# Population characteristics of the blue crab (*Callinectes sapidus)* in Rhode Island coastal waters

Katie Rodrigue, RI DEM Division of Marine Fisheries

RIMFI – April 8, 2025

# Background

- Portunid swimming crab with broad distribution
- Commercial and recreational fisheries
- Major predator in benthic communities


Photo: Jay Fleming, National Geographic

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- Lower winter temps = higher mortality
  - Limits northern range

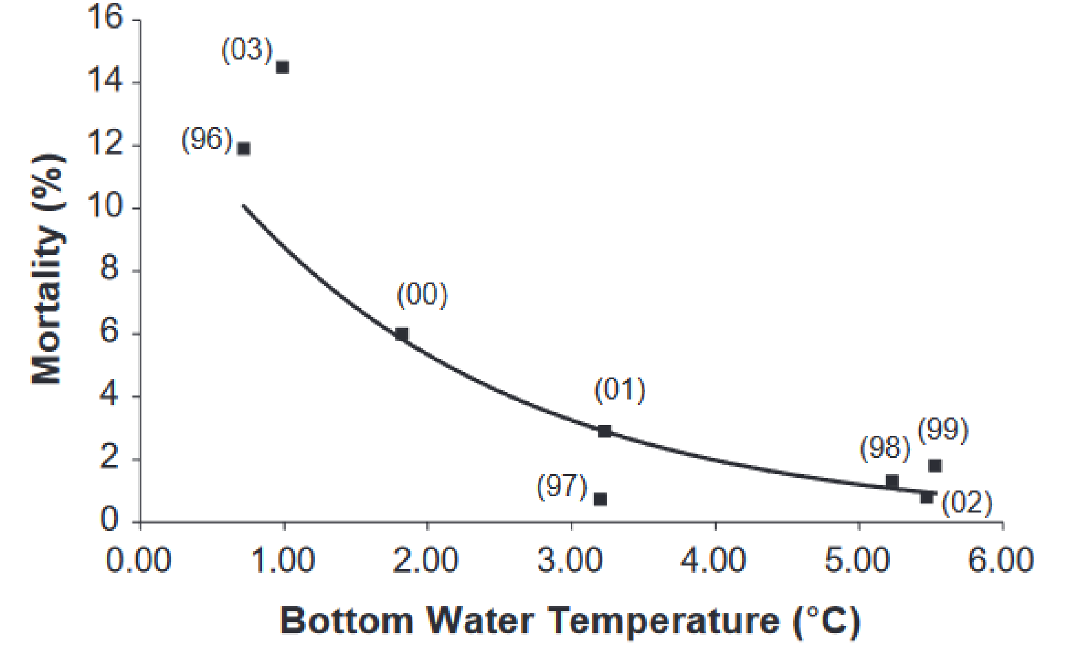


Fig. 2. Annual mortality as a function of February bottom water temperature during MDNR winter dredge surveys, 1996–2003. An exponential curve was fitted to the data yielding the following equation: $y=14.4e^{-0.4963x}$; $R^2=0.7161$. Data for crab size and sex are pooled. The number in parentheses refers to year data were collected.

Rome et al. 2005

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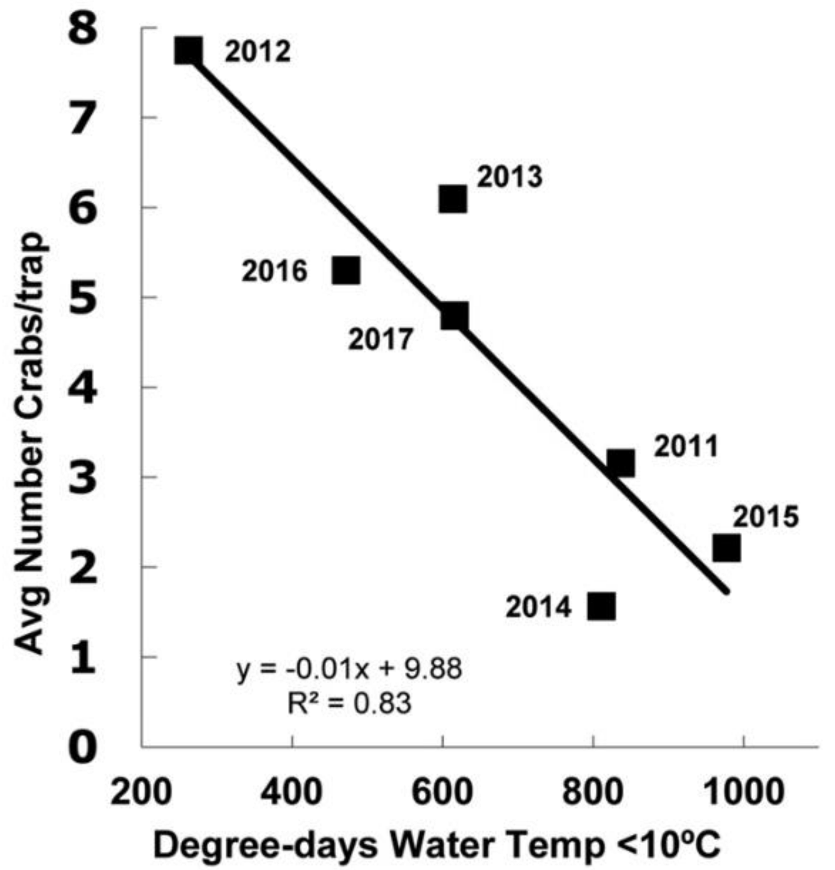


**Figure 4.** Average CPUE of all blue crabs for July–September 2011 to 2017 in all upper river sections *versus* the number of degree-days the water temperature in PIB was <10°C during the prior winter.

Weiss and Downs 2020

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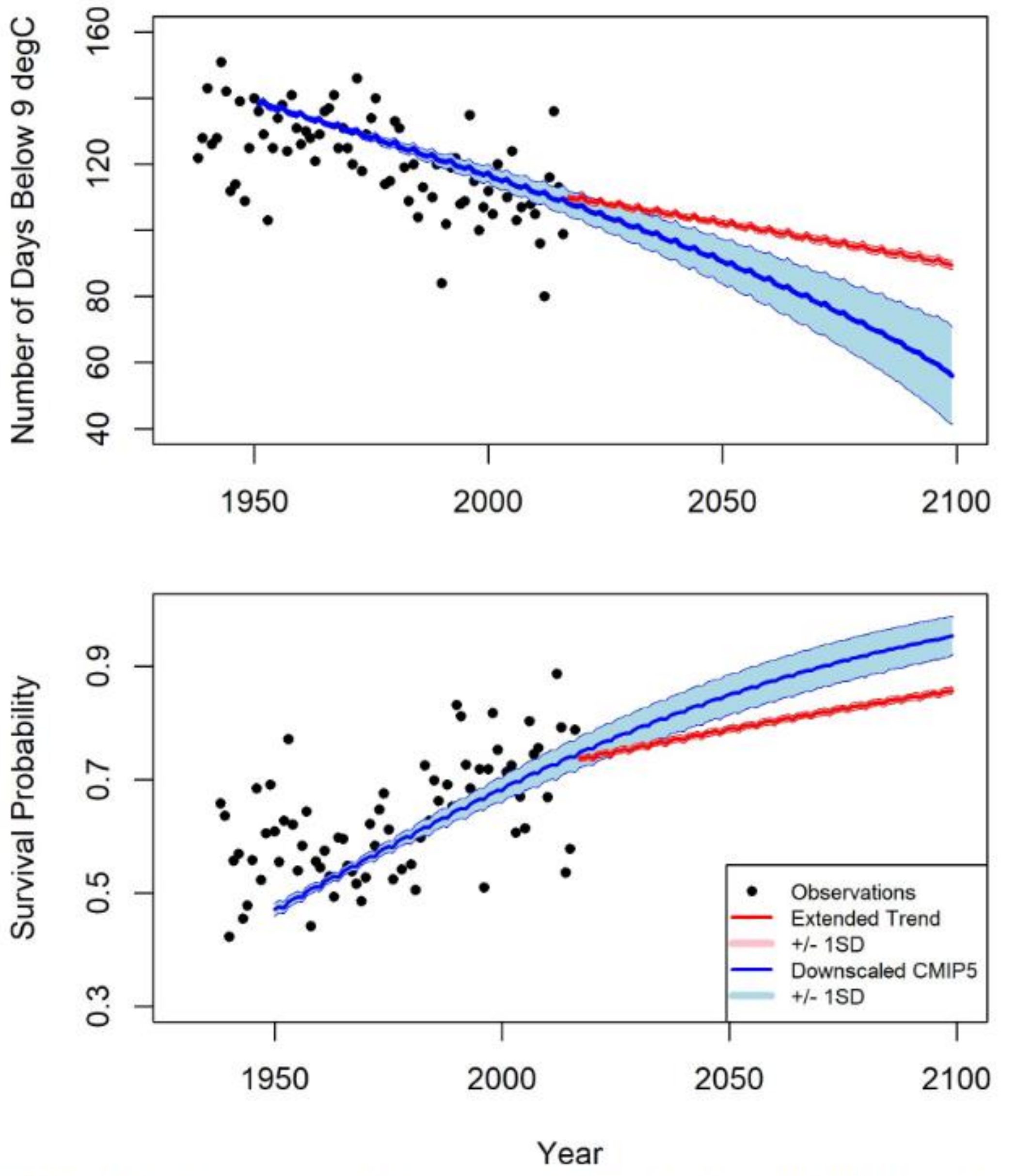


**Fig 3. Length of crab overwintering period (top panel; expressed as the number of days below 9˚C in a given year) and probability of overwinter survival (bottom panel) for observational data (black dots) and projected data from two sources (conservative estimate (Extended Trend) in red and a multi-model ensemble of downscaled GCM data (Downscaled GCM) in blue).** The year 1977 was excluded from the analysis due to large gaps in the observational data for that year. Error bands for projections represent one standard deviation.

Glandon et al. 2019

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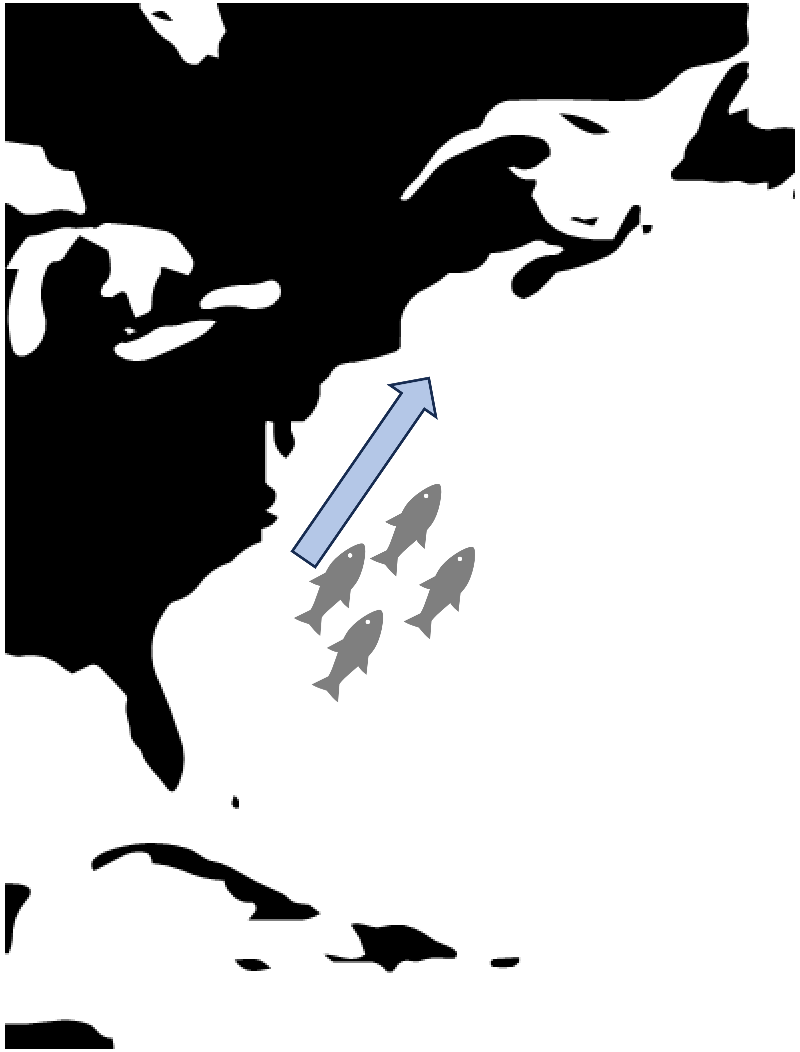

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- Interest in expanded fishery

https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Blue_Crab_Pot%2C_Trap_.jpg/1280px-Blue_Crab_Pot%2C_Trap_.jpg

# Purpose and Objectives

- No population assessment – data limited
- Other species shifting northward
- Interest in expanded fishery
- **Provide essential information on blue crab population dynamics in RI in support of successful management**

# Purpose – Chapter 1

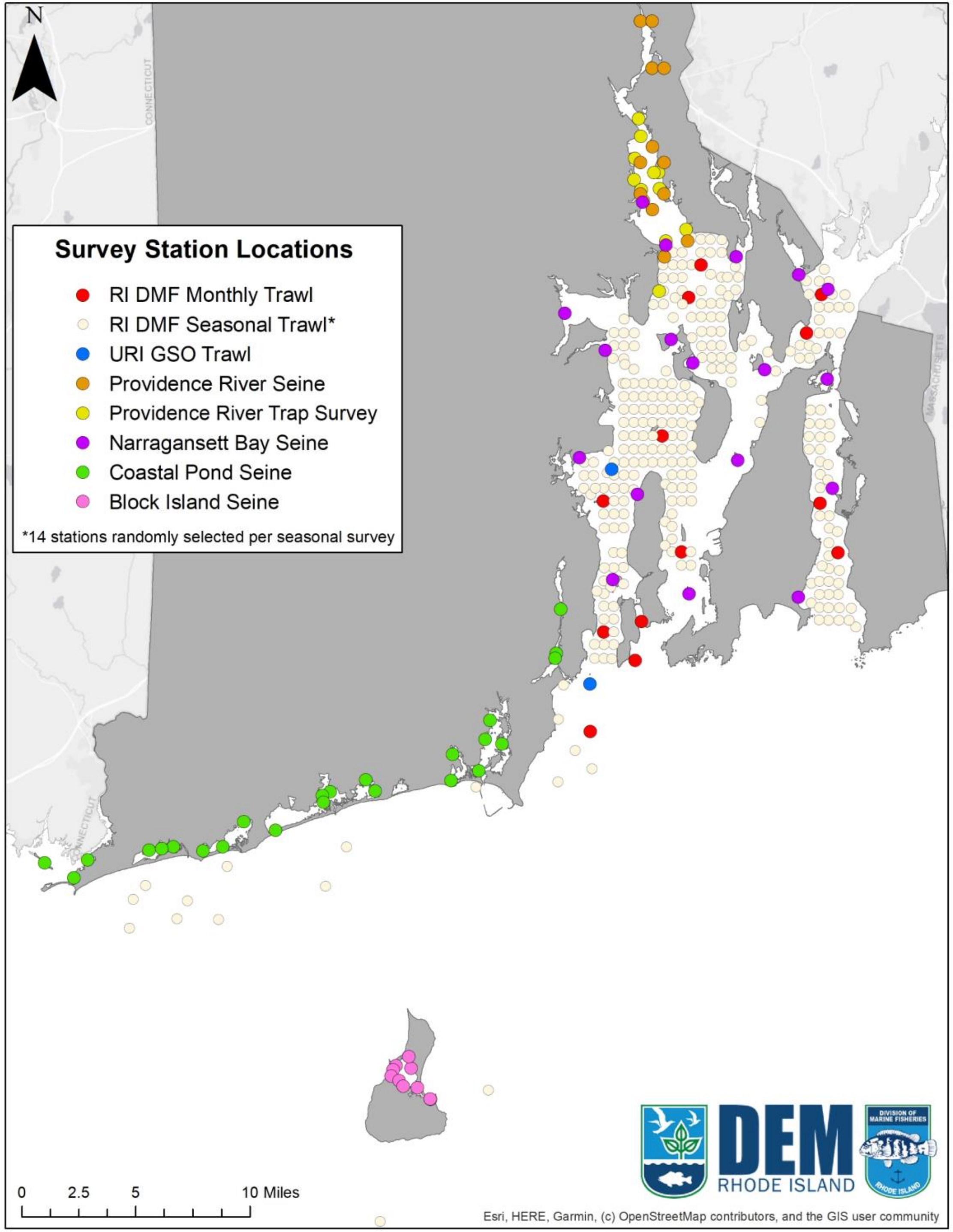
- Leverage existing monitoring surveys

    1. Relative Abundance Index
    2. Size-at-maturity
    3. Length-weight relationship


Photo: Anna Gerber-Williams, RI DMF

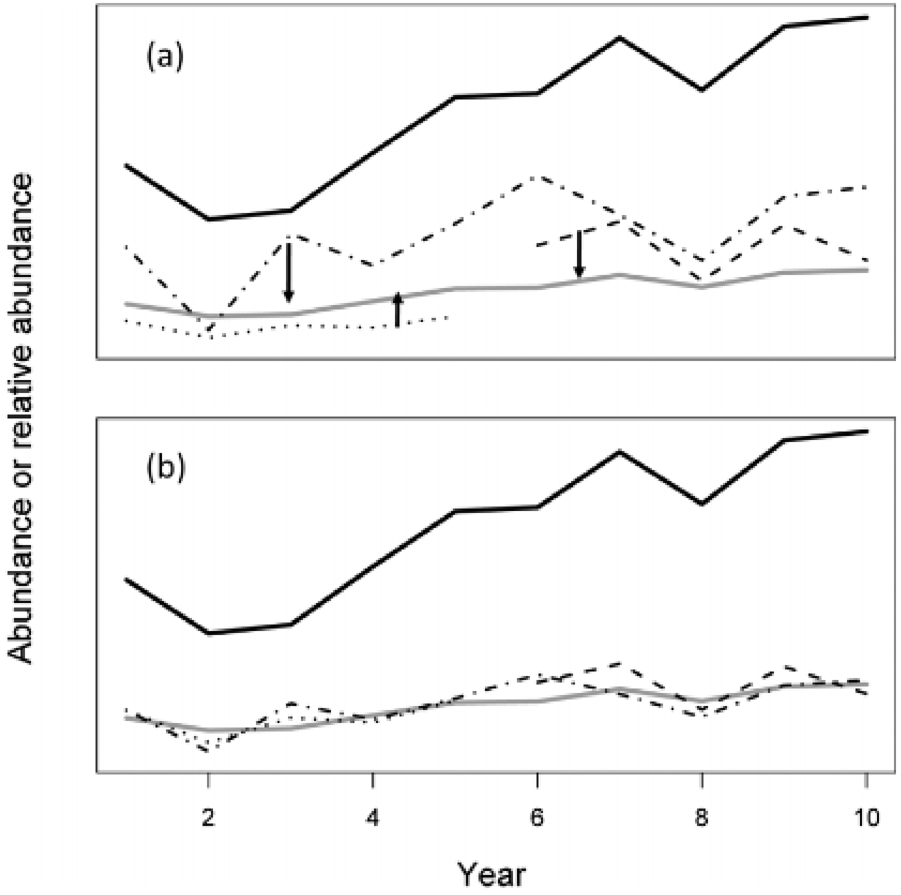
# Abundance

- 8 surveys (RI DMF, URI, TNC)
- Beach seine, trawl, and trap surveys
- Broad coverage across RI coastal waters
- 1970 – 2022



# Abundance

- One composite index from 8 different indices




Conn, 2010

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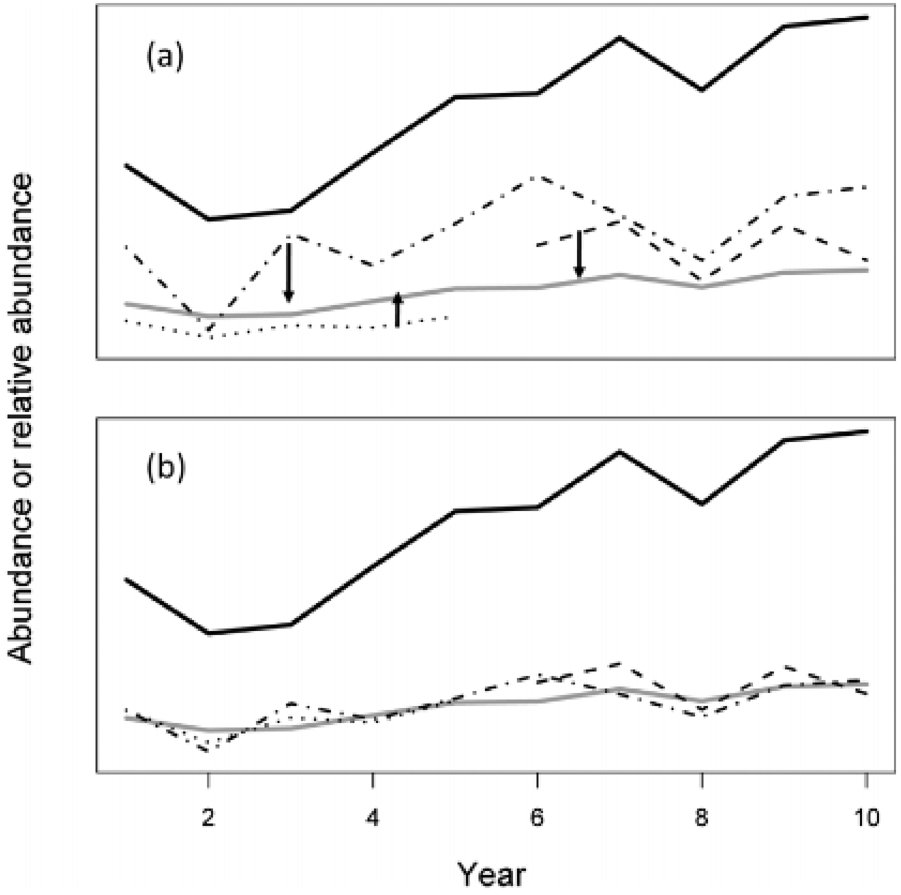
- Each survey sampling same relative abundance, but subject to error and catchability differences

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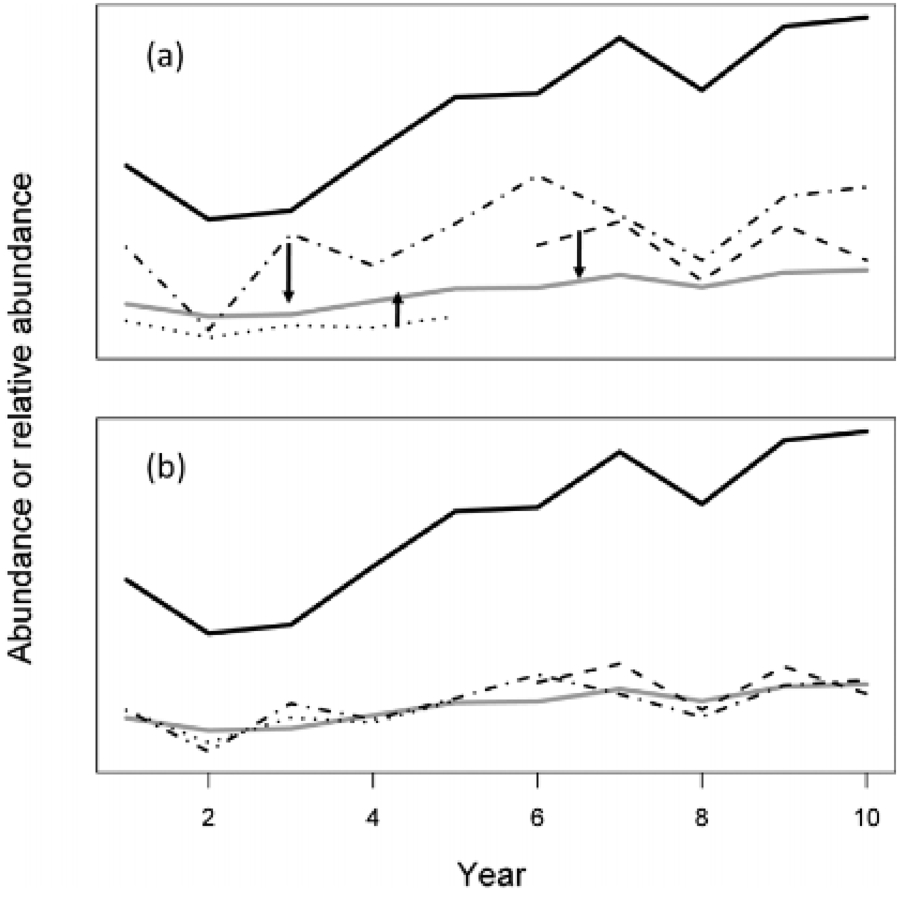
# Abundance

- One composite index from 8 different indices
- Each survey sampling same relative abundance, but subject to error and catchability differences
- Bayesian hierarchical modeling approach (Conn 2010)
- MCMC sampling used for posterior simulation




Conn, 2010

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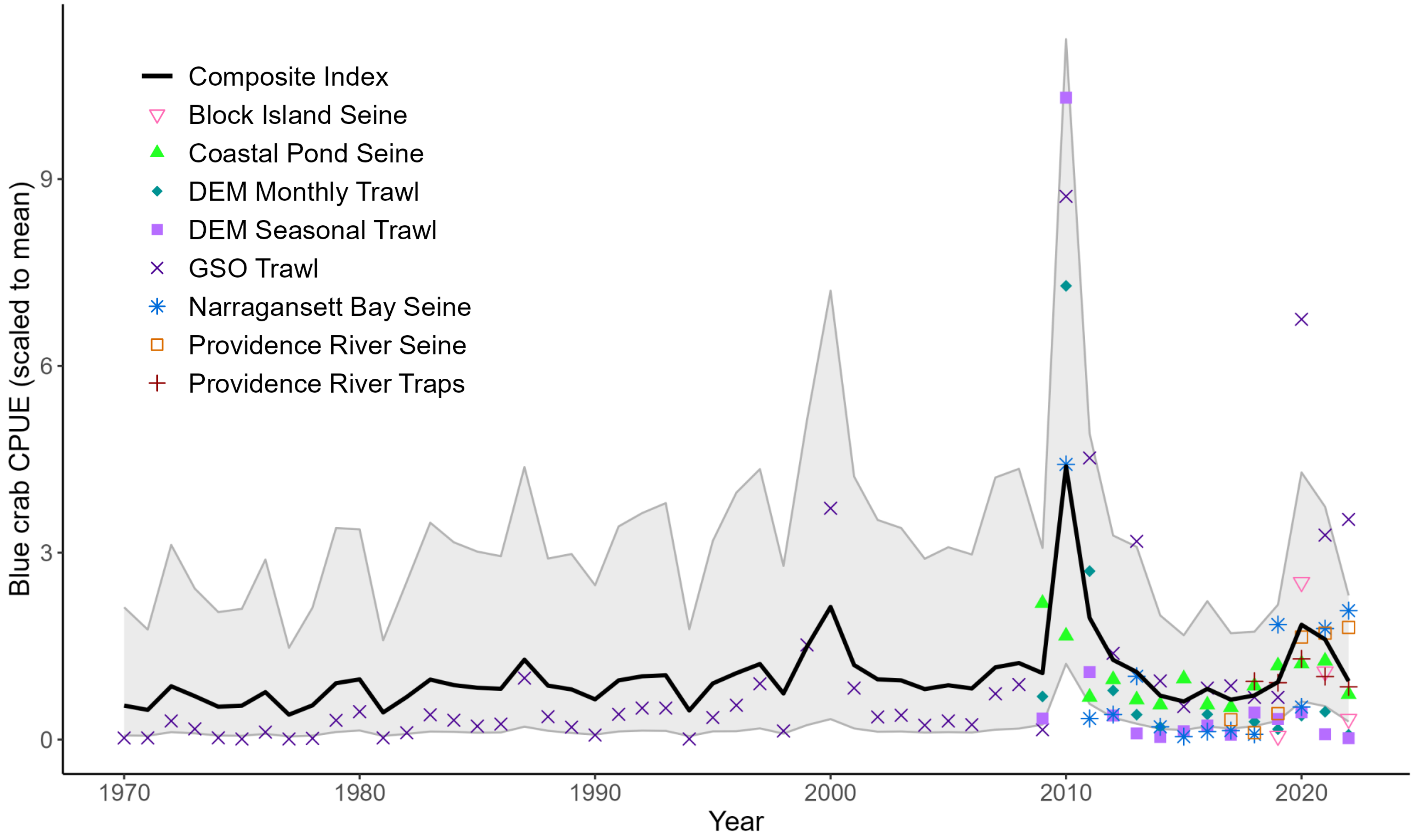
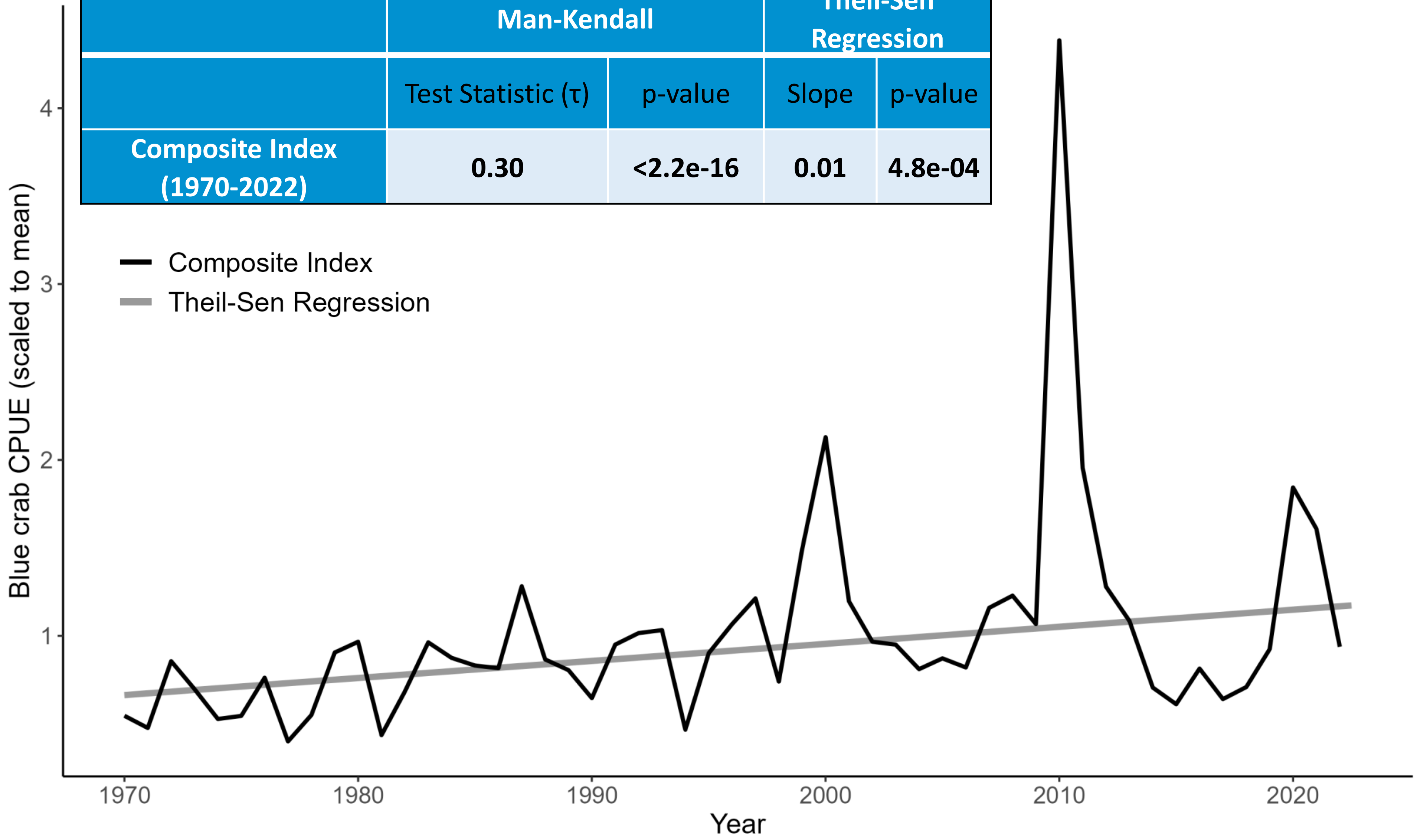


Composite Index
Block Island Seine
Coastal Pond Seine
DEM Monthly Trawl
DEM Seasonal Trawl
GSO Trawl
Narragansett Bay Seine
Providence River Seine
Providence River Traps
Blue crab CPUE (scaled to mean)
0
3
6
9
1970
1980
1990
2000
2010
2020
Year

# Abundance

| | Man-Kendall | | Theil-Sen Regression | |
|---|---|---|---|---|
| | Test Statistic (τ) | p-value | Slope | p-value |
| **Composite Index (1970-2022)** | **0.30** | **<2.2e-16** | **0.01** | **4.8e-04** |



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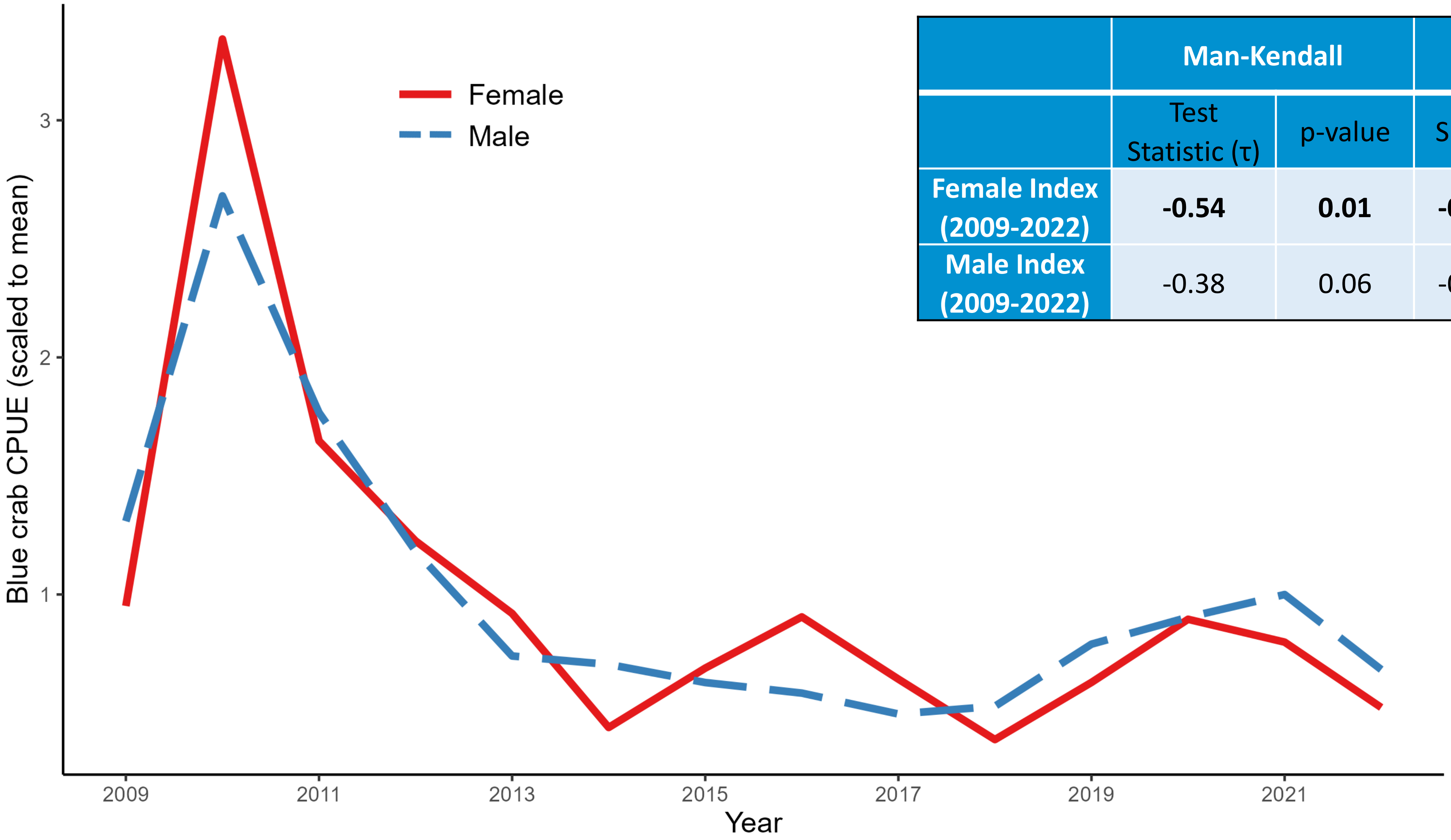
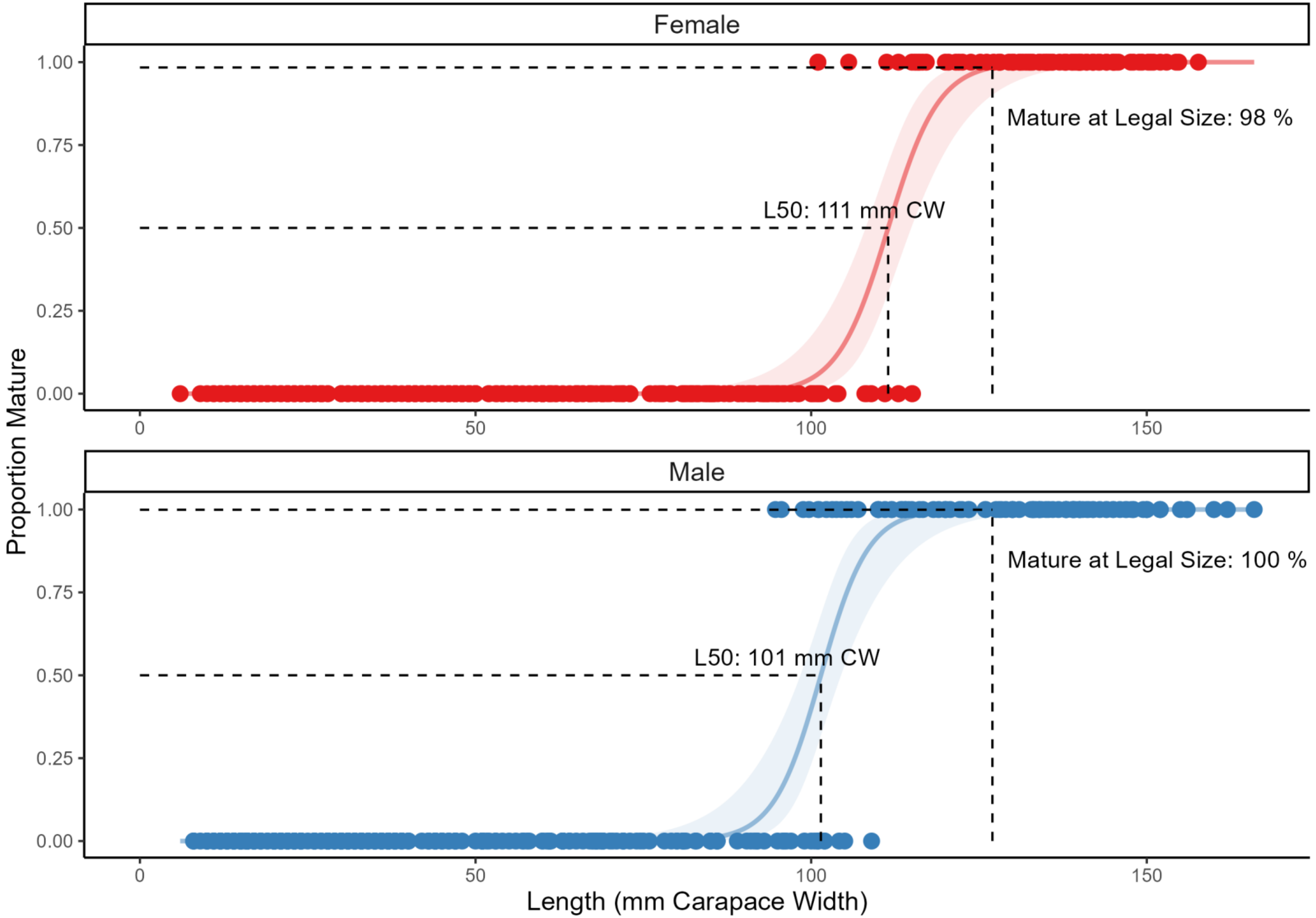



| | Man-Kendall | | Theil-Sen Regression | |
|---|---|---|---|---|
| | Test Statistic (τ) | p-value | Slope | p-value |
| **Female Index (2009-2022)** | **-0.54** | **0.01** | **-0.06** | **0.01** |
| **Male Index (2009-2022)** | -0.38 | 0.06 | -0.05 | 0.06 |

# Maturity




| Size at maturity ($L_{50}$) | | |
|---|---|---|
| | Female | Male |
| This study | 111 | 101 |
| Chesapeake | 108-132 | 107 |
| Seekonk/Taunton* | 129 | - |

*Taylor and Fehon, 2021

# Discussion – Chapter 1

- Blue crab abundance index:
    - Overall positive trend – overfishing likely not occurring
    - Not increased in last 15 years
    - Variable from year-to-year
    - Status-based management

Photo: Anna Gerber-Williams, RI DMF

# Discussion – Chapter 1

- Blue crab abundance index:
    - Overall positive trend – overfishing likely not occurring
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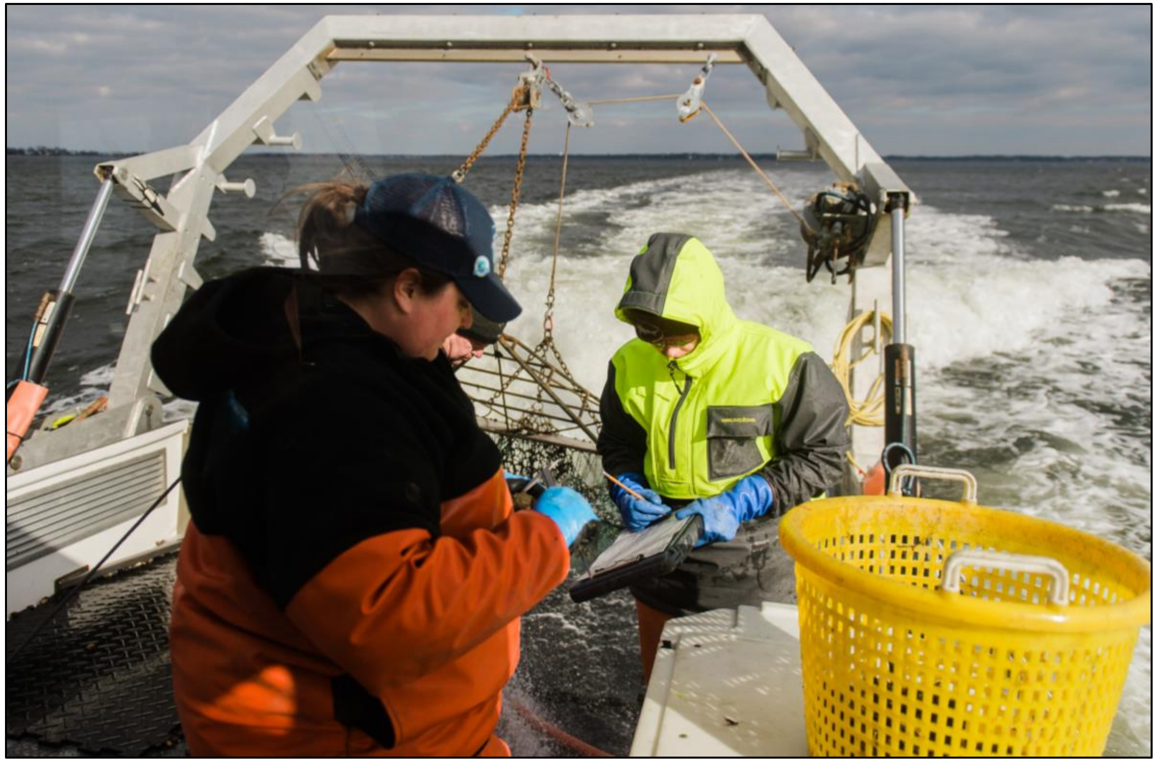
    - Variable from year-to-year
    - Status-based management

- Nearly all crabs mature at legal harvest size
    - Differ by area and/or salinity?


Photo: Anna Gerber-Williams, RI DMF

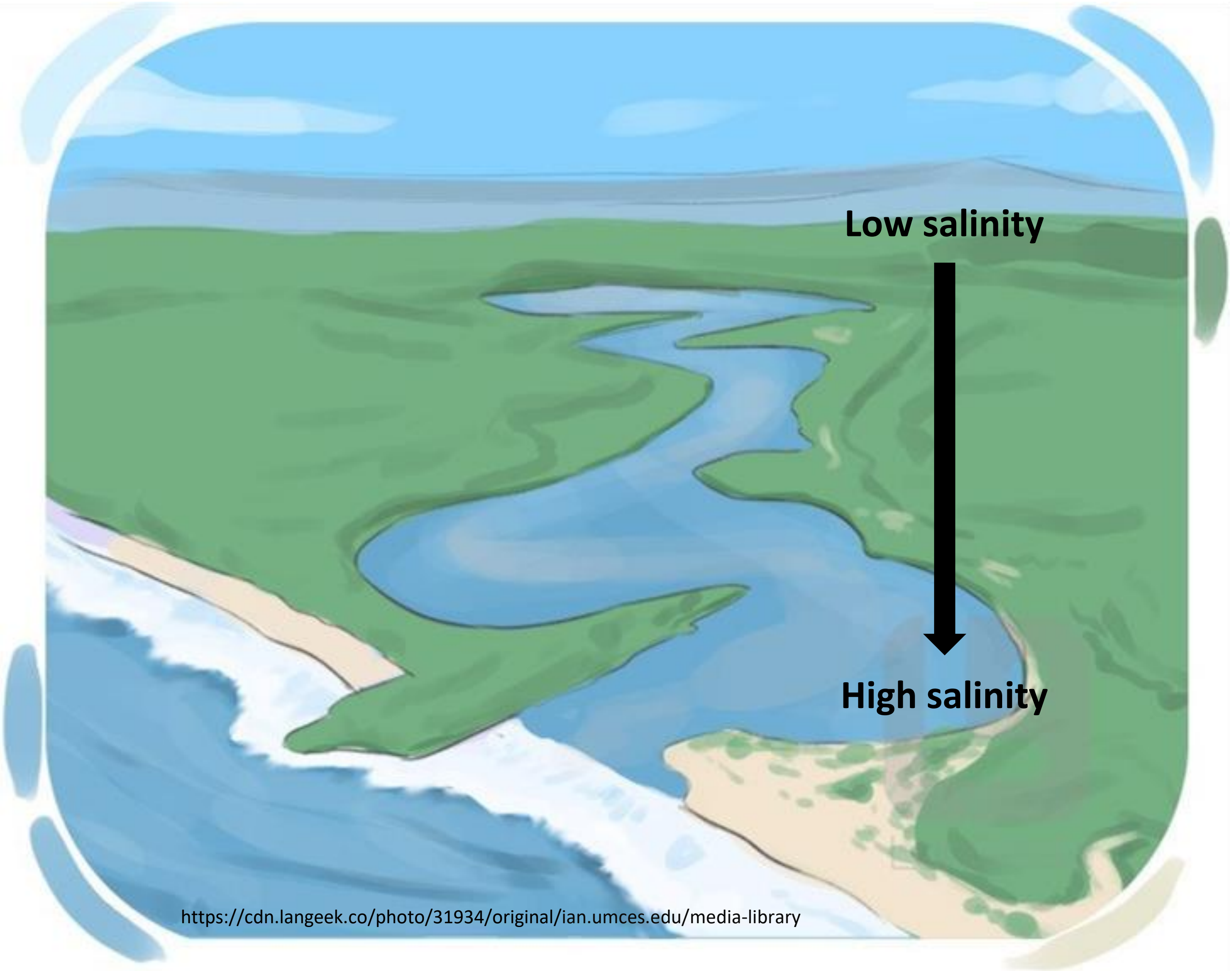
# Purpose – Chapter 2

- Targeted survey as additional tool
    - Fill gaps in data



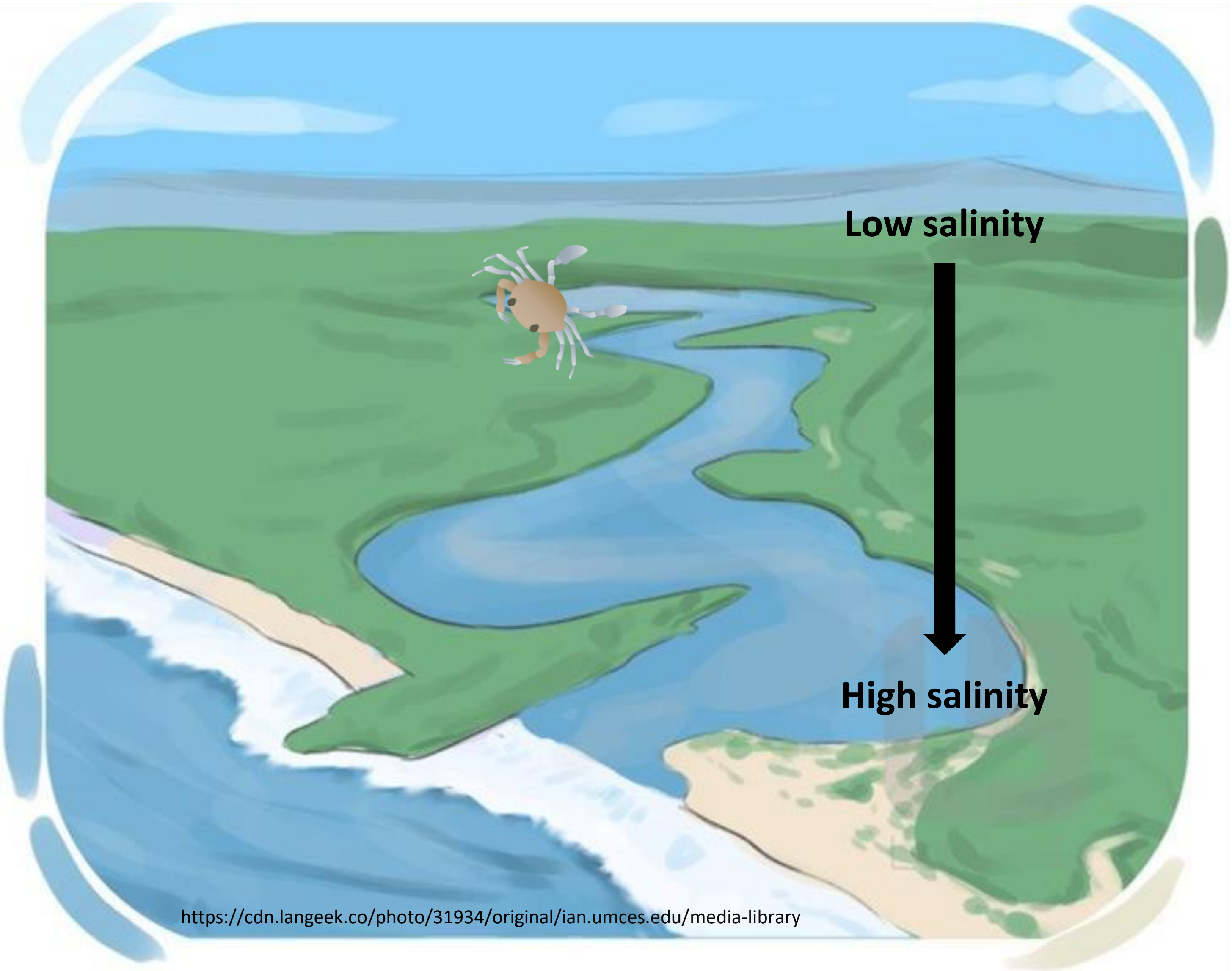
# Purpose – Chapter 2

- Spatially distributed along salinity gradient



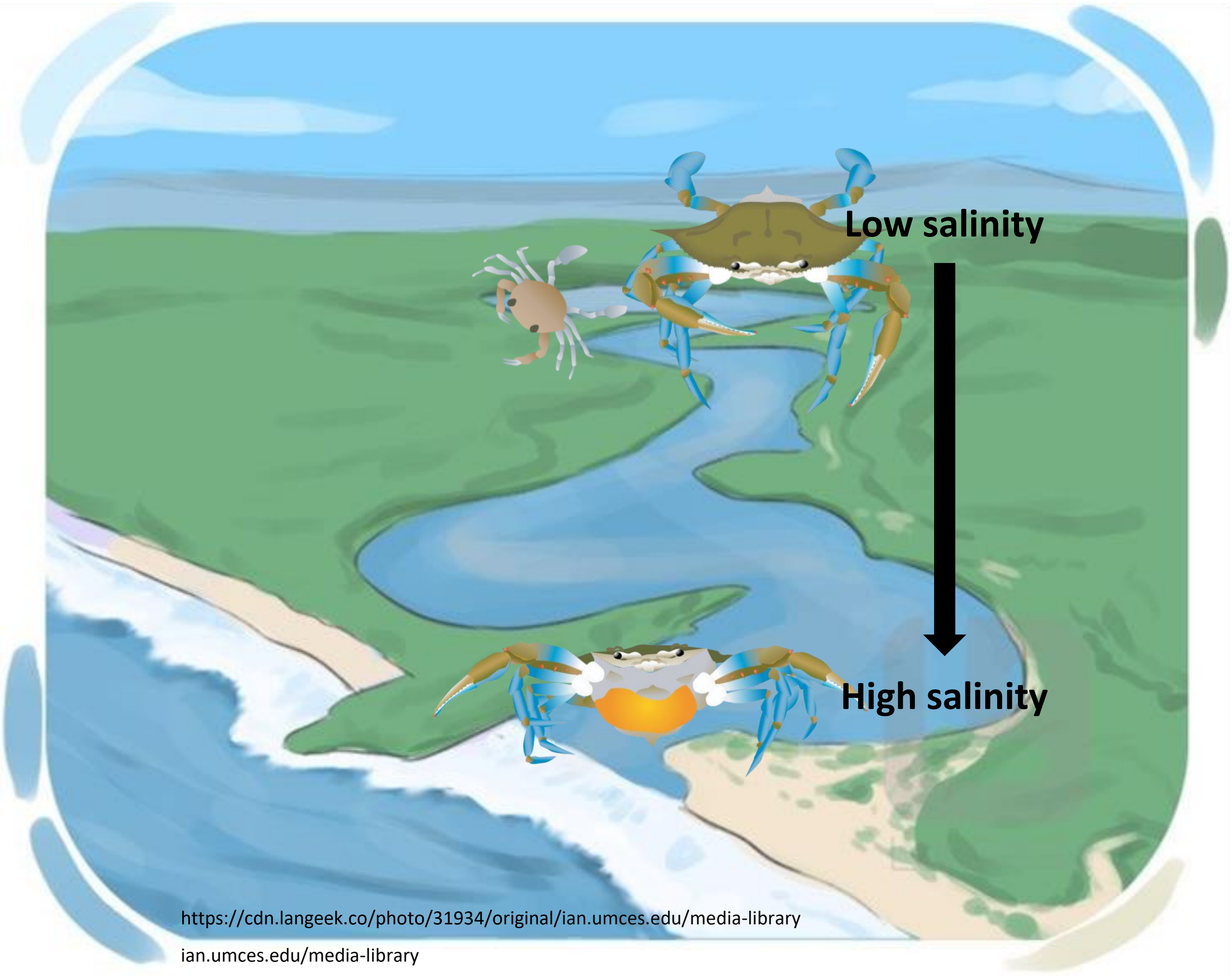
# Purpose – Chapter 2

- Spatially distributed along salinity gradient
- Juveniles settle in upper estuary



# Methods – Chapter 2

- Spatially distributed along salinity gradient
- Juveniles settle in upper estuary
  - Males remain
- Mature females to lower estuary to spawn

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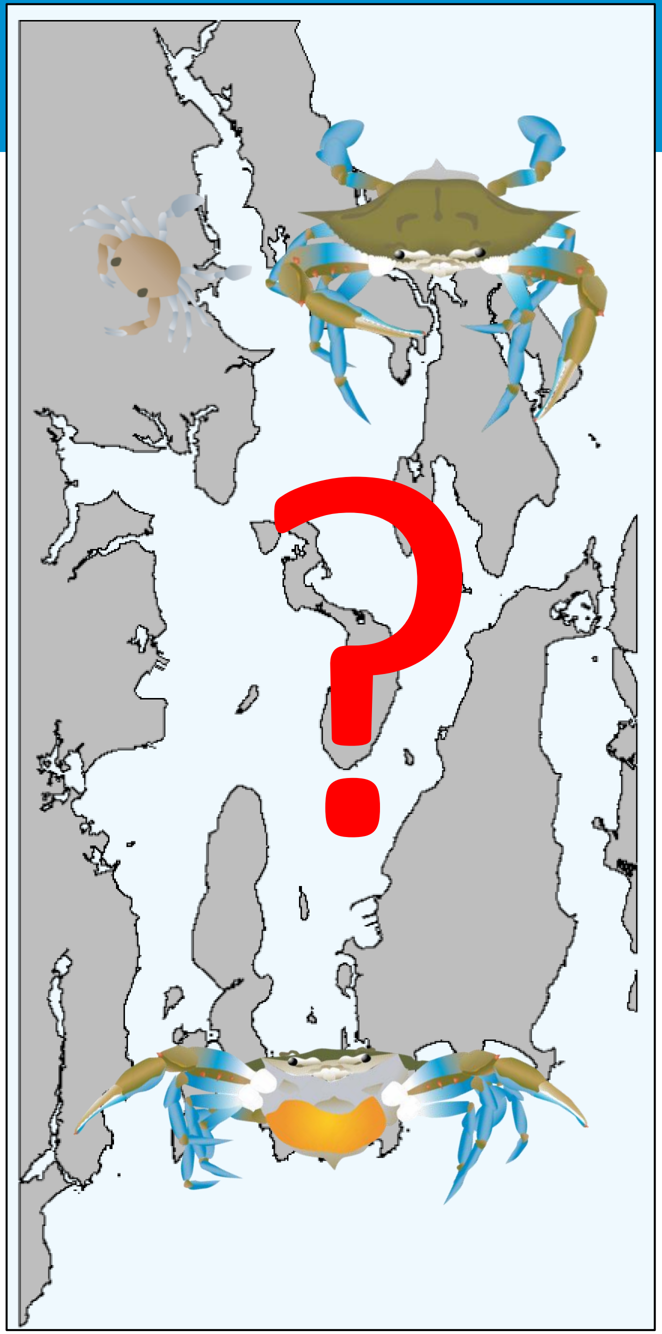
# Methods – Chapter 2

- Spatial segregation in Narragansett Bay?

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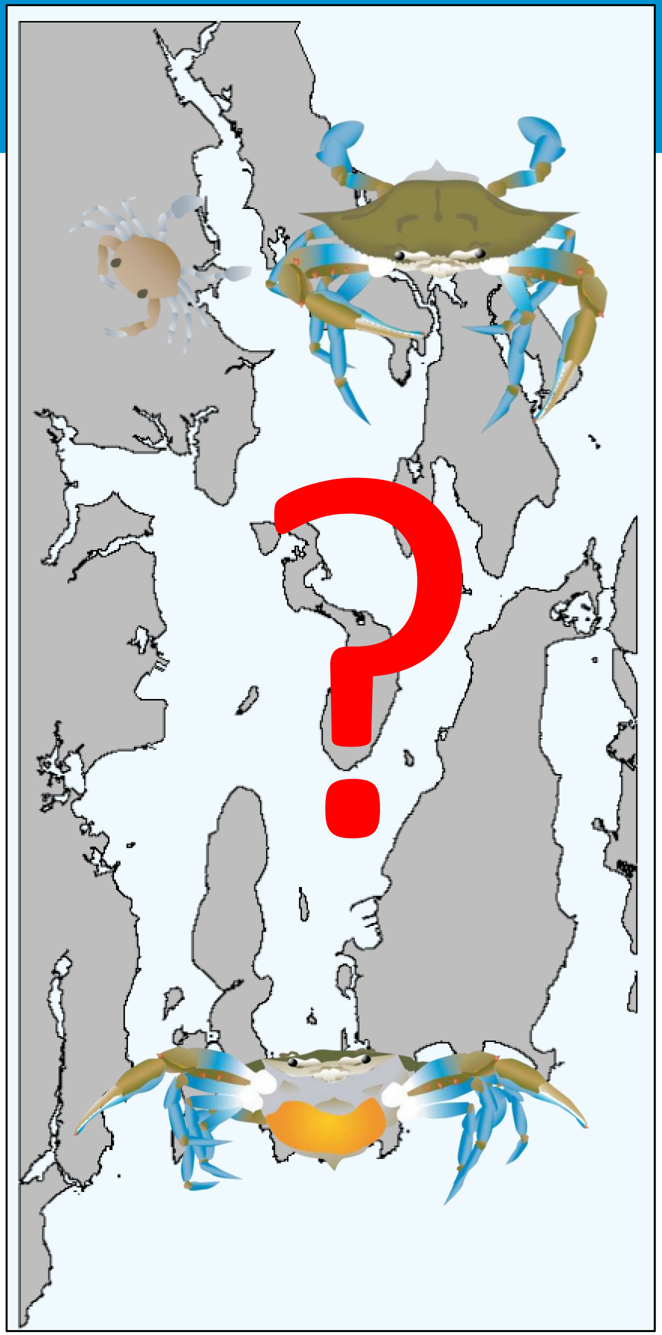
# Methods – Chapter 2

- Spatial segregation in Narragansett Bay?

- “Hotspots” – areas of high density

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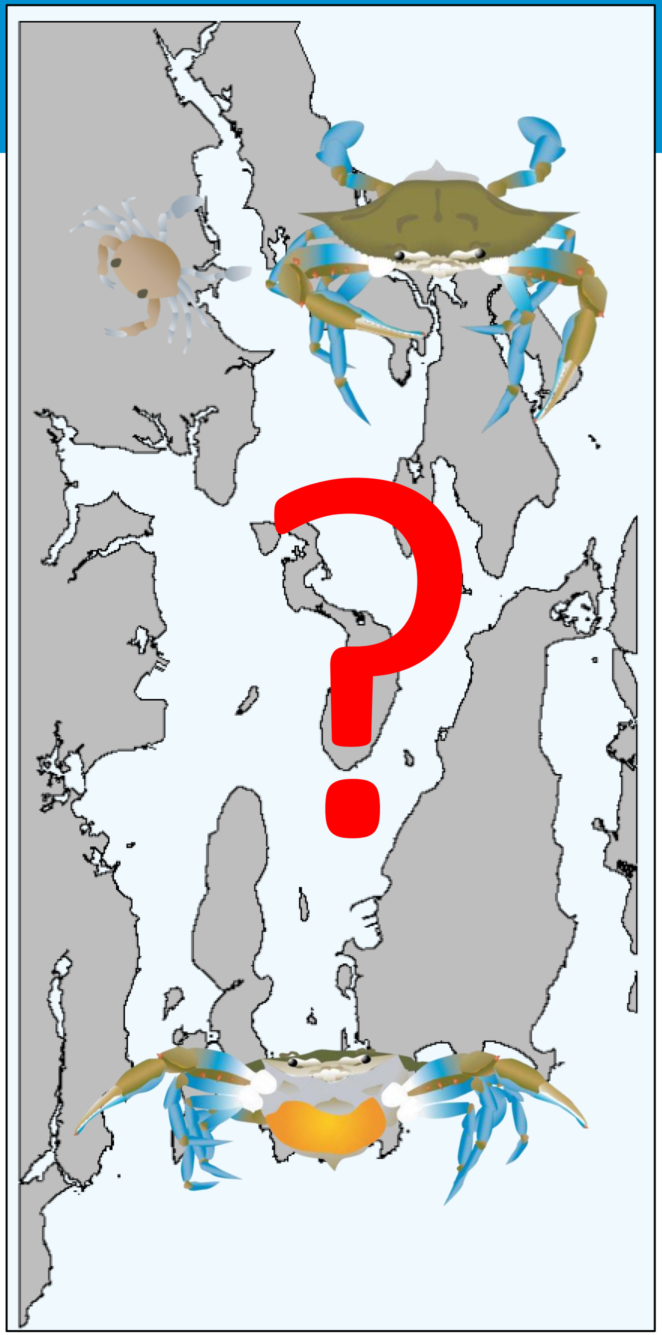
# Methods – Chapter 2

- Spatial segregation in Narragansett Bay?
- “Hotspots” – areas of high density
- Effects of environmental variables

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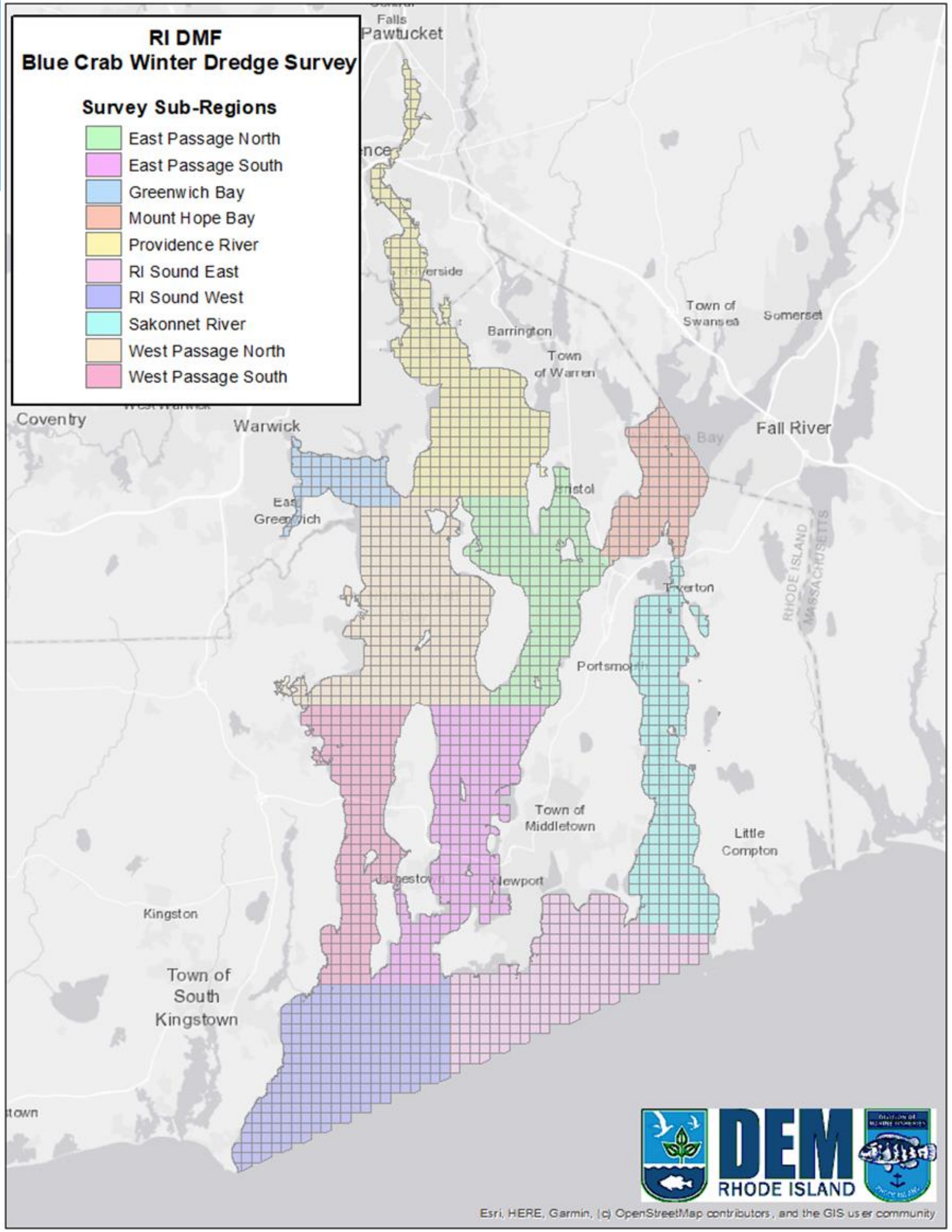
# Methods – Chapter 2

- Based on Chesapeake Bay Winter Dredge Survey methodology



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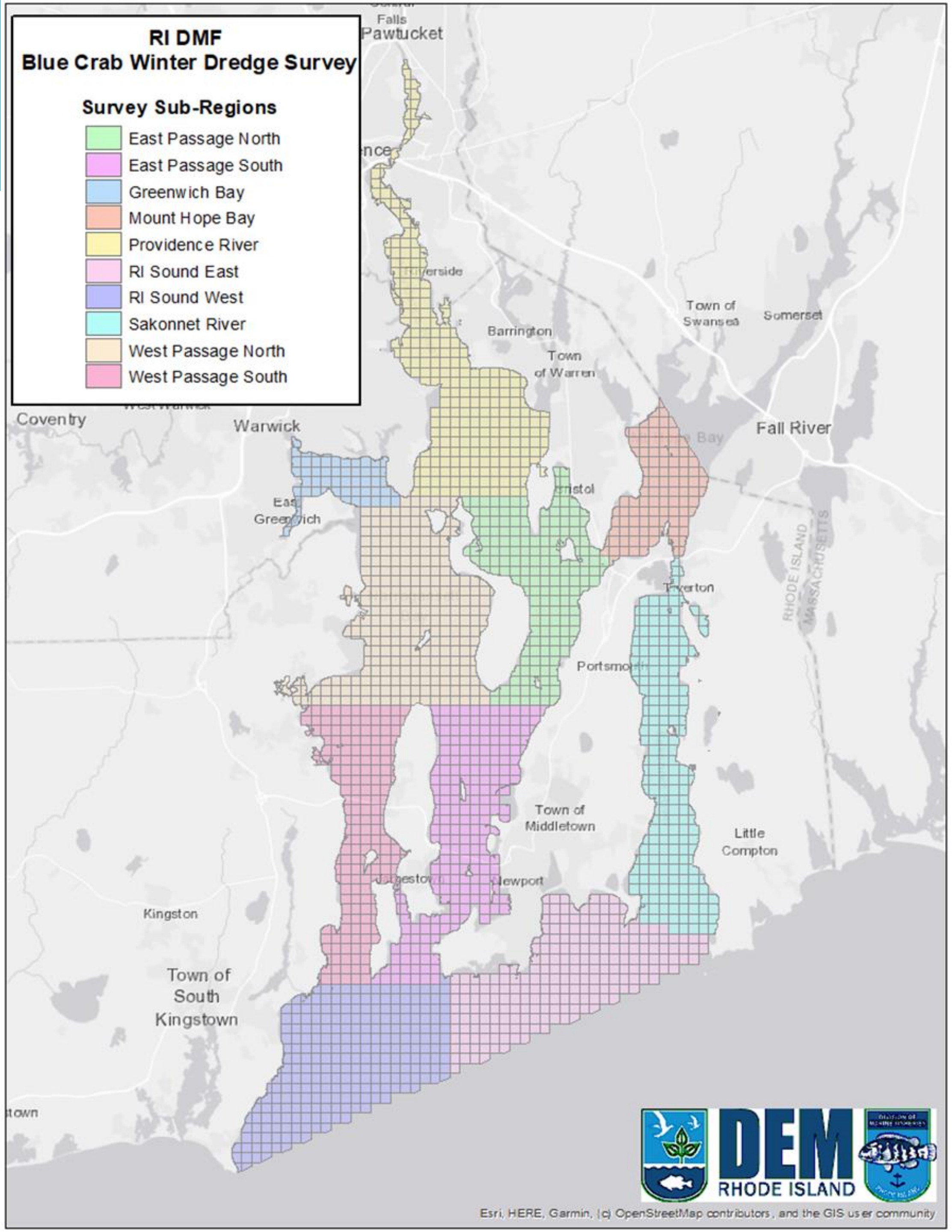
- Stratified-random sampling
  - Strata = region/waterbody



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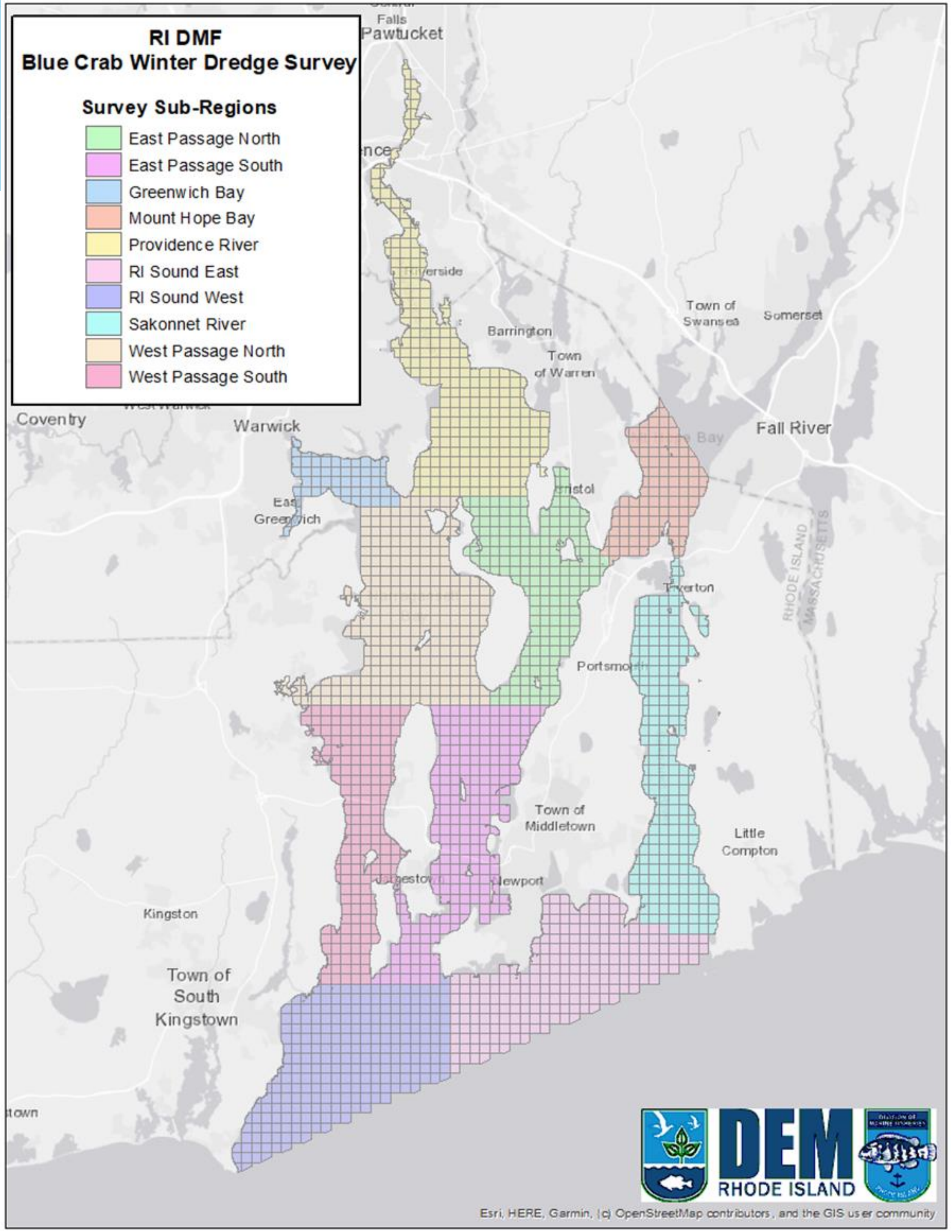

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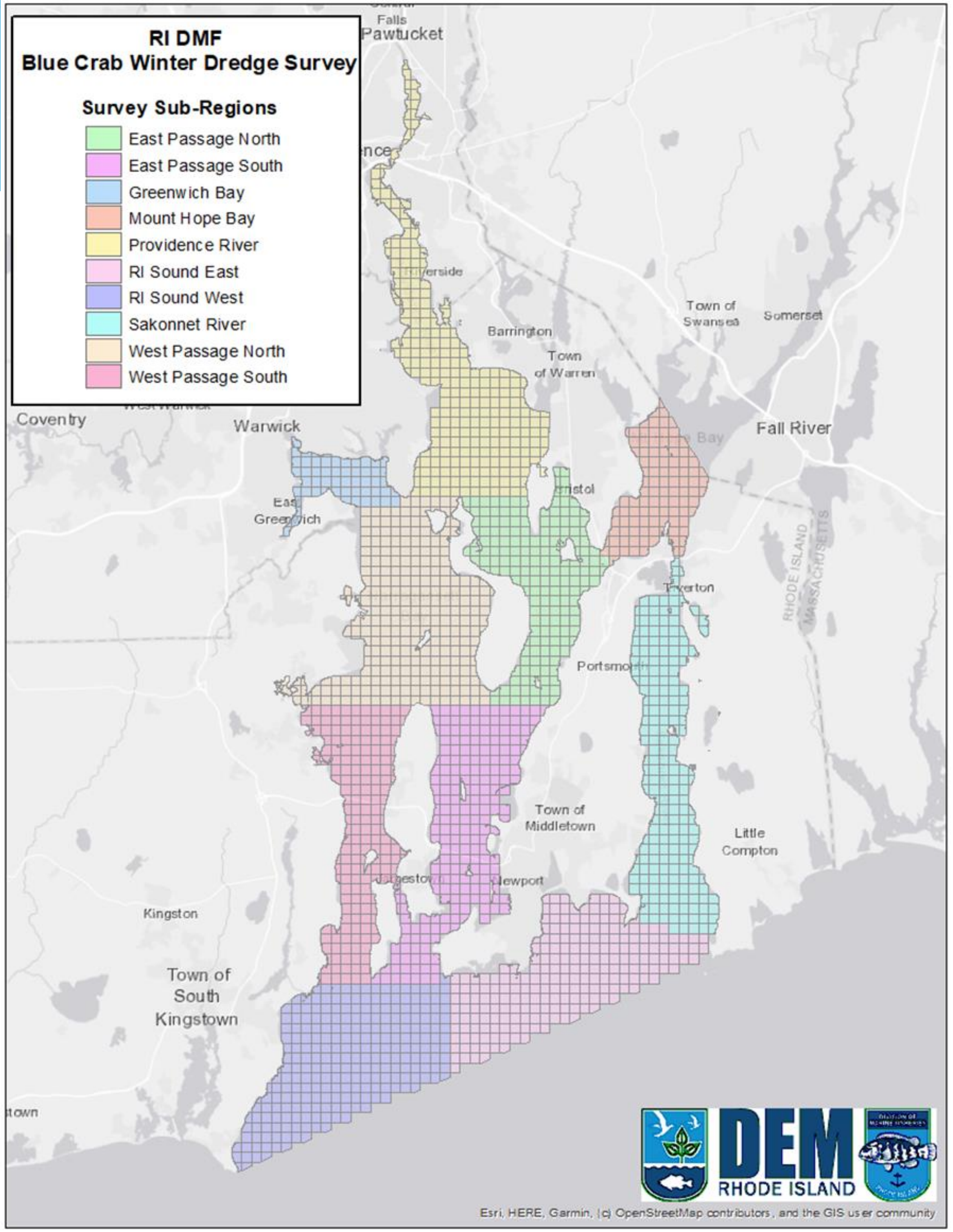

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- Temp, salinity, and depth every 15”
- Noted substrate type

# Results – Chapter 2

- 254 tows January 2022-March 2024

| Subregion | n tows | Mean density (crabs/1000m$^2$) | Std. dev. | % occurrence |
|---|---|---|---|---|
| East Passage North | 21 | 2.56 | 8.52 | 14.29 |
| East Passage South | 11 | 3.62 | 8.71 | 27.27 |
| Greenwich Bay | 34 | 6.72 | 17.92 | 38.24 |
| Mount Hope Bay | 17 | 0.97 | 2.96 | 11.76 |
| Providence River | 72 | 20.69 | 129.26 | 30.56 |
| RI Sound East | 11 | 1.60 | 3.82 | 18.18 |
| RI Sound West | 16 | 1.30 | 3.95 | 12.50 |
| Sakonnet River | 21 | 1.49 | 6.85 | 4.76 |
| West Passage North | 39 | 1.79 | 8.86 | 7.69 |
| West Passage South | 12 | 1.21 | 2.97 | 16.67 |
| **Overall** | **254** | **7.80** | **69.47** | **20.87** |

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# Results – Chapter 2

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- Prov River highest densities and catch rates
  - Followed by Greenwich Bay

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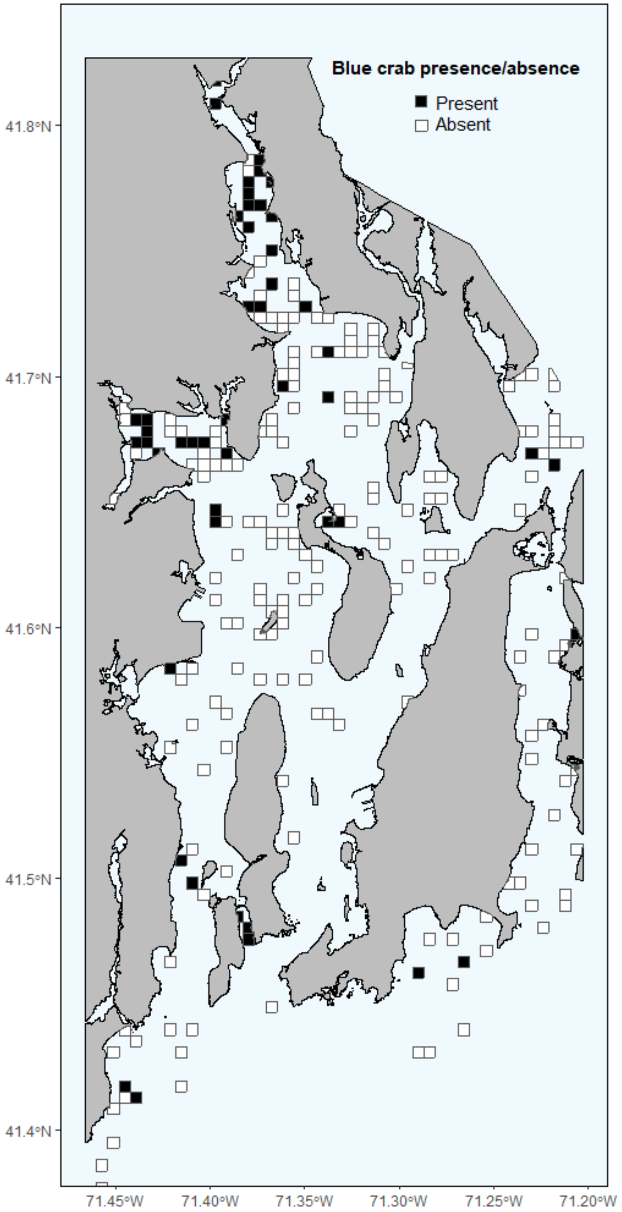


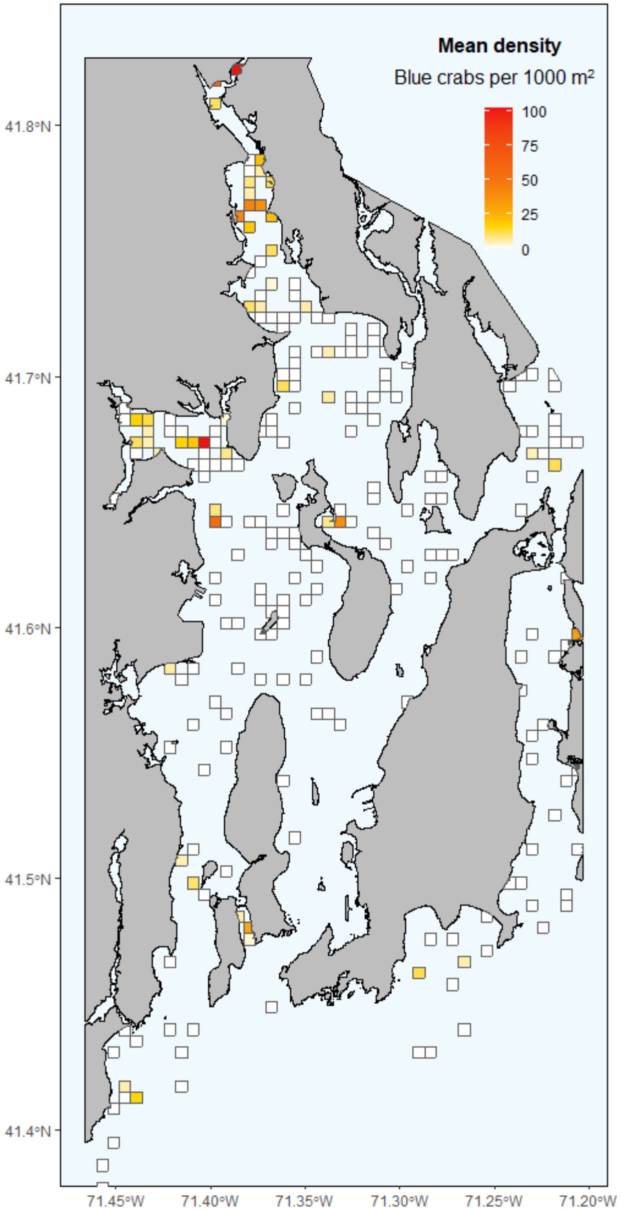

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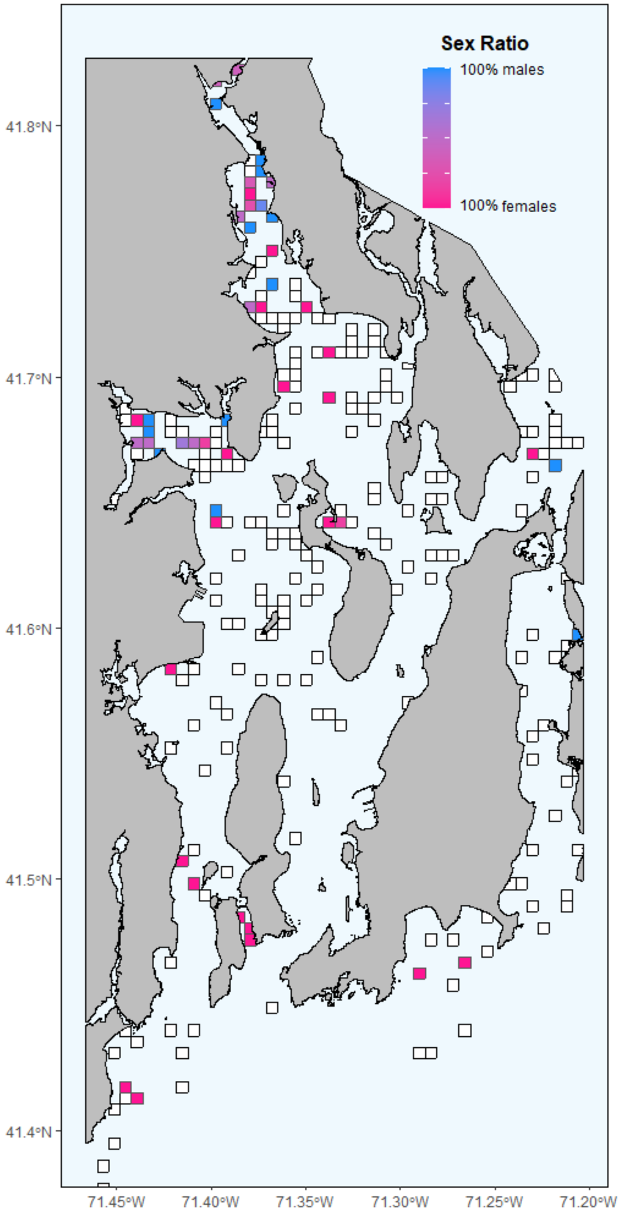


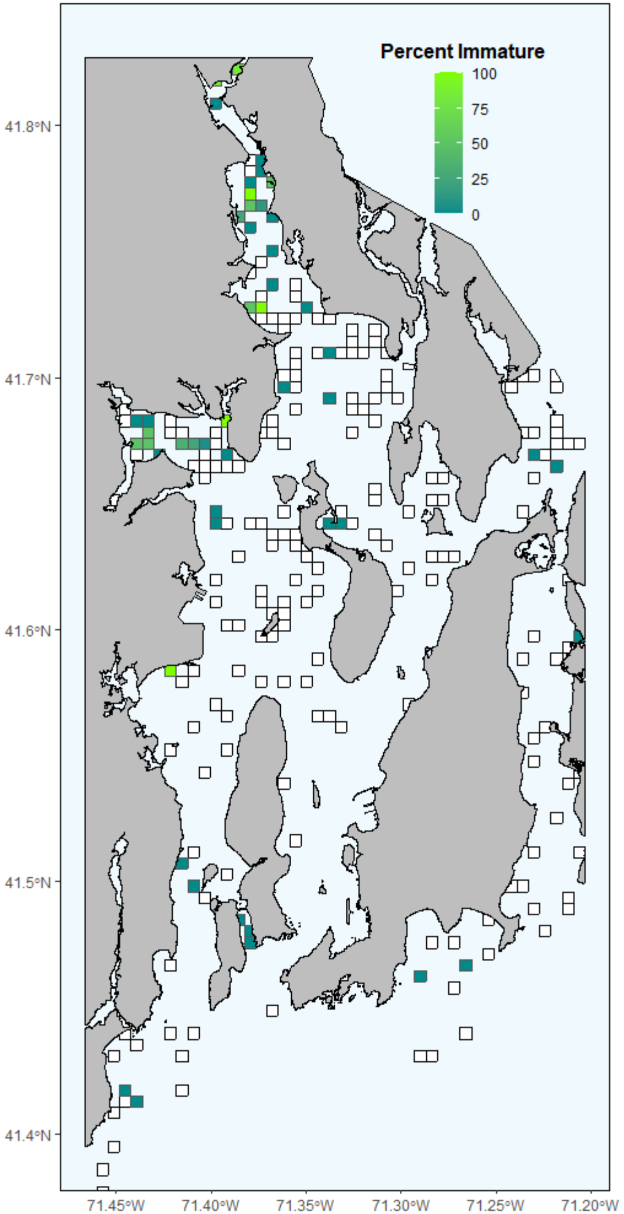

# Results – Chapter 2

- GAMs: how do environmental variables affect presence/absence of blue crabs?
  - Stepwise removal starting with: salinity, bottom temp, depth, substrate type, latitude
  - Family = binomial

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- All crabs combined, males + immature crabs, mature females

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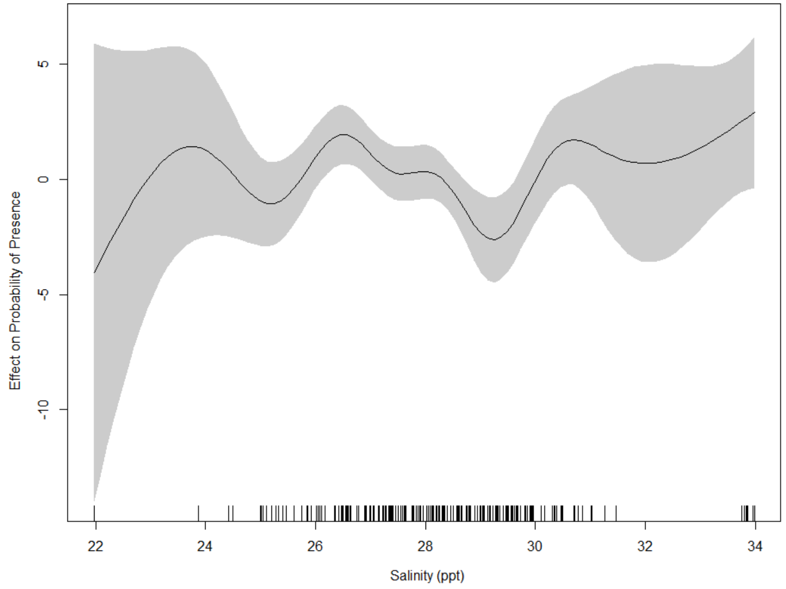
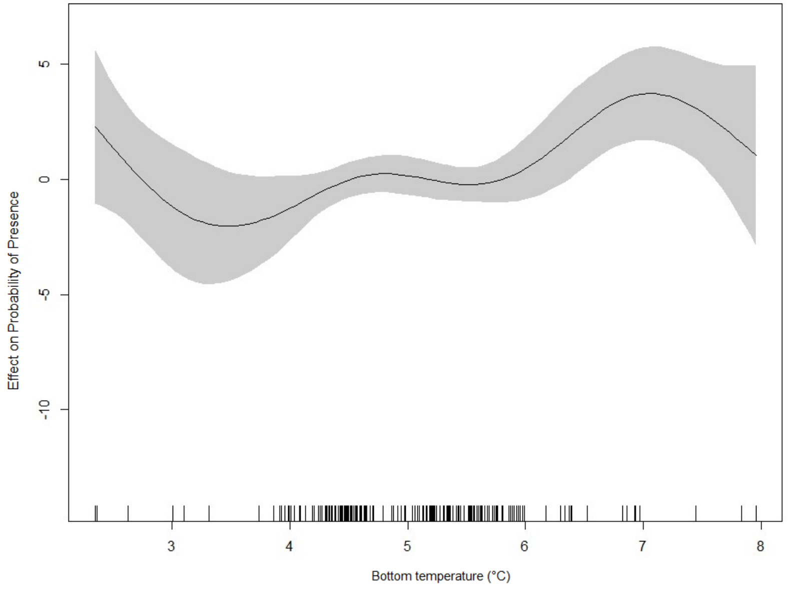
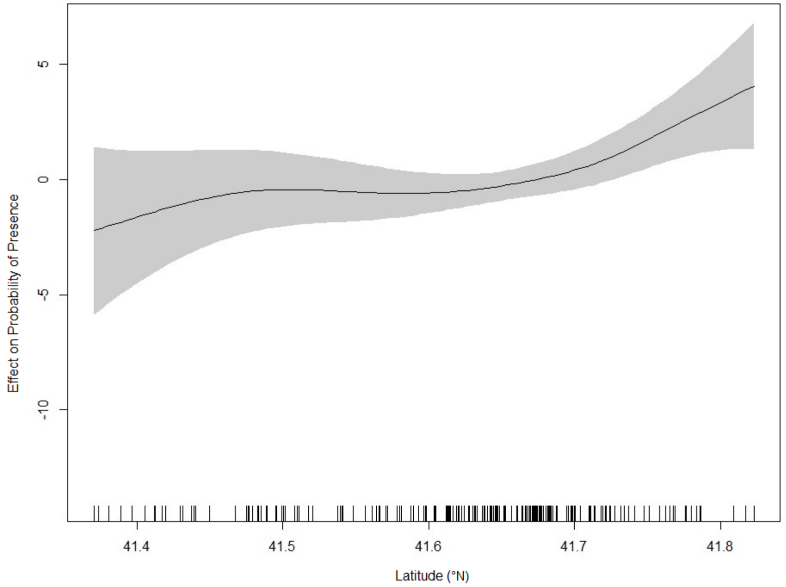


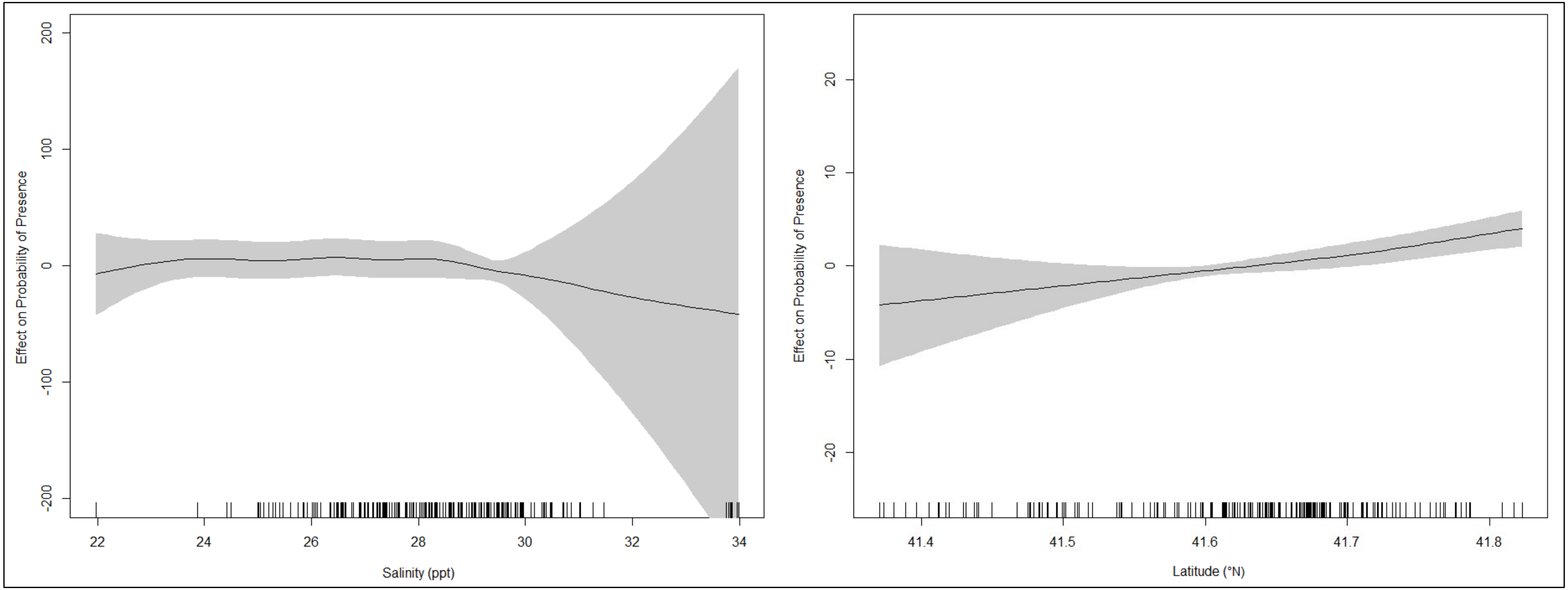




All crabs:

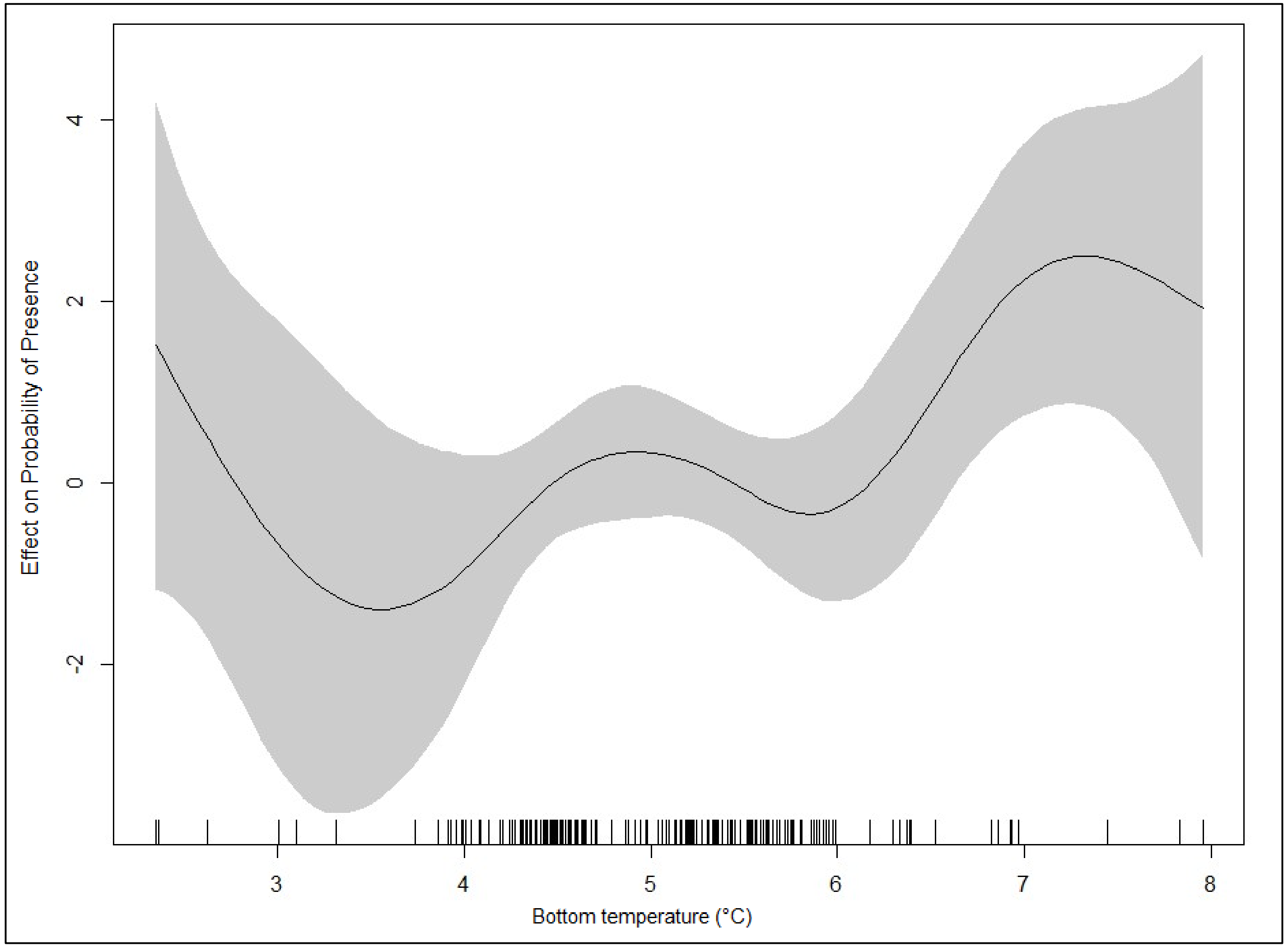
P/A ~ s(salinity) + s(bottom temp) + s(latitude)

# Results – Chapter 2




Male + Immature crabs: P/A ~ s(salinity) + s(latitude)

# Results – Chapter 2




Female crabs: P/A ~ s(bottom temp)

# Discussion – Chapter 2

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  - Over 20% catch rate

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  - Over 20% catch rate
- Spatial understanding of blue crab habitat
- Evidence of environmental drivers
- Refine sampling areas and consider different stratification
- Estimate winter mortality?

# Acknowledgements


Committee:

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UNIVERSITY OF RHODE ISLAND

RI DEM

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- John Lake
- Julia Livermore
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- Scott Olszewski
- Chris Parkins
- Corinne Truesdale
- Many more

DIVISION OF MARINE FISHERIES
RHODE ISLAND

- Dredge photos: Molly Ogren and Jordyn Kastlunger

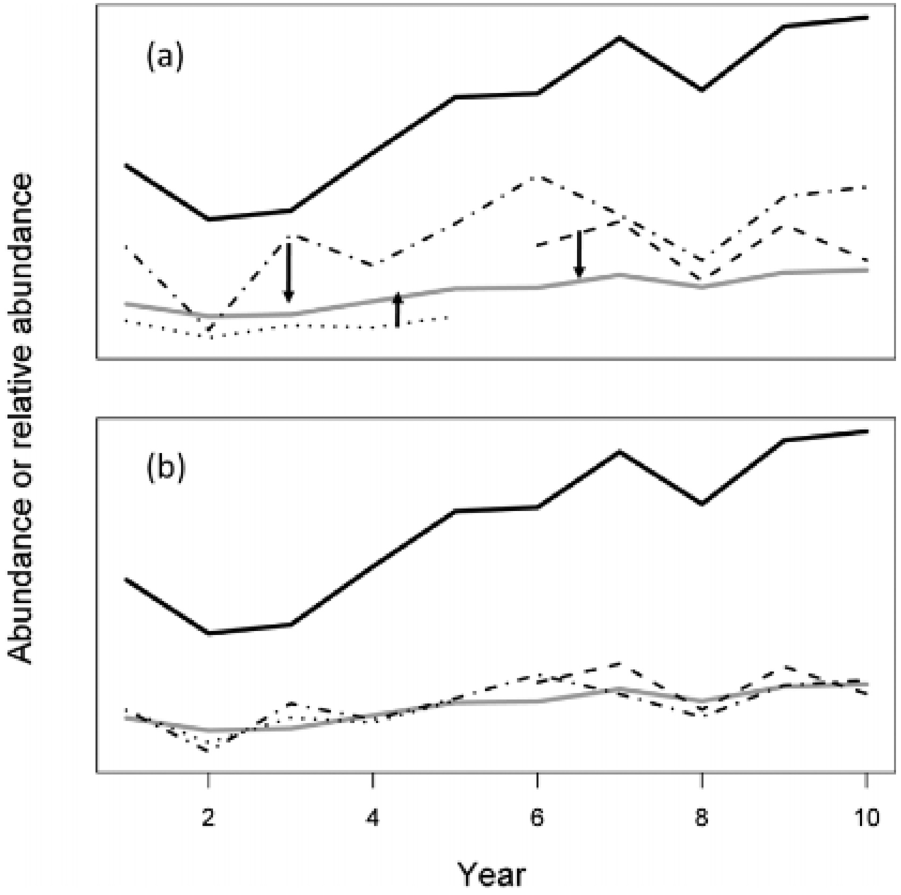
Special thanks to my wife Meg, my family, and friends


# Methods – Abundance

$$\ln(U_{it}) \sim \text{Normal}(\ln(\mu_t) + \ln(q_i), (\sigma_i^p)^2 + (\sigma_{it}^s)^2)$$

- Bayesian hierarchical modeling approach (Conn 2010)

- MCMC sampling used for posterior simulation
  - $\mu_t, q_i, \sigma_i^p$




Conn, 2010

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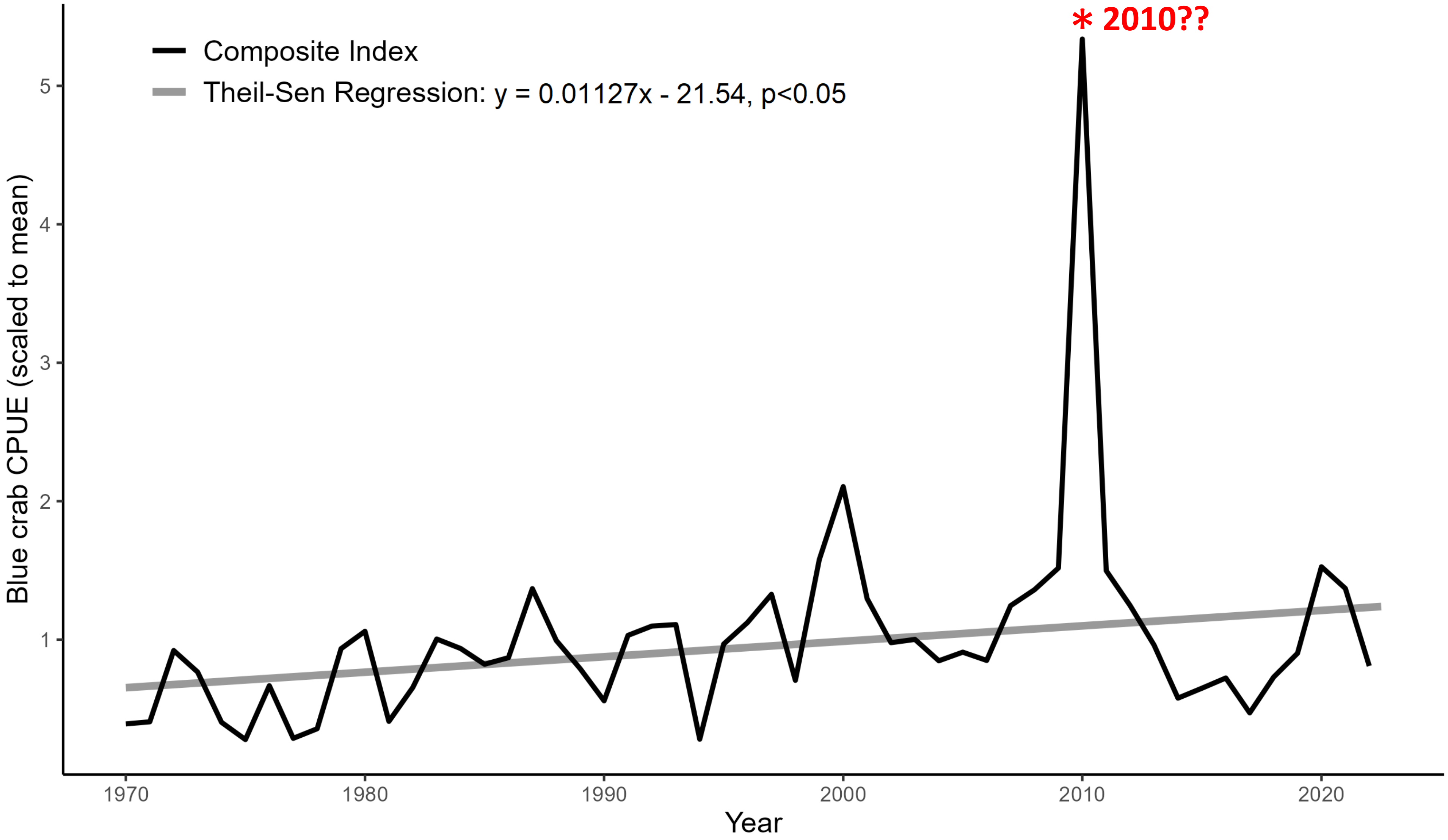

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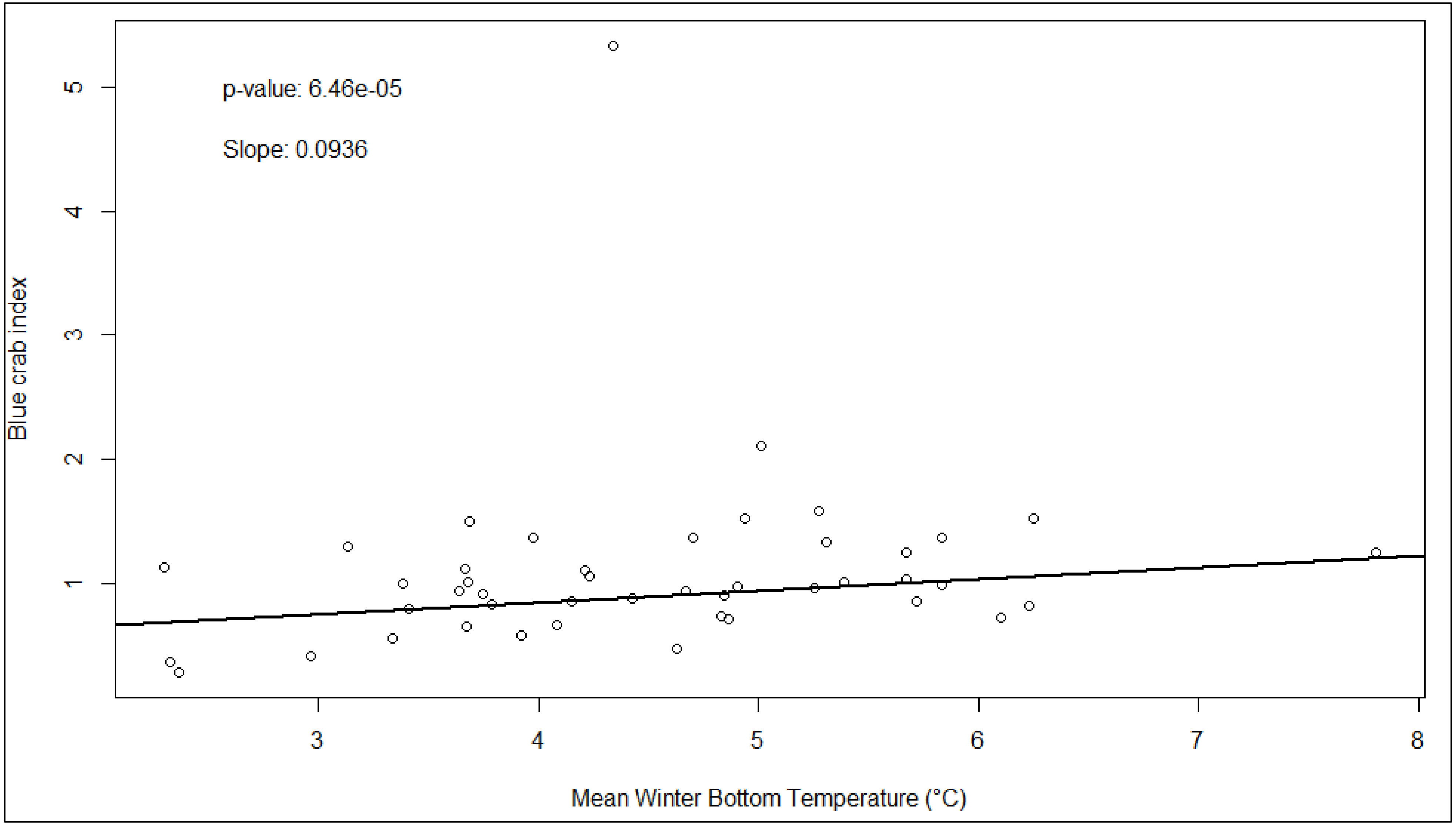

# Length-Weight