# Threshold effects of altered shorelines on forage species: Baywide approach and subestuary approach

- Bay-wide approach – PI Rochelle Seitz

- Subestuary approach – PI Troy Tuckey

- Compare and contrast approaches

# Part 1: Bay Wide: Threshold effects of altered shorelines and other stressors on forage species in Chesapeake Bay

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# Part 1: Bay-wide Approach

- Examine previously compiled Bay-wide data sets (Kornis et al. 2017, Seitz et al. 2018) for threshold shoreline condition effects on important forage species (identified in Ihde et al. 2015 report)

- Examine different species important as forage that were not examined in previous meta-analysis (e.g., weakfish)

- Examine new data sets (e.g., Bay-wide blue crab dredge survey and juvenile crab survey) for threshold shoreline condition effects for blue crabs

# Hypotheses

- Shoreline impacts will interact with upland development impacts (fauna in heavily developed systems may not respond to shoreline development)

- Some forage species (e.g., those linked to shoreline: blue crabs, spot) will show threshold responses, declining with shoreline hardening

- Species not closely related to shoreline (free-swimming menhaden) may respond positively to developed shore

- Non-linear relationships will occur (sigmoidal, piecewise linear)

Sites Examining Nearshore Macrofauna and Subestuarine-Level Factors
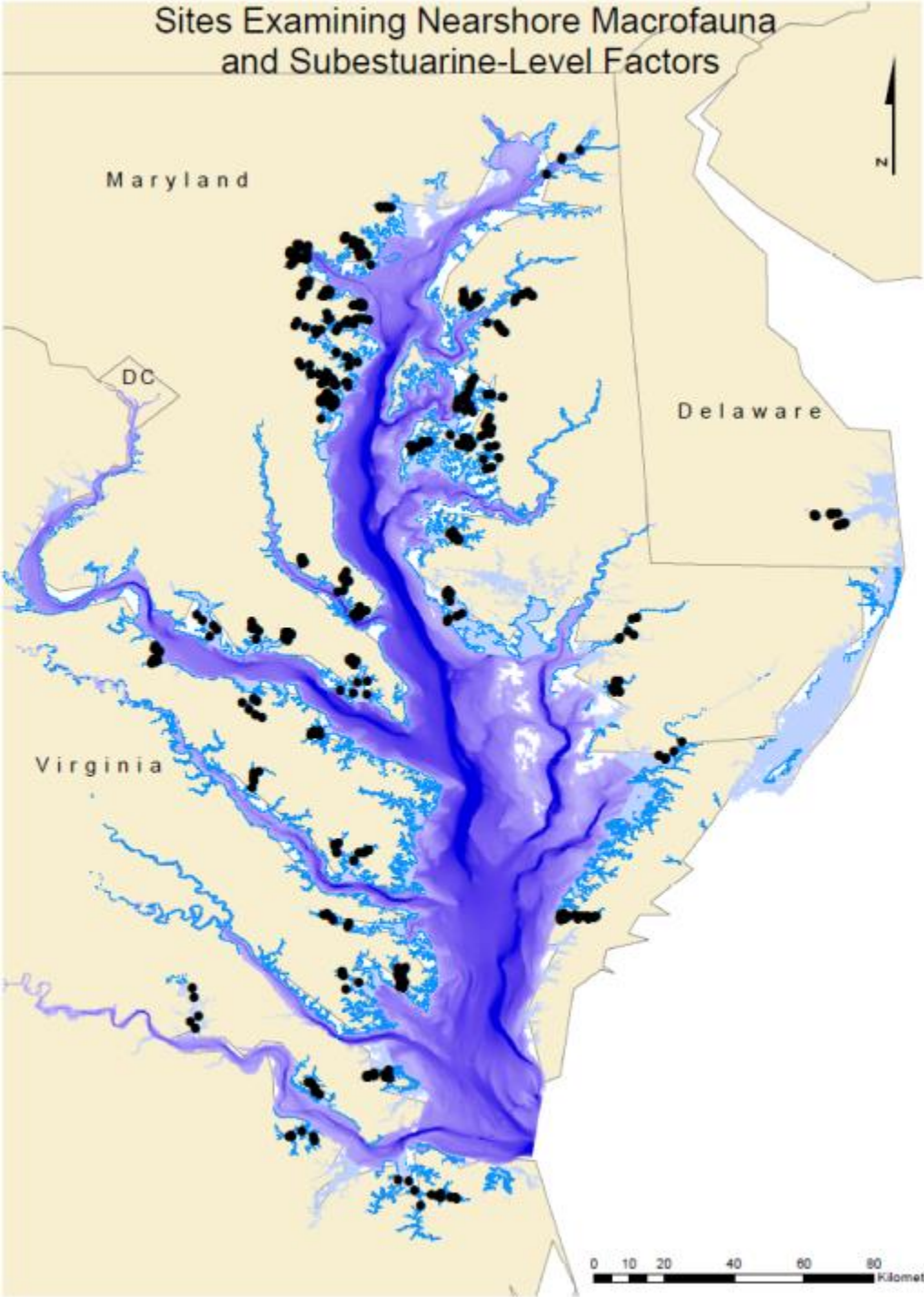
## Fish Data:

- Meta-analysis of fisheries data spanning 39 subestuaries and 587 sites (Kornis *et al*. 2017)
- > 600,000 individuals
- Subset examining direct use of wetland, beach, bulkhead and riprap (64 sites each)

*Data Contributors*
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Steve Giordano & David Bruce (NOAA CBO)
John Jacobs (NOAA Oxford Lab)

# Subestuary-Scale Effects
## Linear Regressions - Significant Predictors for 12 of 16 species

**Positive Relationship**

**Negative Relationship**

| % Cropland- 8 | % Riparian Wetland- 10 | % Hardened Shoreline- 9 |
|---|---|---|
| Blue Crab | Blue Crab | Blue Crab |
| Atlantic Croaker | Atlantic Croaker | Atlantic Croaker |
| Spot | Spot | Spot |
| Silver Perch | Silver Perch | Silver Perch |
| Mummichog | Bay Anchovy | Bay Anchovy |
| Grass Shrimp | Hogchoker | Hogchoker |
| Atlantic Menhaden | Atlantic Menhaden | Atlantic Silverside |
| Centrarchidae | Mummichog | Atlantic Menhaden |
| | Striped Killifish | Centrarchidae |
| | Striped Bass | |

Negative for Benthivores
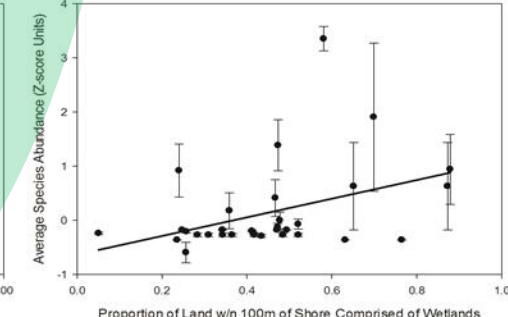Positive for Planktivores

Mostly Negative

Mostly Positive

*Kornis et al. 2017. E&C 40: 1464-1486*

% Cropland | Hard Shoreline | Wetlands
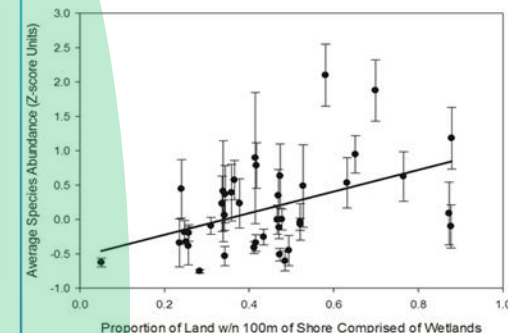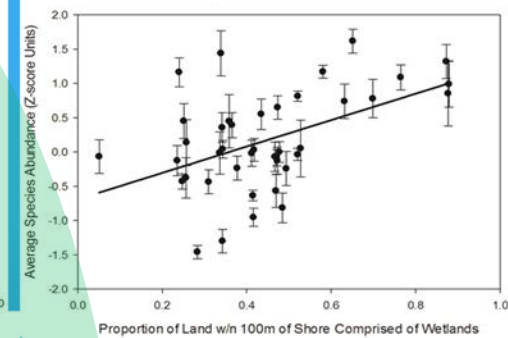
Blue Crab

Spot

Atlantic Croaker

Silver Perch

*Kornis et al. 2017*
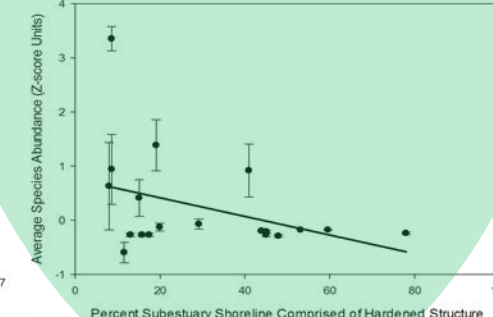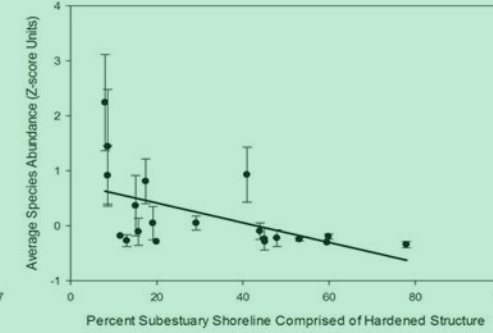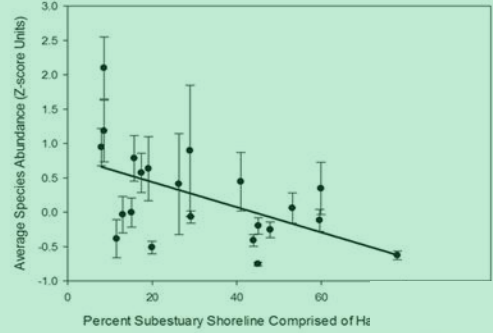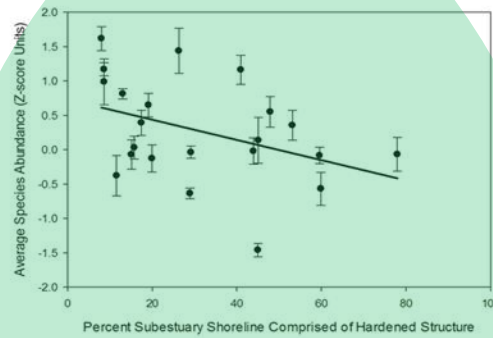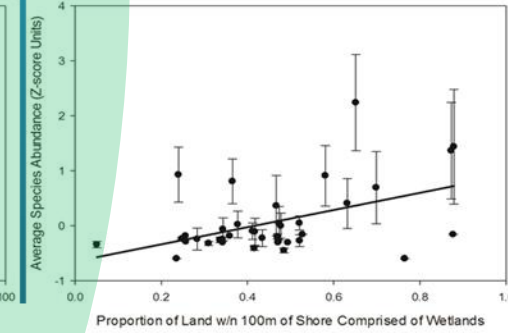
# New analyses

**Figure 1**: Possible relationships between each response variable and % hardened shoreline include: (A) linear; (B) piecewise linear declining to a plateau (similar to exponential decay function); (C) piecewise liner declining from a plateau (similar to a negative logistic function); and (D) sigmoidal. Adapted from Samhouri et al. (2010).
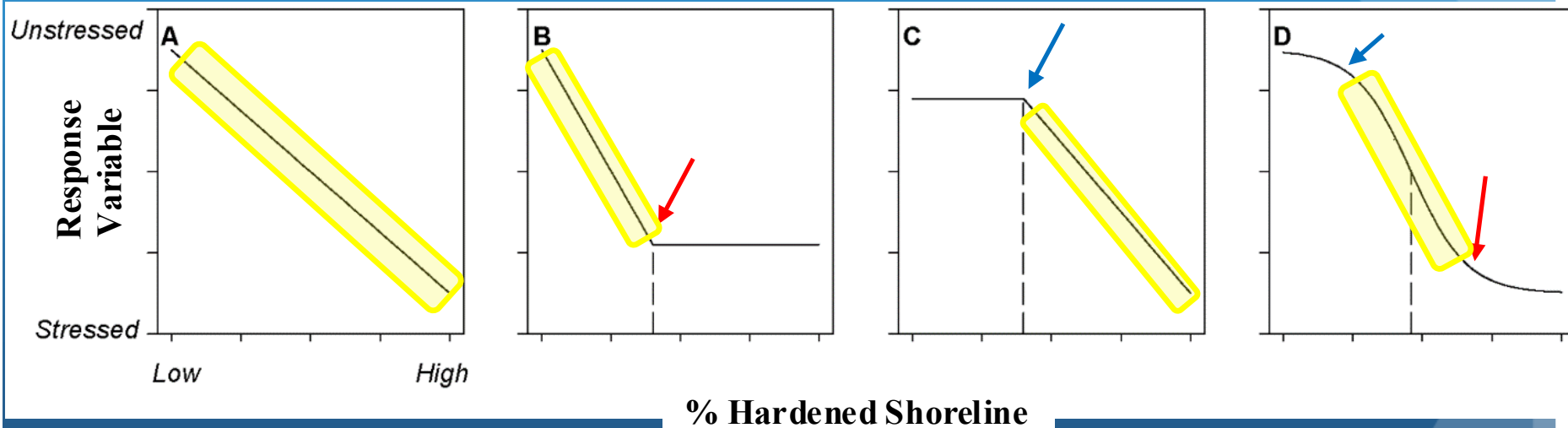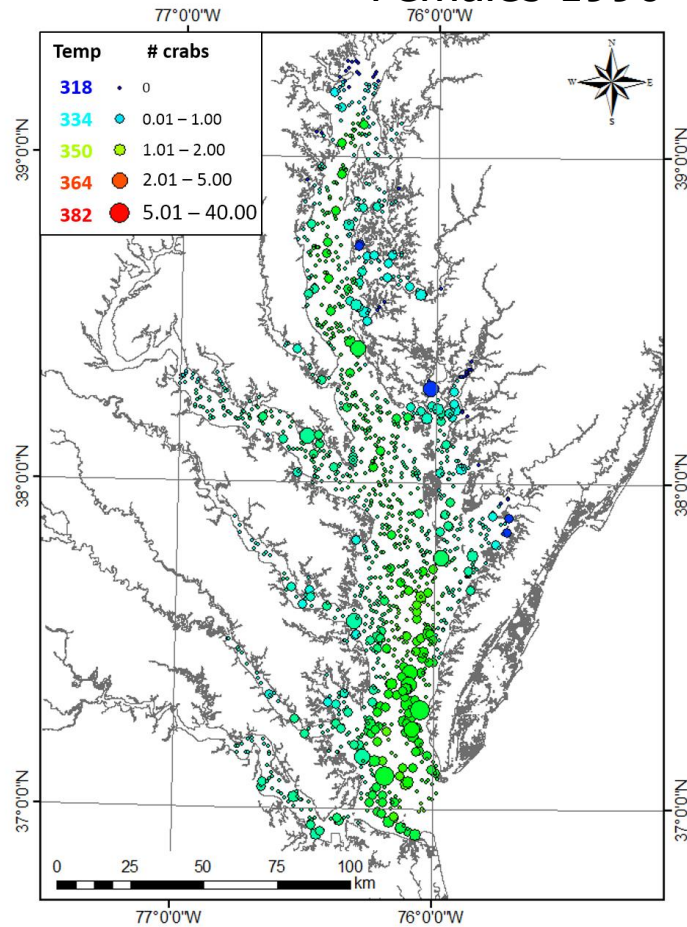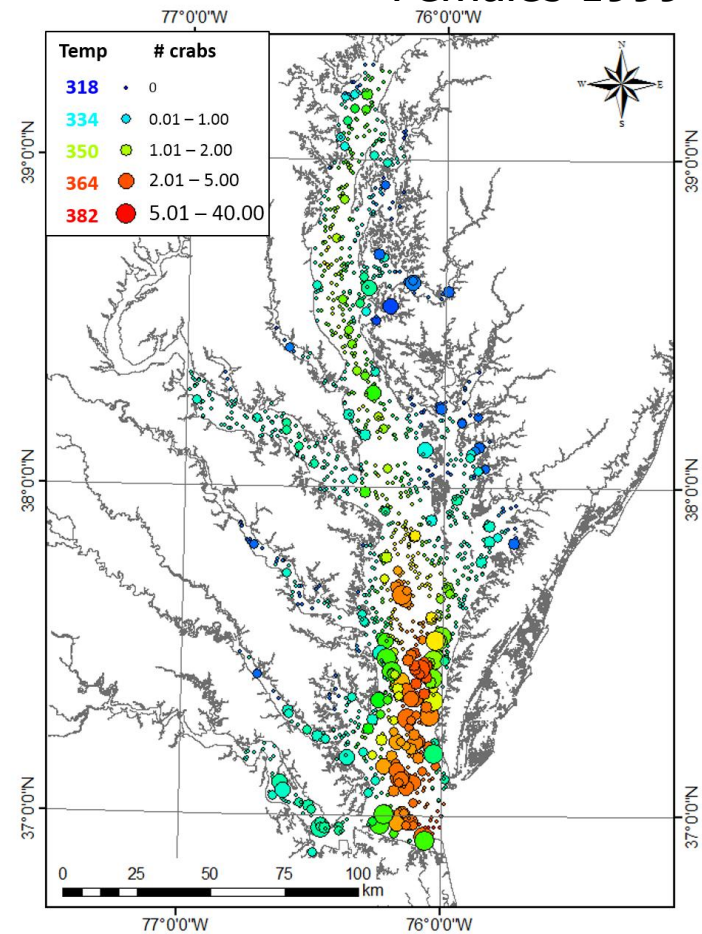


Linear Previously investigated

<------- Non-linear curves to explore ------->

# New Data sets: Crab Winter Dredge Survey (1500 sites annually); examine shallow only
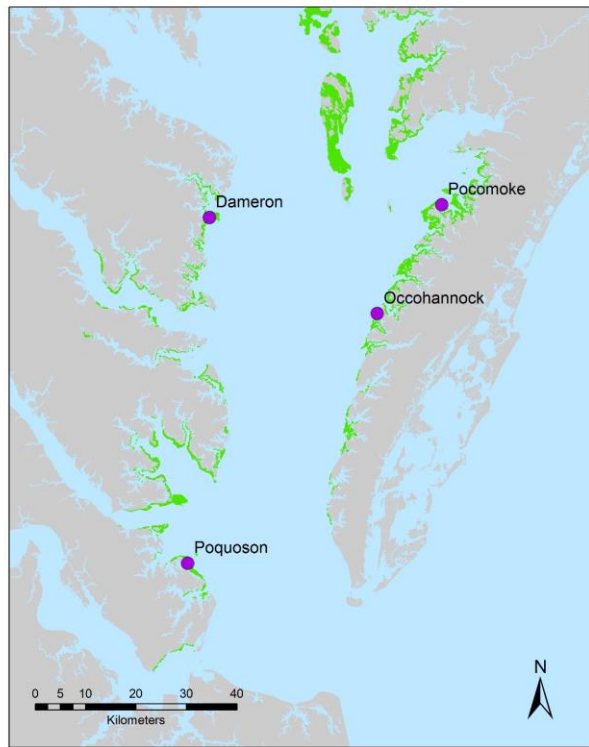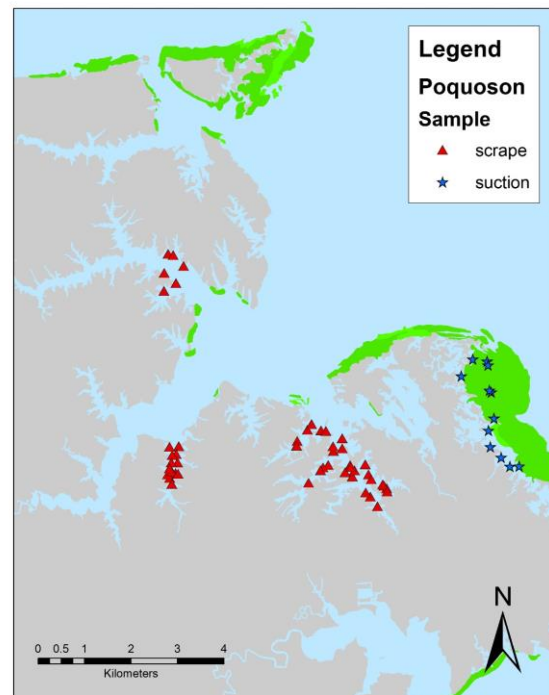


Females 1996

Females 1999

# New data sets: Crab juvenile survey

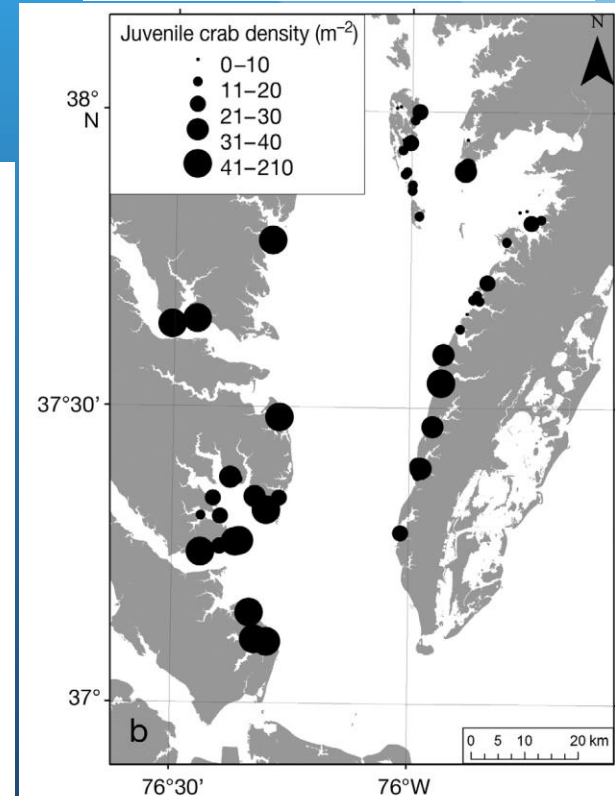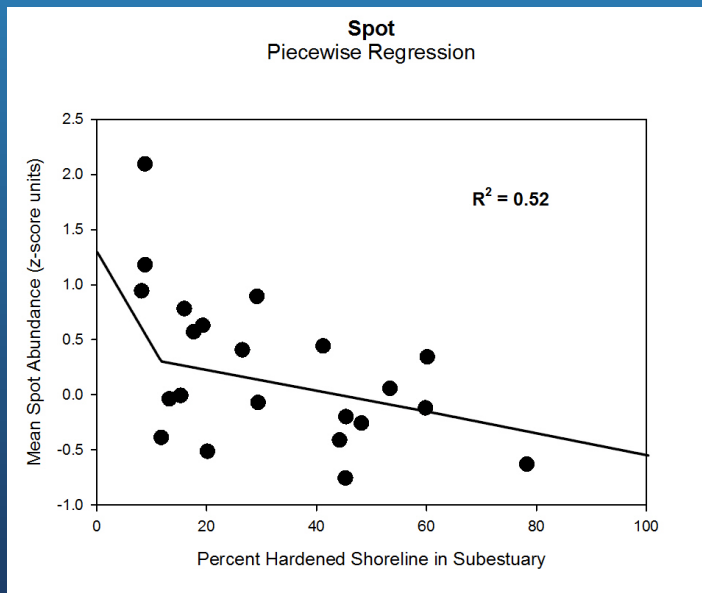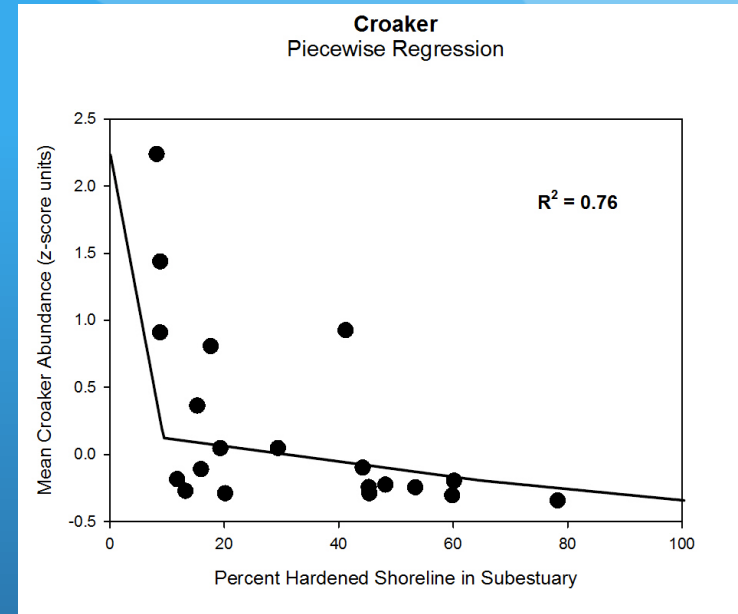- 0+ year class, fall sampling during crab recruitment period (43-61 suction samples annually, 2007 –present)

### Juvenile crab density

### Sampling regions

### Poquoson sites

# New curves: Crab, Spot, Croaker



**Blue Crab**
Piecewise Regression

$R^2 = 0.34$

Mean Blue Crab Abundance (z-score units)
Percent Hardened Shoreline in Subestuary



**Croaker**
Piecewise Regression

$R^2 = 0.76$

Mean Croaker Abundance (z-score units)
Percent Hardened Shoreline in Subestuary



**Spot**
Piecewise Regression

$R^2 = 0.52$

Mean Spot Abundance (z-score units)
Percent Hardened Shoreline in Subestuary
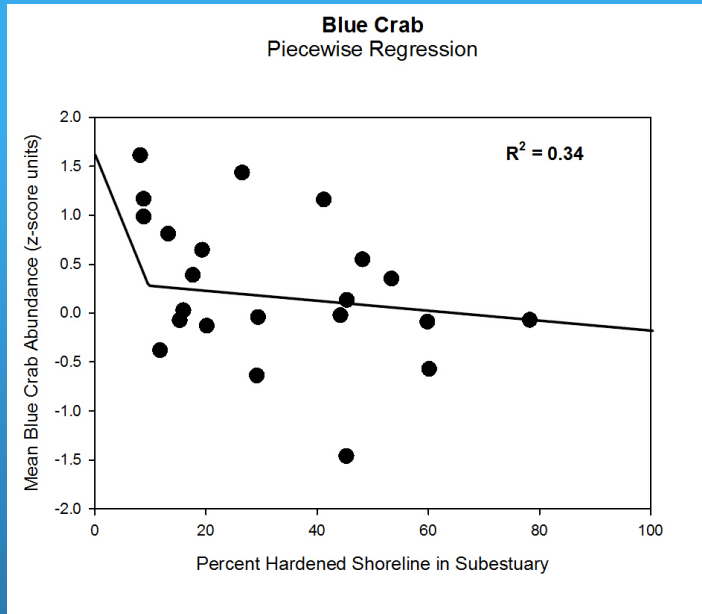
All improved
over linear:
-Crab $R^2$ = 0.16
-Spot $R^2$ = 0.29
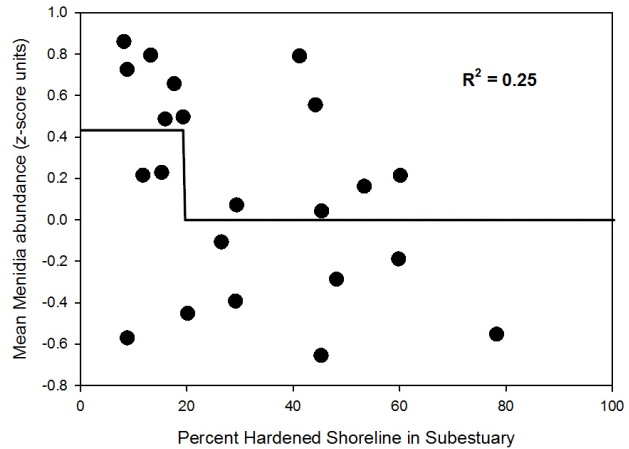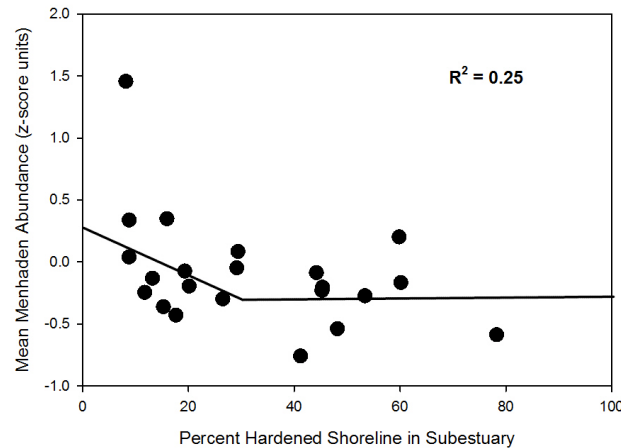-Croaker $R^2$ = 0.29

Threshold levels:
-Crab 10%
-Spot 10%
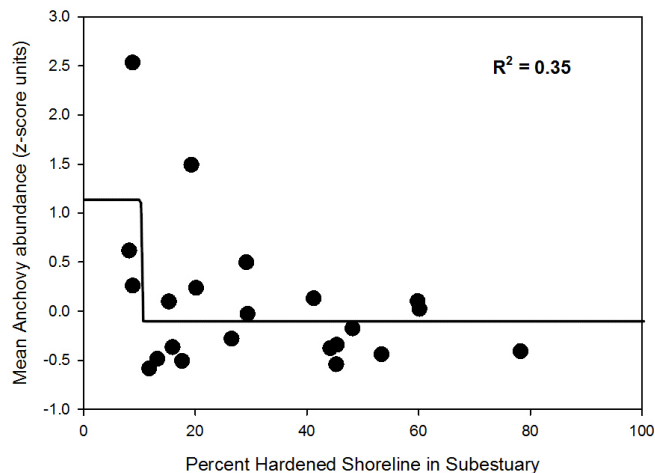-Croaker 10%

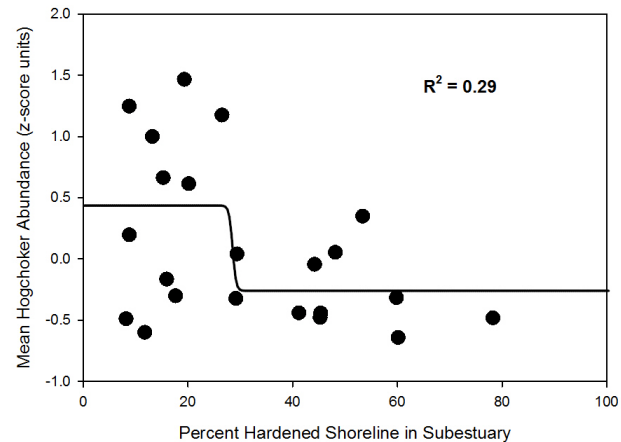# New curves: other fish



**Menidia sp.**
Sigmoidal

**Atlantic Menhaden**
Piecewise Regression

**Bay Anchovy**
Sigmoidal

**Hogchoker**
Sigmoidal

All improved
over linear:
-Menidia $R^2$=0.16
-Anch. $R^2$=0.13
-Menh. $R^2$=0.18
-Hogch. $R^2$=0.19

Threshold levels:
-Menidia 20%
-Anch. 10%
-Menh. 30%
-Hogch. 30%

# Progress and Future Directions

- Adjusting blue crab data

- Continue analyses and explore curve-fitting

- Comparison of Bay-wide and Subestuary-scale approach
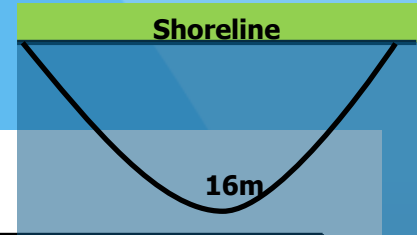
- Coordination with CBT

Ultimately,

- Propose a numerical threshold for shoreline hardening that could inform land-use decisions

# Questions?

Bulkhead and riprap shorelines leave small-bodied fishes between a rock and a hard place

Within 16m From Shore

Shoreline

16m

Average Species Abundance (Z-score Units)

Beach
Native Wetland
Bulkhead
Riprap

Fish Figures by Matt Kornis

RICH   BC   HG   NG   MC   SH   SK   BA   AS   SP   WP   SB   CN