

Effects of watershed and shoreline characteristics on habitats at the land/water interface

Ongoing NOAA-CSCOR Funded Research

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Smithsonian Environmental
Research Center

17 Principal Investigators, 8 Institutions, led by the Smithsonian Environmental Research Center (SERC)

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- Charles Gallegos
- Eric Johnson
- Xuyong Li
- Melissa McCormick
- Patrick Neale
- Gerhardt Riedel
- Donald Weller
- Dennis Whigham

From other institutions:

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- Michael Erwin, USGS
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- Lee Karrh, MD DNR
- Evamaria Koch, UMCES
- Rochelle Seitz, VIMS
- Timothy Targett, UDE
- Denice Wardrop, PSU

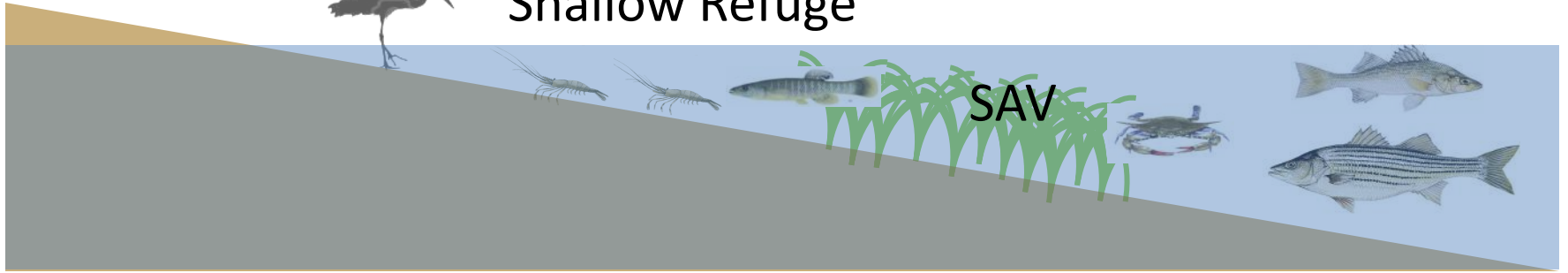
Notable SERC Postdocs:

- Matt Kornis
- Chris Patrick

Beach



Shallow Refuge



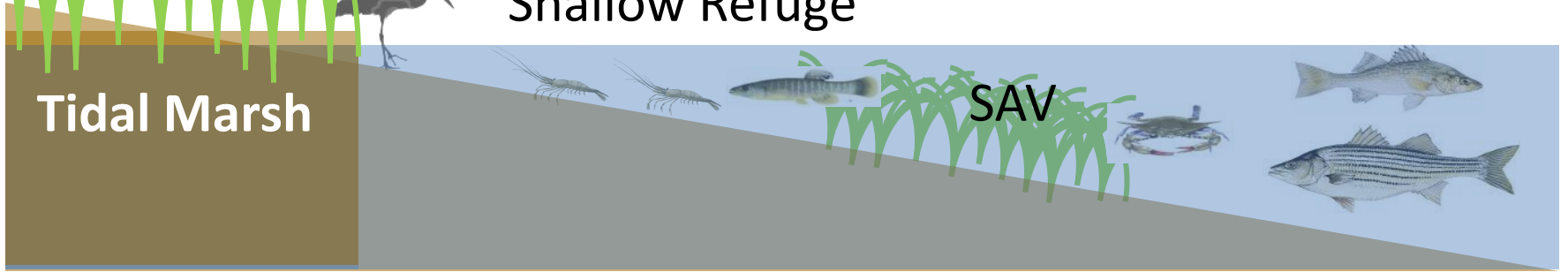
SAV



Tidal Marsh



Shallow Refuge

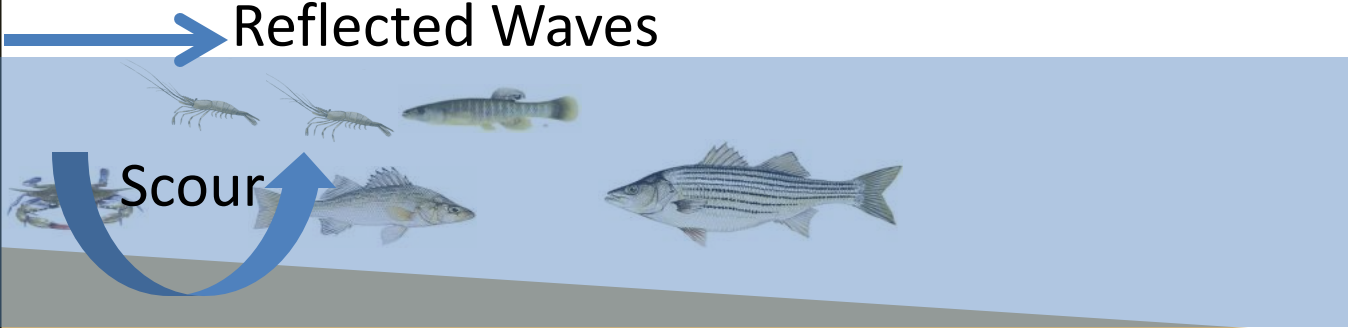


SAV

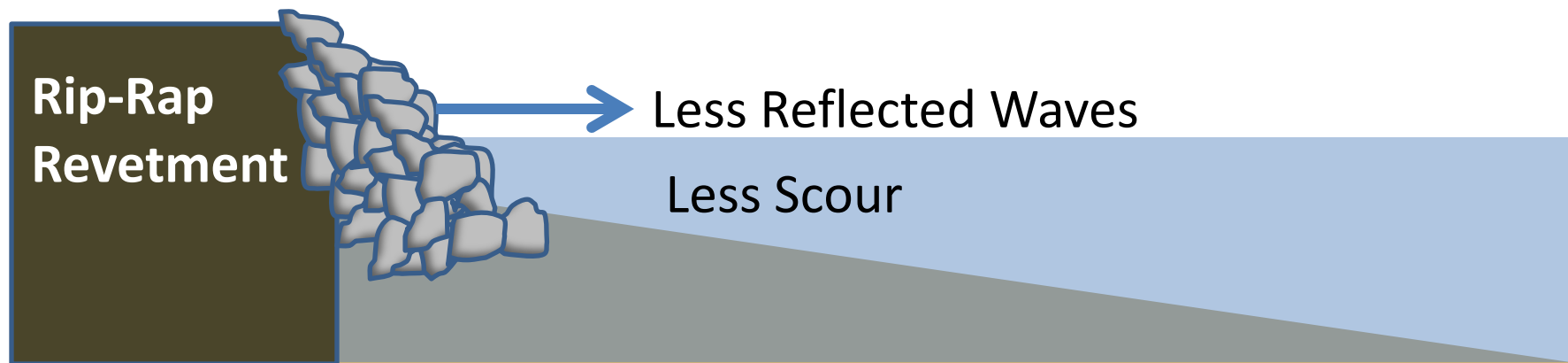
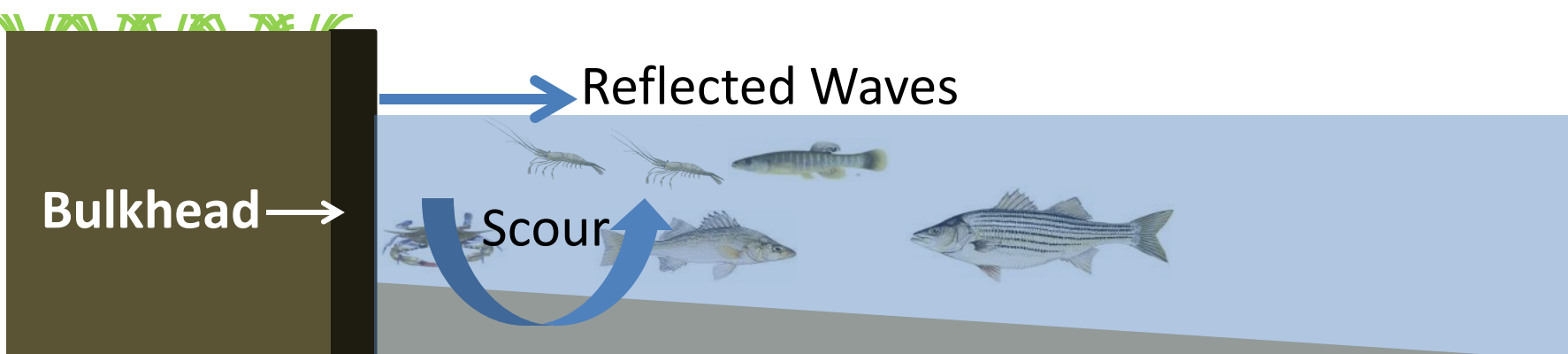


Bulkhead →

Reflected Waves



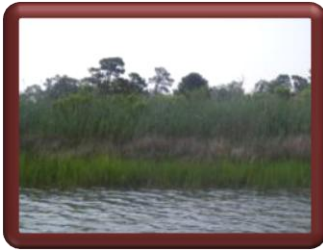
Scour



Compare shoreline types...



Natural Marsh



Phragmites
Marsh



Rip-Rap



Bulkhead



Beach



Forested



Residential Development



Agricultural

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

Compare shoreline types in bays and subestuaries with watersheds having differing land use.

142 systems identified

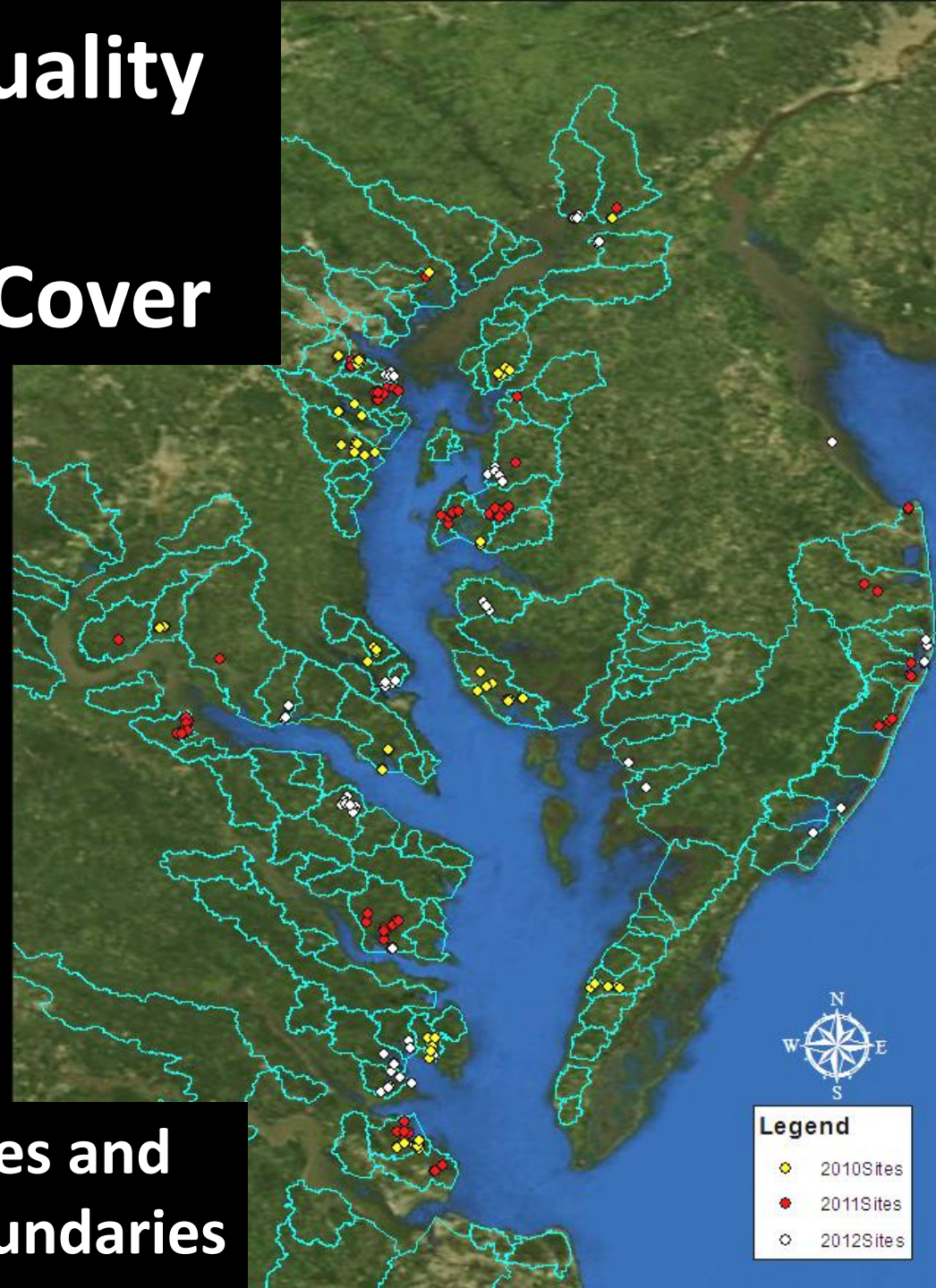
- 128 in Chesapeake Bay
- 14 in Coastal & Inland Bays



Relating Water Quality to Watershed Land Cover

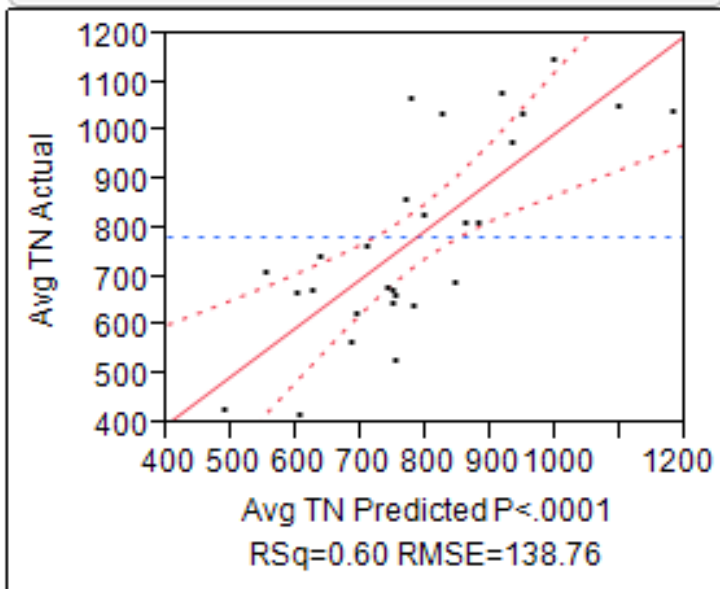
47 Subestuaries and Bays
Sampled 2010-2012

Sampling Sites and
Watershed Boundaries

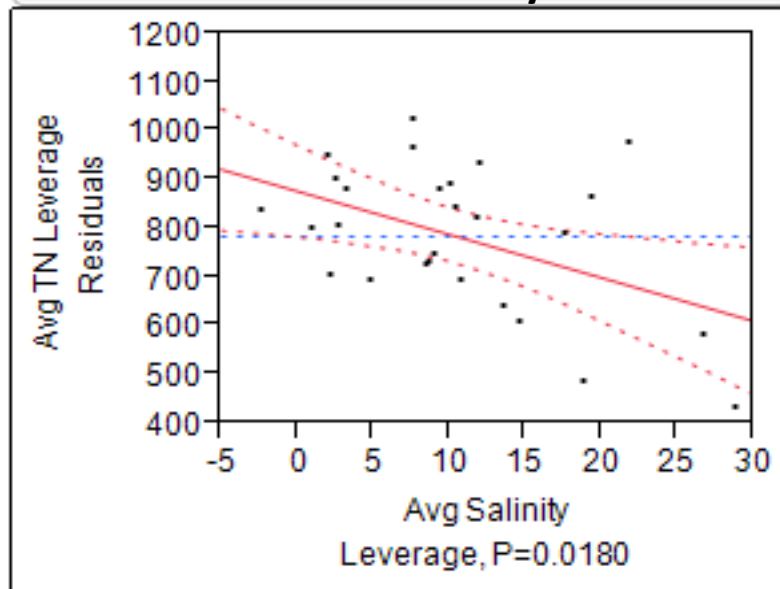


Multiple Regression: Total N vs. % Cropland, % Developed Land, and Salinity

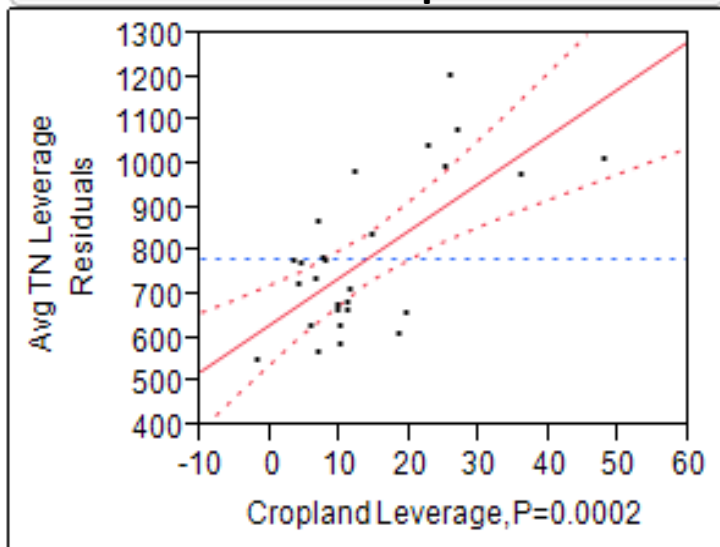
Actual by Predicted Plot 2010-11



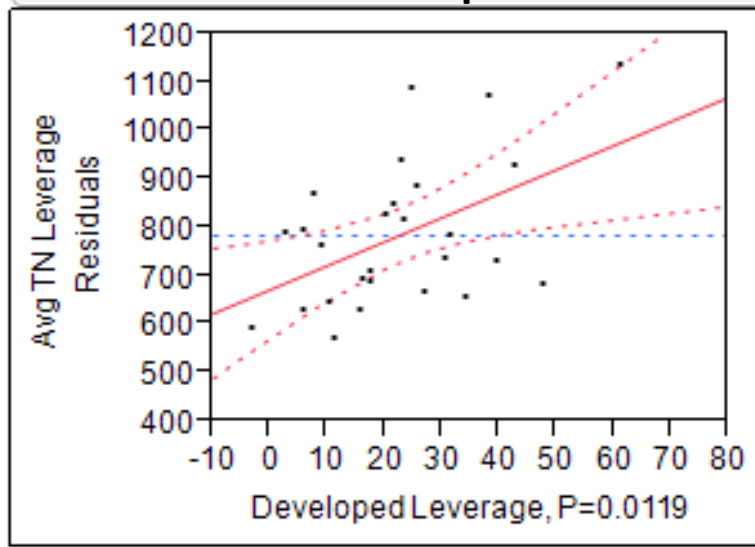
Leverage Plot Salinity



Leverage Plot Cropland



Leverage Plot Developed Land



Conclusions

- Cropland in watershed increases N and P in estuary except during drought conditions.
- Developed land increases N concentrations.

Submerged Aquatic Vegetation (SAV)

Field transect studies



Transects
perpendicular
to shoreline at
riprapped
site and
adjacent natural
site

Sampling methods



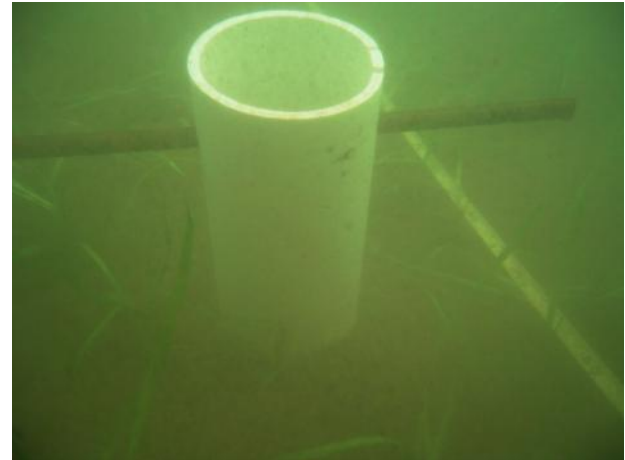
0.25m² quadrat



SCUBA survey

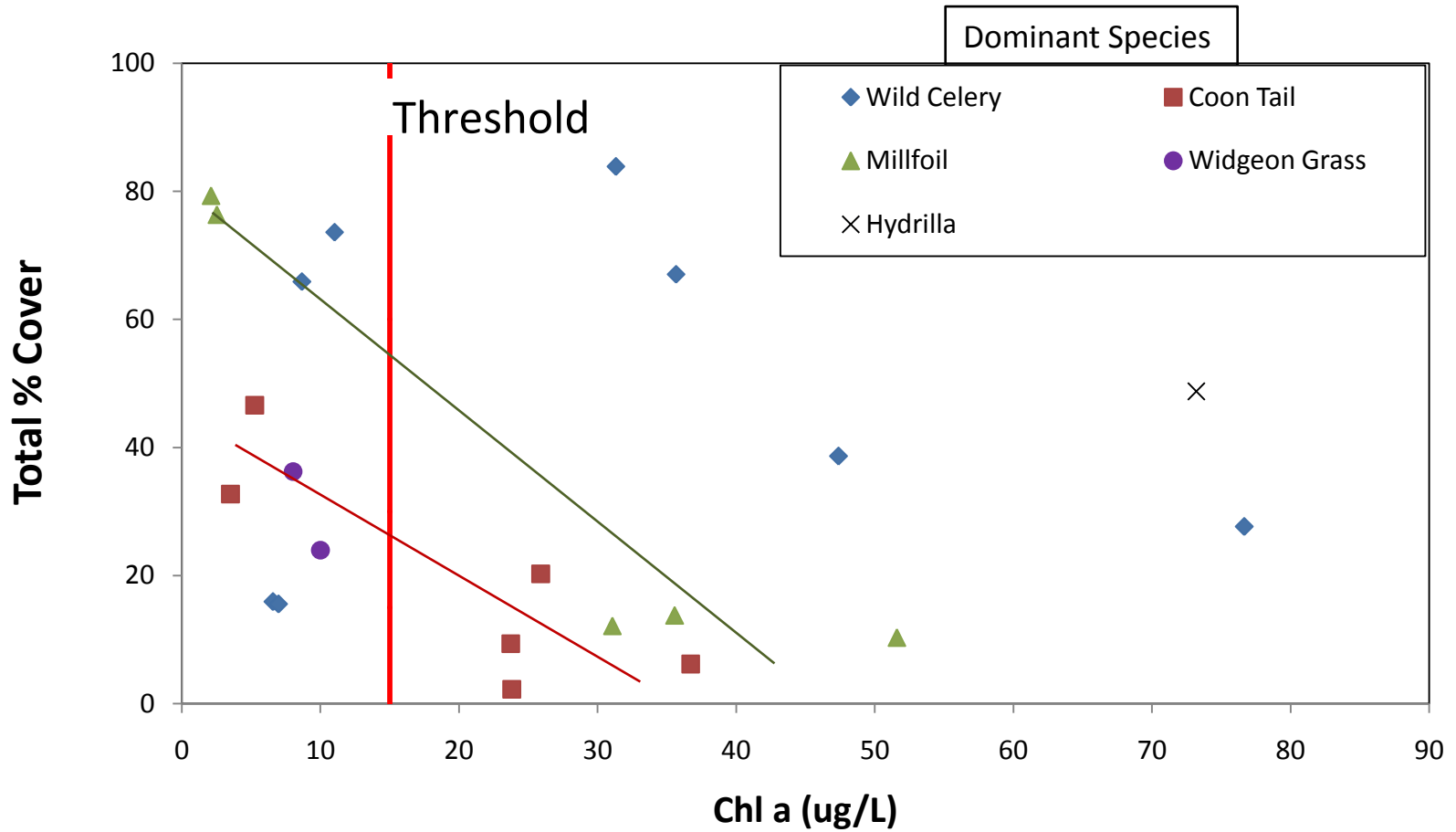


Sediment cores



Biomass core

Oligohaline SAV Percent Cover



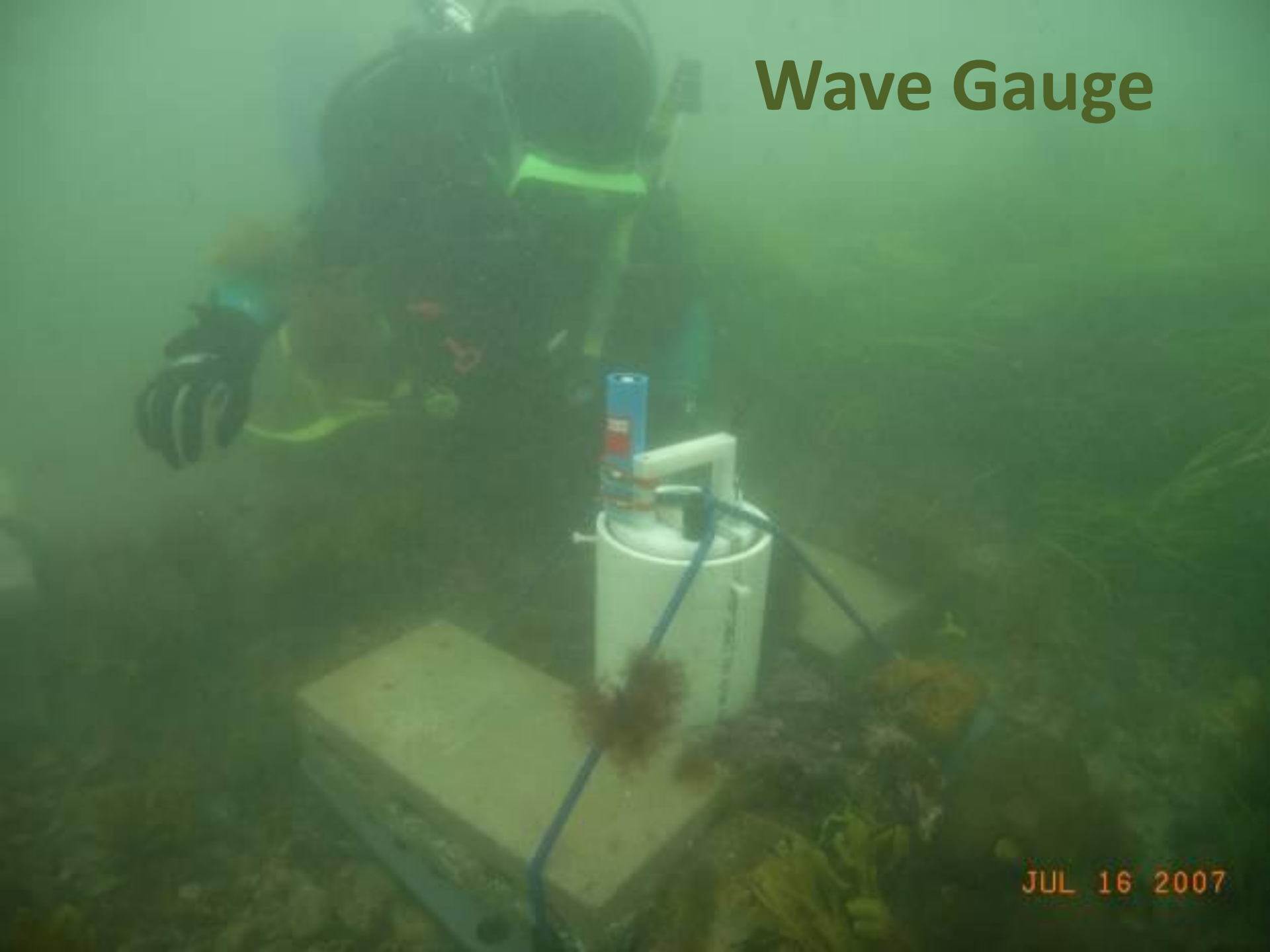
SAV and water quality

- Conditions in many oligohaline SAV beds are often poorer than published habitat limits.
- Coon Tail and Millfoil seem more sensitive to water quality than other oligohaline species.
- Horned pondweed and eel grass seem more sensitive than other polyhaline species.

SAV and shoreline type

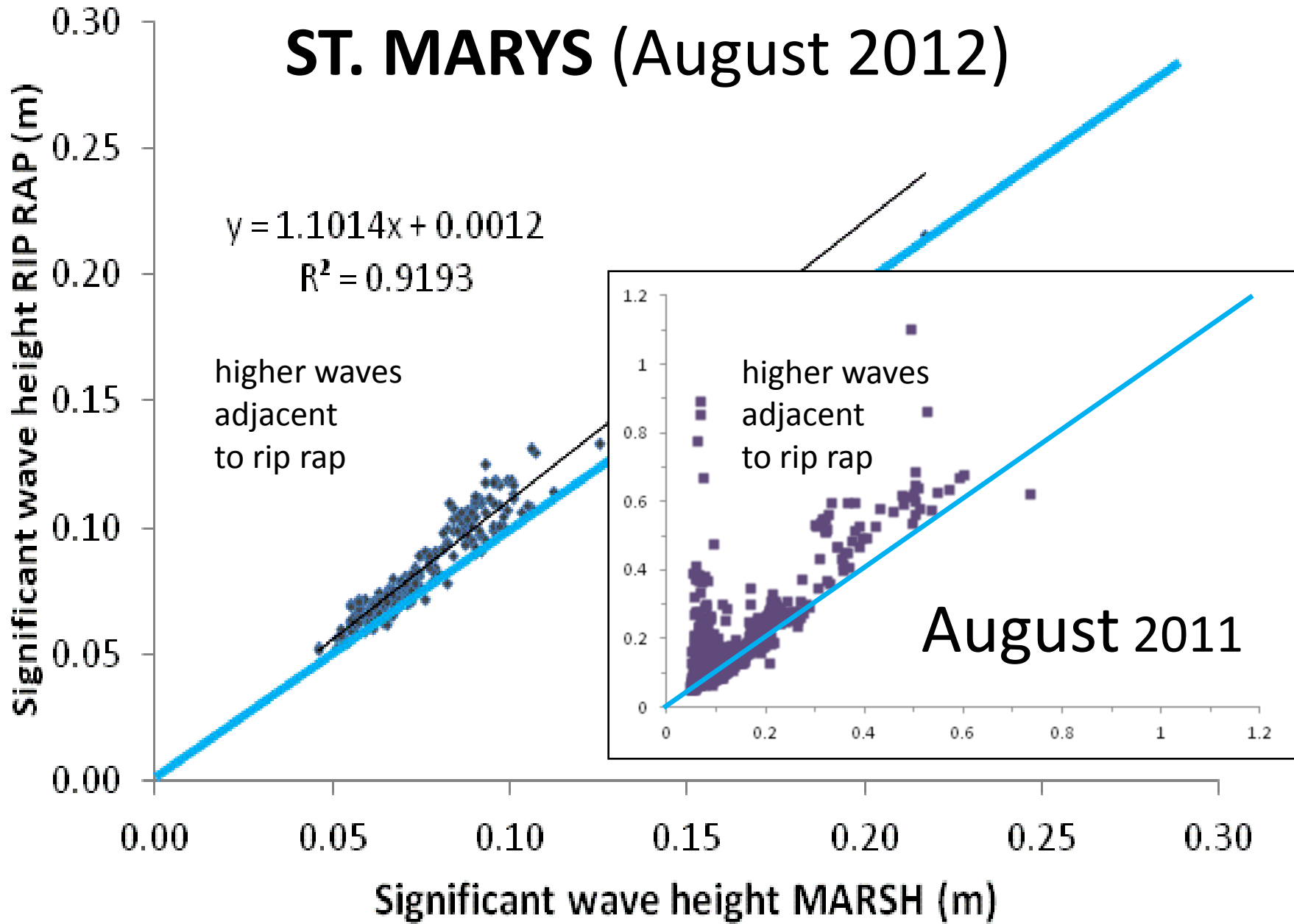
- SAV adjacent to natural shorelines have:
 - higher densities, species richness and diversity
 - longer bed length and beds begin closer to shore
- Sub-estuaries may respond differently to shoreline stressors depending on their salinity/SAV community type.

Wave Gauge



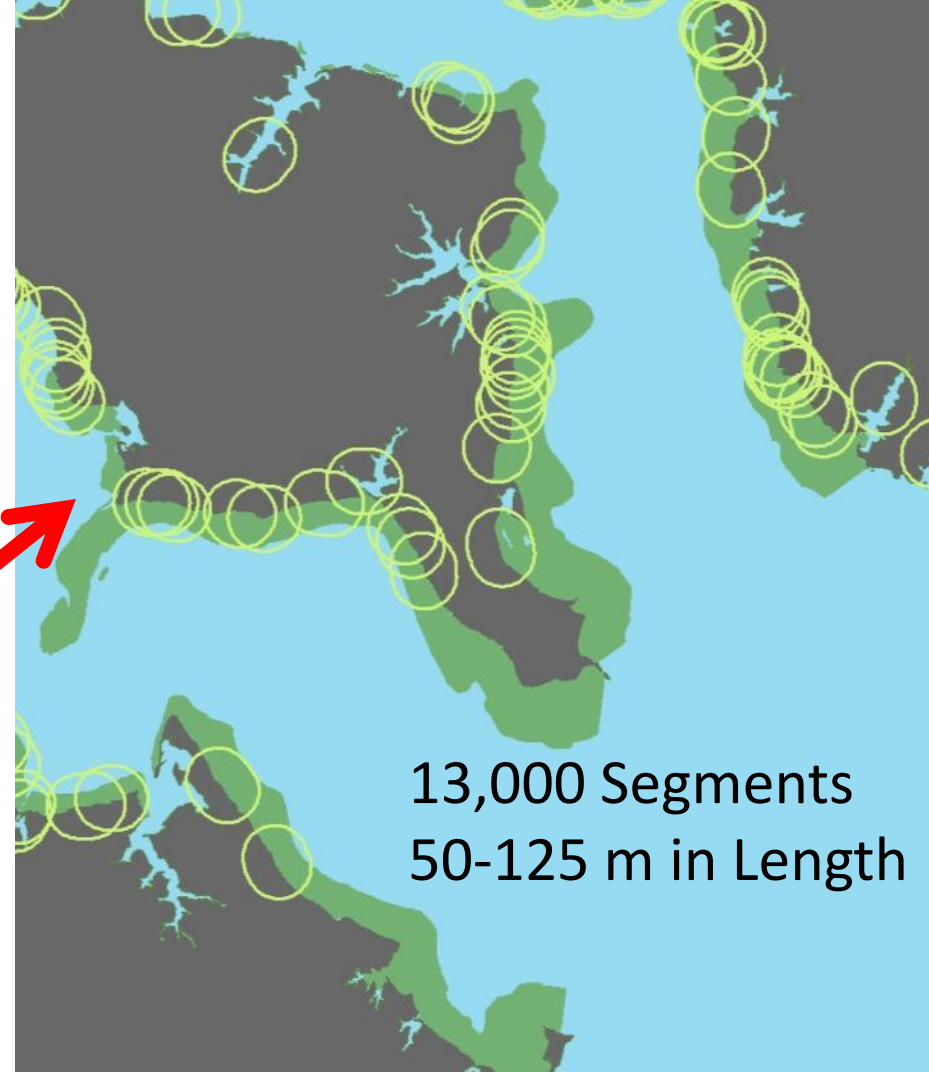
JUL 16 2007

ST. MARYS (August 2012)

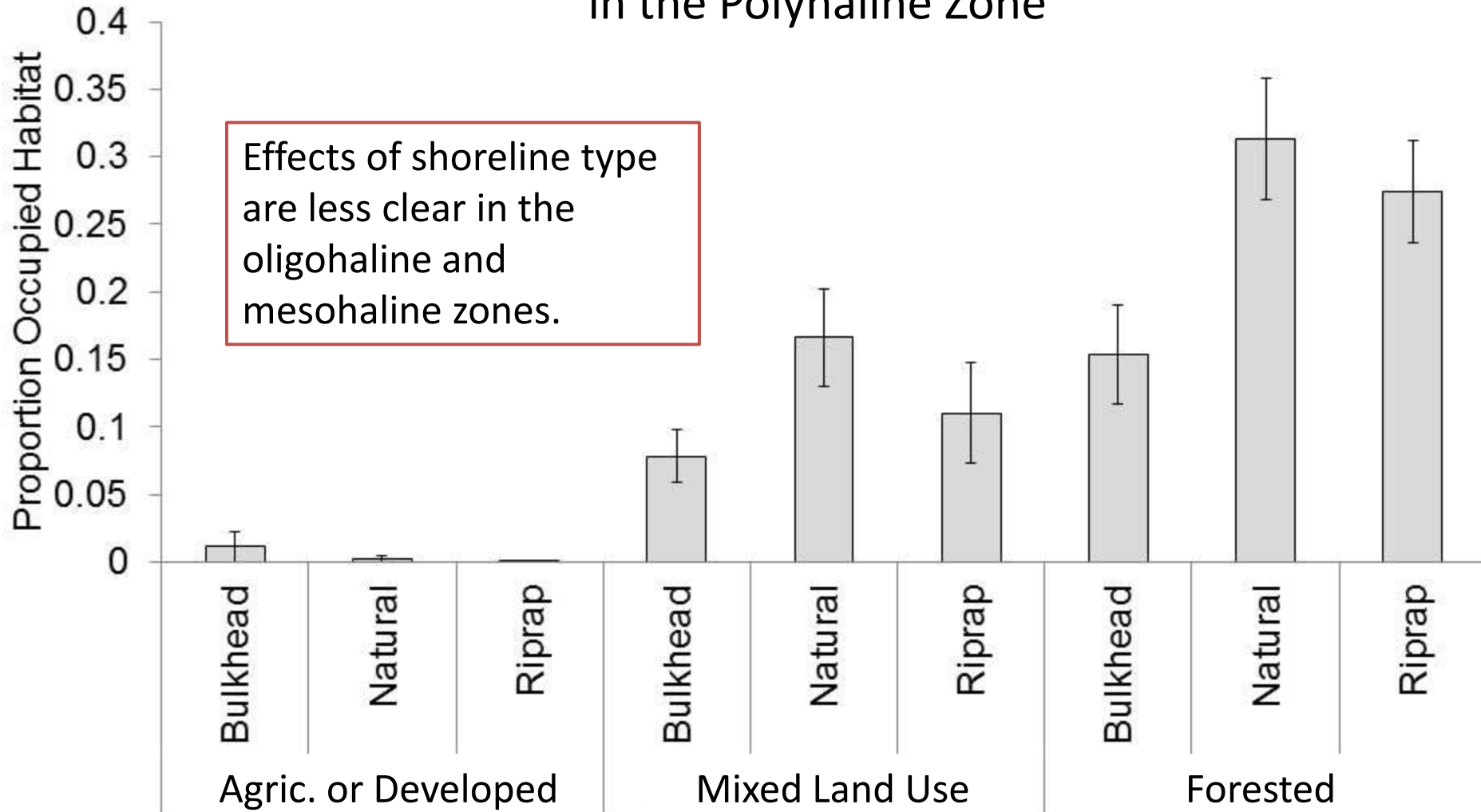


Spatial Analysis of Shoreline Segments

Using VIMS shoreline survey and Ches. Bay Program aerial SAV survey



Interaction of Watershed Land Cover and Shoreline Type in the Polyhaline Zone



SAV: Spatial Analysis Summary

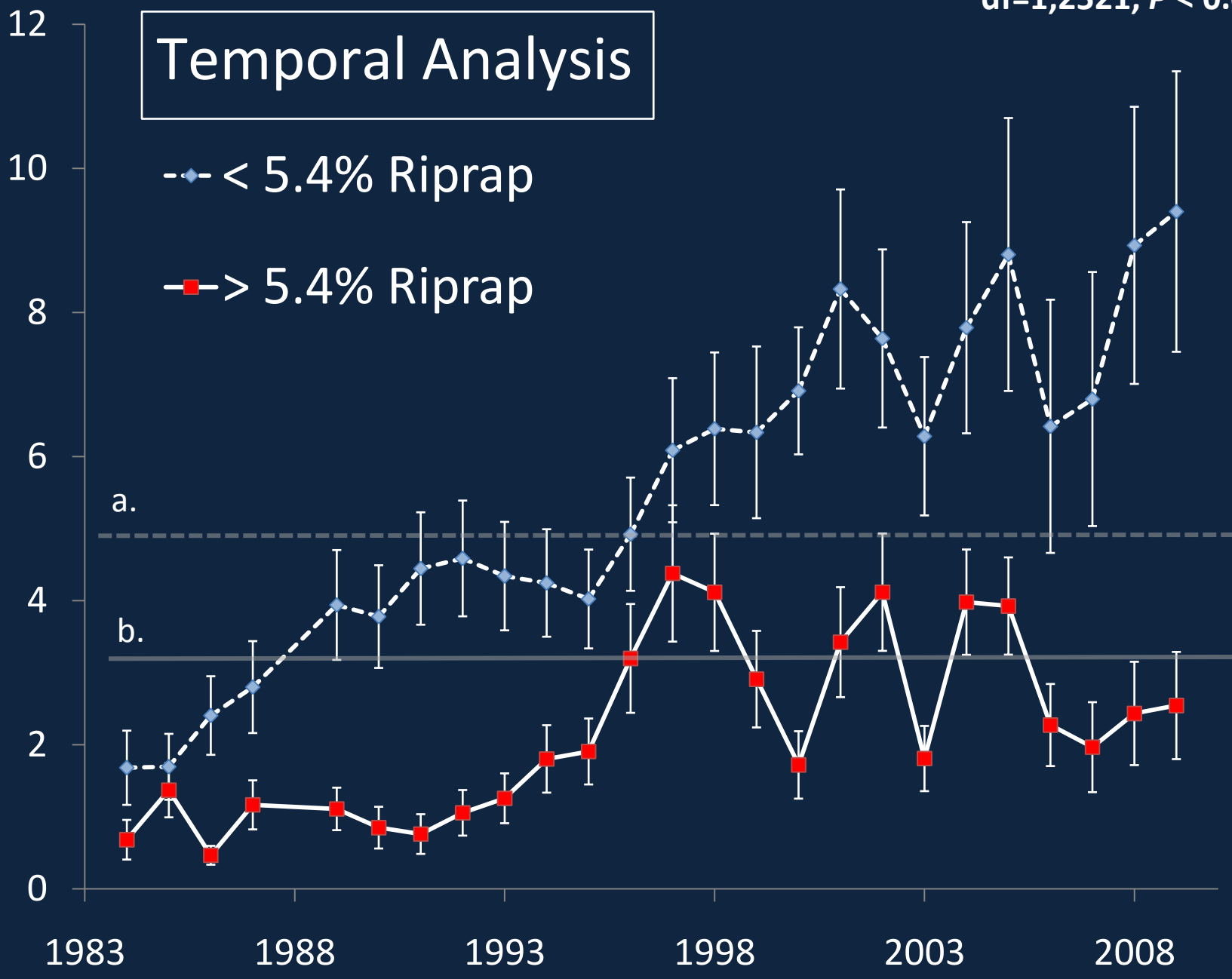
- Baywide – Bulkhead has a negative impact on adjacent SAV
- Bulkhead & Riprap have strongest effect in the polyhaline zone
- Bulkhead effects occur closer to shore than riprap effects
- Watershed land-uses that decrease water quality override the effects of shoreline hardening on SAV

df=1,2521, $P < 0.001$

Temporal Analysis

Average Subestuary SAV Coverage

- ◆-- < 5.4% Riprap
- > 5.4% Riprap



Year

SAV: Temporal Analysis Summary

Strong effect of Chl a and major river nitrogen loads on year to year variation in SAV coverage

The best predictor and timing varies among salinity zones

For example: When March Chl a levels and Major River Annual Nitrogen Loads (Susquehanna, Potomac river) are high one year, SAV in the polyhaline zone is likely to be low the following year

Timing may relate to shoot emergence

Macrofauna:

Benthic Invertebrates

Fish and Crabs

Waterbirds

Sampling Fish and Crabs



Beach



Bulkhead



Marsh



Rip-rap

Used a system with 3 nested nets to capture both very near-shore and more mobile species and to reduce escape.



Fish, Crabs, Benthic Invertebrates Shoreline Habitat

- Natural shorelines provide critical refuge habitat for prey species of benthic invertebrates and fish
- Small-bodied prey fishes are less abundant near hardened shorelines
- Planktivorous prey species at beach, littoral prey species at marsh
- Larger-bodied species at marshes and altered shorelines, but are farther from shore at marshes
- Fish communities similar at bulkhead and riprap

Index of Waterbird Community Integrity (IWCI)

S_{IWCI} (range 21 to 5)

Disturbance Sensitive Species



Royal Tern
(*Thalasseus maximus*)
 $S_{iwci} = 21$



Semipalmated Sandpiper
(*Calidrus pusilla*)
 $S_{iwci} = 20.5$



Bald Eagle
(*Haliaeetus leucocephalus*)
 $S_{iwci} = 16.5$



Laughing Gull
(*Leucophaeus atricilla*)
 $S_{iwci} = 15.5$



Hooded Merganser
(*Lophodytes cucullatus*)
 $S_{iwci} = 14$

Disturbance Tolerant Species



Ring-billed Gull
(*Larus delawarensis*)
 $S_{iwci} = 10$



Double-crested Cormorant
(*Phalacrocorax auritus*)
 $S_{iwci} = 9.5$



Canada Goose
(*Branta canadensis*)
 $S_{iwci} = 7$



Mallard
(*Anas platyrhynchos*)
 $S_{iwci} = 7$



Domestic duck
 $S_{iwci} = 5$

Waterbird Summary:

- IWCI is showing to be sensitive to measuring bird communities across subestuary conditions
- Positive relationships with:
 - Site-level % Natural Marsh
 - Landscape level % Wetland
 - Water quality Dissolved Oxygen (Exploratory)
 - SAV (Exploratory)
- Season makes a difference (Late Summer vs Fall/Winter)



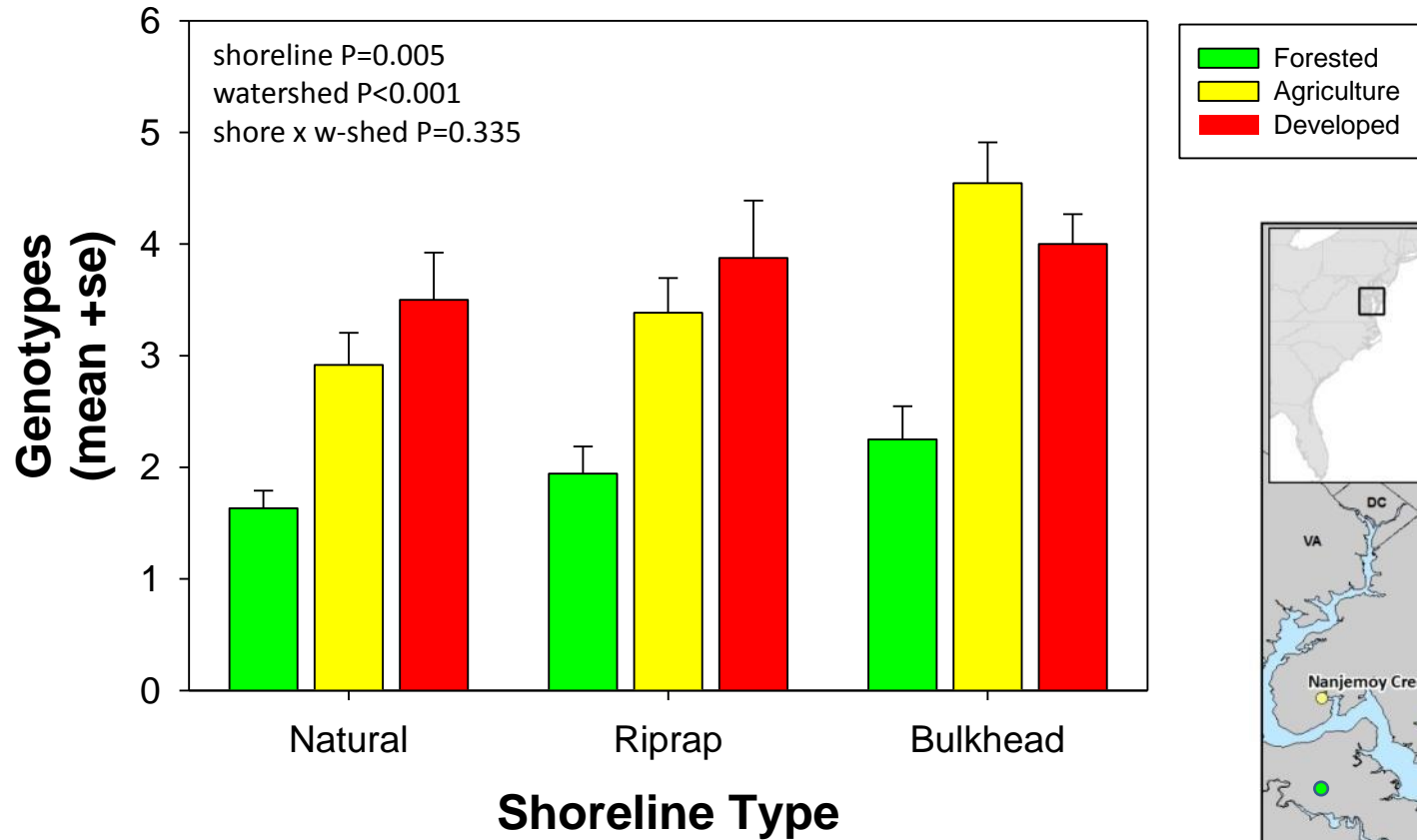
Invasion of Wetlands by *Phragmites*:

How does shoreline hardening affect *Phragmites* abundance and spread?

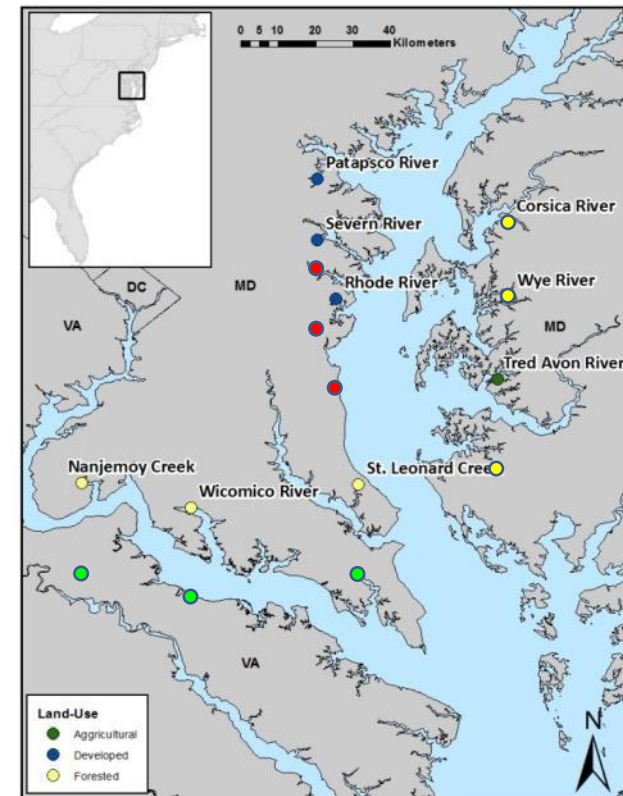
Shoreline development correlates with *Phragmites* cover
(Silliman and Bertness 2004; King et al. 2007, Wardrop et al. in prep.)

- Disturbance?
 - This might affect establishment of seedlings
- Reproduction?
 - If more seedlings become established, patches may be more diverse and so produce more viable seeds to fuel additional spread

Shoreline hardening promotes more genetically diverse *Phragmites* patches.



Shoreline hardening may contribute to *Phragmites* invasion.



To be continued...

Our five-year study is entering
its fourth field-season.