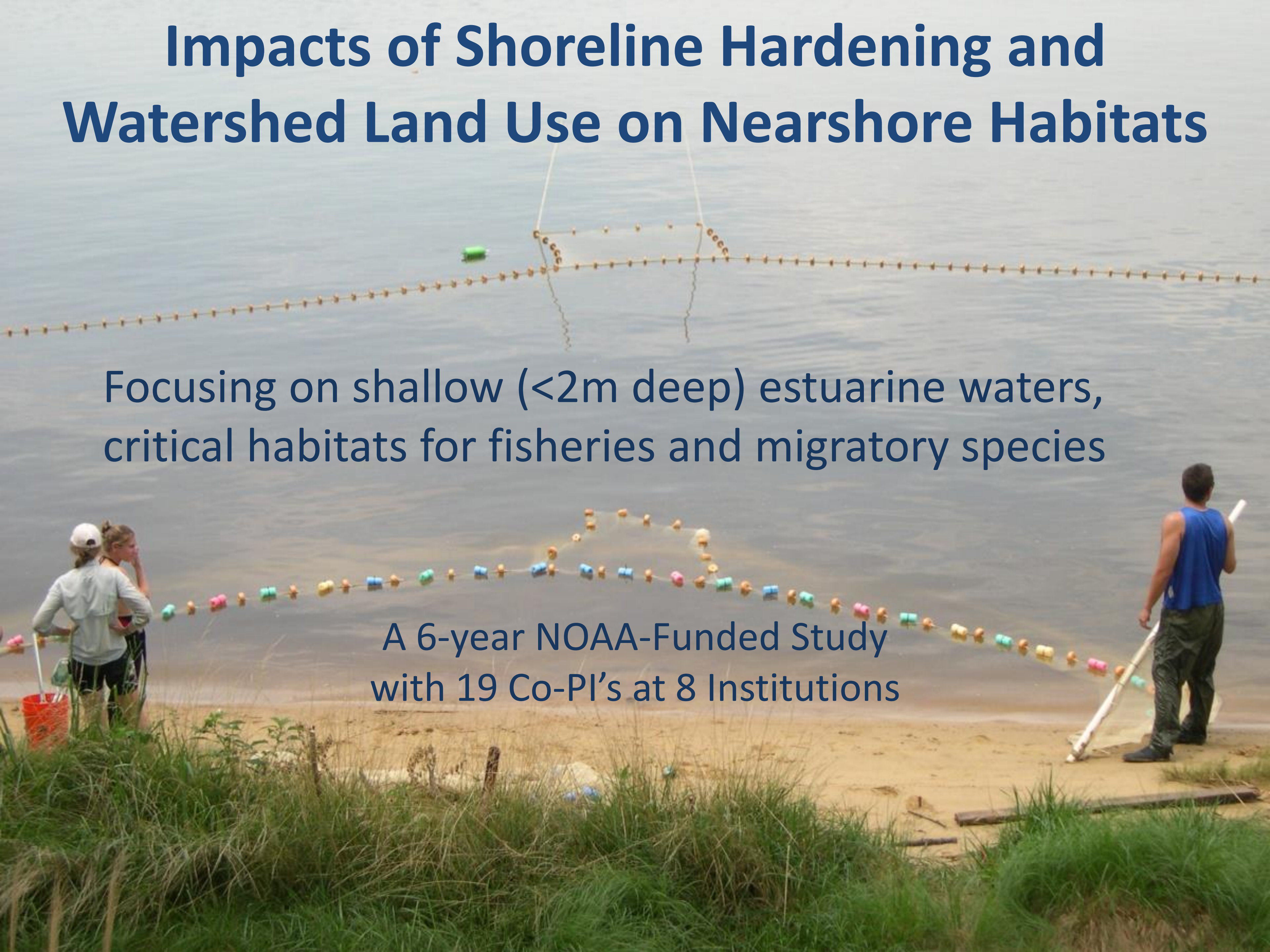
Impacts of Shoreline Hardening and Watershed Land Use on Nearshore Habitats

Focusing on shallow (<2m deep) estuarine waters, critical habitats for fisheries and migratory species

A 6-year NOAA-Funded Study
with 19 Co-PI's at 8 Institutions



Land use effects compounded with stressors at the intertidal zone

- Watershed inputs of nutrients, sediments, and toxic substances
- Shoreline alterations: Bulkhead, riprap revetments, and “living shorelines”
- Spread of invasive reed *Phragmites*

Compare shoreline types…

Natural Marsh

Phragmites Marsh

Rip-Rap

Bulkhead

Beach

…in bays and sub-estuaries with watersheds that have differing land use

Forested

Residential Development

Agricultural

Our study sites include Chesapeake Bay sub-estuaries and Coastal Bays.

142 systems identified
- 128 in Chesapeake Bay
- 14 in Coastal & Inland Bays

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47 systems sampled

Many more modeled

Nutrients and Chlorophyll: Summary

- Total N and chlorophyll increase with % cropland and % developed land.

- Total P increases with % cropland.

Submerged Aquatic Vegetation (SAV)

Don Weller, Chris Patrick, Chuck Gallegos, Meghan Williams (SERC)

Lee Karrh, Brooke Landry, Becky Golden (MD-DNR)

Eva Koch, Larry Sanford (UMCES-HPL)

SAV

- Stressor impacts differ among SAV species and salinity zones.
- Local watershed land use affects subestuary SAV abundance.
- Lower abundance in watersheds dominated by agriculture or developed land.
- Shoreline hardening can reduce SAV abundance.
- Shoreline hardening has more impact on SAV in subestuaries with healthy watersheds.
- Forested shorelines are positively related to adjacent SAV abundance but marsh shoreline has a negative effect, possibly by promoting muddy sediments.

Controlling the Invasion of Tidal Wetlands by *Phragmites australis*

- In many parts of the C. Bay, it is too late for restoration.
- Only individual sites can be managed when restoration goals can be met.
- BUT there has not been a Bay-wide effort to quantify the scale of the problem.

Macrofauna

Birds
(Prosser)

Fish, crabs, shrimp
(Breitburg, Targett, Kornis)

Benthos
(Seitz)

Waterbird Community Integrity

- *Decreases* with percent **<u>bulkhead</u>** in the subestuary.

- *Increases* with percent **<u>native wetlands</u>** in the subestuary.

Fish and Crabs

Blue Crab

Spot

Atlantic Croaker

Silver Perch

- *High* % **agriculture in watershed** associated with decreases in several benthivores and piscivores but increases in 2 planktivores
- *Increasing* % **hardened shoreline** in subestuaries is associated with decreased abundances of many nearshore fish species and blue crab; only juvenile centrarchids seem to be favored.
- Abundance of fishes & blue crab *increases with increasing* nearshore **wetlands** in the subwatershed.

Benthos

- **Natural shoreline** habitats have higher abundance, biomass, and diversity of benthic invertebrates than developed habitats.
- **Developed and mixed-developed watersheds** have reduced benthic density, biomass, & richness.
- **Riprap-sill structure** provides higher habitat quality for shore zone estuarine fishes (and blue crabs) than does riprap revetment.
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UPDATE: Bay Wide Approach: Threshold effects of altered shorelines and other stressors on forage species in Chesapeake Bay

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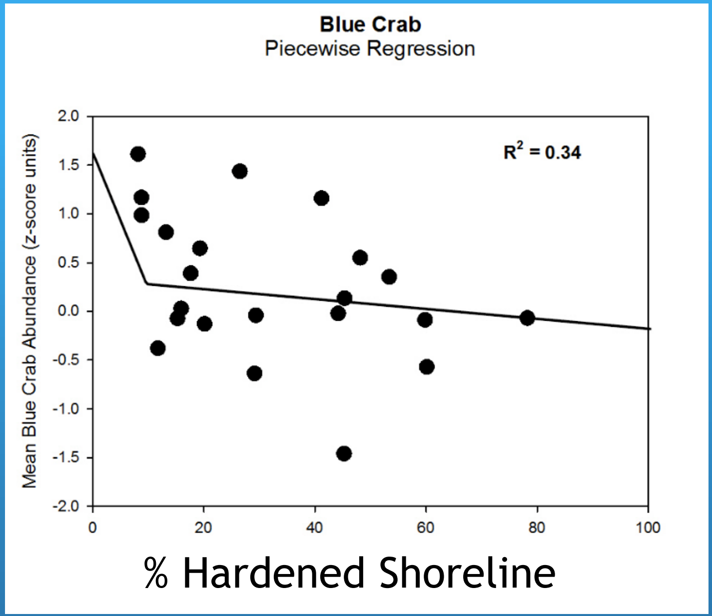
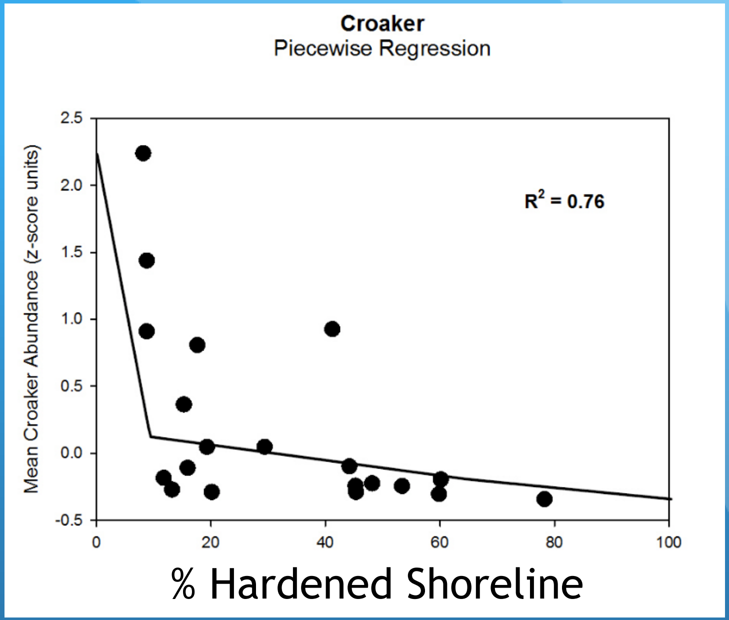
CBTRUST
Chesapeake Bay Trust

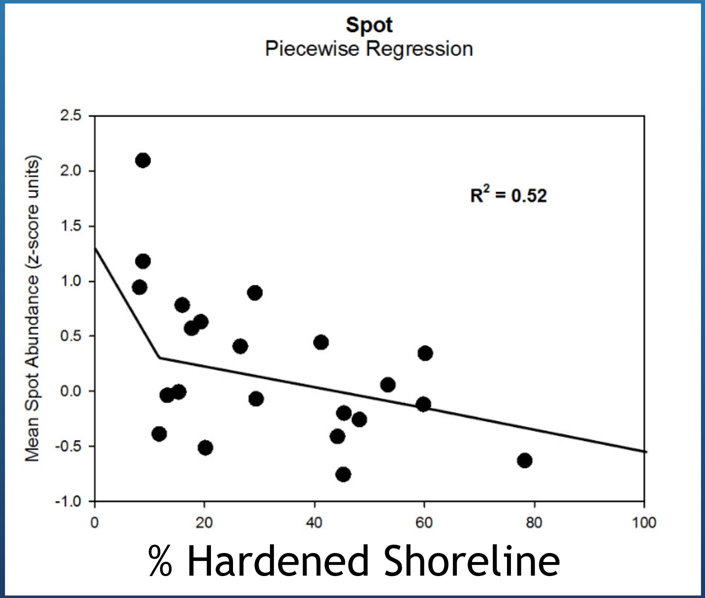
Bay-wide Approach: Methods

- Examine previously compiled Bay-wide data sets (588 sites Kornis et al. 2017) for threshold shoreline condition effects on important forage species (identified in Ihde et al. 2015 report)
- Graphical approach fitting non-linear curves (piecewise, sigmoidal)
- Examine new data sets (e.g., juvenile blue crab survey and Bay-wide blue crab dredge survey) for threshold shoreline condition effects for blue crabs

Abundance Thresholds - Crab, Spot, Croaker







All improved over linear:

-Crab $R^2 = 0.16$

-Spot $R^2 = 0.29$

-Croaker $R^2 = 0.29$

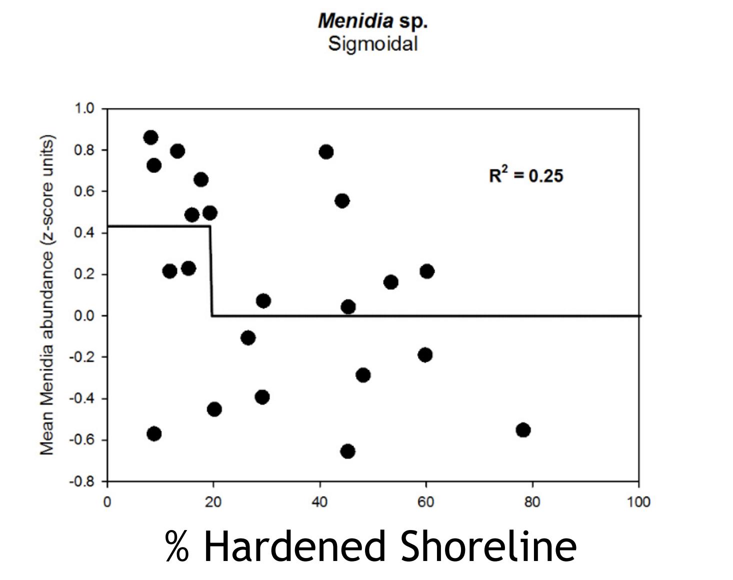
Threshold levels:

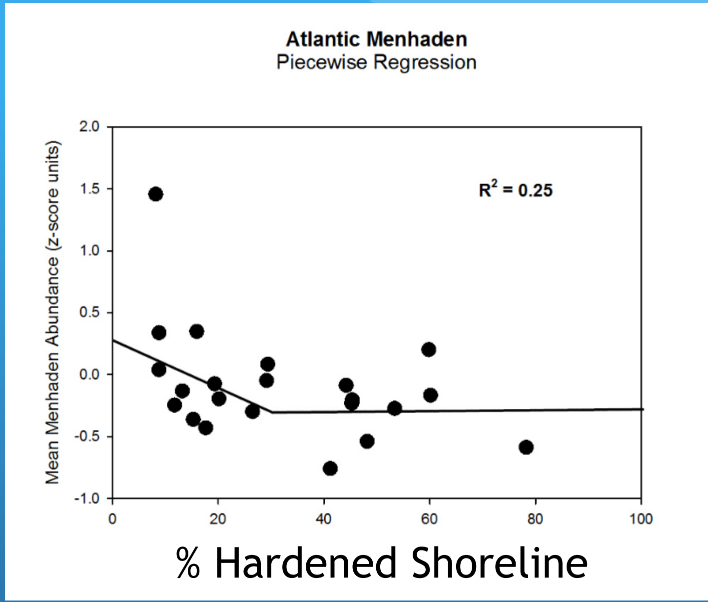
-Crab 10%

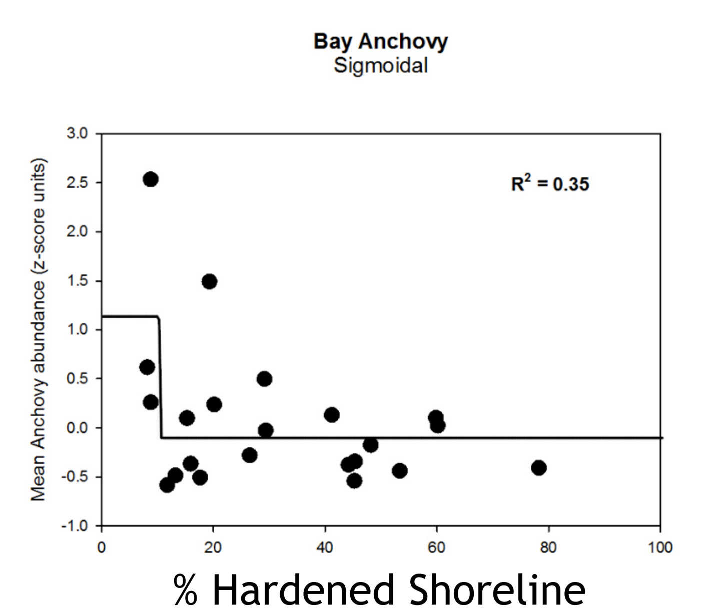
-Spot 10%

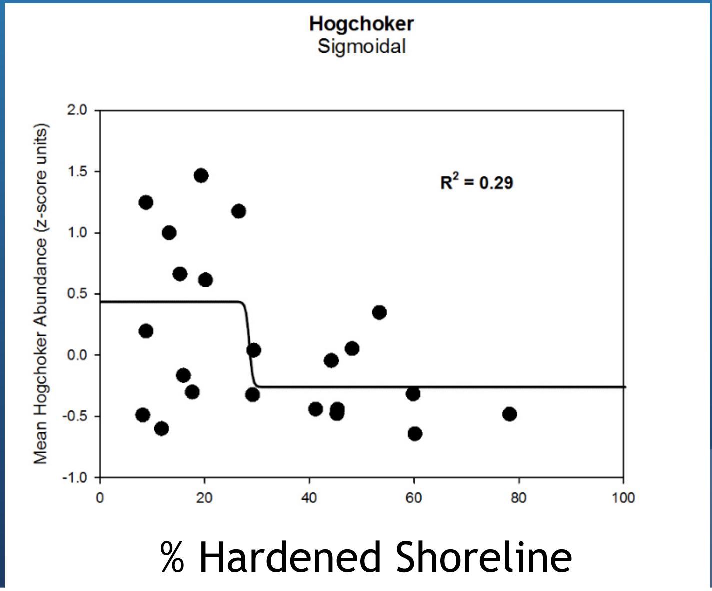
-Croaker 10%

Abundance Thresholds - other fish









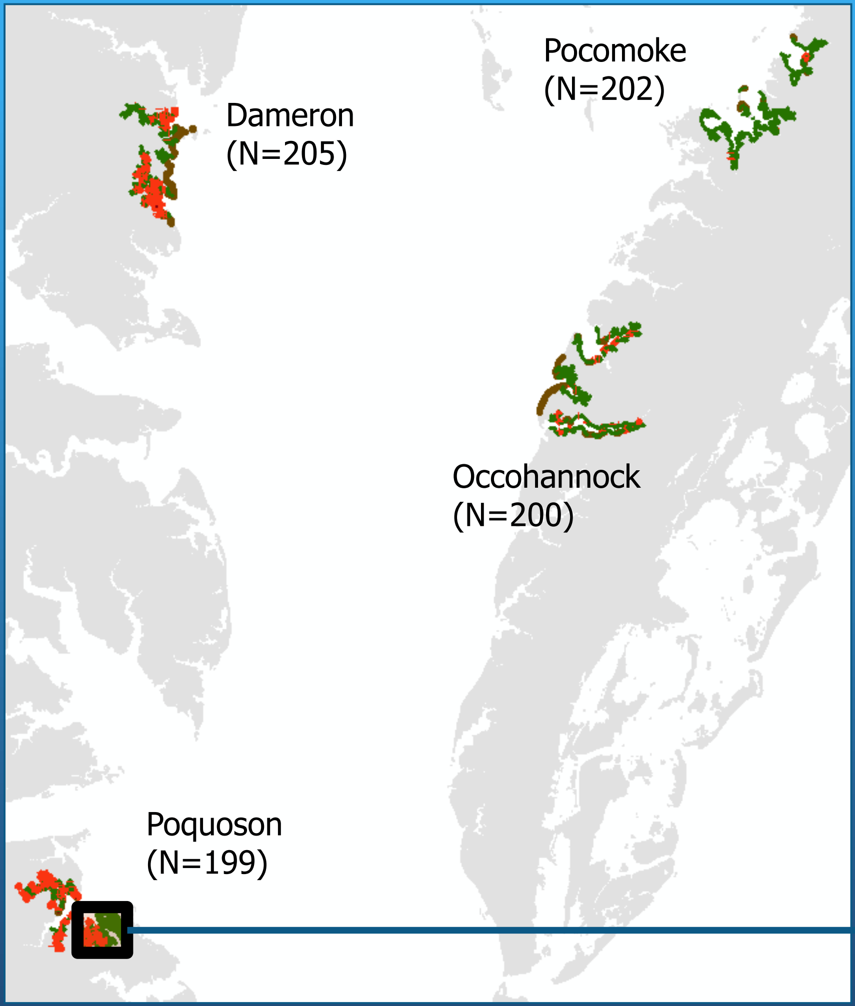
All improved over linear:

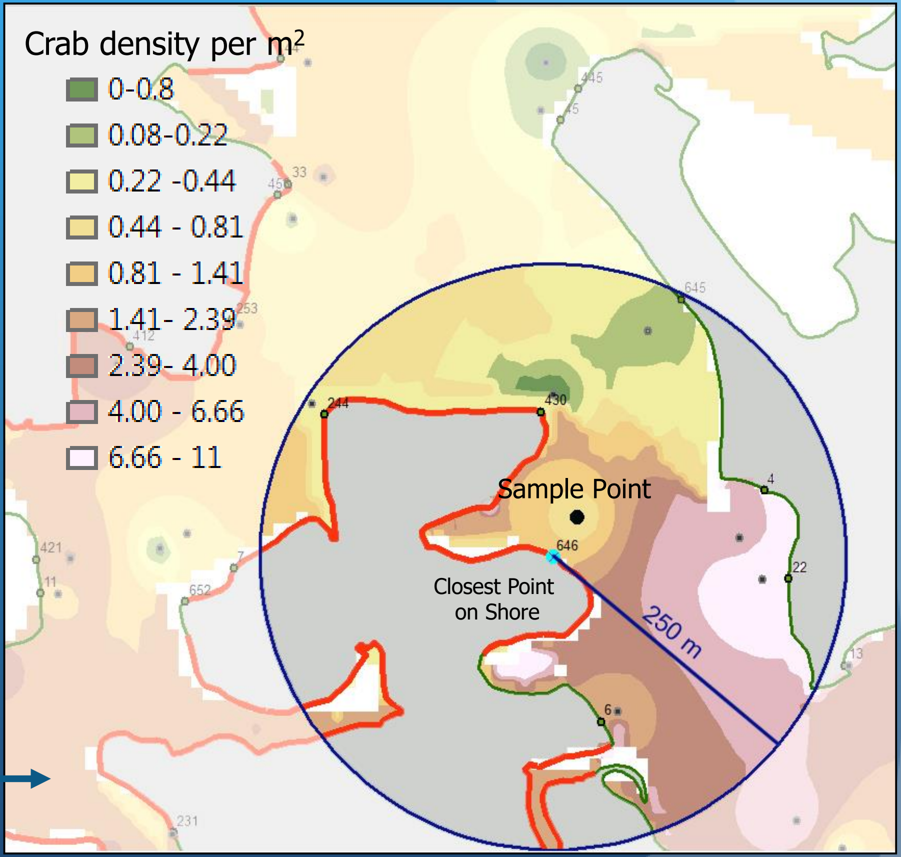
- -Menidia R^2=0.16
- -Anch. R^2=0.13
- -Menh. R^2=0.18
- -Hogch. R^2=0.19

Threshold levels:

- -Menidia 20%
- -Anch. 10%
- -Menh. 30%
- -Hogch. 30%

Methods: Juvenile Crab survey – link to nearest shoreline





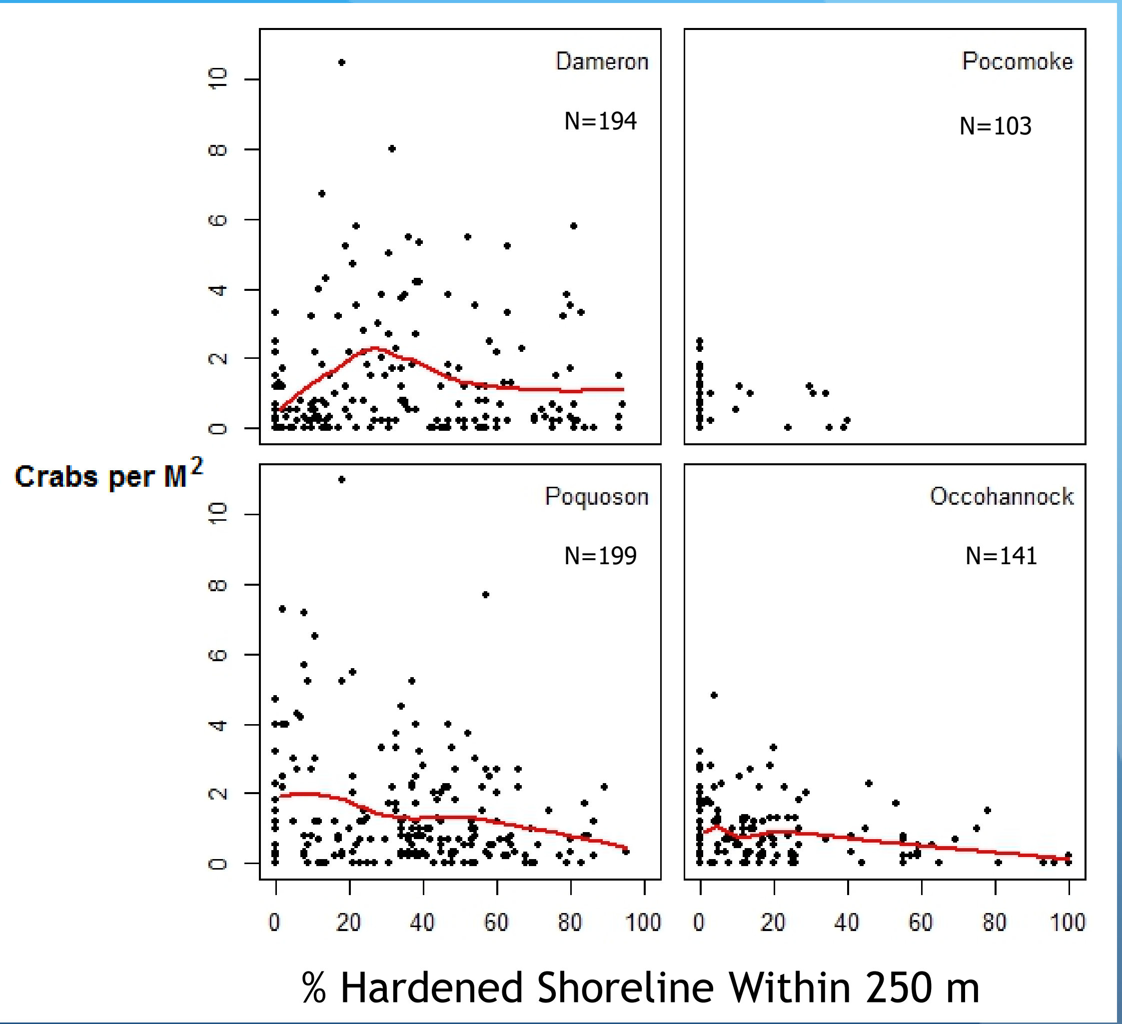
Shoreline Key:
Red = developed
Green + Brown = natural

Juvenile blue crab survey: thresholds?

- Including only points within 250 m from land and using 250 m shoreline buffer

- Results: Loess smoothed line shows generally declining linear relationship between crab density and % hardened shoreline (no threshold)

- Note - Red is Loess line



Progress and Future Directions

- Further investigations using adult blue crab data (dredge survey)
- 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 for some species but not others
- This could inform land-use decisions

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