

Losing Their Muscle?: A Bayesian Approach to Diagnosing the Effect of Acidic Events on Length-Weight Relationships for Atlantic Sea Scallops (*Placopecten magellanicus*)

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Introduction

- The Atlantic sea scallop fishery is one of the most economically important shellfish fisheries in the Mid-Atlantic
- Impacts of ocean acidification (OA) on marine shellfish:

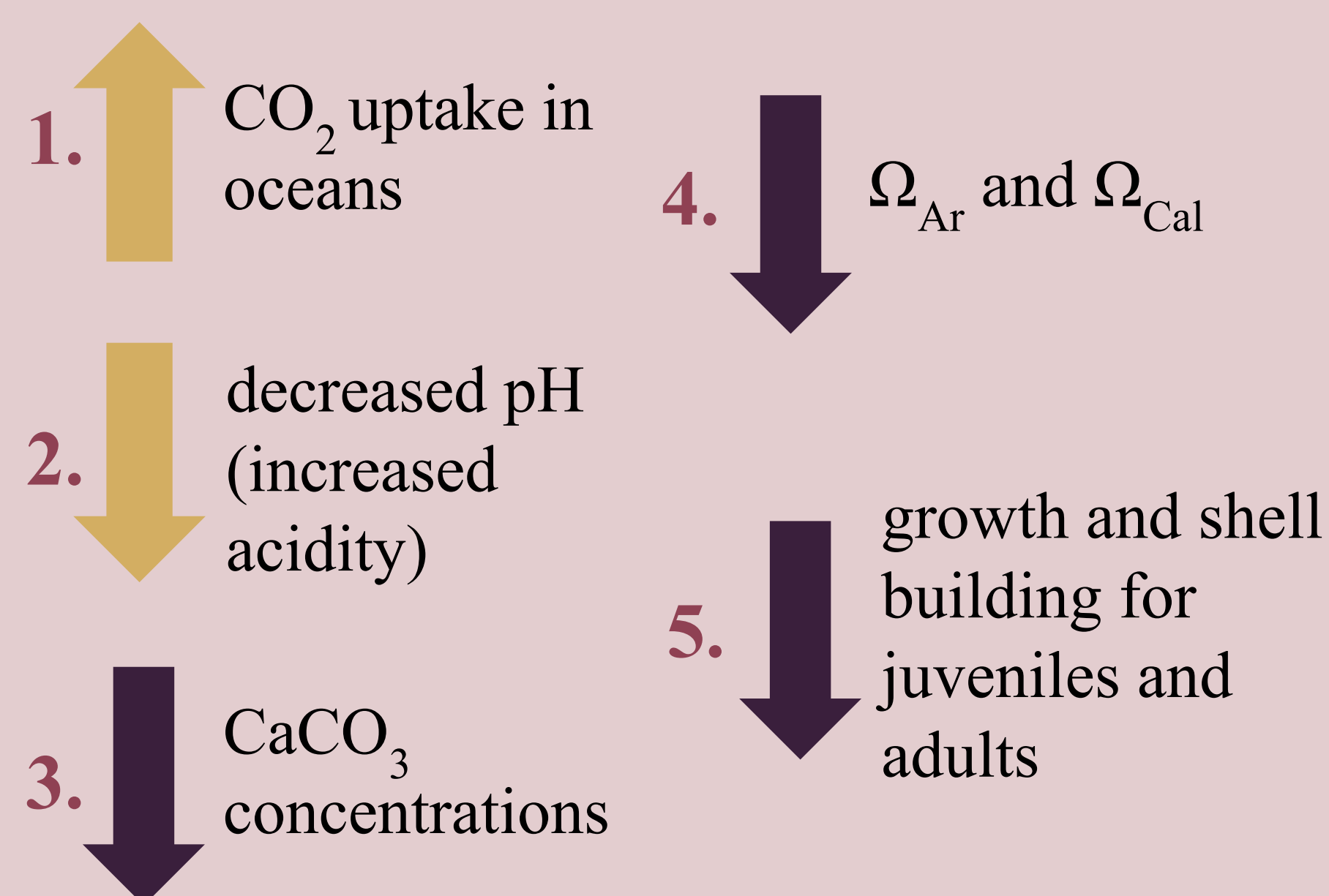


Figure Credit: Joel Wooser

- Growth and survival could be hindered at aragonite saturation states (Ω_{Ar}) less than 1.4 (adults)¹ and 0.74 (juveniles)²
- A recent study modeled the long-term impacts of OA on scallops³, but biological impacts on scallops remain understudied

Data Description

MACAN Data

- pH
- pCO_2
- DIC
- TA
- Salinity
- Ω_{Ar}
- Ω_{Cal}



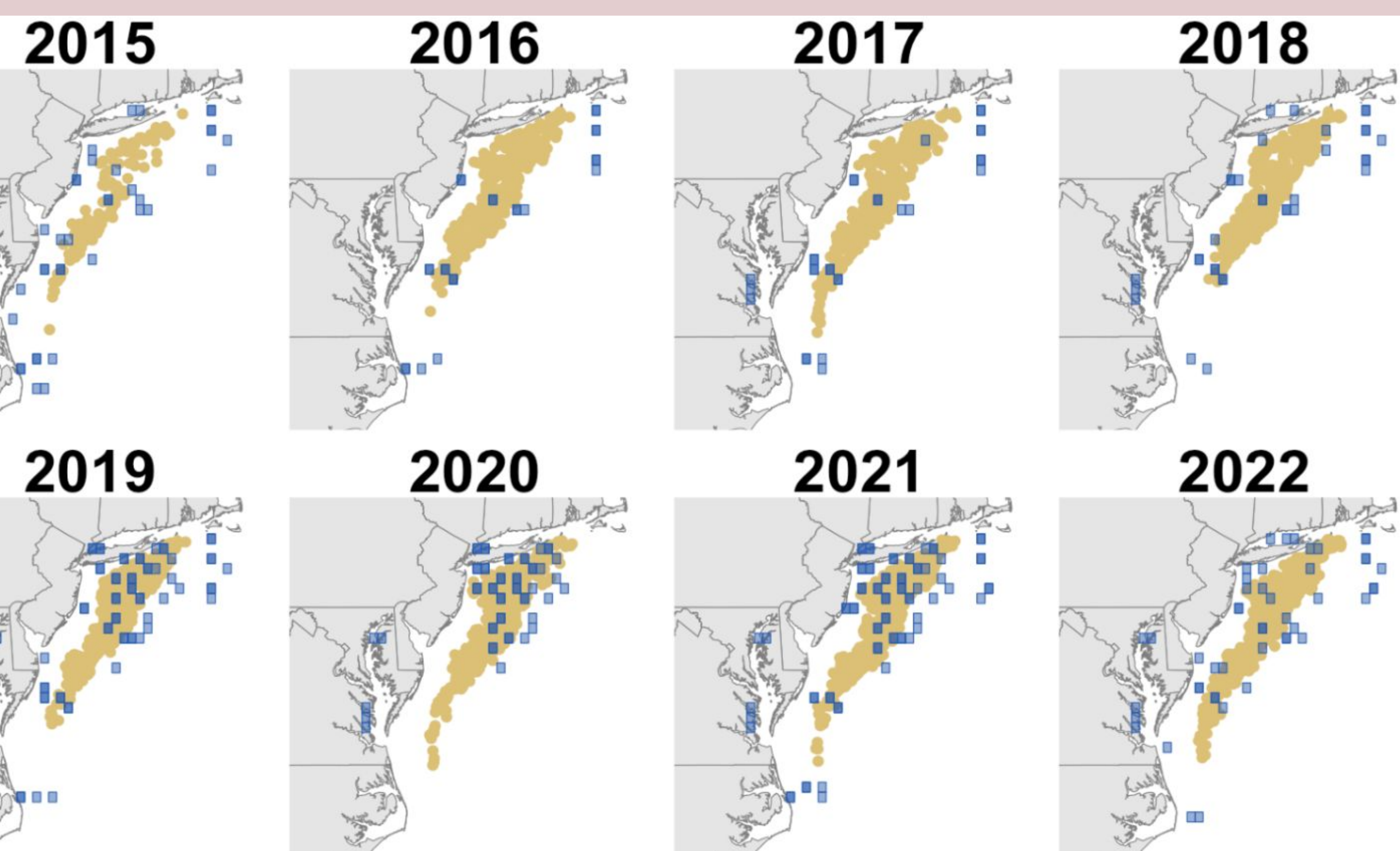
Scan the QR code to explore scallop and OA data layers on the MARCO Mid-Atlantic Ocean Data Portal!

VIMS Scallop Survey Data

- 15-30 scallops per station
- shell height (mm)
- adductor muscle meat weight (g)



Figure Credit: Eastern Fisheries Inc.



Survey
● VIMS Scallop Survey
■ MACAN OA Data

Methodological Framework: Exploring Scallop Allometry

Many locations have experienced acidic events

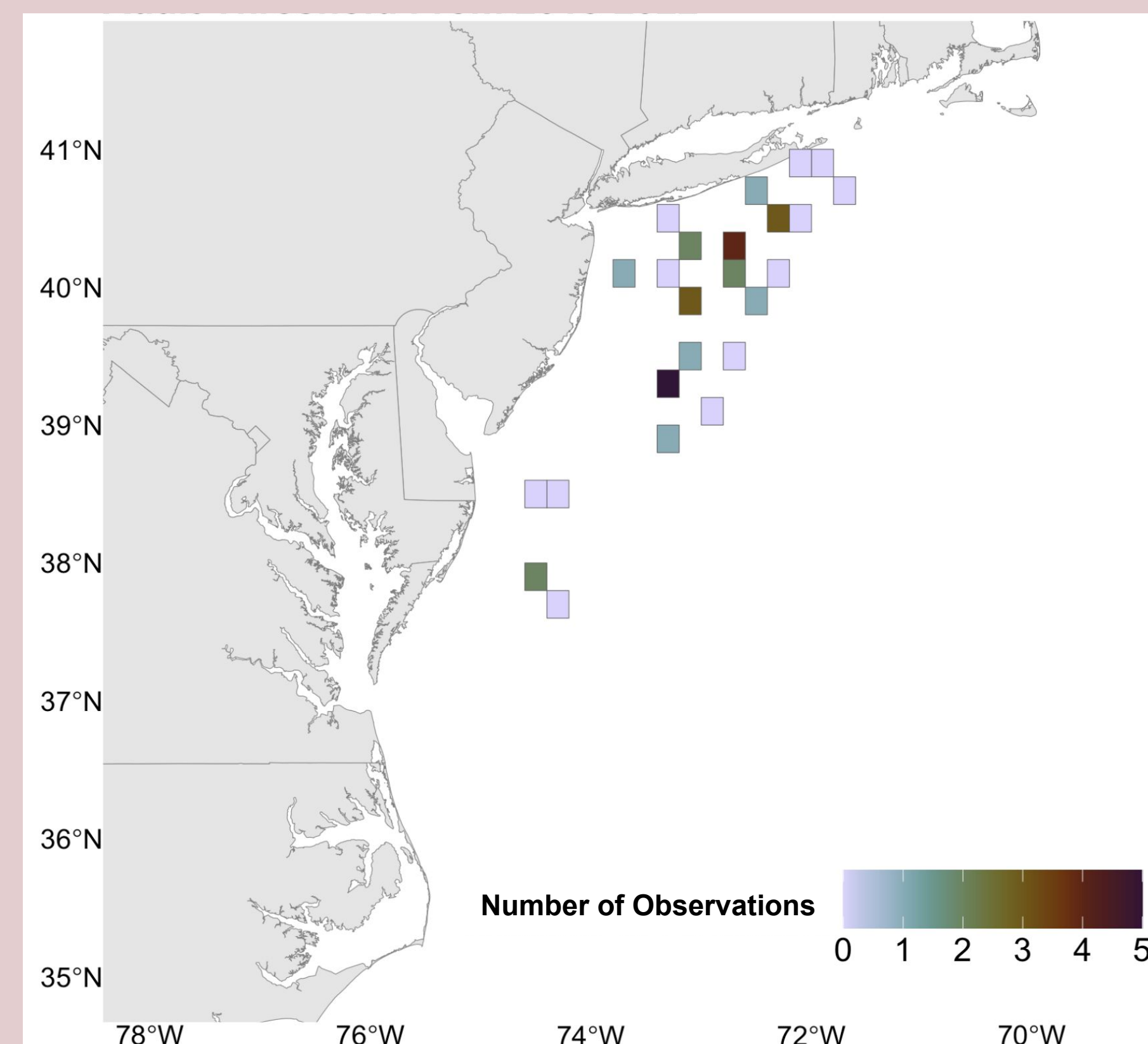


Fig 2: Exploration of acidic events. Number of observations below the Ω_{Ar} adult threshold (1.4)¹ from 2015-2022.

1. Basic Allometry Equation:

$$W_i = aL_i^b$$

where:

- W: meat weight
- L: shell height
- i: individual scallop
- a: growth coefficient
- b: controls proportionality of growth in W to growth in L
- $b \approx 3$ is common in shellfish

2. Transformation to linear model:

$$\log(W_i) = \log(a) + b * \log(L_i) + \epsilon_i$$

3. Add baseline covariates

4. (Next steps) Add OA parameters as impacts to growth parameters

Response

Meat weight

Growth parameters

a

b

Other covariates

OA parameters

pH, pCO_2 , Ω_{Ar} , and Ω_{Cal}

Shell height

location (random slope)

*Models were fit using NIMBLE software

Results: Proof-of-Concept

No strong spatial pattern in meat weight predictions, but OA parameters could improve predictions

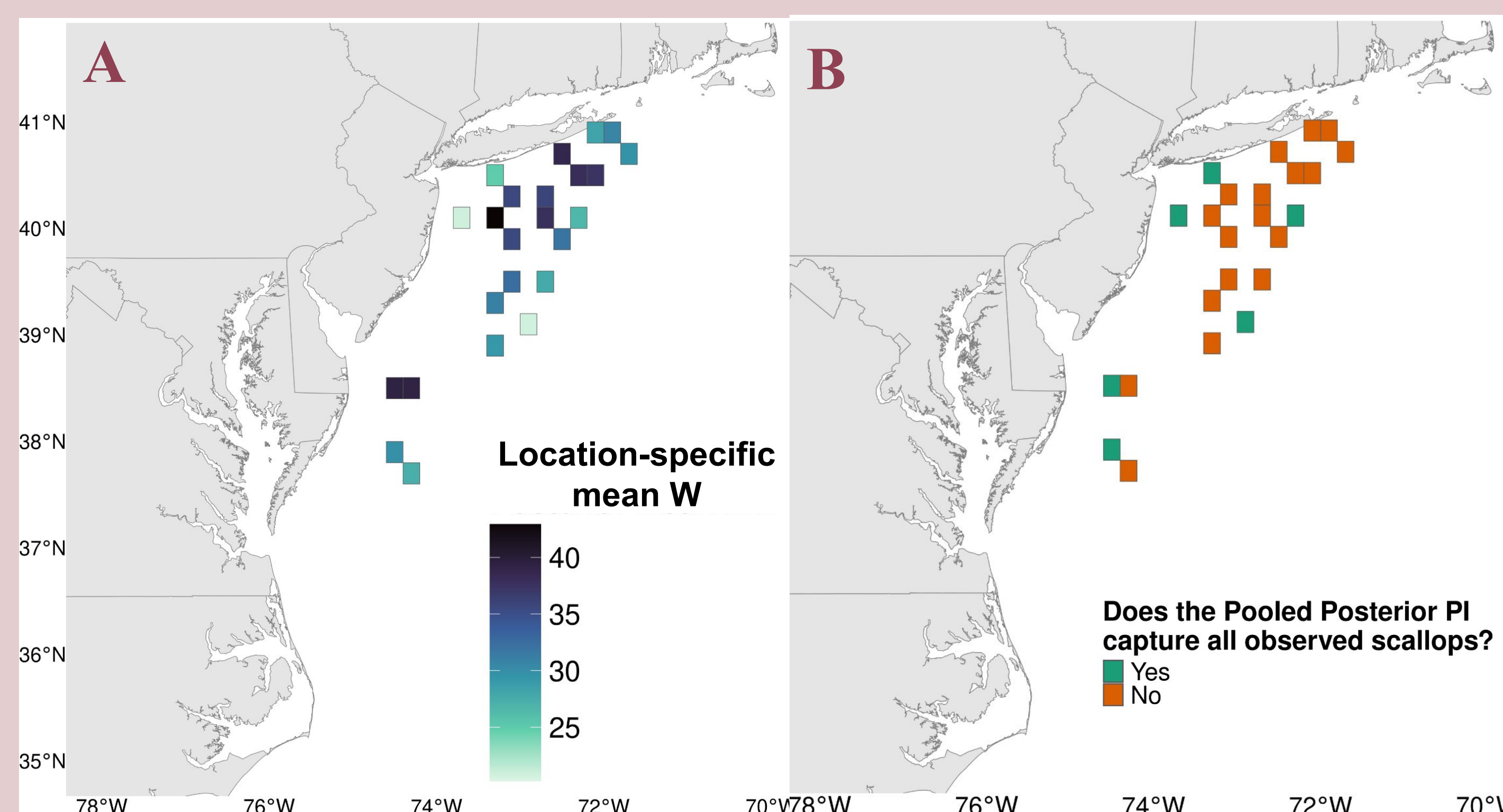


Fig 3: Location-specific posterior analysis of meat weight. Map of the A) posterior mean W at each location and B) locations where the location-specific 90% predictive interval (PI) captures W of all scallops

Inshore, northern scallops may be longer and skinnier (larger b), but show more variability

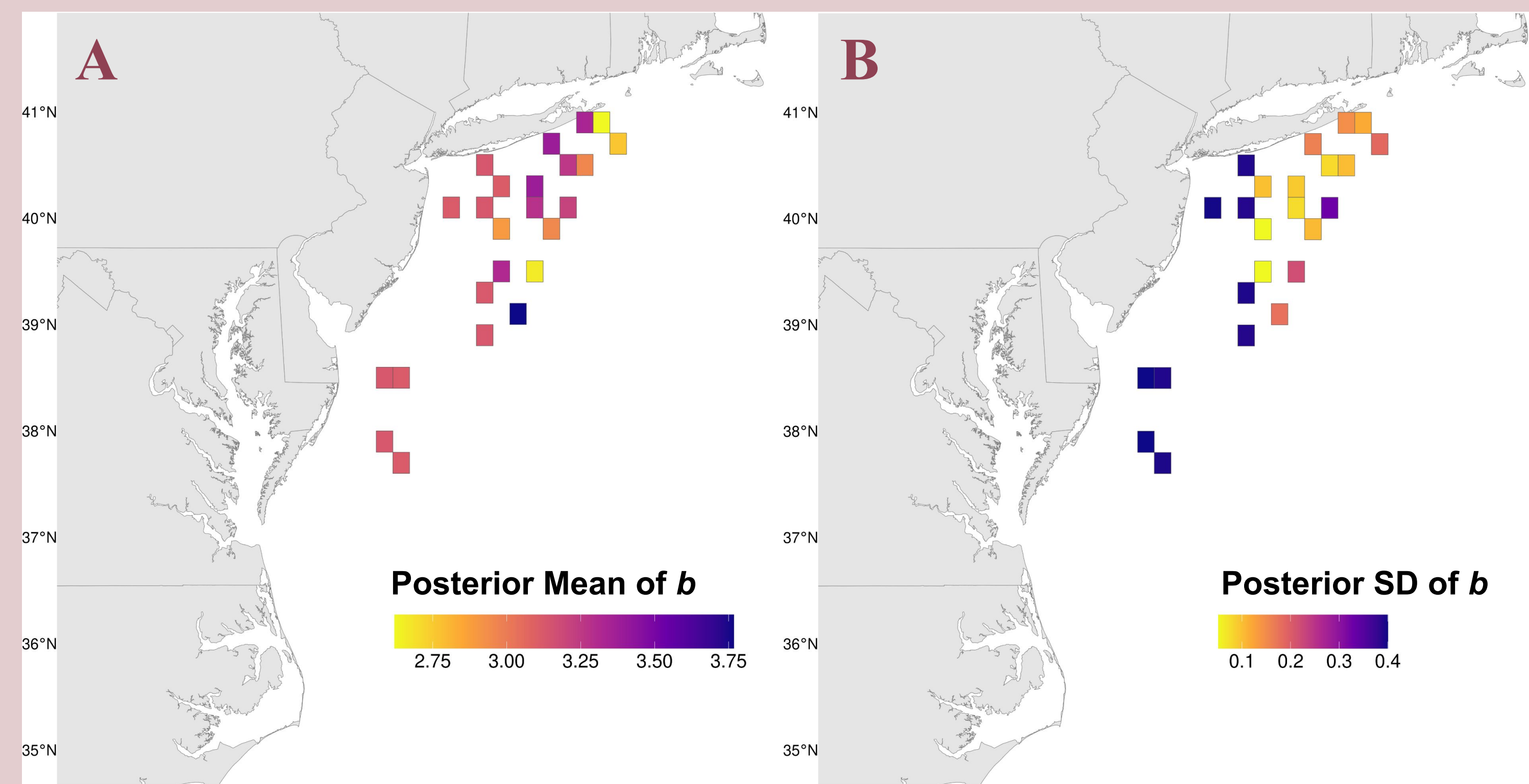


Fig 4: Analysis of scallop allometry. Map of the A) posterior mean of b (n = 5,000 scans) and B) posterior standard deviation of b (n = 5,000 scans)

Discussion and Next Steps

- Current model does not capture all variability in scallop weight
- Diagnosing the effect of space captures baseline variability in scallop growth and shape due to location
- Inshore scallops tend to have a larger b (Fig 4), which may overlap with the locations that experienced the least amount of acidic events in recent years (Fig 2)
- Could acidic events contribute to scallops shifting their energy to grow shells as opposed to their meat weight?
- Results could influence the expected resiliency of scallops in the Mid-Atlantic Bight, as they rely on larval transport from northern scallop beds^{4,5}
- Scallops could experience a wide range of acidic events during larval stages before settlement in the MAB
- Smaller meat weights in response to OA could impact the lucrative scallop industry
- Next steps: explicitly include pCO_2 , pH, Ω_{Ar} , and Ω_{Cal} in the model

References

Scan this QR code for references and final results in the future!

