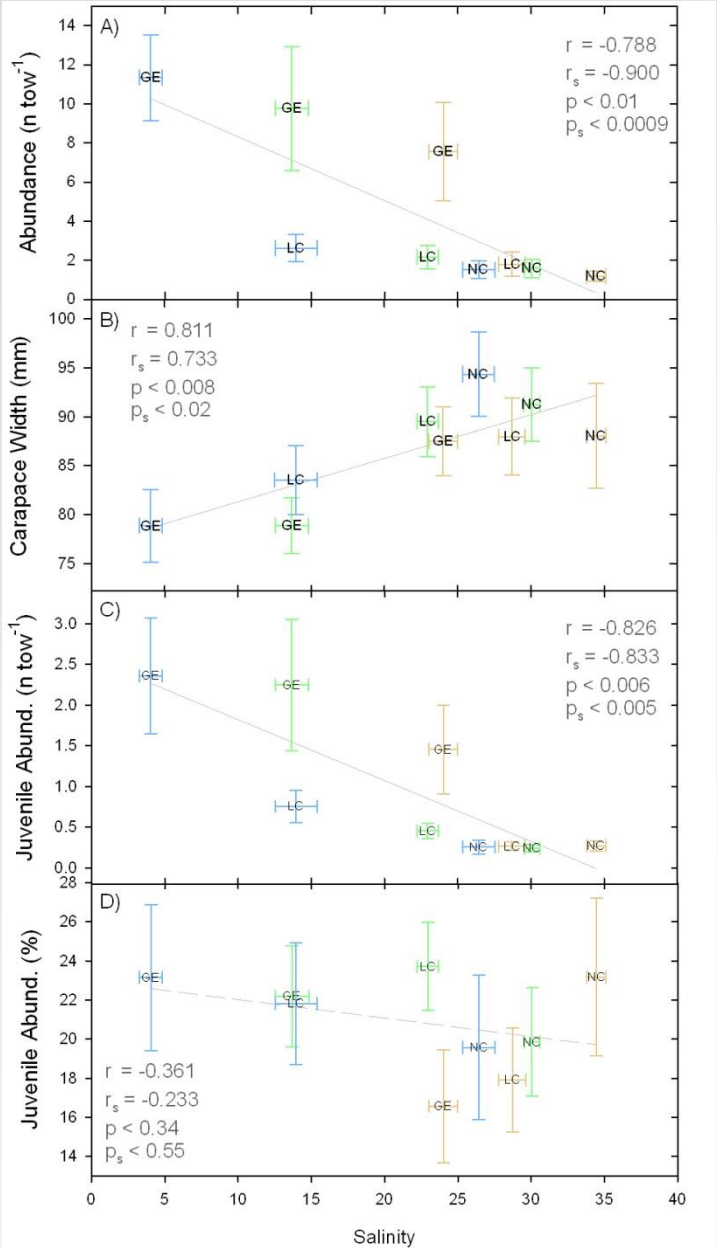
Abundance ⟺

Size (length) ⟺

Juvenile Abundance ⟺

Juvenile % ⟺

Effects of Droughts on Blue Crab



Abundance

Size (width)

Juvenile Abundance

Juvenile %

Conclusions

Drought effects:

- ↑Salinity
- ↓ DO, pH & Turbidity
- ↓ Chl & Nutrients (Not NH_4)
- ↑ Macrobenthic Diversity
- ↓ White Shrimp Abund.
- ↓ Blue Crab Abund.

- Droughts dominate the region
- Salinity increases and nutrient loads decrease
- Negative affect on primary and secondary production in estuaries that have brackish conditions