Drought severity impacts on blue crab abundance in Texas estuaries

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TCC Crab Subcommittee, Oct 28, 2025

Gulf Ecosystem Initiative (GEI)

A partnership between the National Center for Ecological Analysis and Synthesis (NCEAS) and the NOAA RESTORE Science Program that funds synthesis science working groups and postdoctoral research

Zhanfei Liu fka Christopher Biggs GEI working group

How does severe weather affect ecosystems in two contrasting Texas estuaries?

Topics

Research question exploration

Drought severity impact on blue crab abundance

Objective

Is there evidence that a severe weather "signal" can be detected in the blue crab abundance time series (TPWD)?

- Wavelet transform
- Coherence analysis

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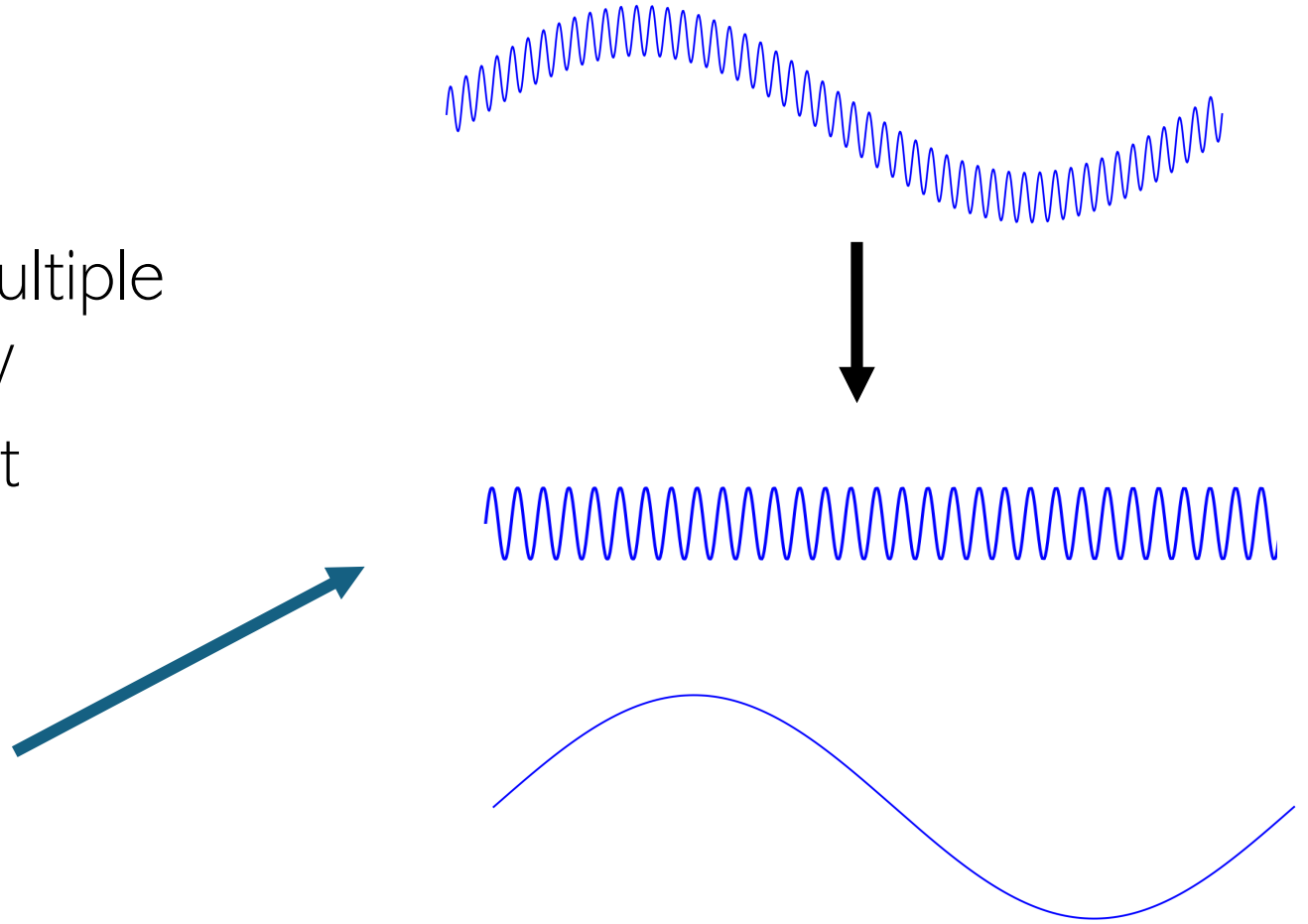
Wavelets suited for non-stationary time series

Wavelet transform:

Detect changes over multiple time scales concurrently

Long-term and transient events

“signal decomposition”

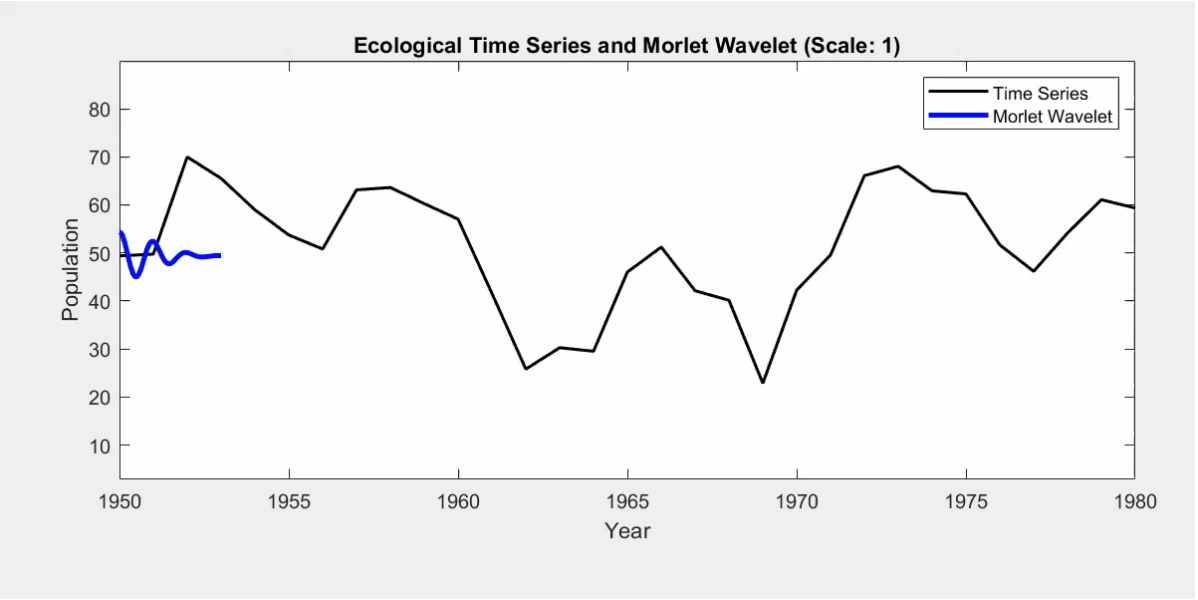


Mother wavelet loops through time series

Each wavelet is looped with a specific scale

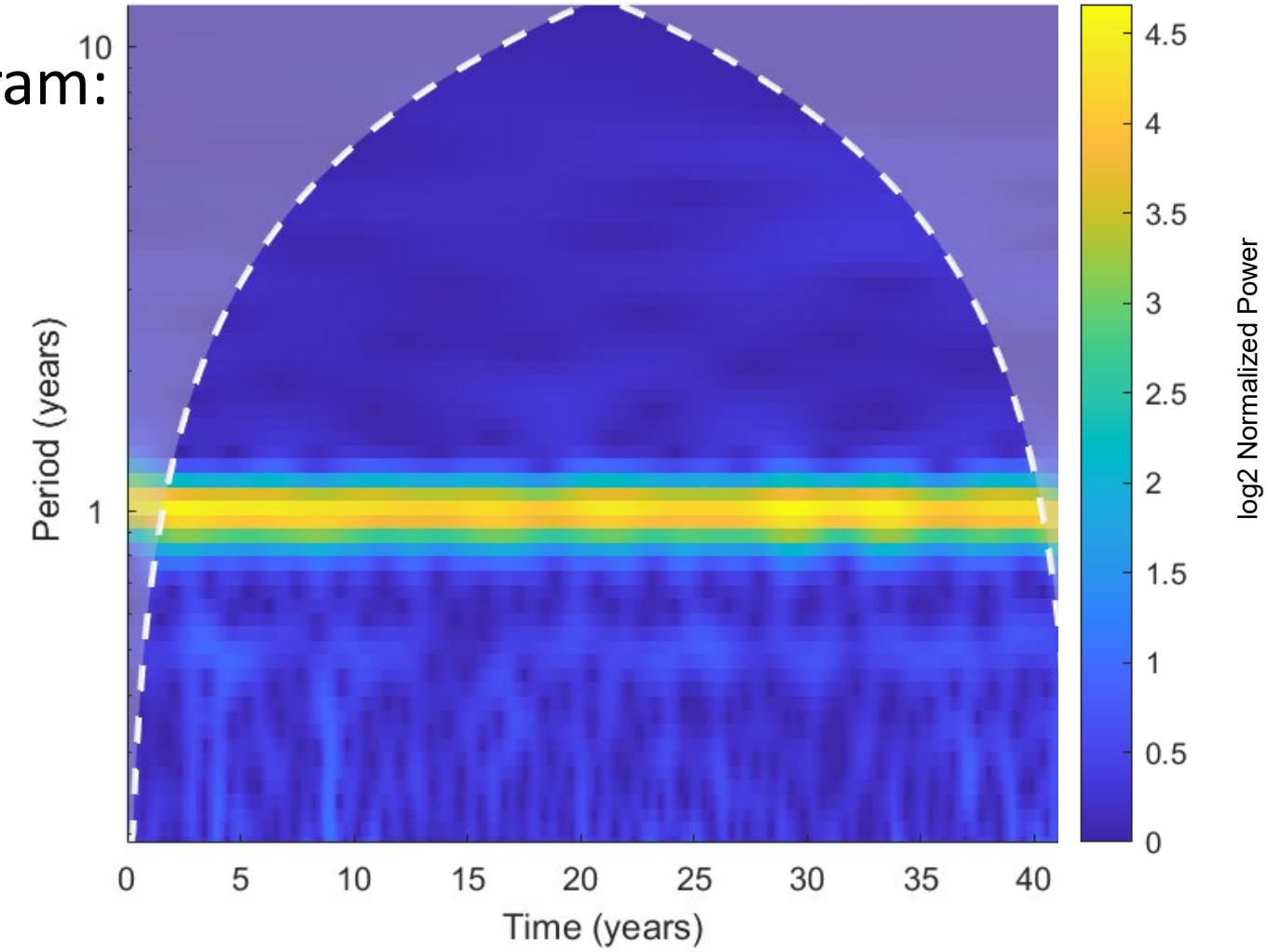
Small scale = high frequency

Large scale = low frequency

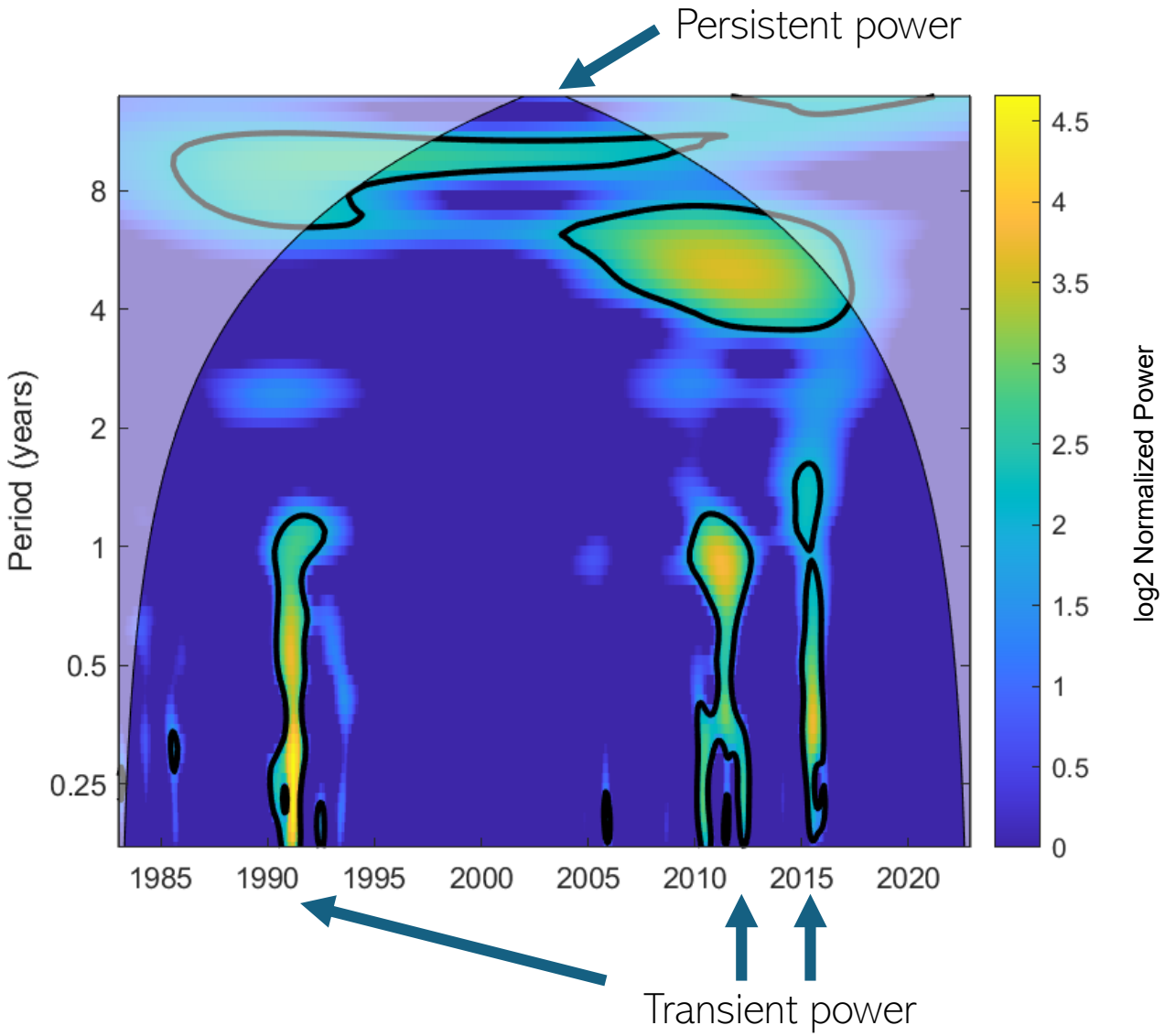


Persistent power → underlying pattern

Wavelet scalogram: temperature

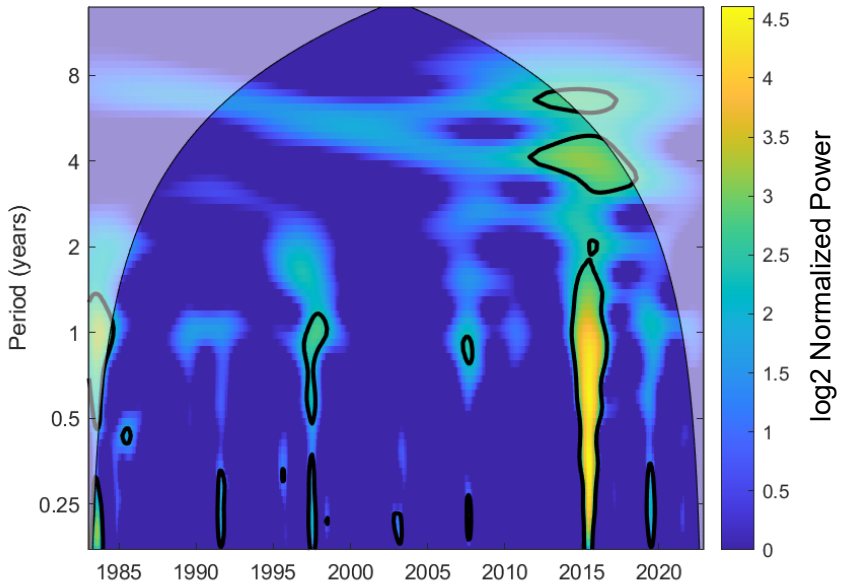


Transient power → events?

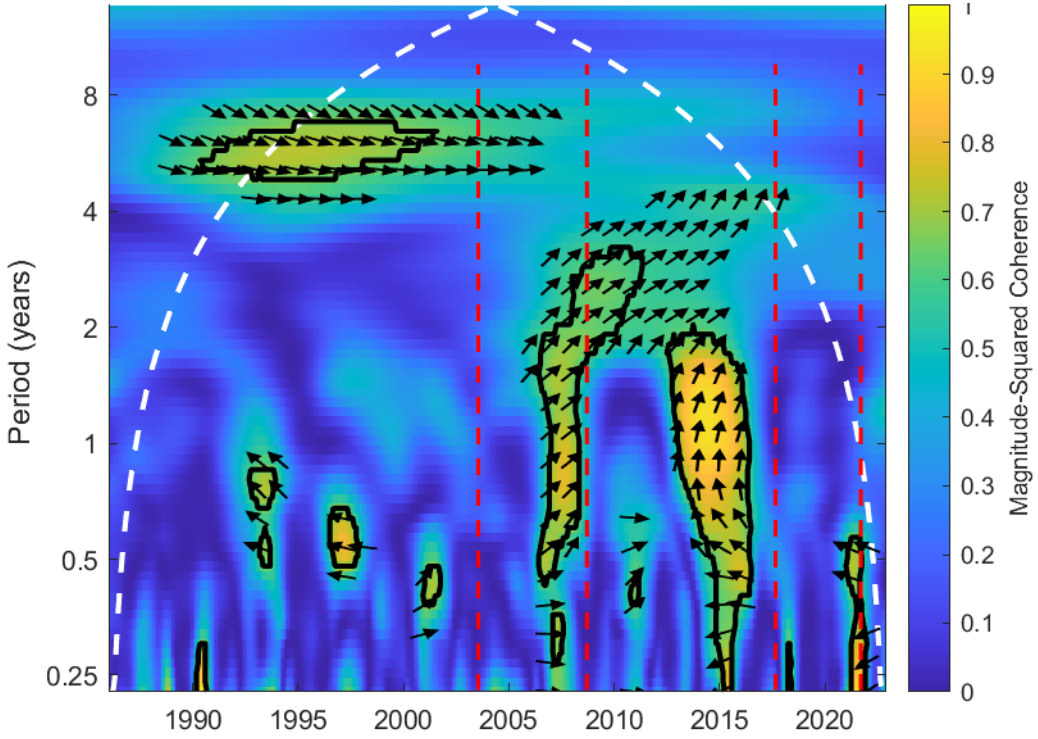


Wavelet transforms overlays → Wavelet coherence

Wavelet transform
Adult crabs



Wavelet coherence
Discharge vs. Adult crabs



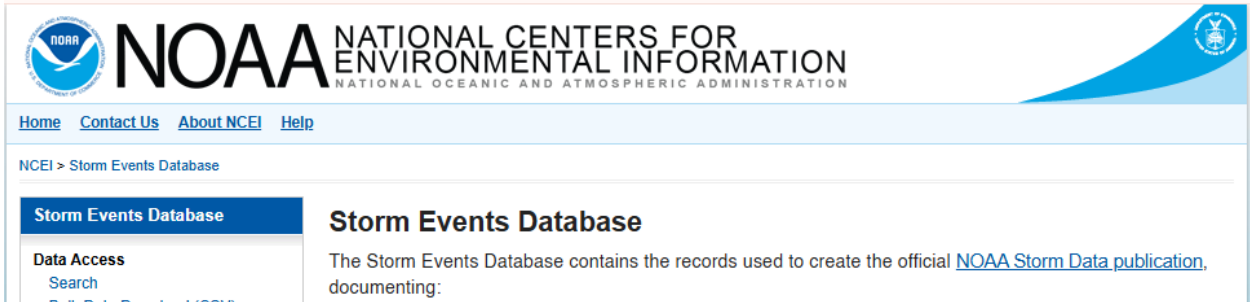
Detect areas where signals between wavelet transforms match

Wavelet coherence with climate and weather variables

Climate and weather variables

- Climate oscillations
- Discharge
- Windspeed
- Precipitation
- Salinity
- Temperature

Weather event reporting



Detectable severe weather impacts?

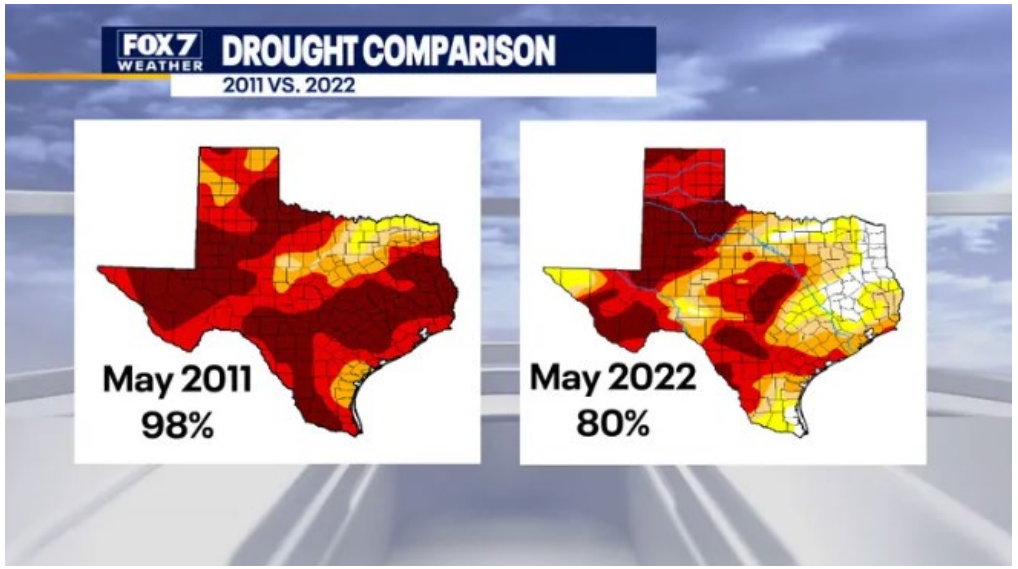
- ☑ Wet/dry transitions – drought
- ☒ Hurricanes
- ? Floods
- ? Excessive heat
- ? Freeze event

Drought severity and blue crab abundance

Local hydrology shapes life-stage specific responses of blue crab (*Callinectes sapidus*) abundance to drought severity

Mai S. Fung, Jagger Alexander, Christopher Biggs, Raymond Czaja Jr., Jiabi Du, Xinping Hu, Christine C. Jensen, Paul A. Montagna, Marisa Morse, Zachary Olsen, Jennifer Beseres Pollack, Antonietta Quigg, Zong-Liang Yang, Zhanfei Liu

Texas one of the most drought-prone areas



1

In Texas "…projections indicate drier conditions during the latter half of the 21st century than even the most arid centuries of the last 1,000 years that included megadroughts."

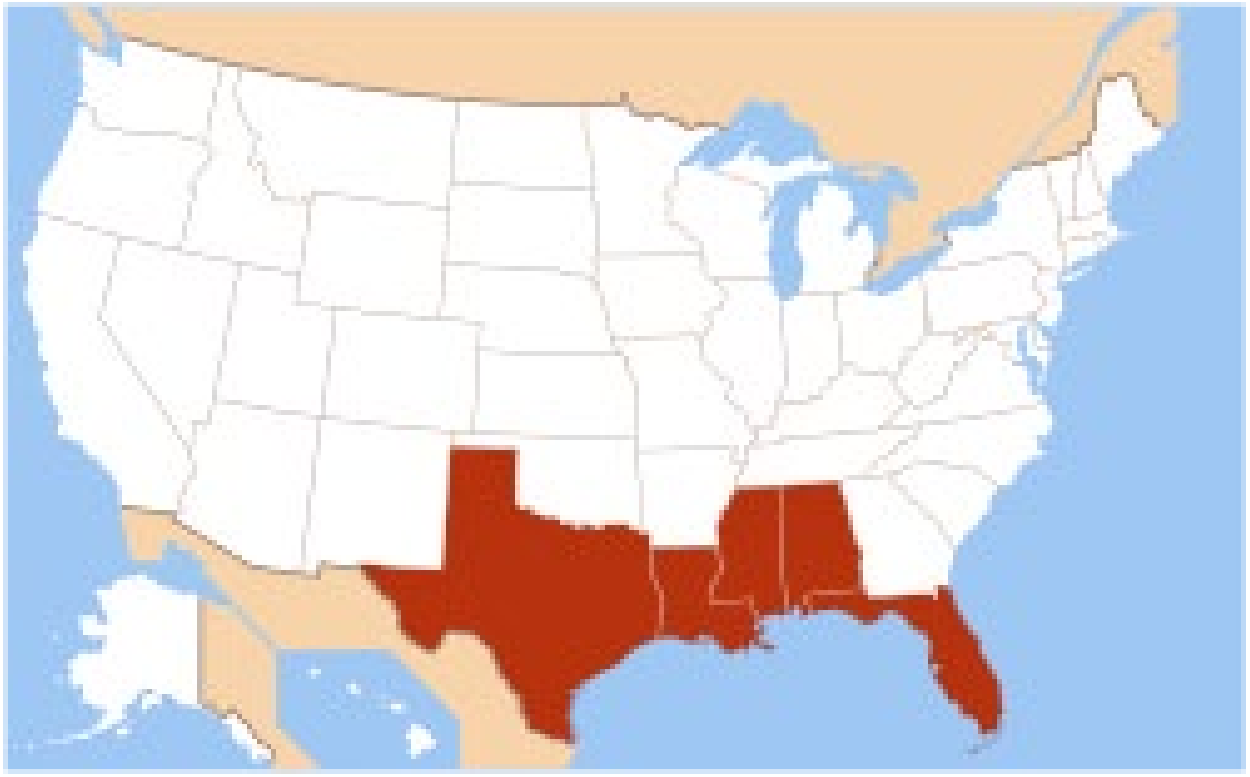
Nielsen-Gammon et al. 2020

2

2

2

On top of drought stress → declining abundances



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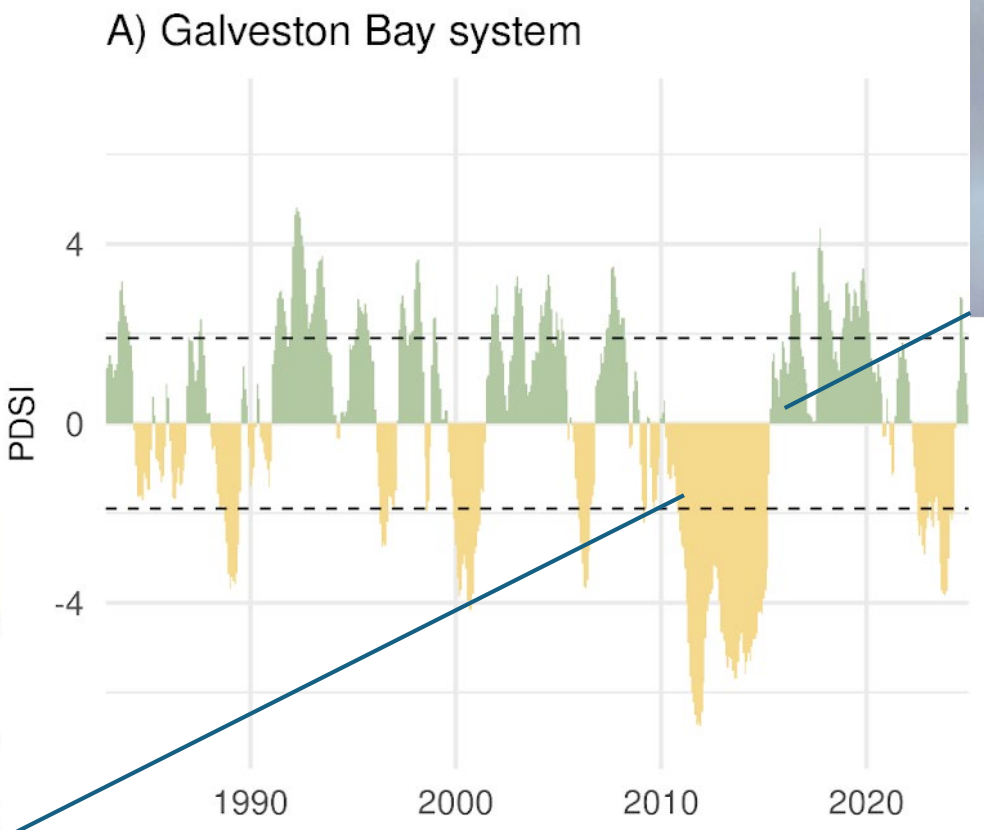
Declines since the mid-1980s

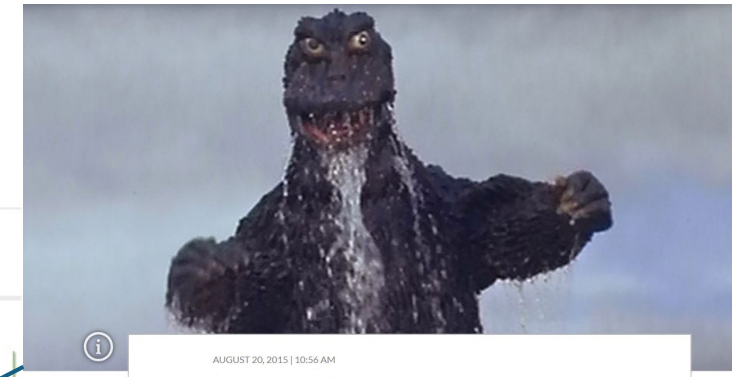
In Texas, 70% reduction in blue crab biomass from 1982 to 2005

Ward, 2012

Previous research

Dry conditions linked to decreased abundances





AUGUST 20, 2015 | 10:56 AM

'Godzilla' El Niño has Oklahoma Farmers Excited But Guarded

Logan Layden

2

Star-Telegram

'Where The West Begins' Serving Fort Worth, Arlington and Northeast Tarrant $1 Thursday, August 18, 2011

Perry again says global warming is unproven

Obama plans push for jobs

The jobs package that President Barack Obama plans to unveil shortly after Labor Day could include tens of billions of dollars to renovate thousands of dilapidated public schools and a tax break to encourage businesses to hire new workers, according to people familiar with White House deliberations. A companion plan to reduce federal budget deficits over the next decade is also in the works. 6A

More political coverage inside
■ Michele Bachmann discusses how biblical teachings on the role of wives fit with her presidential aspirations. 6A
■ The president's vacation to Martha's Vineyard this week revives a seemingly annual debate. 6A

Gov. Rick Perry stirred controversy Wednesday in New Hampshire, saying he considers man-made global warming an unproven scientific theory. He has long argued that case, but not as a presidential candidate. Environmental groups blasted his stance. Aman Batheja, 7A

AGRICULTURE

Drought takes $5 billion toll

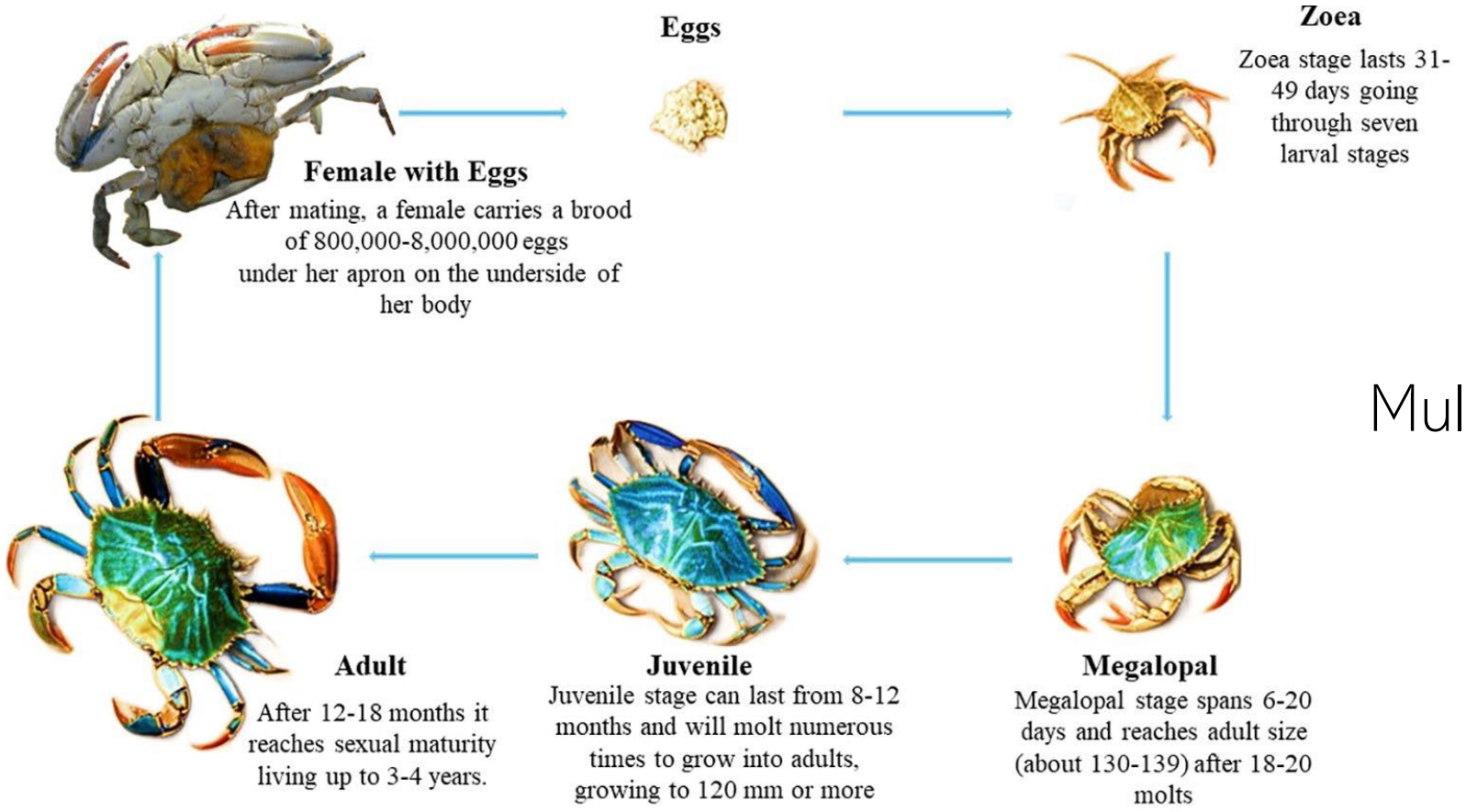
Texas farmers and ranchers suffer devastating losses as water and crops dry up

Airlines seek to

1

Multiple dry/wet cycles

Complex life history



Multiple life stages

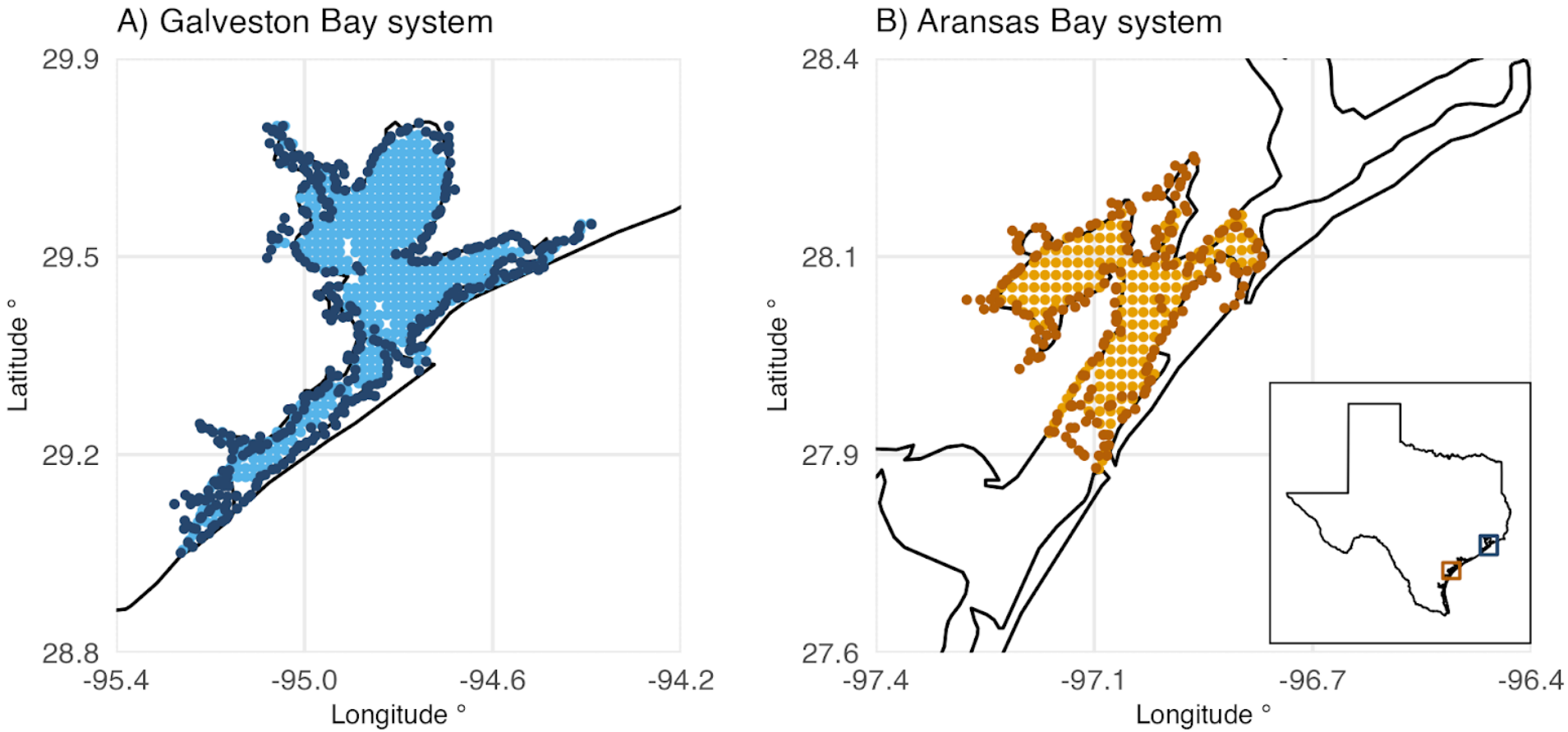
Nardelli et al. 2024

Objective

Assess the relationships between blue crab abundance and drought severity by life stage and between contrasting systems

- Long-term trends
- Abundance patterns
- Bayesian hierarchical models

Study sites


A) Galveston Bay system
29.9
29.5
29.2
28.8
Latitude °
-95.4
-95.0
-94.6
-94.2
Longitude °
B) Aransas Bay system
28.4
28.1
27.9
27.6
Latitude °
-97.4
-97.1
-96.7
-96.4
Longitude °

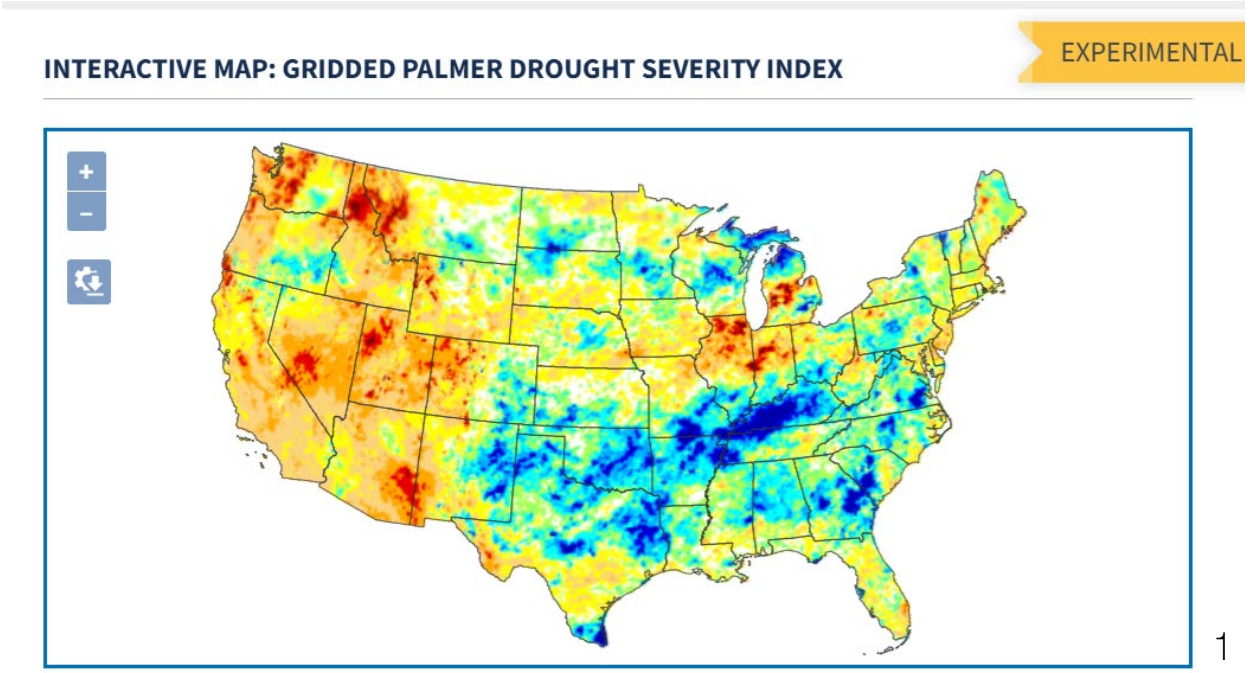
Data

- Bag seine + otter trawl sampling (1983-2022, TPWD)

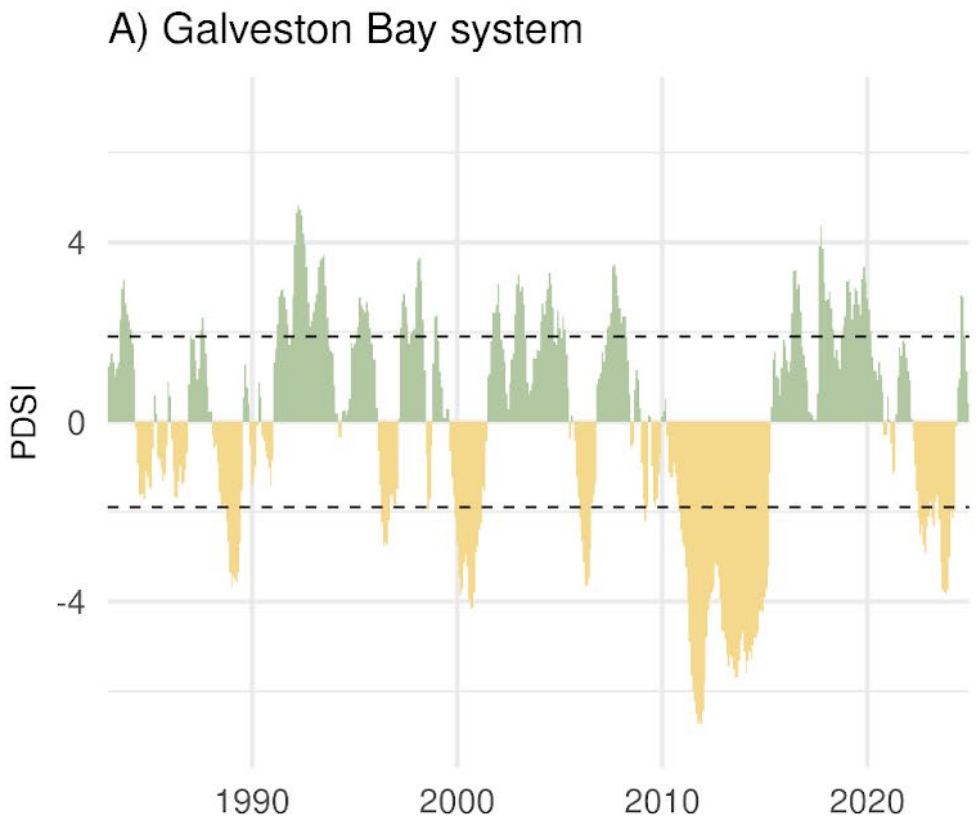
  early juvenile (≤ 80 mm), late juvenile (81-126 mm), adult (≥ 127 mm)

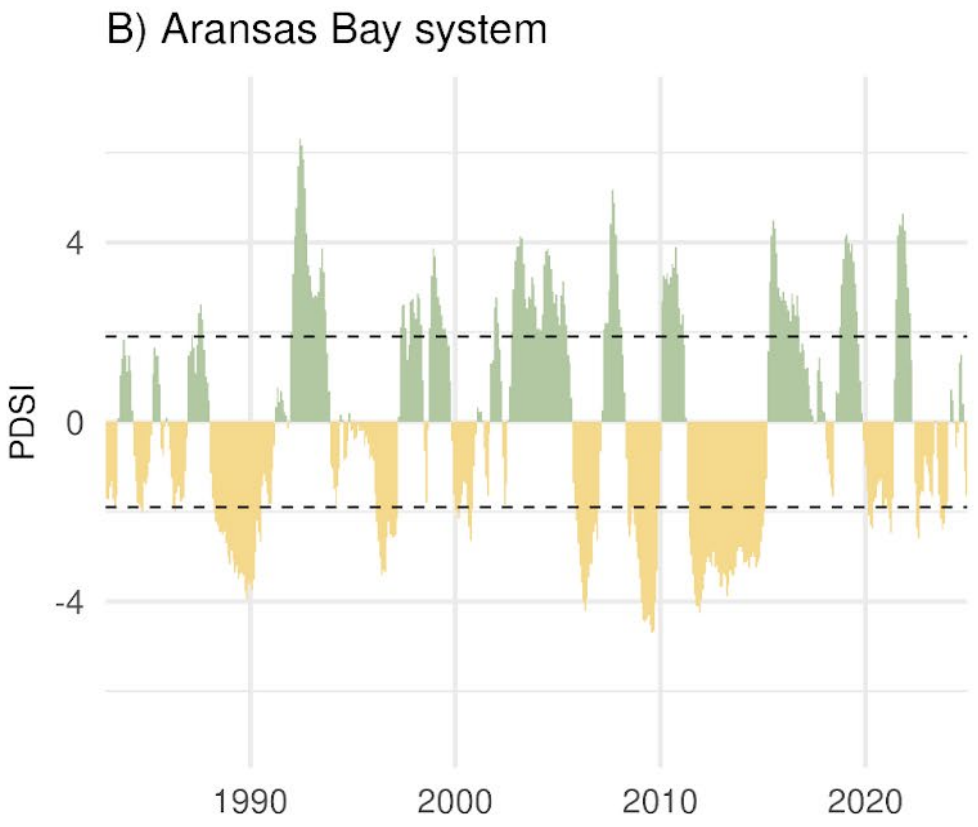
- Temperature
- Dissolved oxygen

- Gridded Palmer Drought Severity Index (PDSI)



Palmer Drought Severity Index (PDSI)

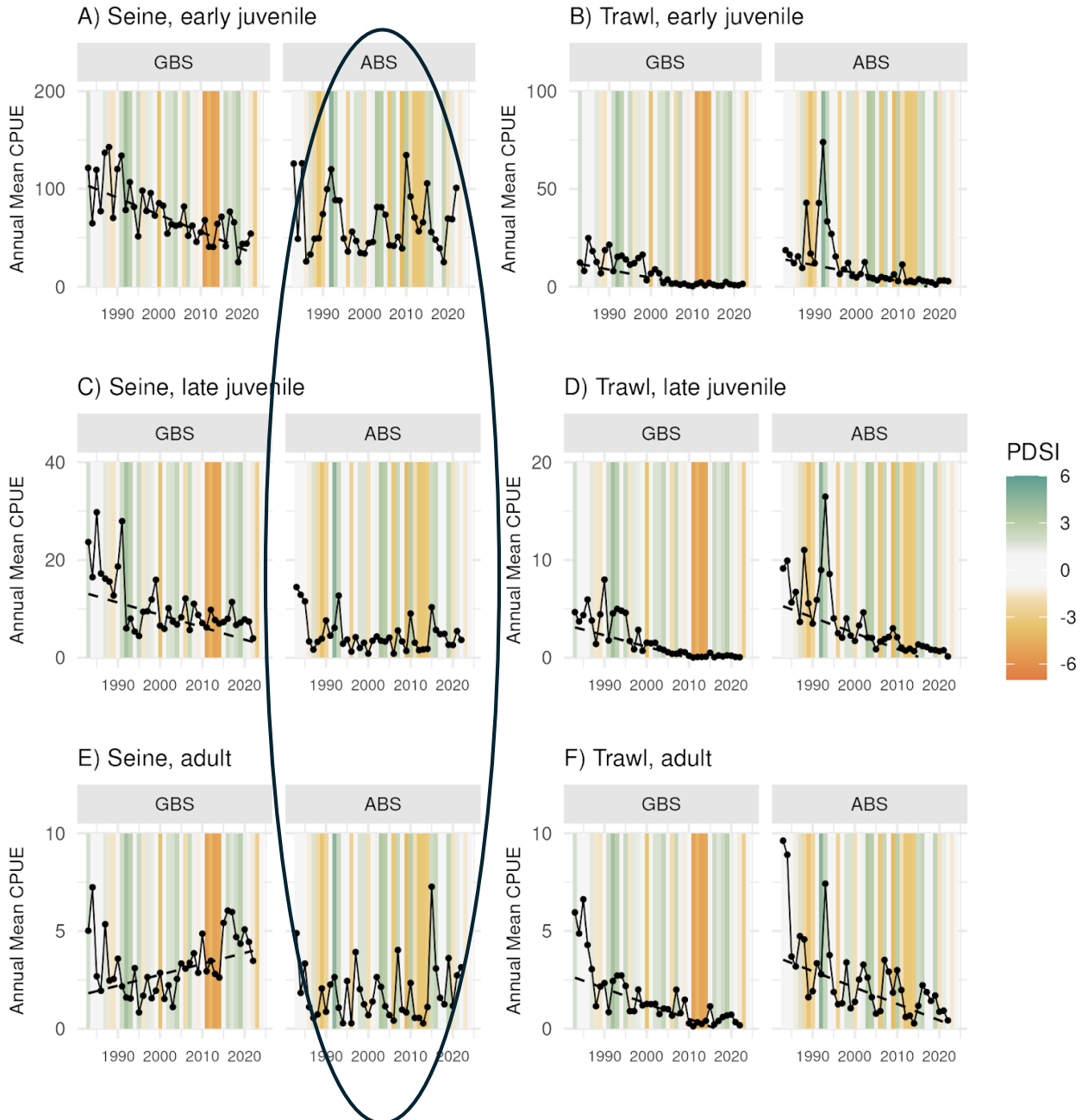




Long-term trends

Mostly decreasing

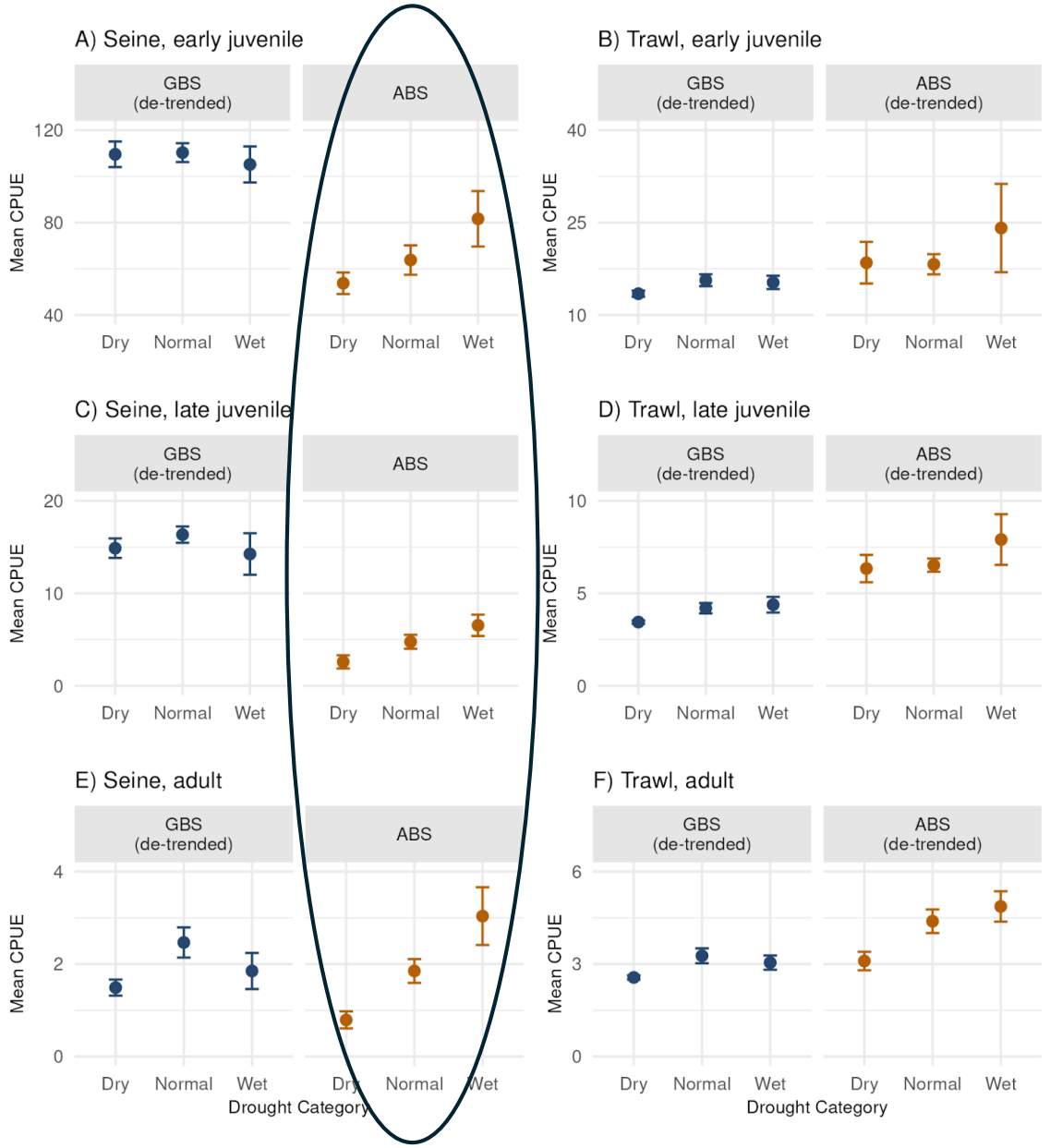
No long-term trends in seine data for Aransas Bay system



Patterns in abundance

Overall abundance by drought category

Clearest drought impact pattern in Aransas



Bayesian models

Seine model

and

Trawl model

early juveniles, late juveniles, adults

estuary + interannual + seasonal + dissolved oxygen + PDSI + error (AR(1))

seasonal spline or temperature

Response to drought severity

Seine model

Galveston: --
Aransas: 4.8%

Galveston: --
Aransas: 13.9%

Galveston: --
Aransas: 13.0%

% change in abundance
per unit change in PDSI

Response to drought severity

Trawl model

Galveston: --
Aransas: --

Galveston: --
Aransas: --

Galveston: 7.8%
Aransas: 12.1%

% change in abundance per unit change in PDSI

Response to drought severity

Nearly 2x higher in Aransas than Galveston (for adults)

Seine model

Galveston: --
Aransas: 4.8%

Galveston: --
Aransas: 13.9%

Galveston: --
Aransas: 13.0%

Trawl model

Galveston: --
Aransas: --

Galveston: --
Aransas: --

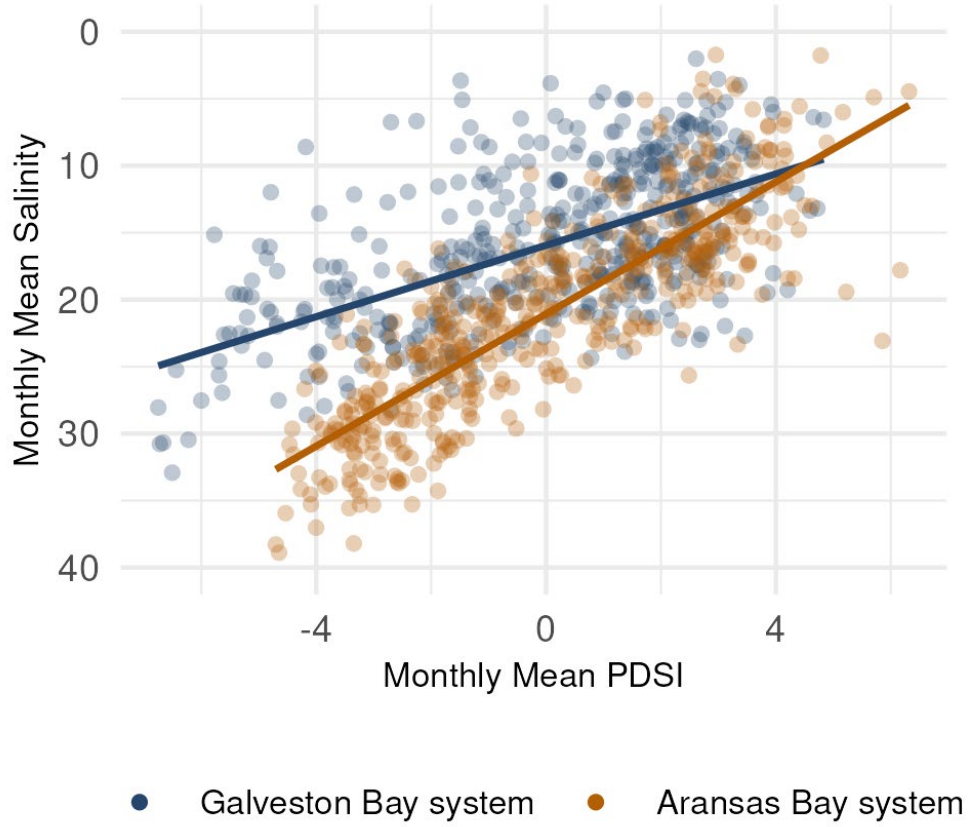
Galveston: 7.8%
Aransas: 12.1%

Why is there a differential estuarine response?

Local hydrology:

Dry and wet conditions proportionally greater impact in Aransas vs Galveston

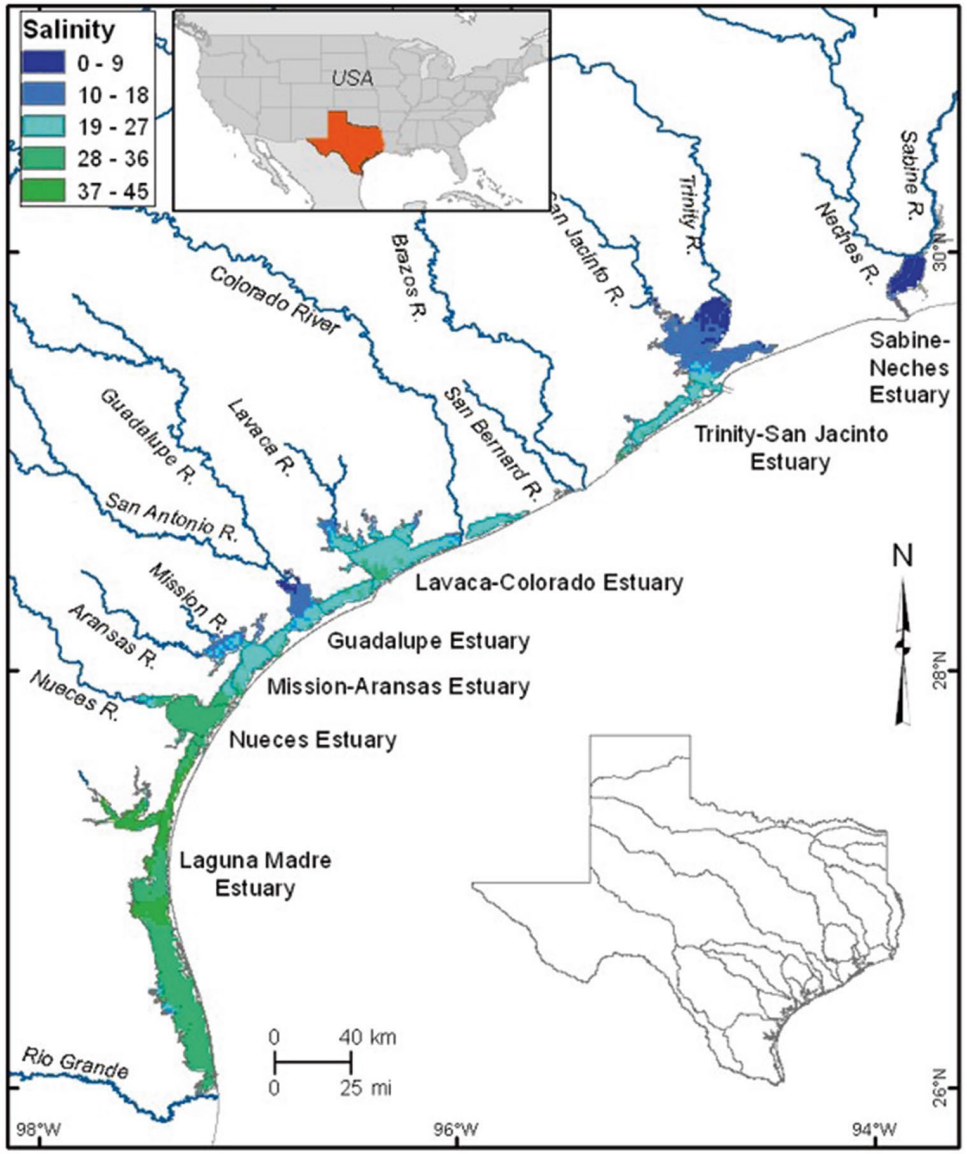
Change in PDSI → greater Aransas salinity shifts



Some estuaries may be more vulnerable

High salinity + low flow estuaries vulnerable to drought?

Changing climate → conservative water management



Montagna et al. 2025

Thank you!

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Image references:

Slide 4: 1. Reuters 2. David J. Phillip/Associated Press 3. Jay Janner/American-Statesman 4. Joe Raedle/Getty Images

Slide 11: 1. Jay Janner/Austin American-Statesman

Slide 12: 1. landmarkwildlife.com/ultimate-guide-to-texas-blue-crab/

Slide 13: 1. fox7austin.com/weather/austin-texas-heat-drought-worst-summer-since-2011 2. Jay Janner/American-Statesman

Slide 14: 1. en.wikipedia.org/wiki/Gulf_Coast_of_the_United_States

Slide 15: 1. stateimpact.npr.org/ 2. lastwordonnothing.com/2012/01/26/3303/

Slide 19: 1. drought.gov/data-maps-tools/us-gridded-palmer-drought-severity-index-pdsi-gridmet

Gulf Ecosystem Initiative Request for Proposals 2026

Funding and support for **two working groups** and **one postdoc** advancing synthesis science to inform solutions to pressing challenges in the Gulf of America in:

Climate Change

Fisheries

Ecological Impact of Management Actions

Applications Due By

Friday, February 20, 2026 | 5:00 pm PDT / 7:00 pm CDT

More Information

www.nceas.ucsb.edu/gulfeco

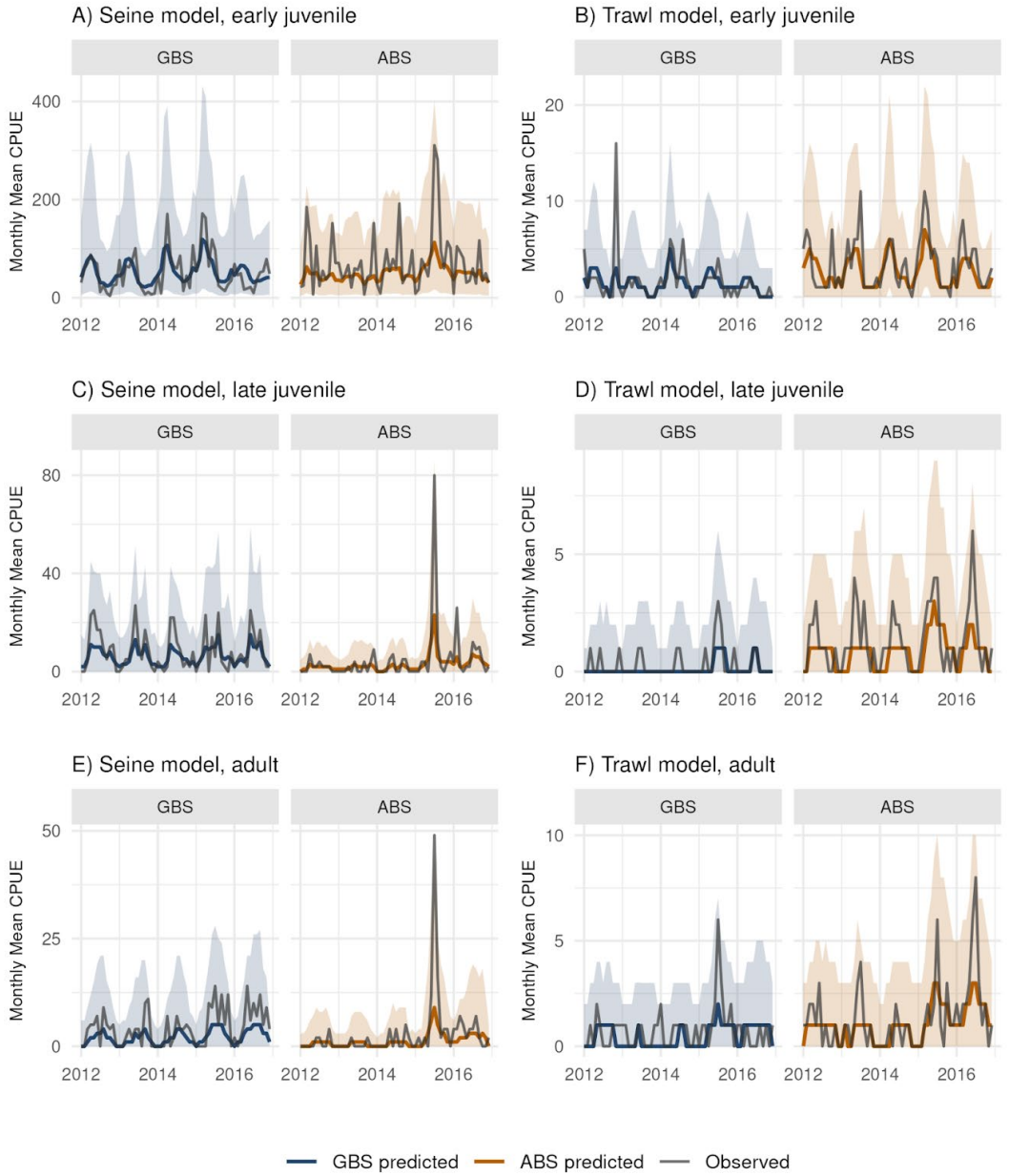
For Inquiries

gulfeco@nceas.ucsb.edu

Additional slides

Model fits

Monthly: snapshot from extreme drought to very moist conditions



Model fit

Annual aggregate