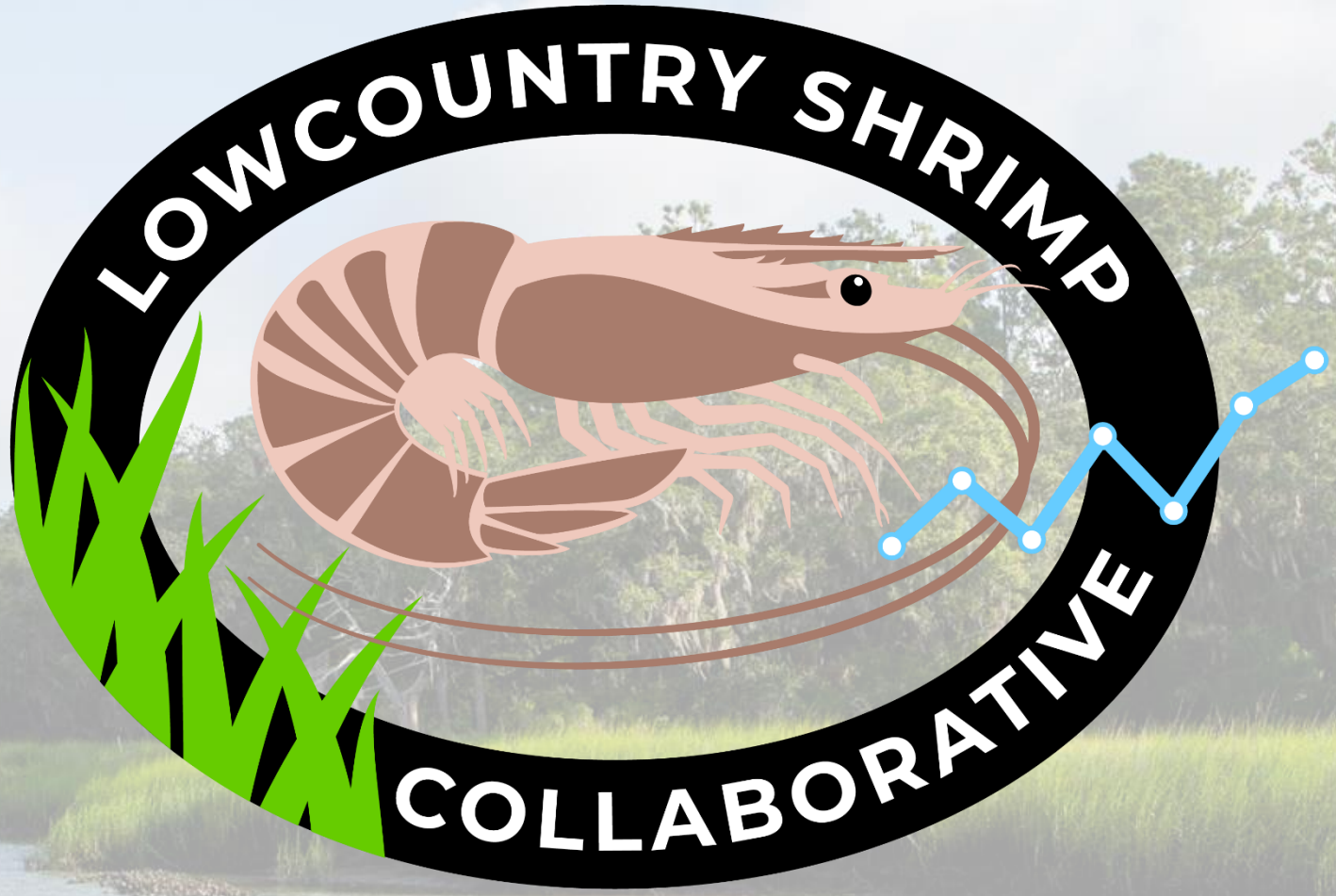
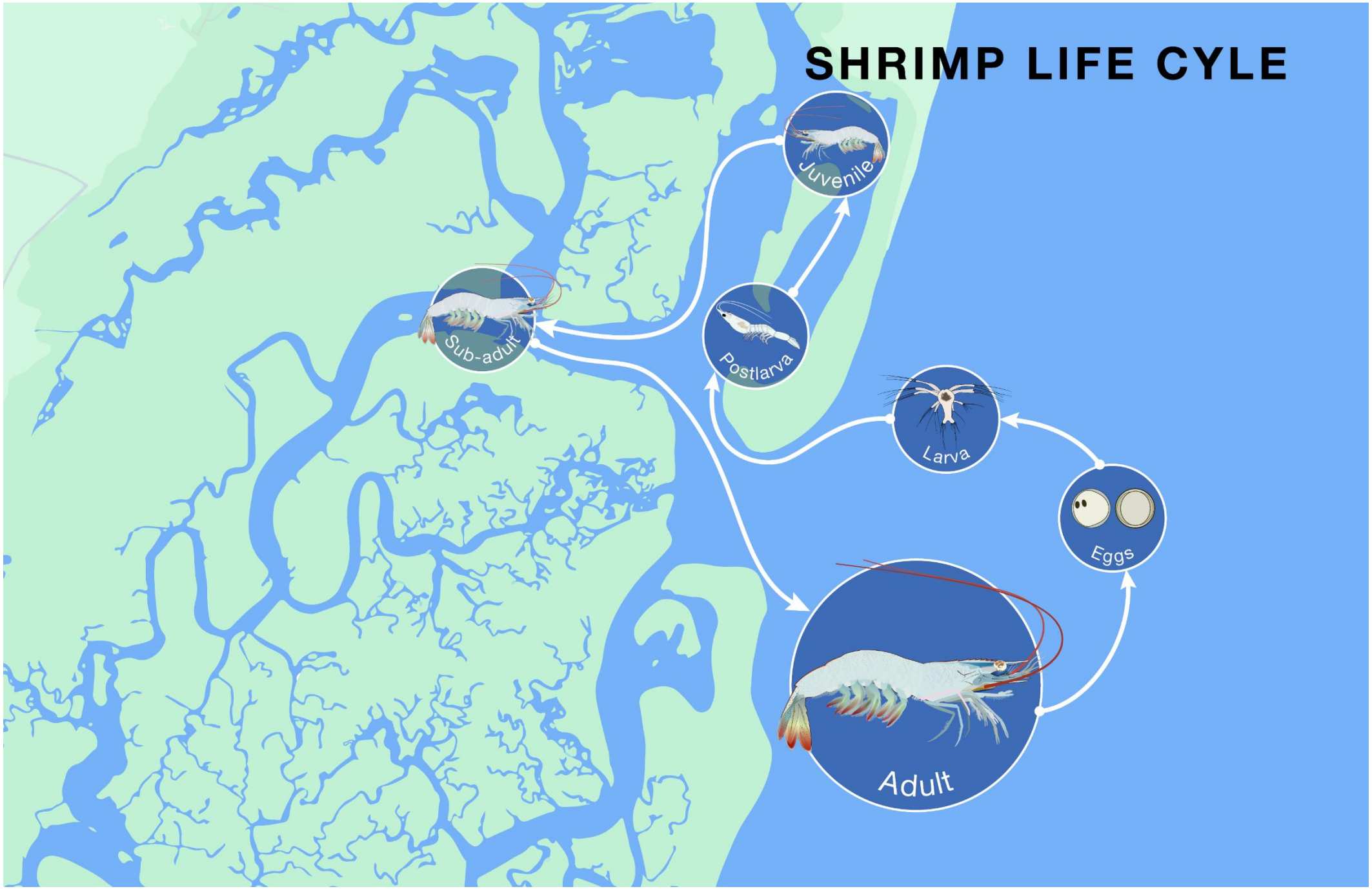


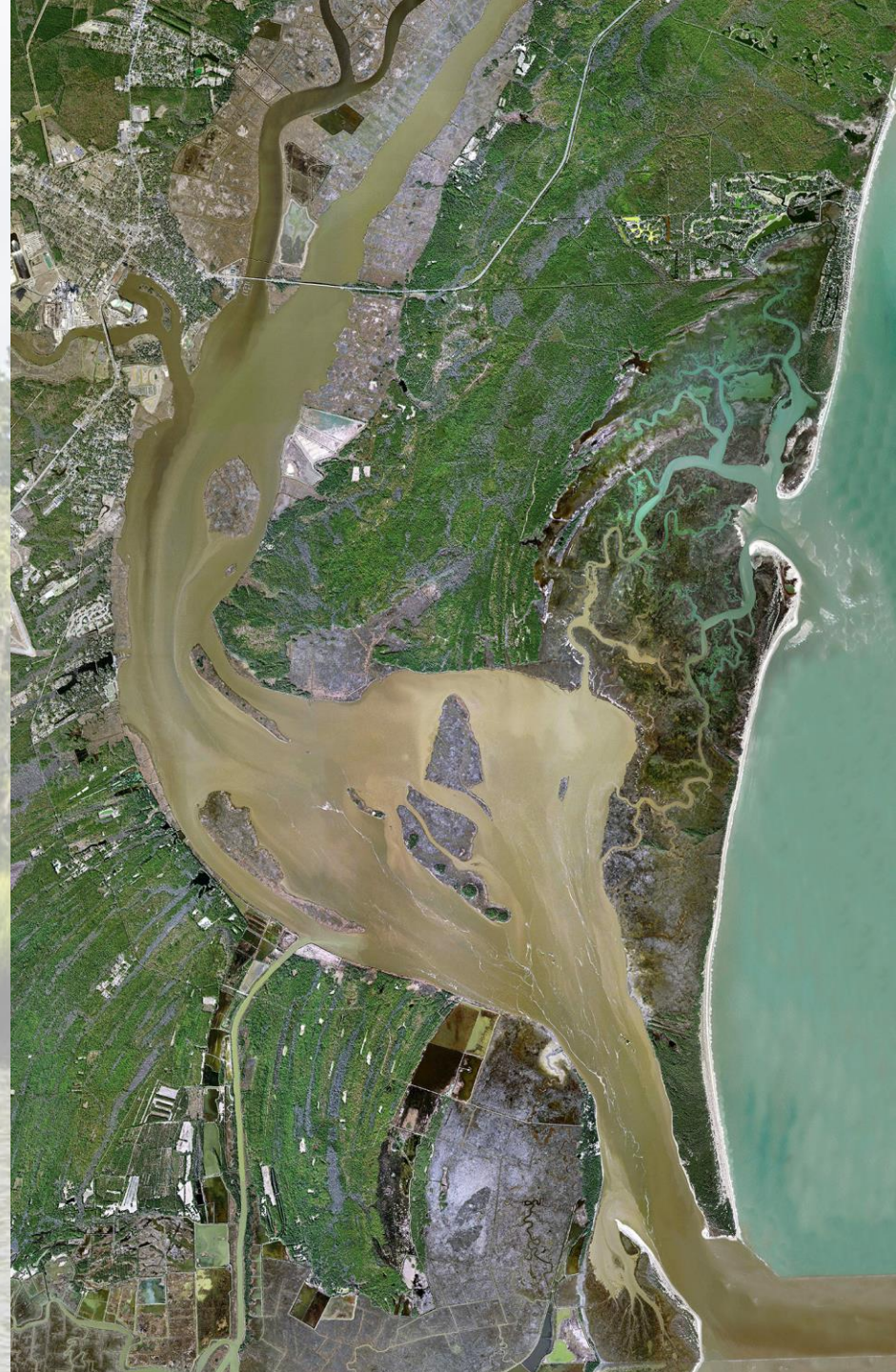
Robert Dunn, PhD
North Inlet-Winyah Bay NERR &
Baruch Marine Field Laboratory, University of South Carolina

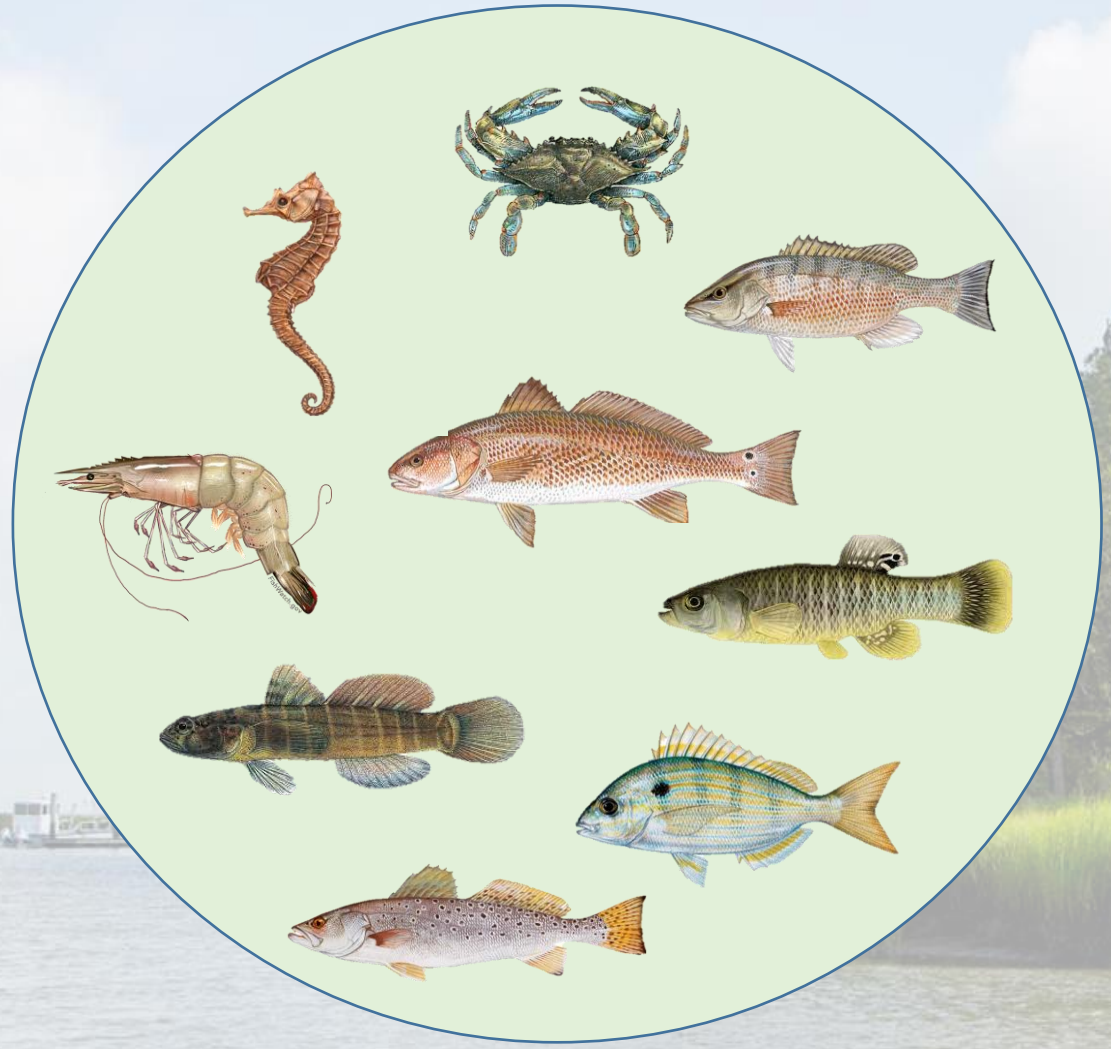
National Estuarine Research Reserve System Science Collaborative


SHRIMP LIFE CYLE
Juvenile
Sub-adult
Postlarva
Larva
Eggs
Adult

Why should I care about estuaries?

- Productive and dynamic ecosystems
- Serve as nursery habitat for numerous species (including Penaeid shrimp)
- Ecosystem functions and services vary temporally and spatially





Estuaries support diverse communities

- Provide refuge, foraging opportunities and act as nursery habitat
- Habitat requirements are species specific
- Effective management requires understanding environmental effects on communities
- Temperature, salinity, and nutrient concentrations, expected to change with climate change

LOWCOUNTRY SHRIMP COLLABORATIVE

To understand changes in shrimp populations in response to environmental variability due to changing climate conditions, weather events, and habitat modifications.

North Inlet - Winyah Bay National Estuarine Research Reserve

Sapelo Island National Estuarine Research Reserve

ACE Basin National Estuarine Research Reserve

South Carolina Department of Natural Resources

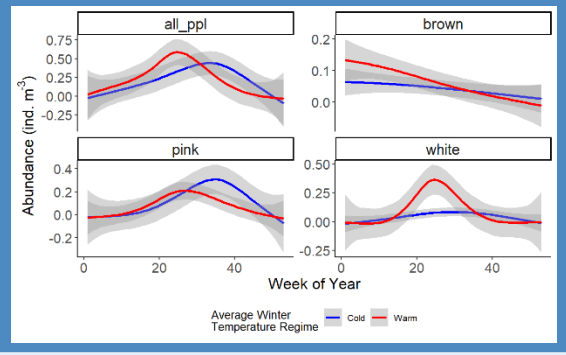
Sea Grant S.C. Sea Grant Consortium

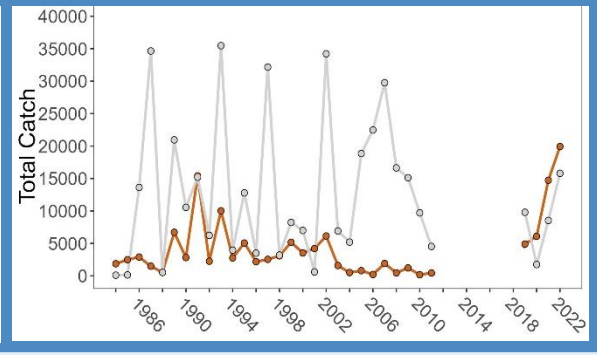
University of Georgia Marine Extension and Georgia Sea Grant

Baruch Marine Field Laboratory University of South Carolina

Coastal Carolina University

Analyses of long-term surveys and historic samples





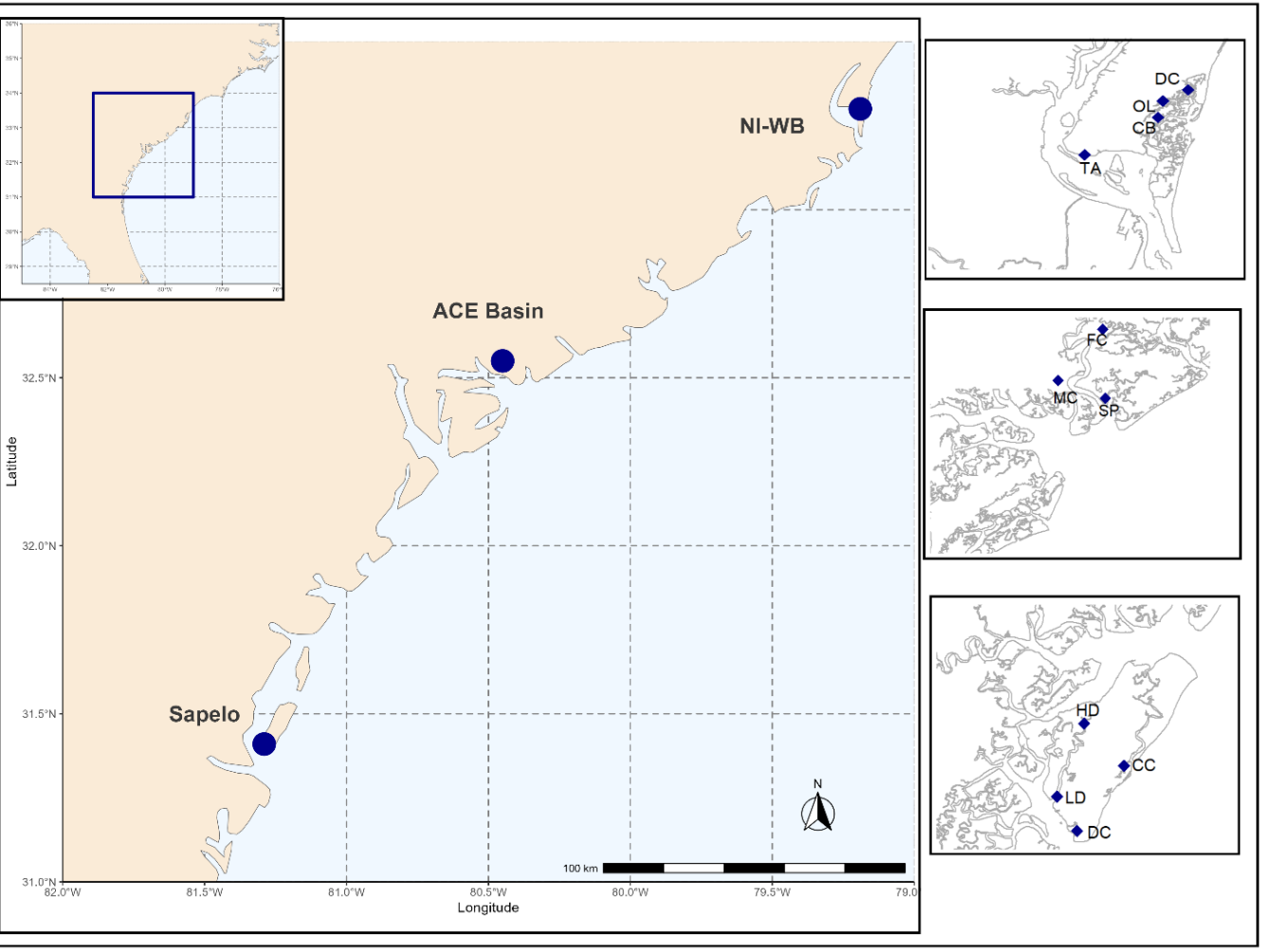
Stakeholder interviews

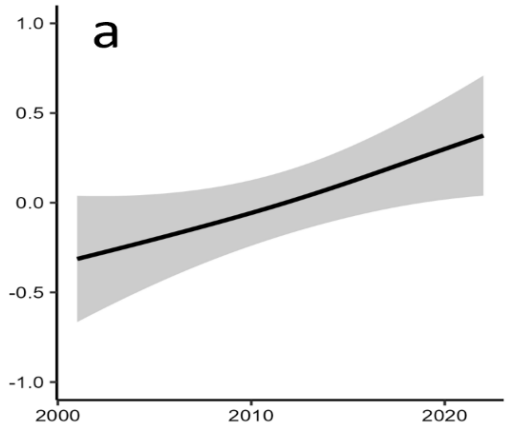
Density-dependent growth and mortality experiments

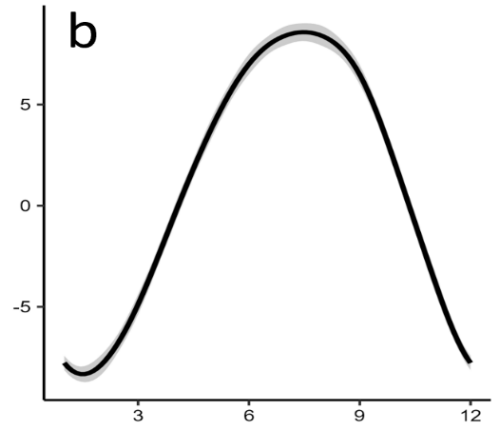
Field sampling

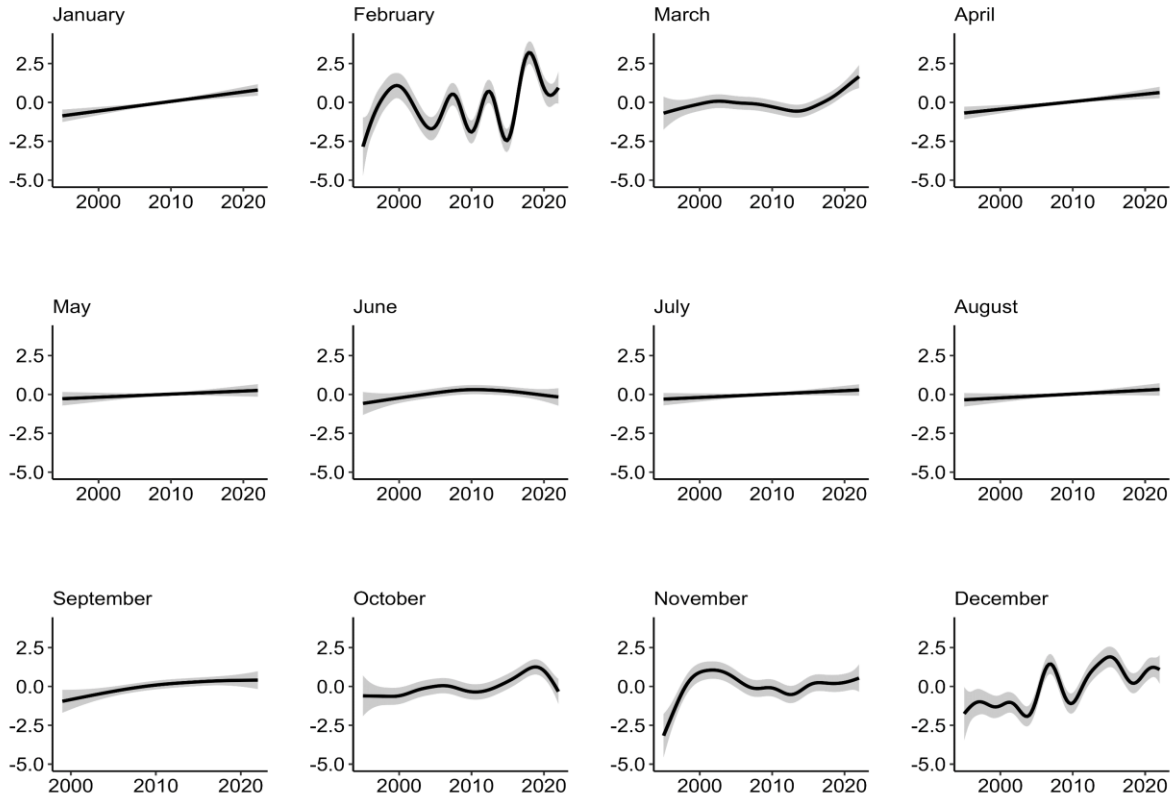

OceanPro
EVINRUDE
200
BOSTON
WHALER

Long-term trends: water quality

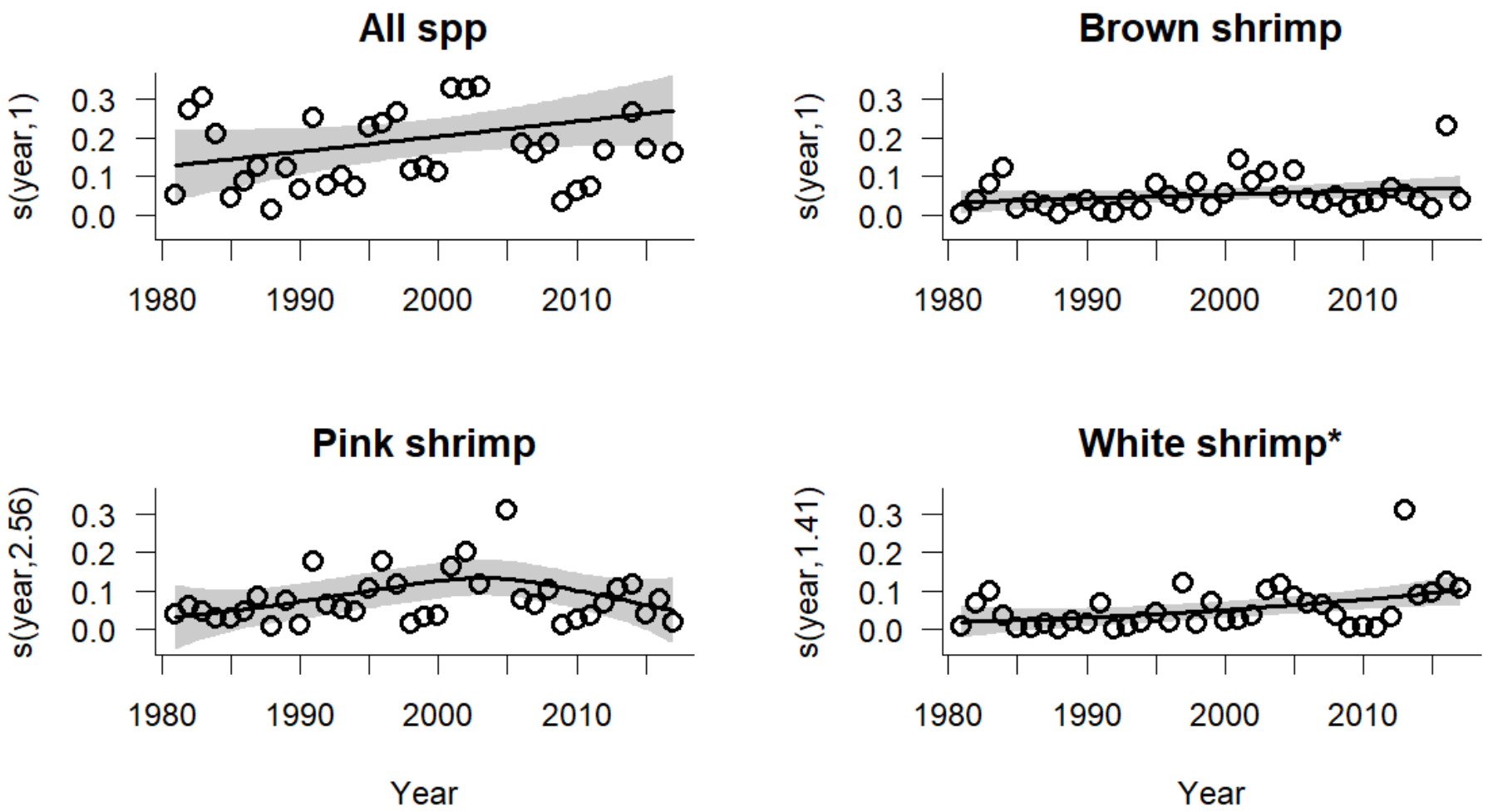




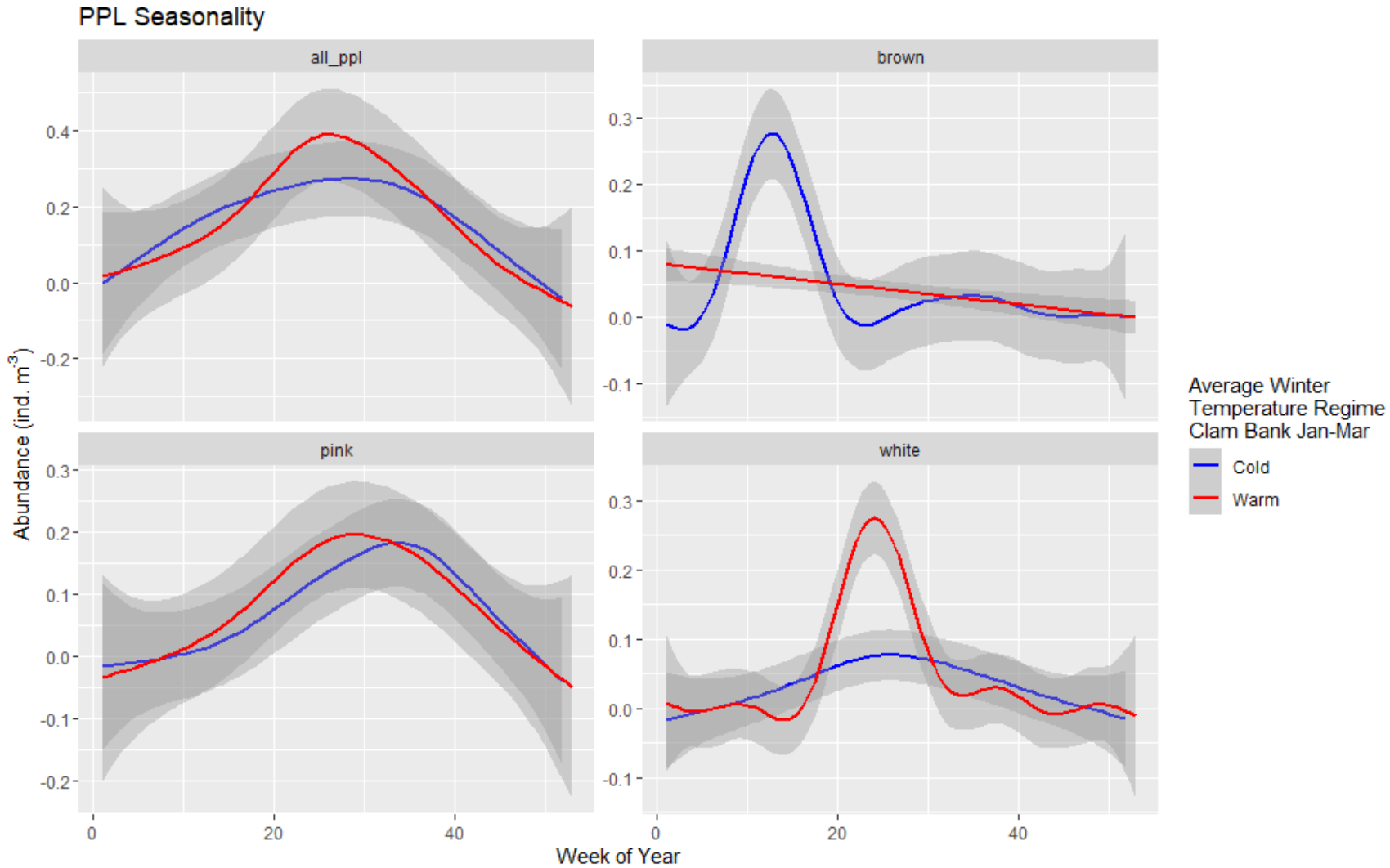




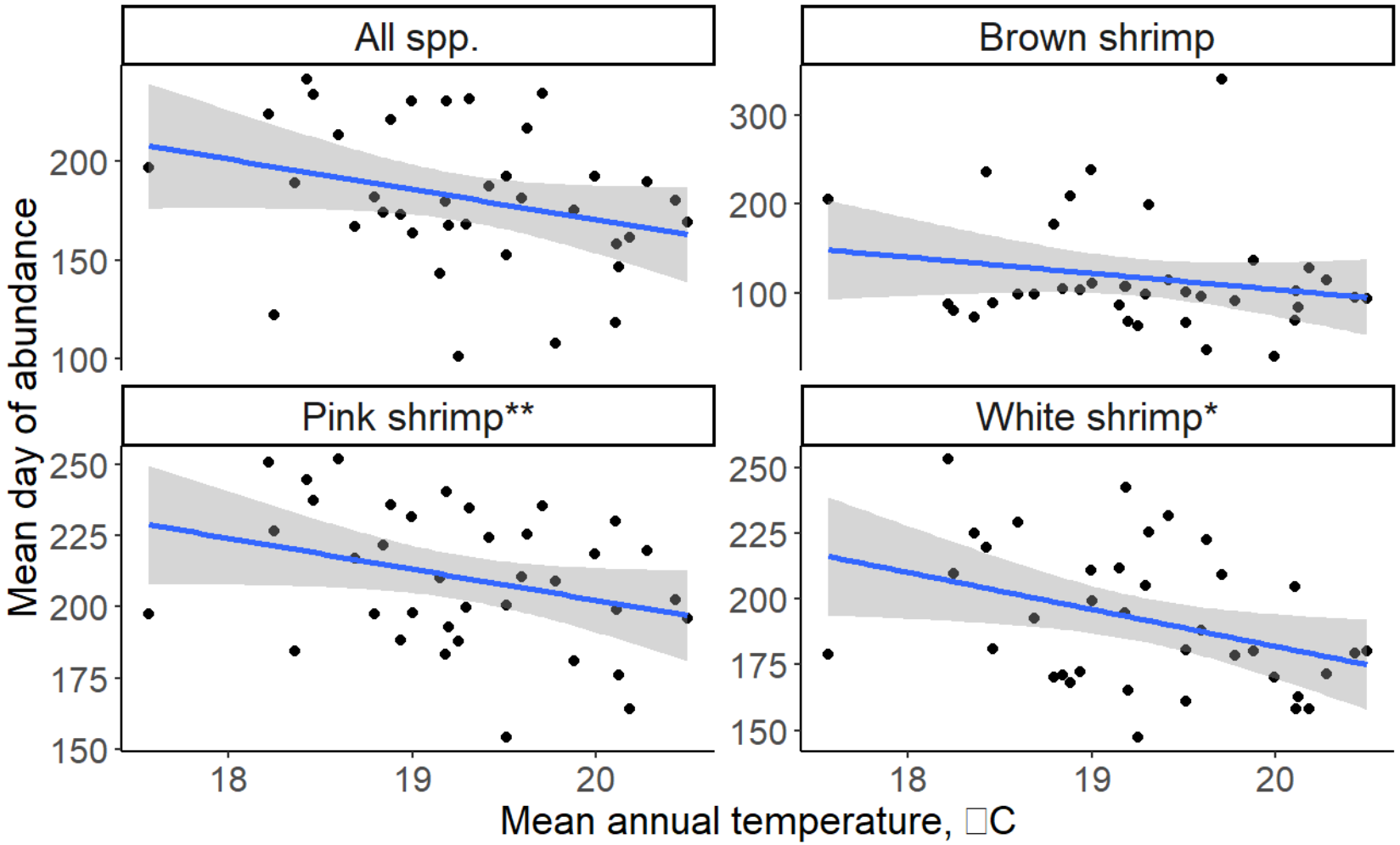
Postlarval abundance trends



Postlarval abundance – impacts of winter temperature



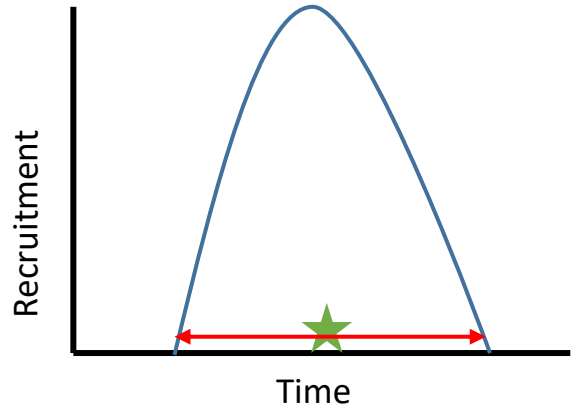
Postlarval timing – impacts of annual temperature



Phenology

Temporal occurrence of natural phenomena (often major life history events)

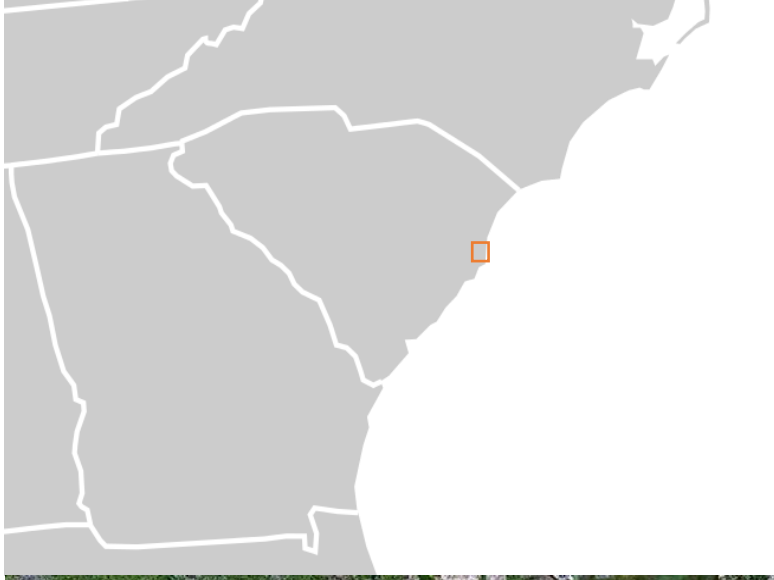
- Timing: The date at which some event occurs ★
- Synchrony: The spread of dates over which an event occurs ↔

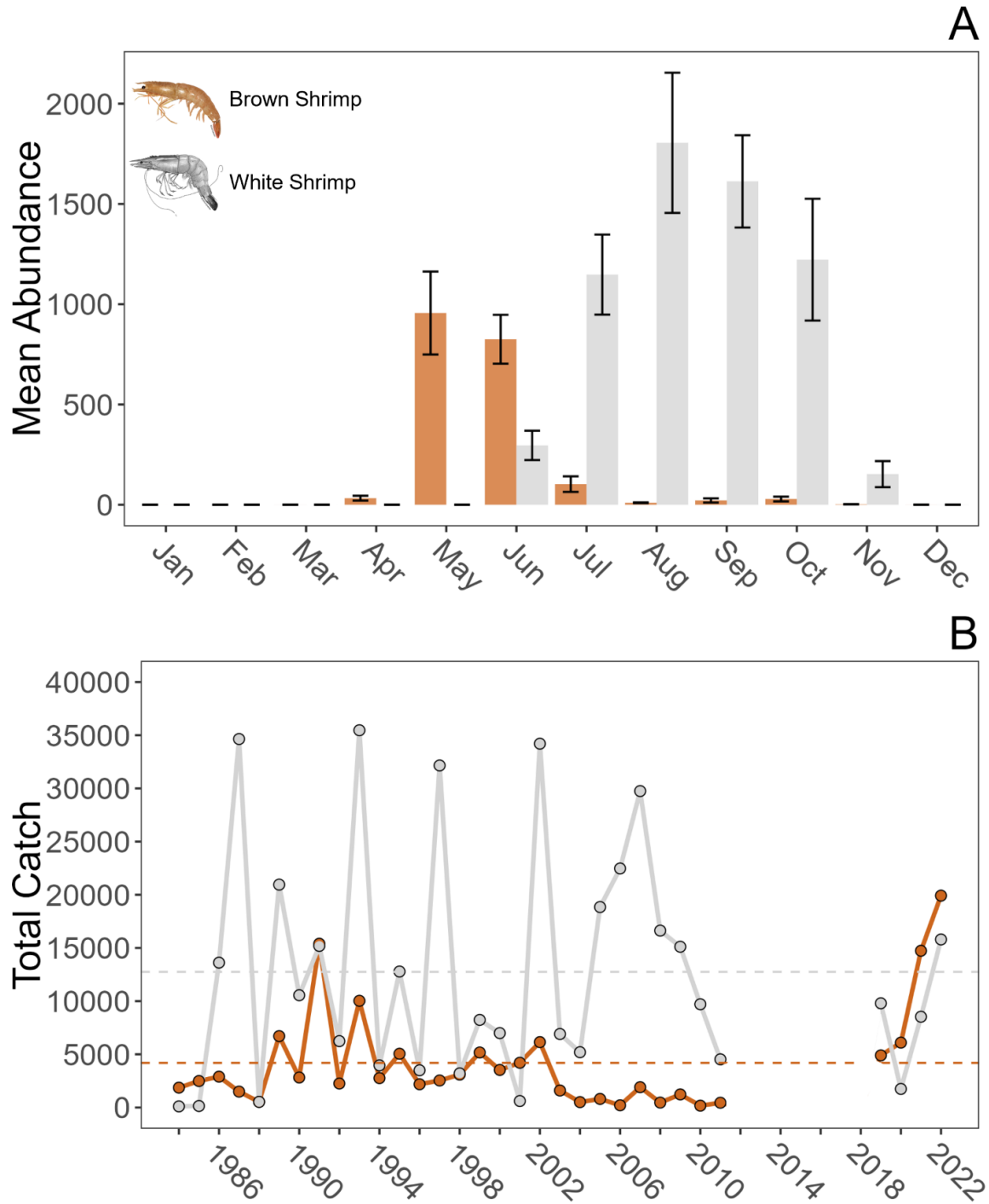


- Changes in timing and synchrony influences resource availability, predator-prey dynamics, and harvest

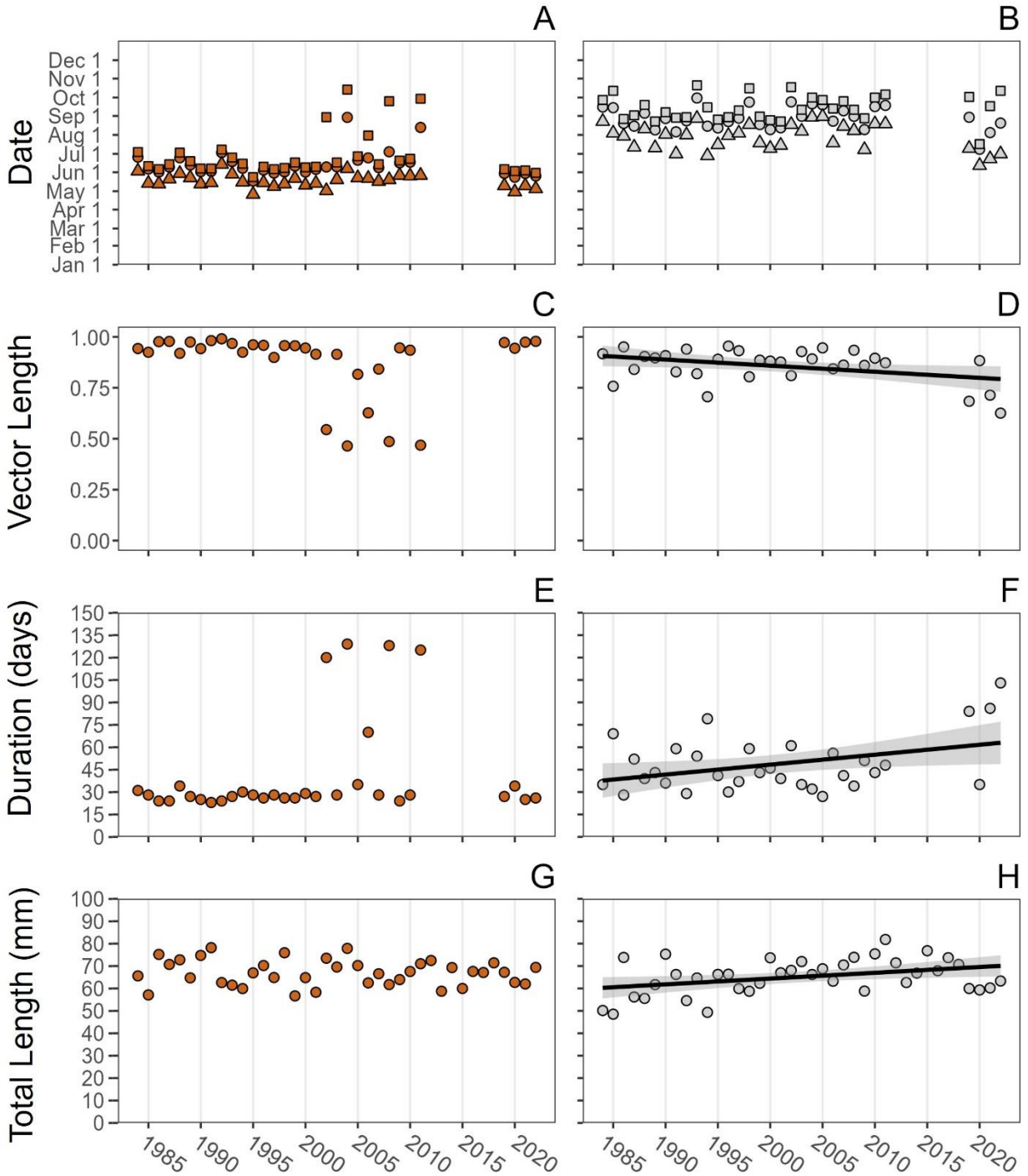
To evaluate changes in juvenile shrimp phenology:

Analyzed 38-year time series of survey data from North Inlet Winyah Bay National Estuarine Research Reserve

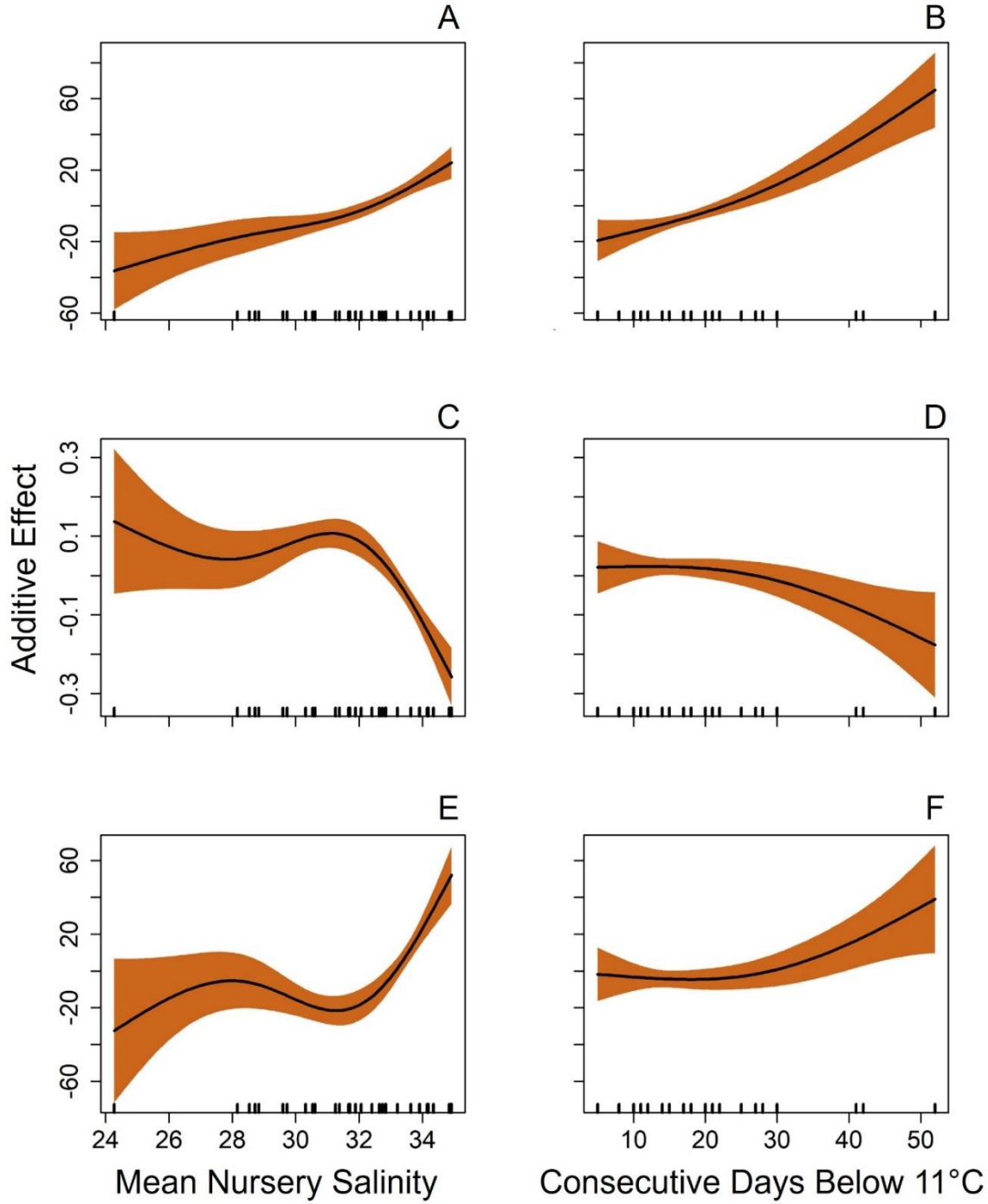



A
Brown Shrimp
White Shrimp
Mean Abundance
2000
1500
1000
500
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
B
Total Catch
40000
35000
30000
25000
20000
15000
10000
5000
0
1986
1990
1994
1998
2002
2006
2010
2014
2018
2022

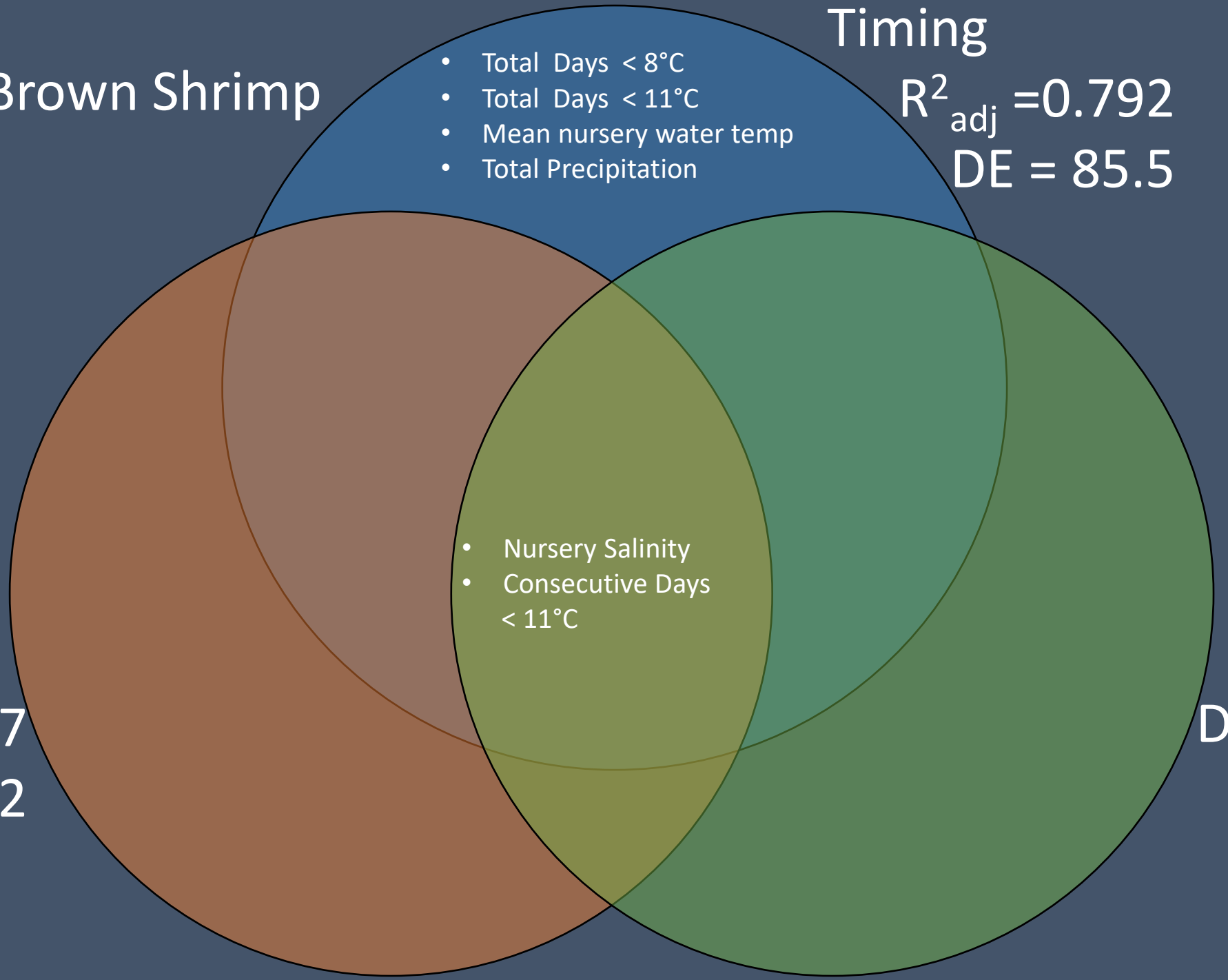
Brown shrimp: No significant change over time



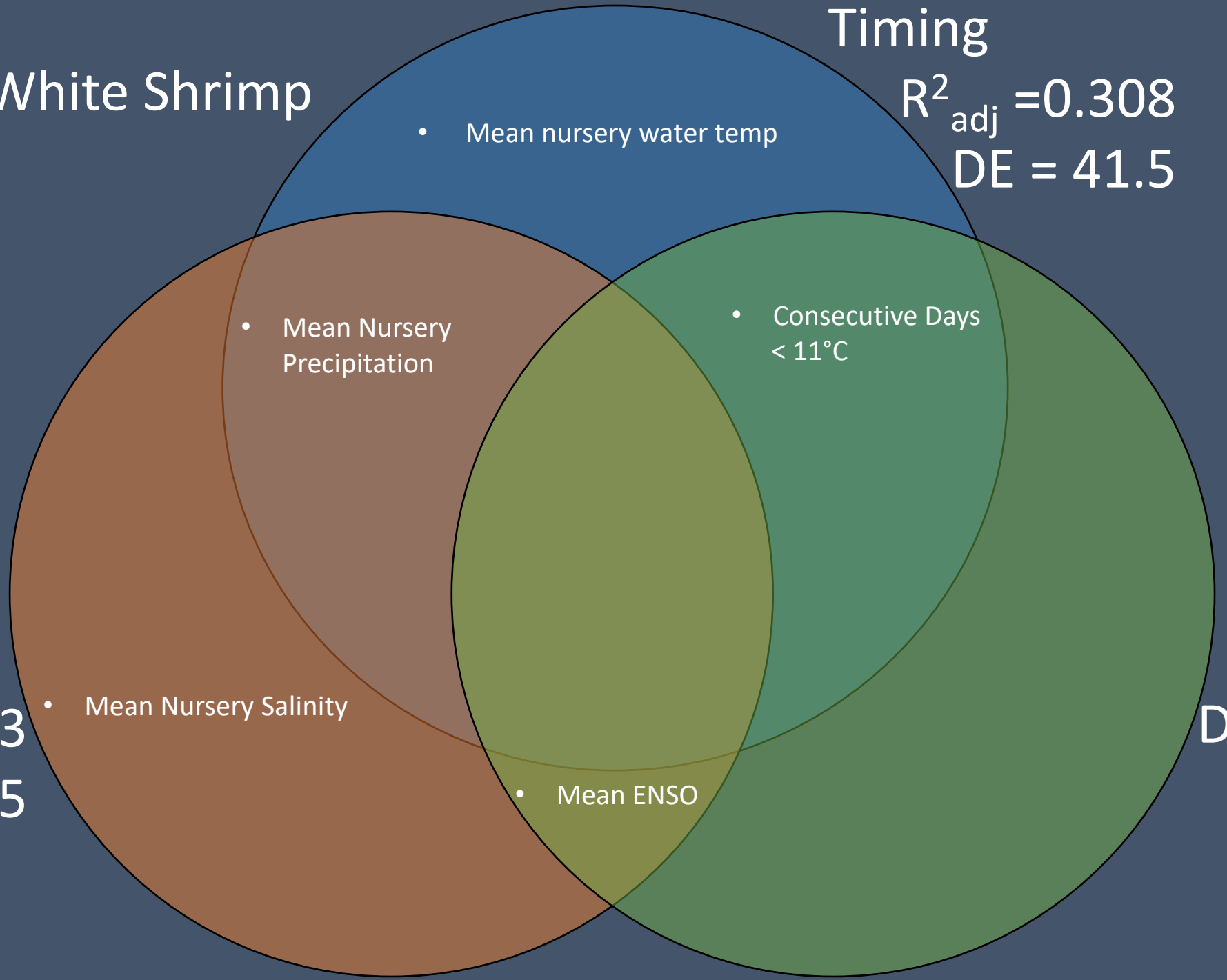
White shrimp: Timing, duration and size all shifting


A
B
C
D
E
F
Additive Effect
60
20
-20
-60
0.3
0.1
-0.1
-0.3
24
26
28
30
32
34
10
20
30
40
50
Mean Nursery Salinity
Consecutive Days Below 11°C

Results: Brown Shrimp



Results: White Shrimp



Stakeholder surveys: Motivation

- NERR System emphasis on end-user driven, management relevant projects
- Goal: Assess perceptions of trends in commercial shrimp harvest and effort within the context of changing environmental conditions.
- Specific areas of interest:
  - Environmental changes and concerns
  - Changes in shrimp biology, disease
  - Modifications to shrimping operations (location, timing, etc.)
  - Resources to inform shrimpers about weather and environmental conditions
  - Best practices for researchers to communicate with industry

Sea Grant
S.C. SEA GRANT CONSORTIUM

UNIVERSITY OF GEORGIA
Marine Extension and Georgia Sea Grant

Stakeholder surveys: Demographics

- 12 commercial shrimpers based in SC or GA
- Experience in the industry ranged from 10 - >50 years, cumulatively ~370 years.
- 8 of 12 interviewees currently captains or co-captains and owners of a vessel (2 of these also owned or co-owned docks or processing/retail facilities). Remaining 4 currently captains.
- 6 shrimpers operate primarily within their home state's waters (state or fed.), six travel to other states depending on time of year.
  - Shrimping locations range from Outer Banks of NC to Cape Canaveral, FL
- Home ports ranged from St. Marys, GA to McClellanville, SC

Stakeholder surveys: Results

"Right now the way it's getting in this industry, if you don't have a shrimp that, with the head off, a 31-35 or better, it's kind of not even worth messing with."

*"It seems like that **melt your face off days** come around more often"*

*"Our brown shrimp used to be pretty much a staple in the summertime; now they show up **very small** and are only around for two or three weeks and they never grow; It used to be up into August catching brown shrimp but for the last 3-4 years August you pretty much stay tied up because no shrimp and **plenty of sharks**"*

*"Look, **warmer weather**. Yeah, well, we've had **milder winters**. So the warmer weather comes around sooner. The **black gill** shows up sooner with warmer weather."*

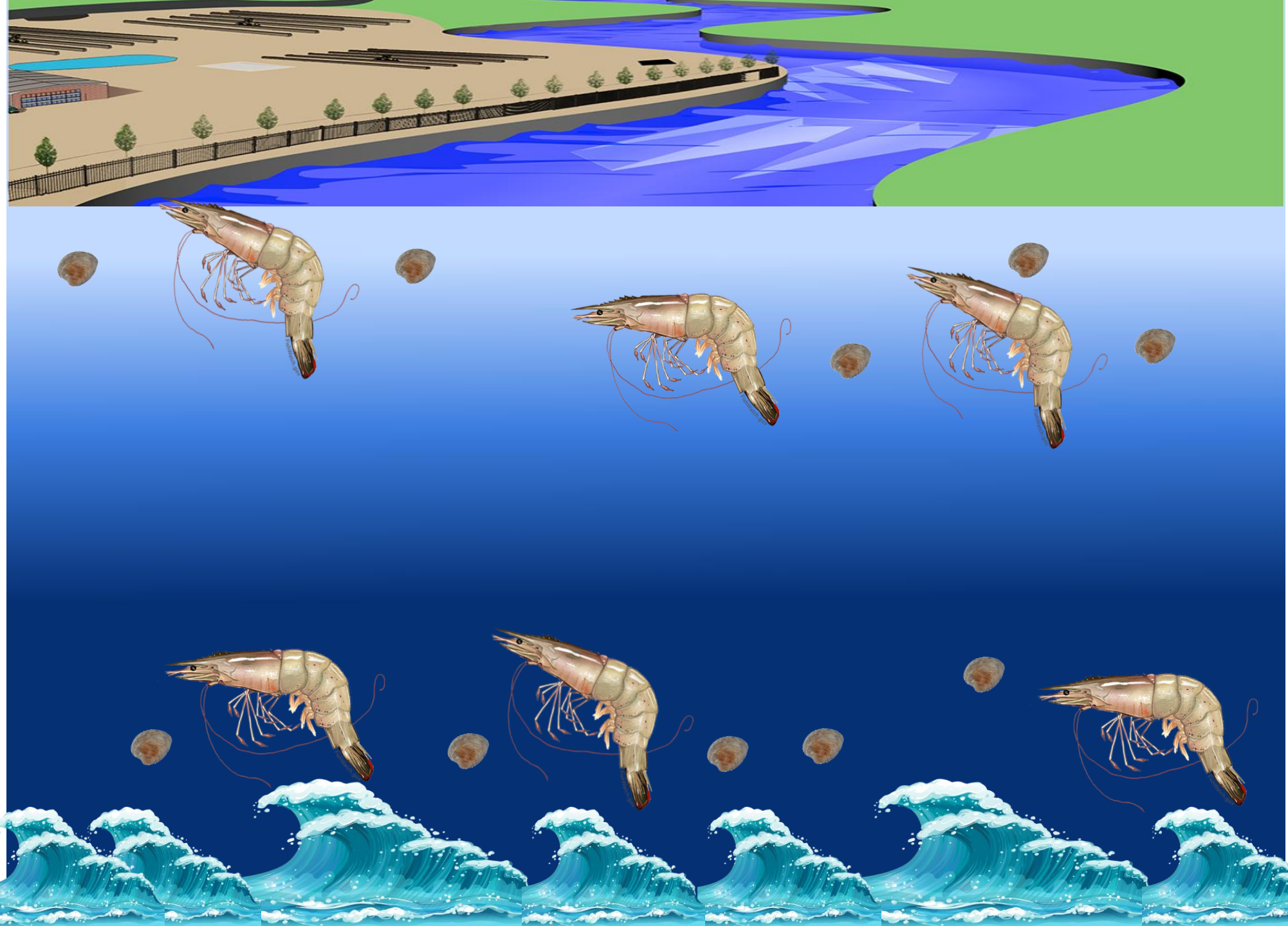
*"It's just – expenses are so high, and you gotta get something for what you're selling but you just can't compete against real **high fuel [costs]** and **not getting any [money] for your catch**"*

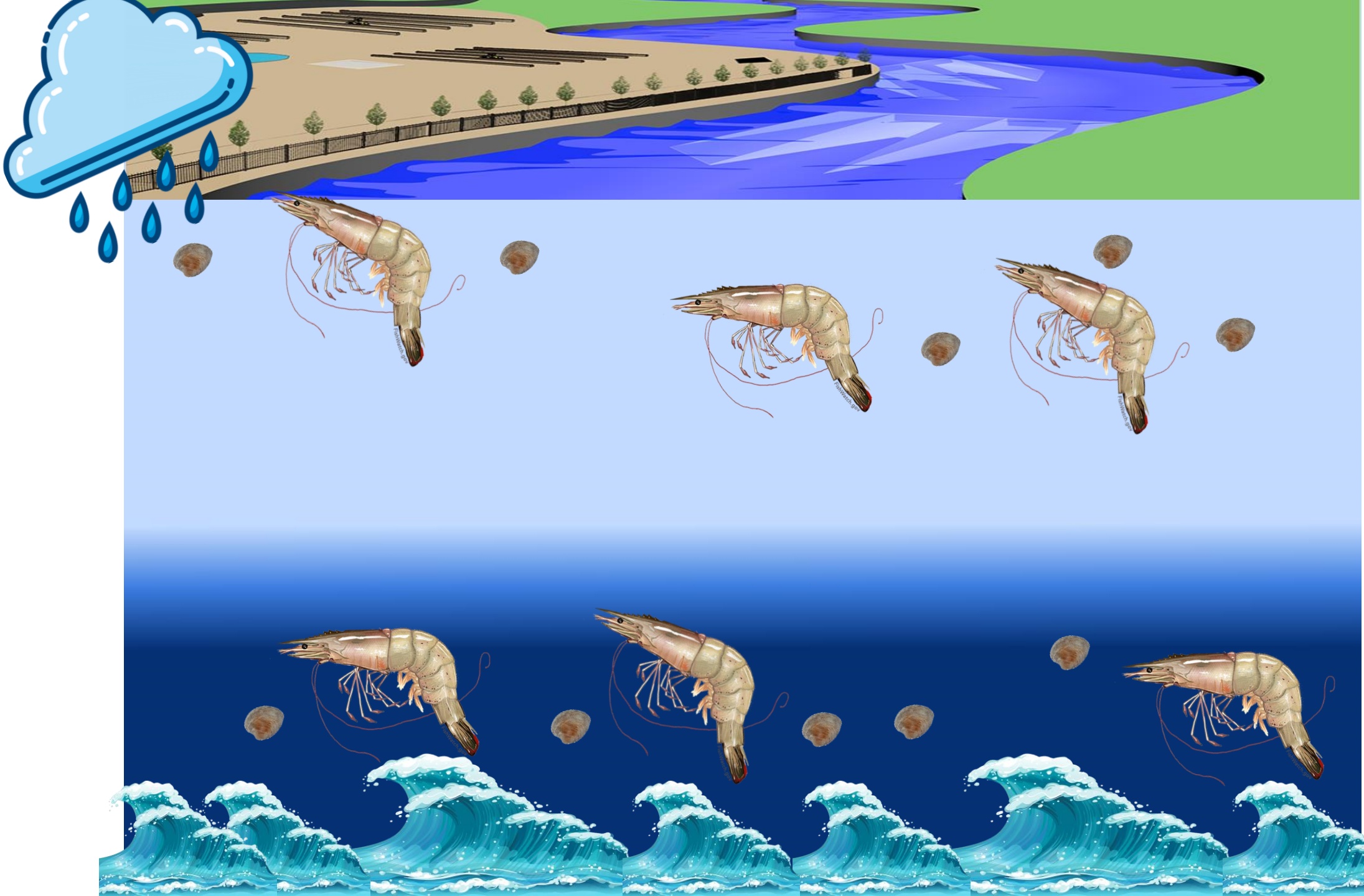
Stakeholder surveys: Top concerns

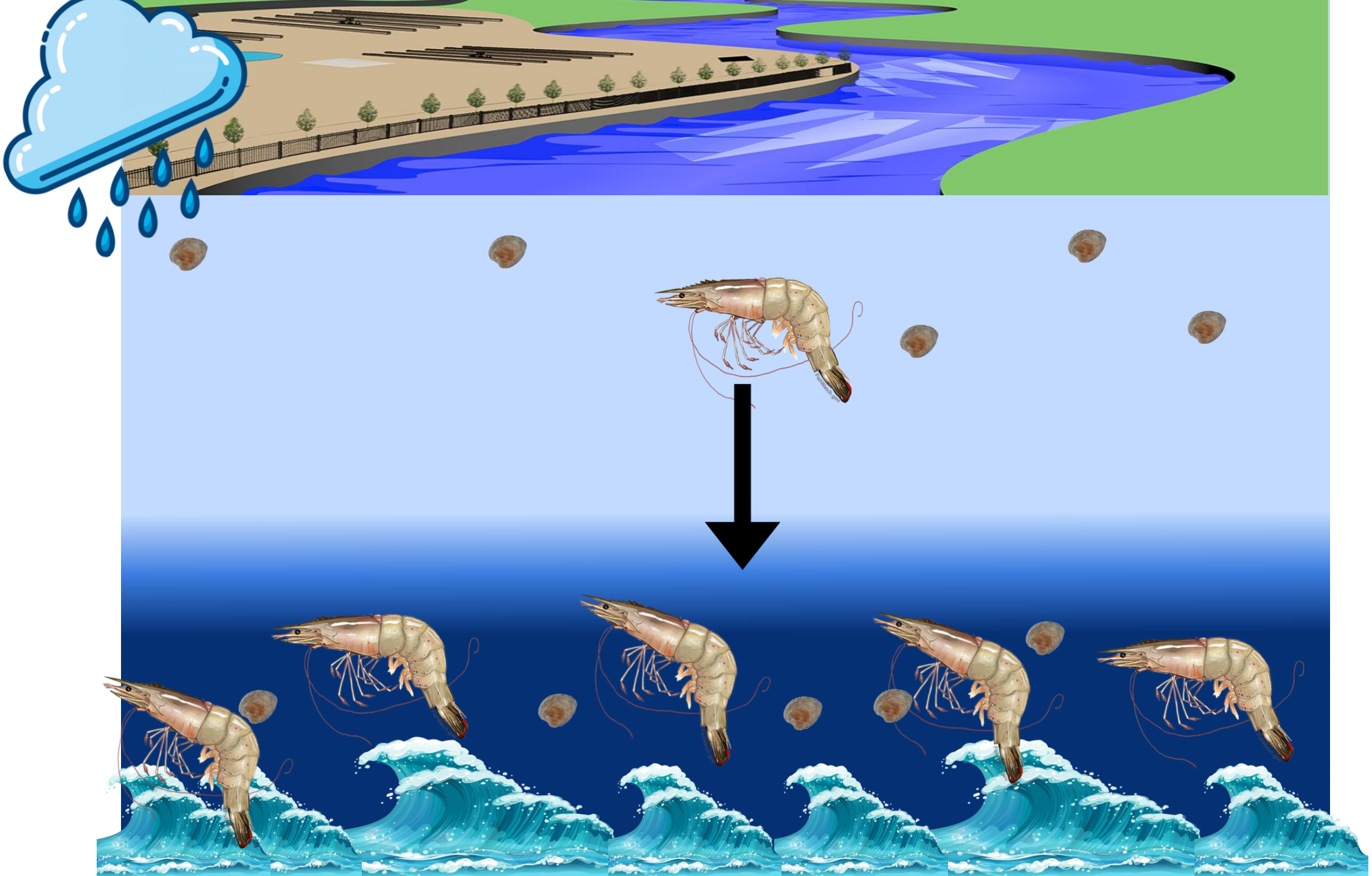
- Top 3 concerns today compared with 10 years ago

- Mostly socio-economic as opposed to environmental
  - Operating costs, fuel prices
  - Competition with imports and stagnant prices for local product
- Shark depredation
- Conflicts with wind farms
- Only 1 reference to fewer shrimp being available

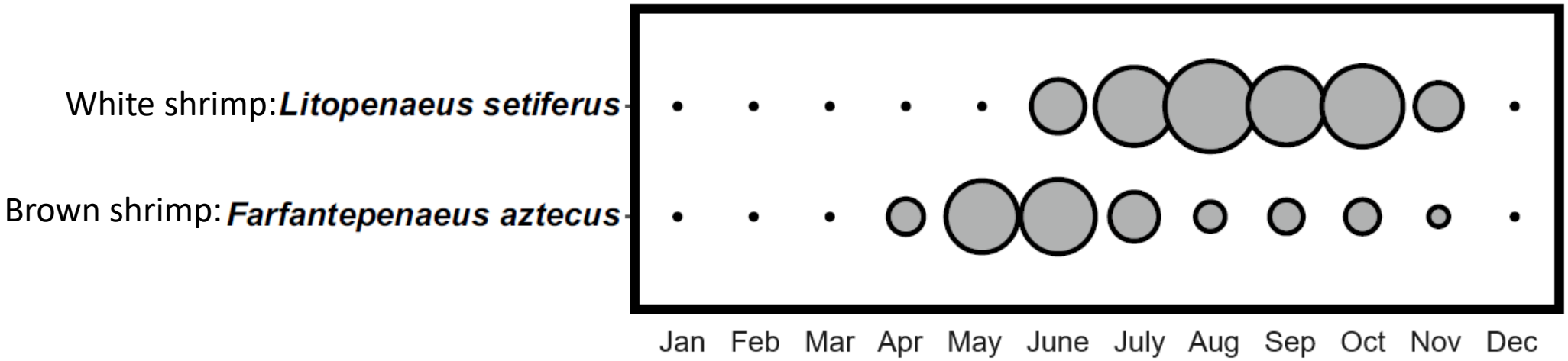

Babolat





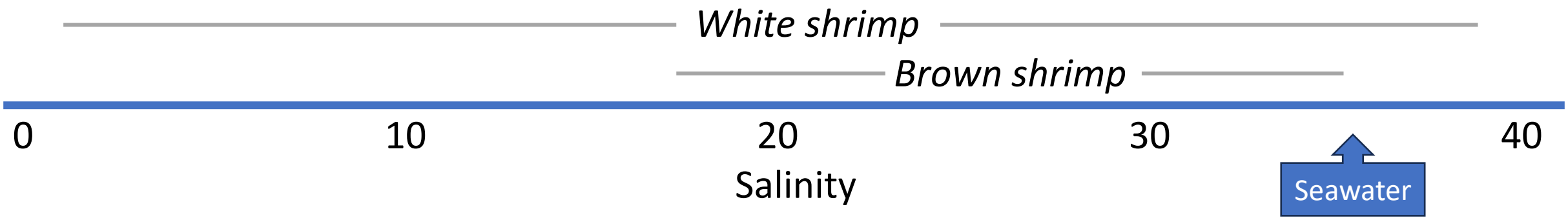


Historically, juvenile penaeid shrimp temporally partition nursery habitat (with some overlap) but exhibit different salinity preferences.



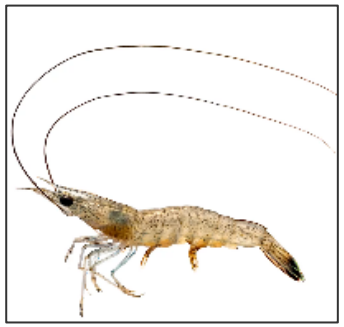
Kimball et al. 2023

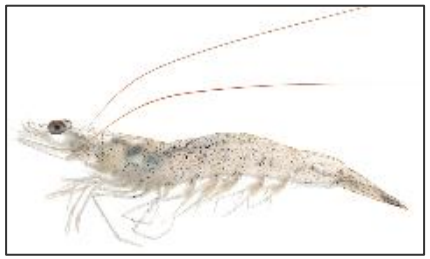
Doerr et al. 2016

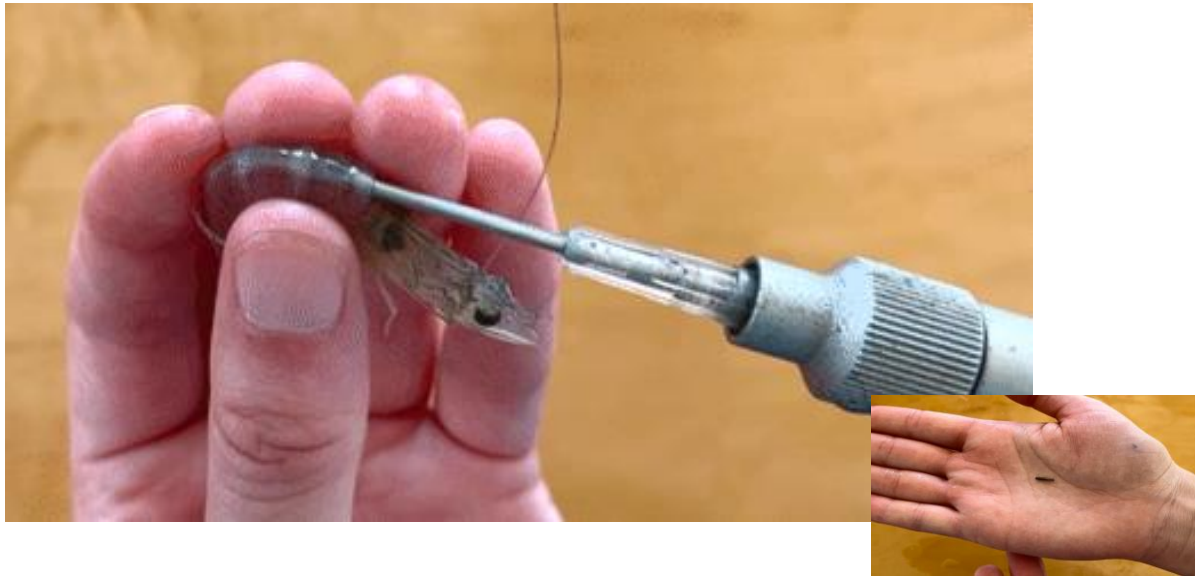


Are growth and mortality of juvenile shrimp in estuarine nurseries density-dependent?

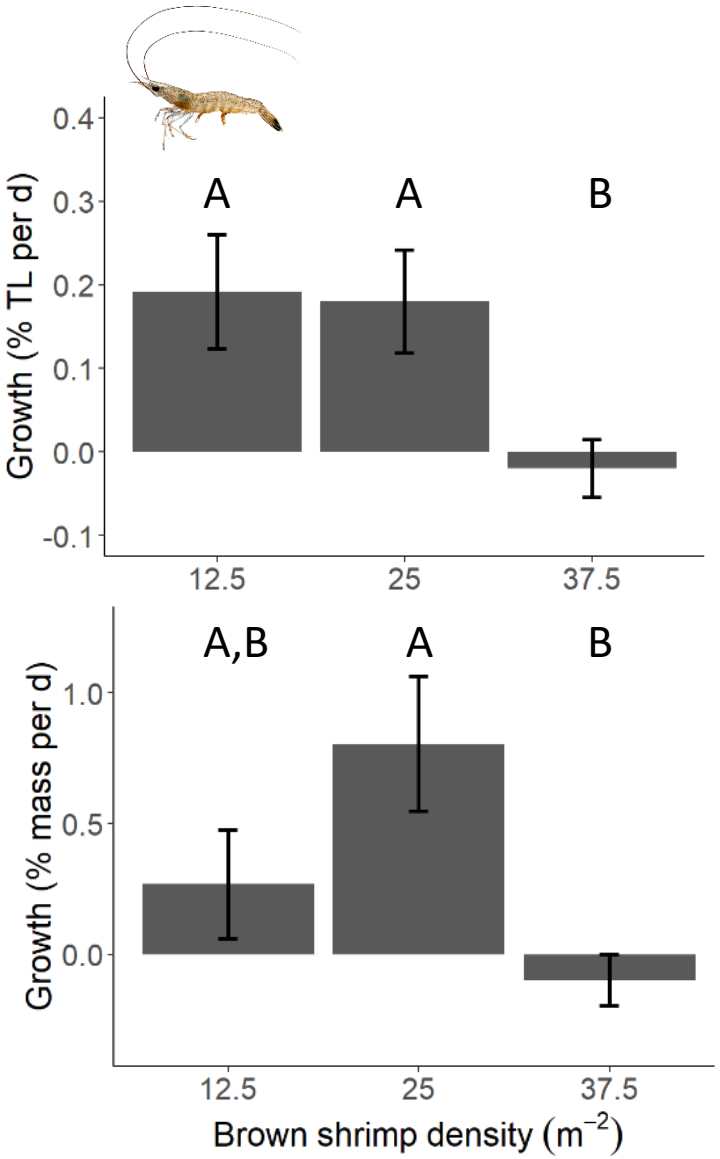
Does D-D vary with species composition (due to temporal partitioning)?





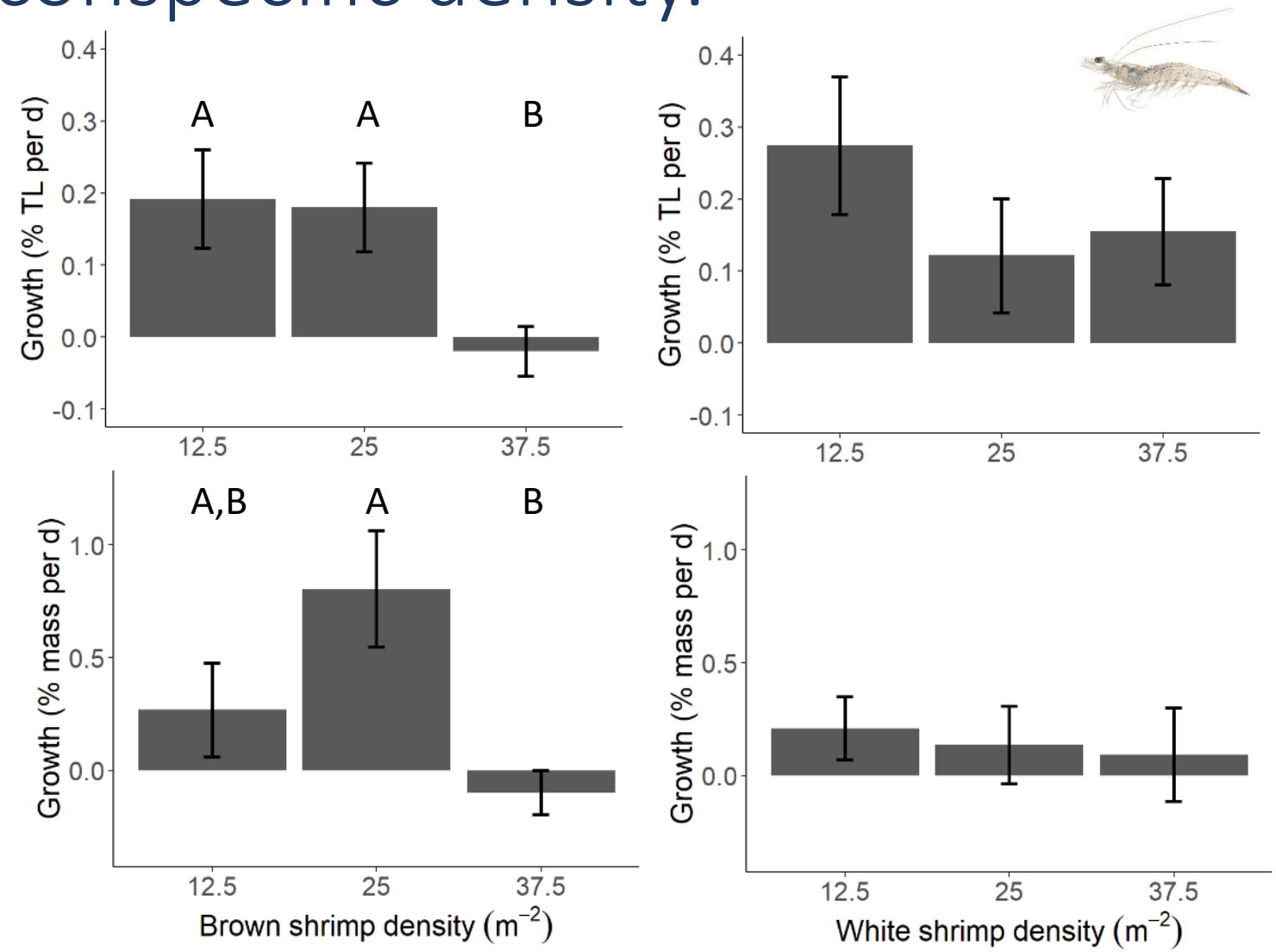


Brown shrimp in monoculture exhibited D-D growth.



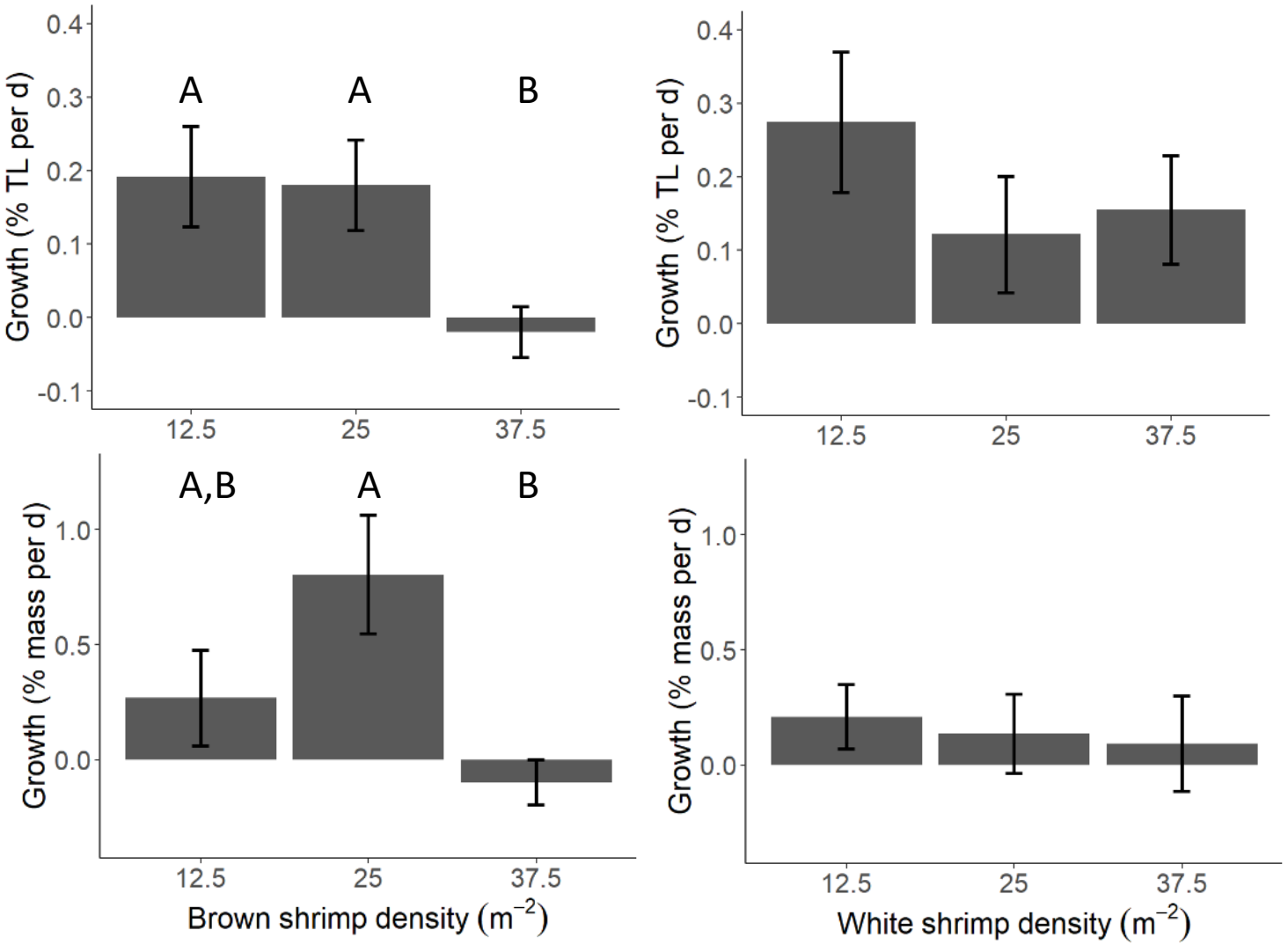
Dunn et al. *In prep*

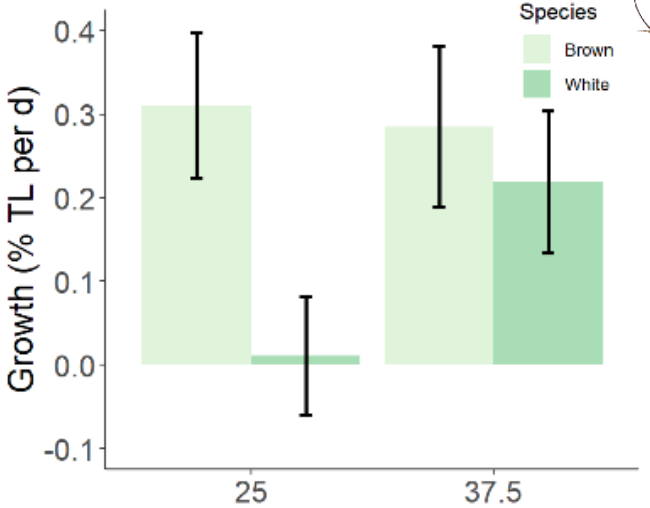
White shrimp growth rates did not change with conspecific density.

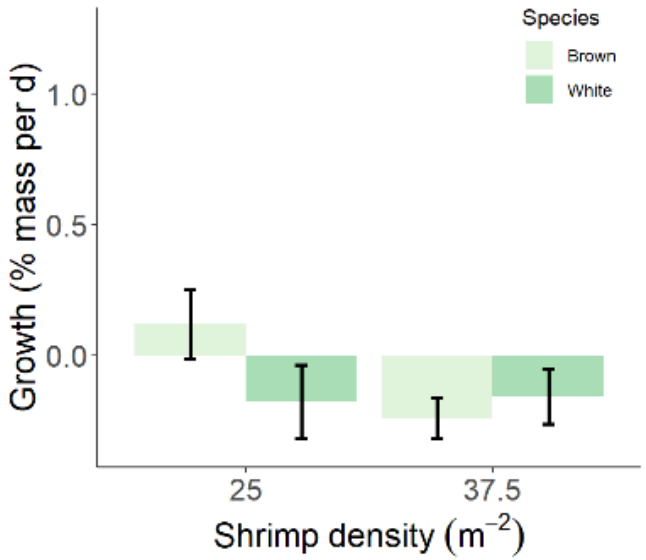


Dunn et al. *In prep*

When found together, growth was variable, and not impacted by density.



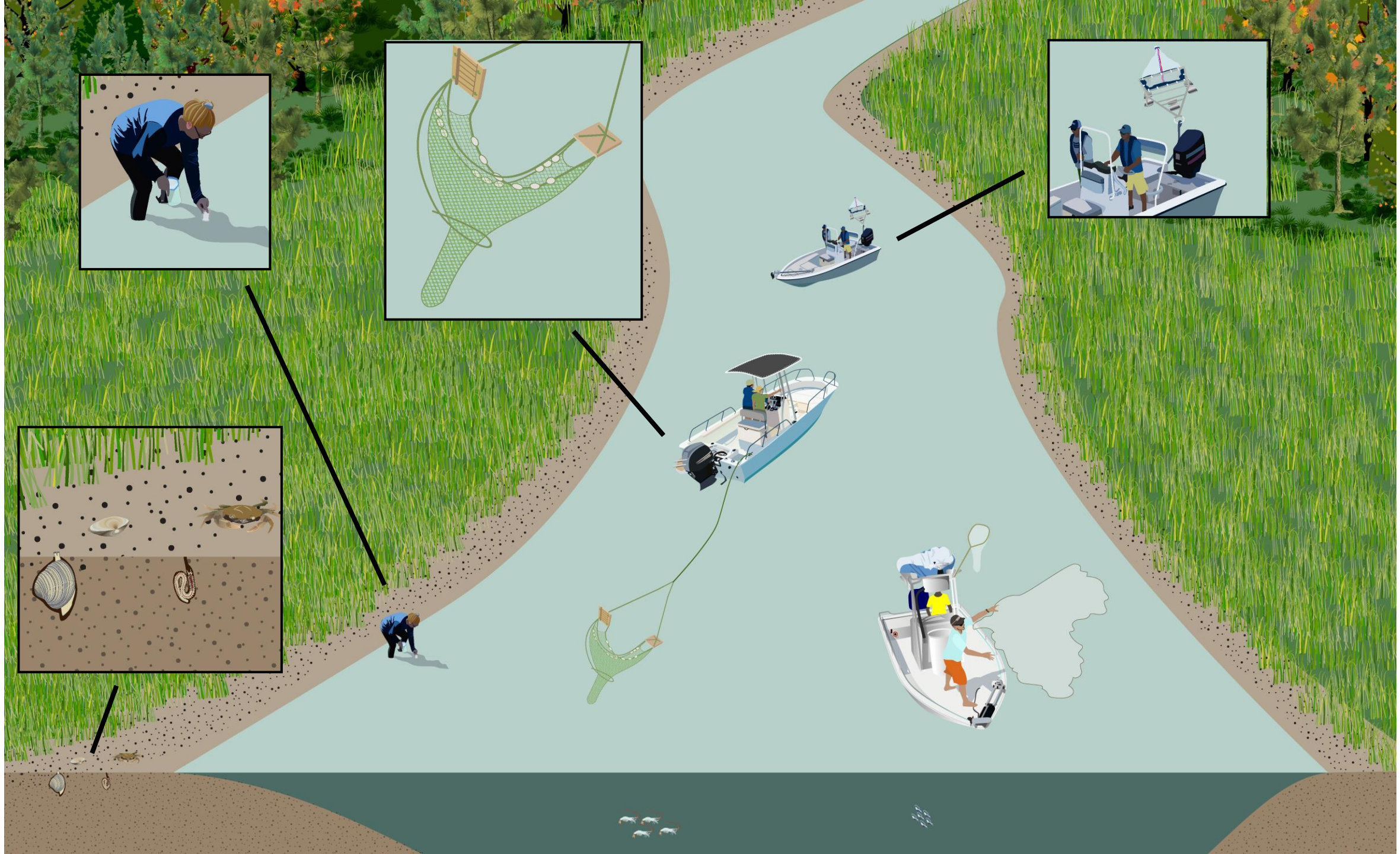




Dunn et al. *In prep*

Take-aways

- Individual growth and mortality rates are highly variable
- Brown shrimp exhibit more evidence of density-dependence (growth & mortality)
- During overlap period, interspecific competition reduces growth (mass)
- Size matters

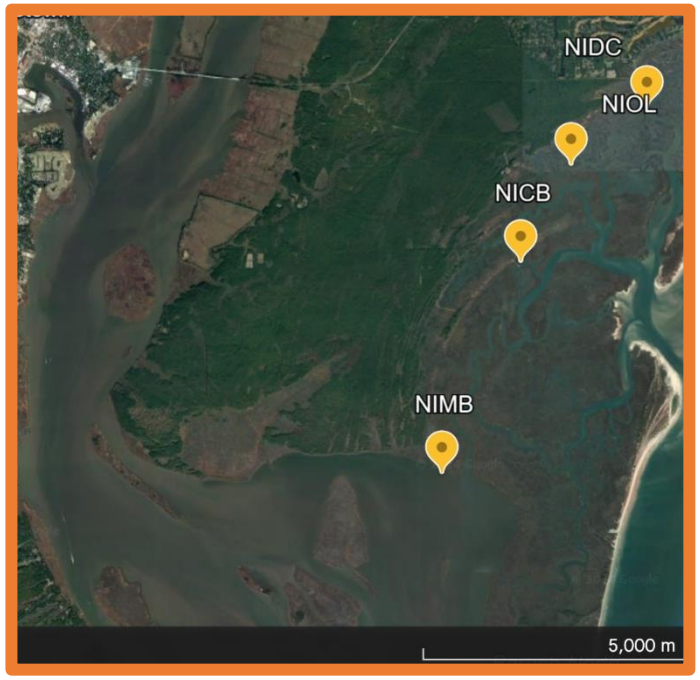


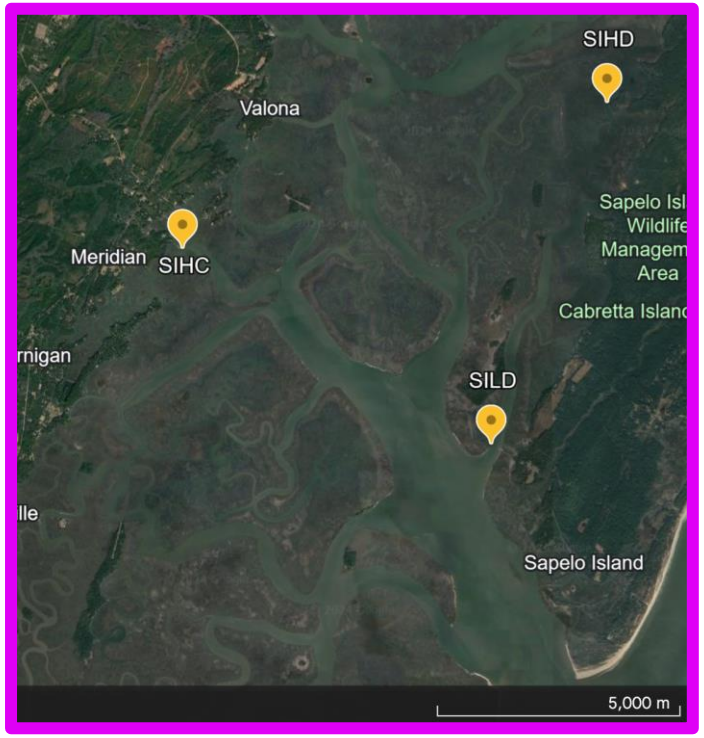
NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

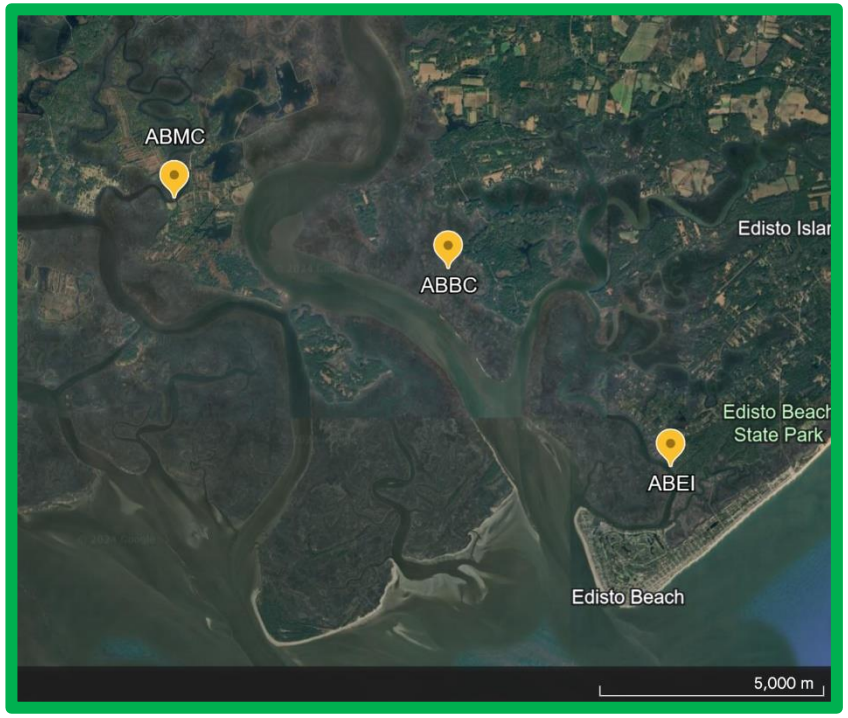
North Inlet Winyah Bay

ACE Basin

Sapelo Island







10 sampling sites

Sites trawled monthly April – September

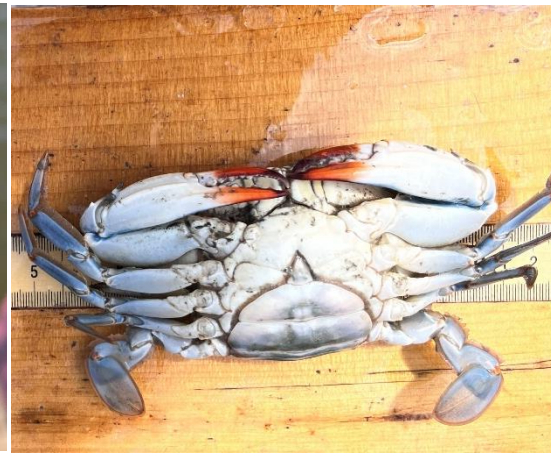
Nekton ID’d to species

Subset measured

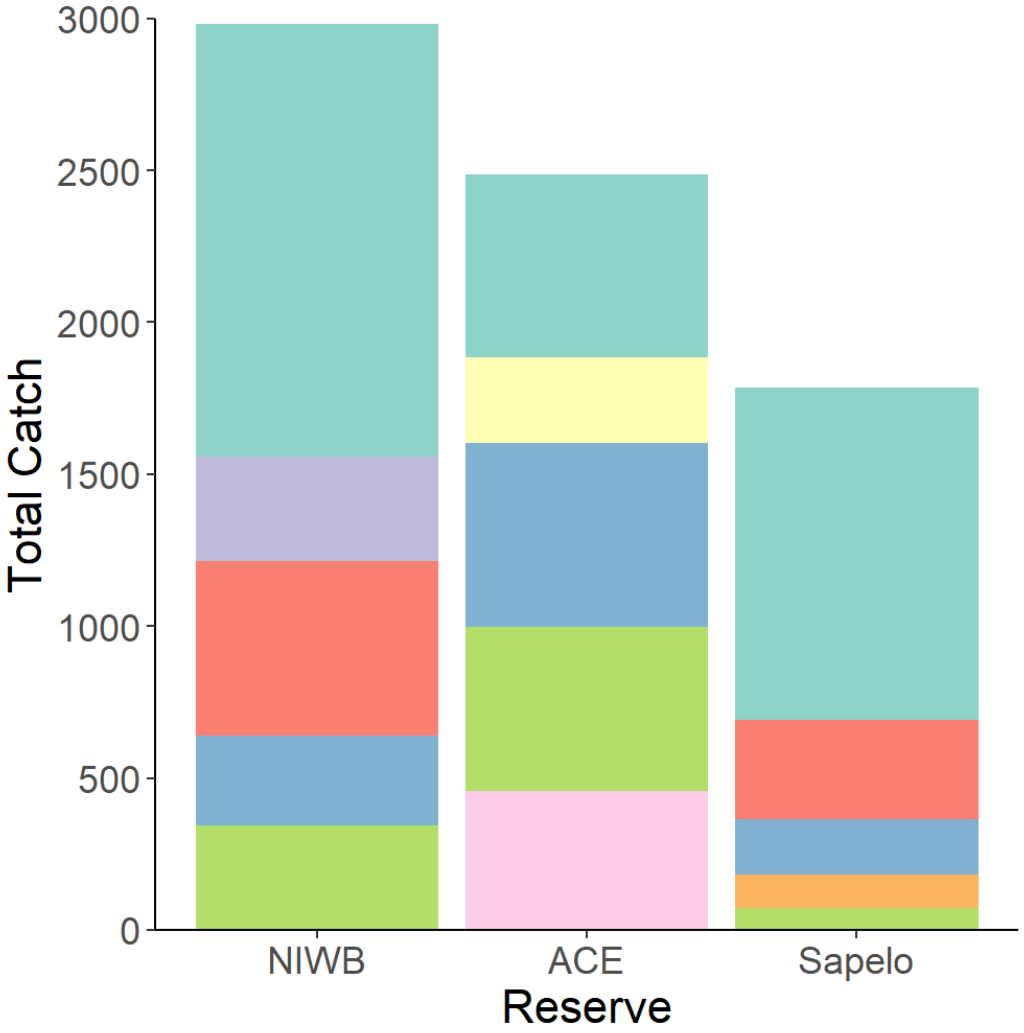
- 180 trawls
- Total nekton: 9,395
- 4 elasmobranch species
- 8* decapod crustacean species
- 1 cephalopod species
- ~46 finfish species

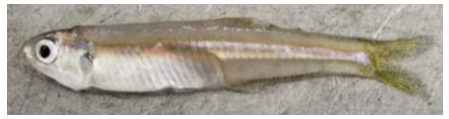










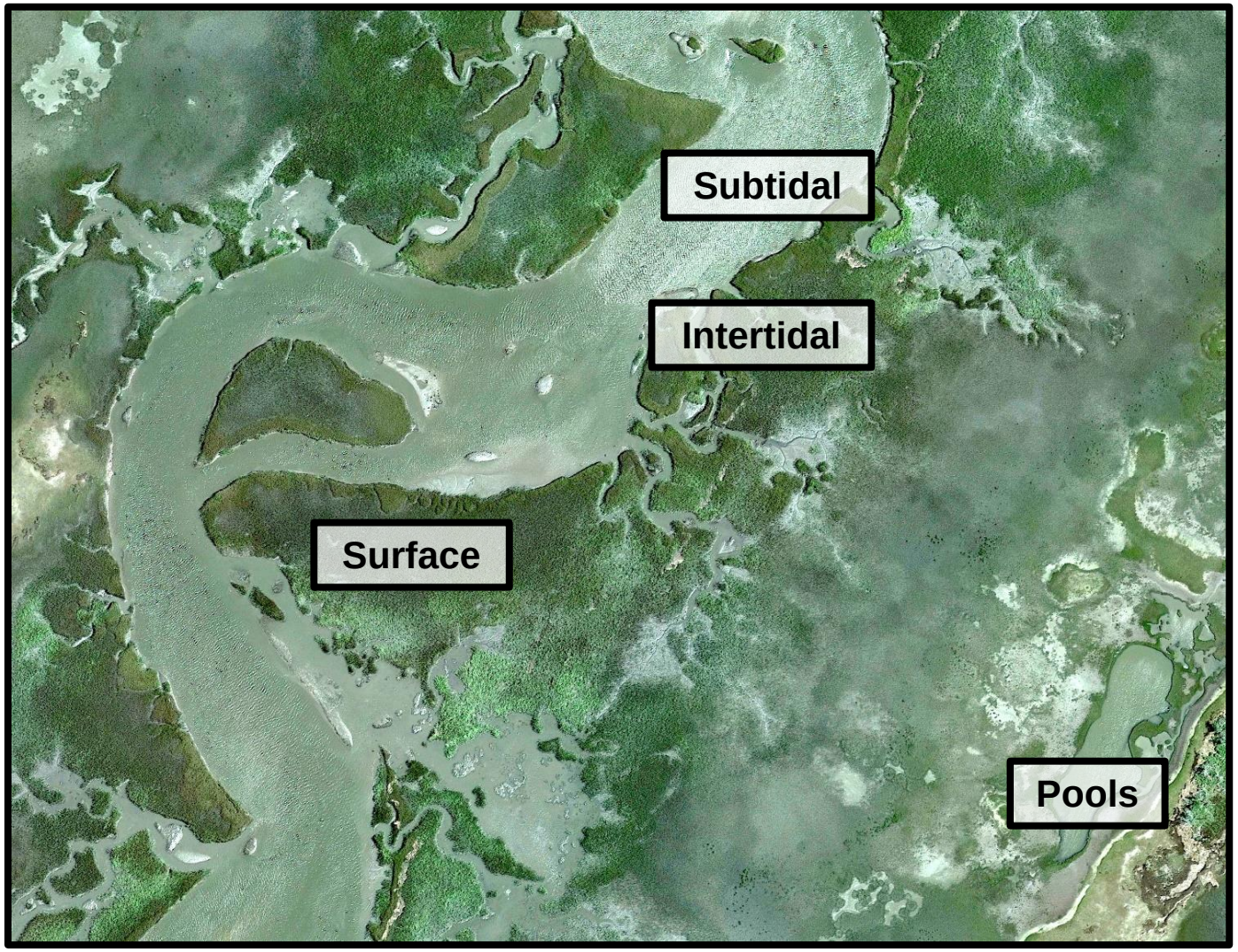
Species

- Bay Anchovy
- Brown Shrimp
- Pinfish
- Spot
- White Shrimp
- Atlantic Brief Squid
- Atlantic Croaker
- Star Drum

- Bay anchovies most abundant in all Reserves
- White shrimp & croaker in top 5 for all
- Spot abundant at Sapelo and North Inlet
- Brown shrimp and star drum abundant at ACE

Intertidal creek habitat use and growth of juvenile brown shrimp

Juvenile Habitat Use

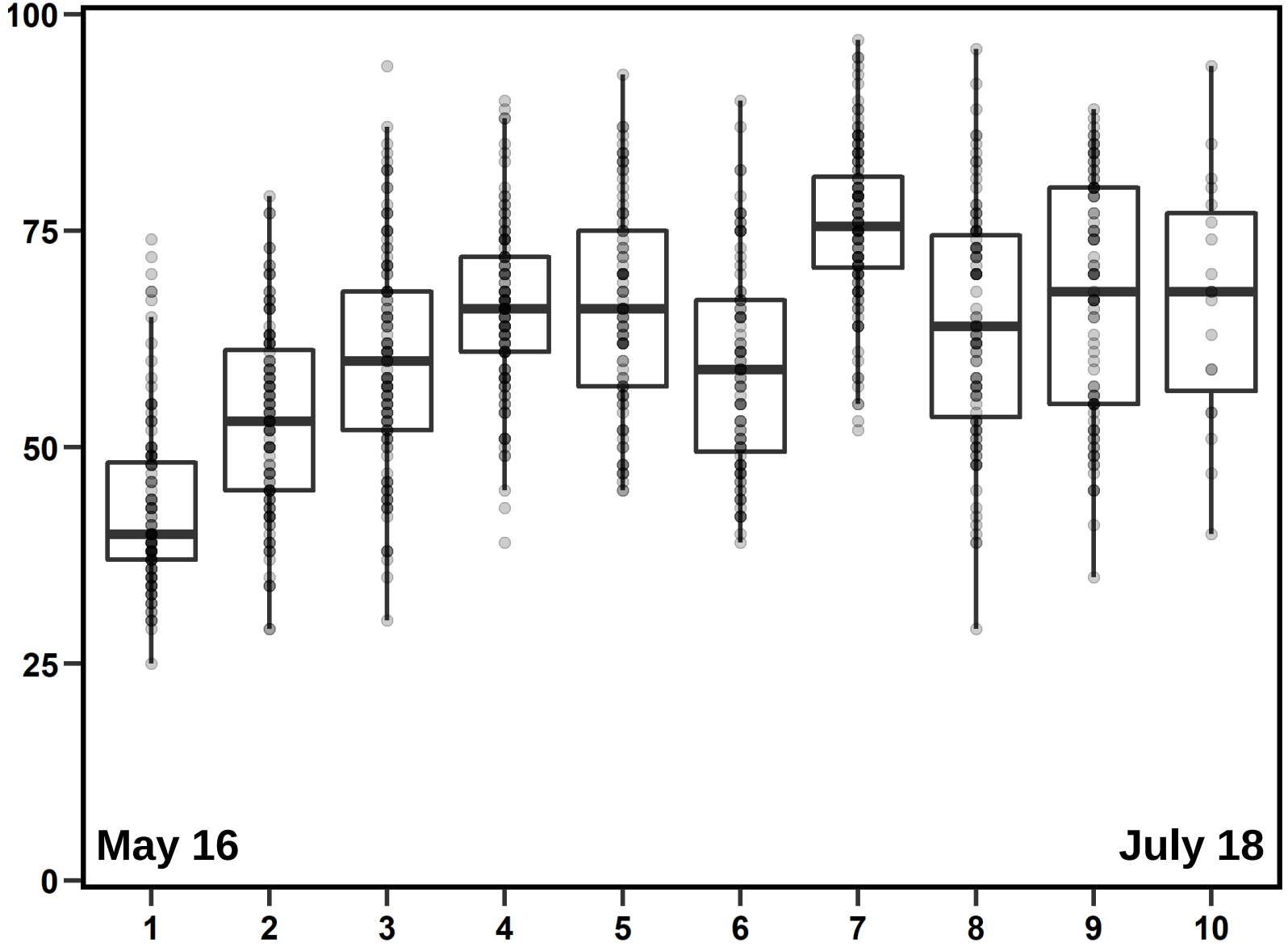


- Occur across estuarine mosaic
- Habitat-specific information lacking

Objectives

1. Evaluate *size structure*
2. Estimate *growth rates*
3. Compare *estimates*

Results: Size Structure

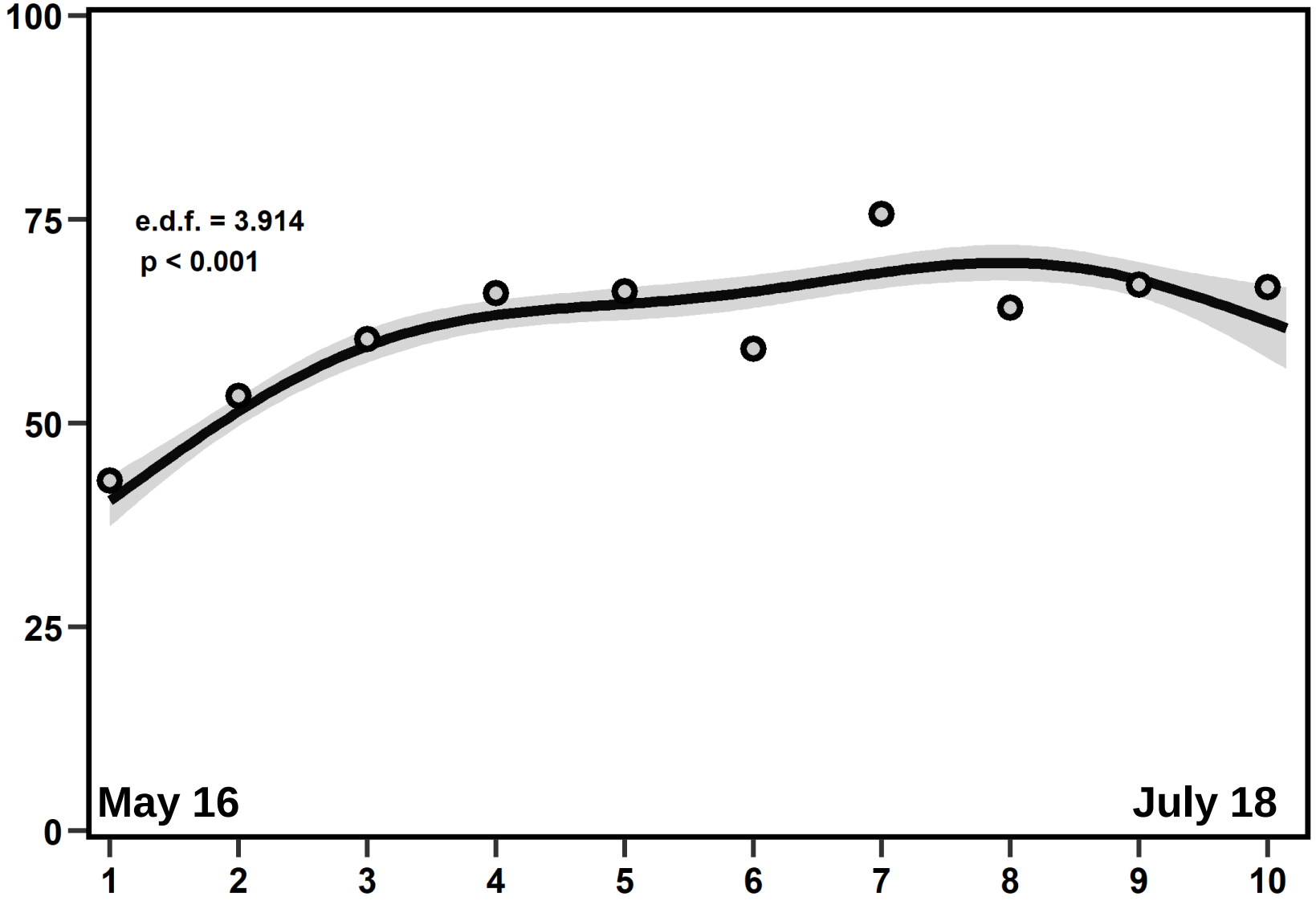


- **TL increase weeks 1 – 5**
- **Plateau weeks 6 – 10**
- **Range: 25 – 97 mm TL**

Box Plot Interpretation:

- **Box lines = Median**
- **Box = 1st quartile / 3rd quartile**
- **Whiskers = 1.5 x IQR**

Results: Growth Rates



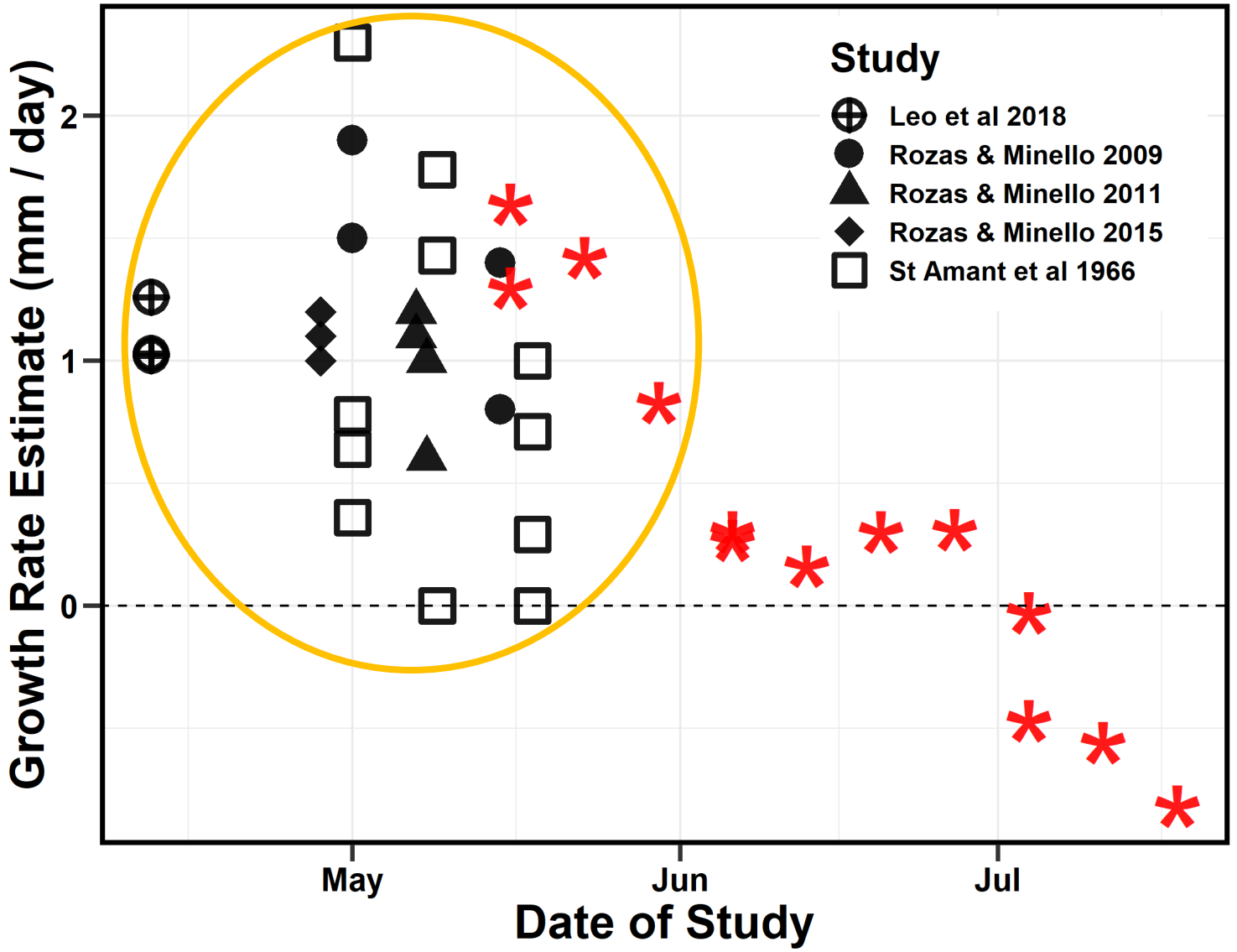
- **Greatest rates in mid- to late-May**
- **Decline in June**
- **Rates ≤ 0 by July**

GAM Interpretation

- **Line = model predicted mean TL**
- **Grey bands = 95% CI**
- **Circles = observed mean TL**
- **e.d.f = effective degrees of freedom**

Results: Comparison of Growth

- **Similar estimates in May across studies**
- **Less informative in mid-June, July?**



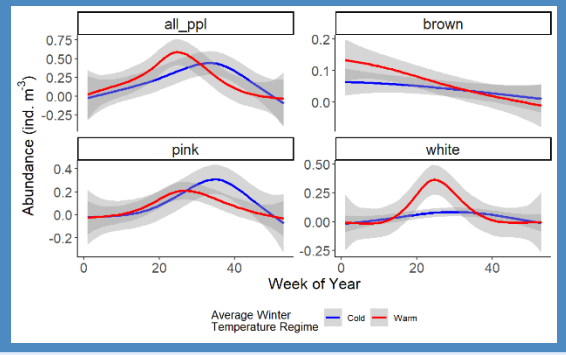
Summary

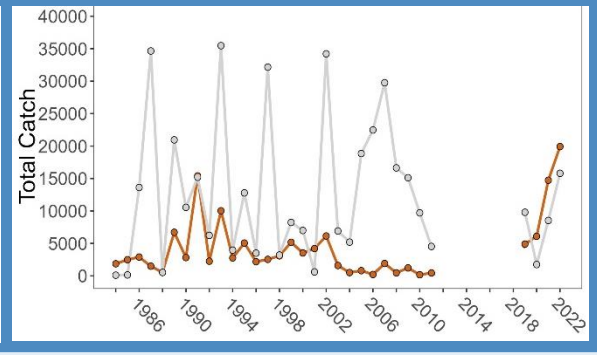
1. Evaluate ***size structure***
   - Increase in TL, followed by plateau

2. Estimate ***growth rates***
   - Decline from initial peak in mid-May
   - Mix of growth, emigration, later cohort(s)

3. Compare ***estimates***
   - Overlap among studies, esp. in May

Analyses of long-term surveys and historic samples





Stakeholder interviews

Density-dependent growth and mortality experiments

Field sampling

Robert Dunn
Robert@baruch.sc.edu