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

Ongoing NOAA-CSCOR Funded Research

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Smithsonian Environmental

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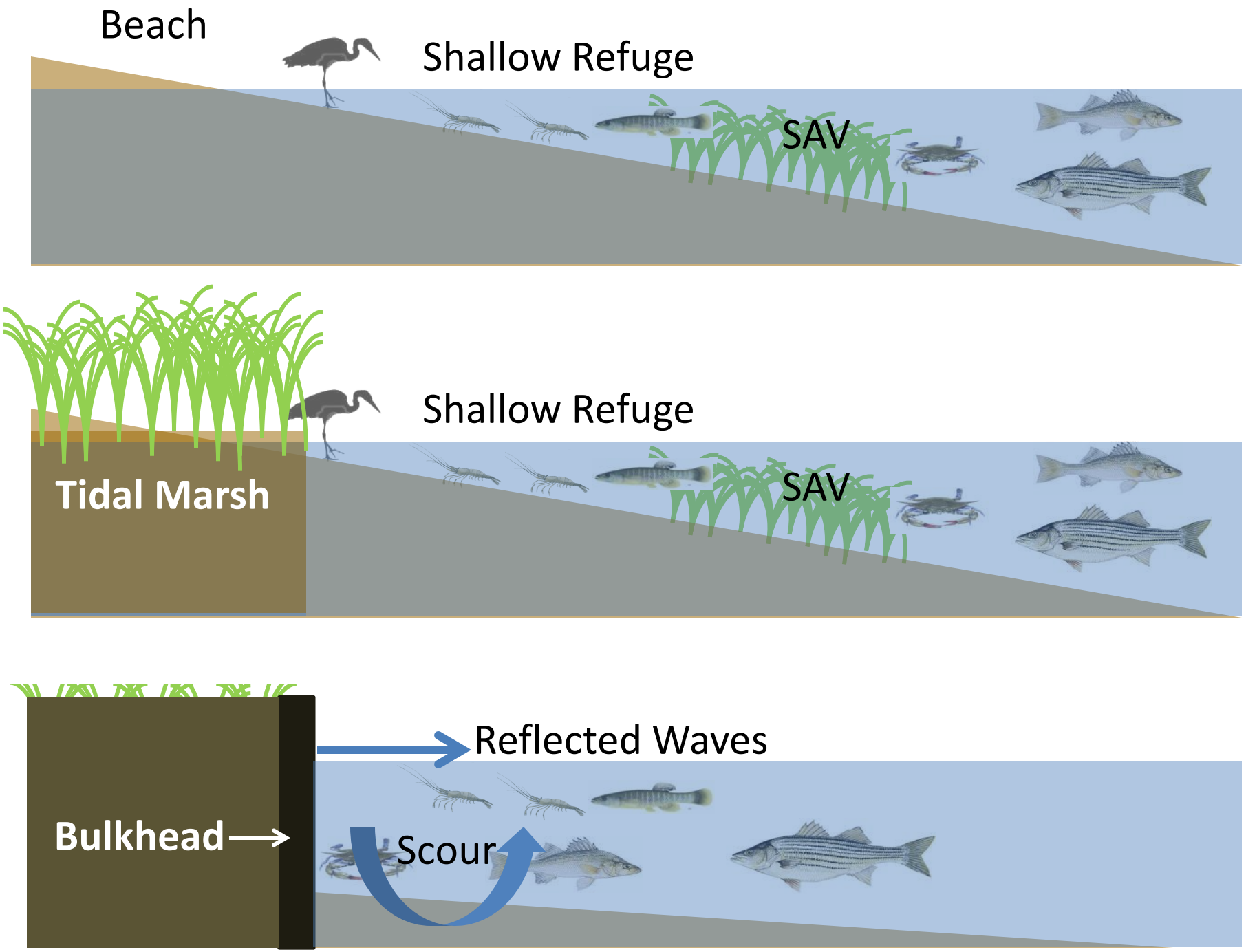
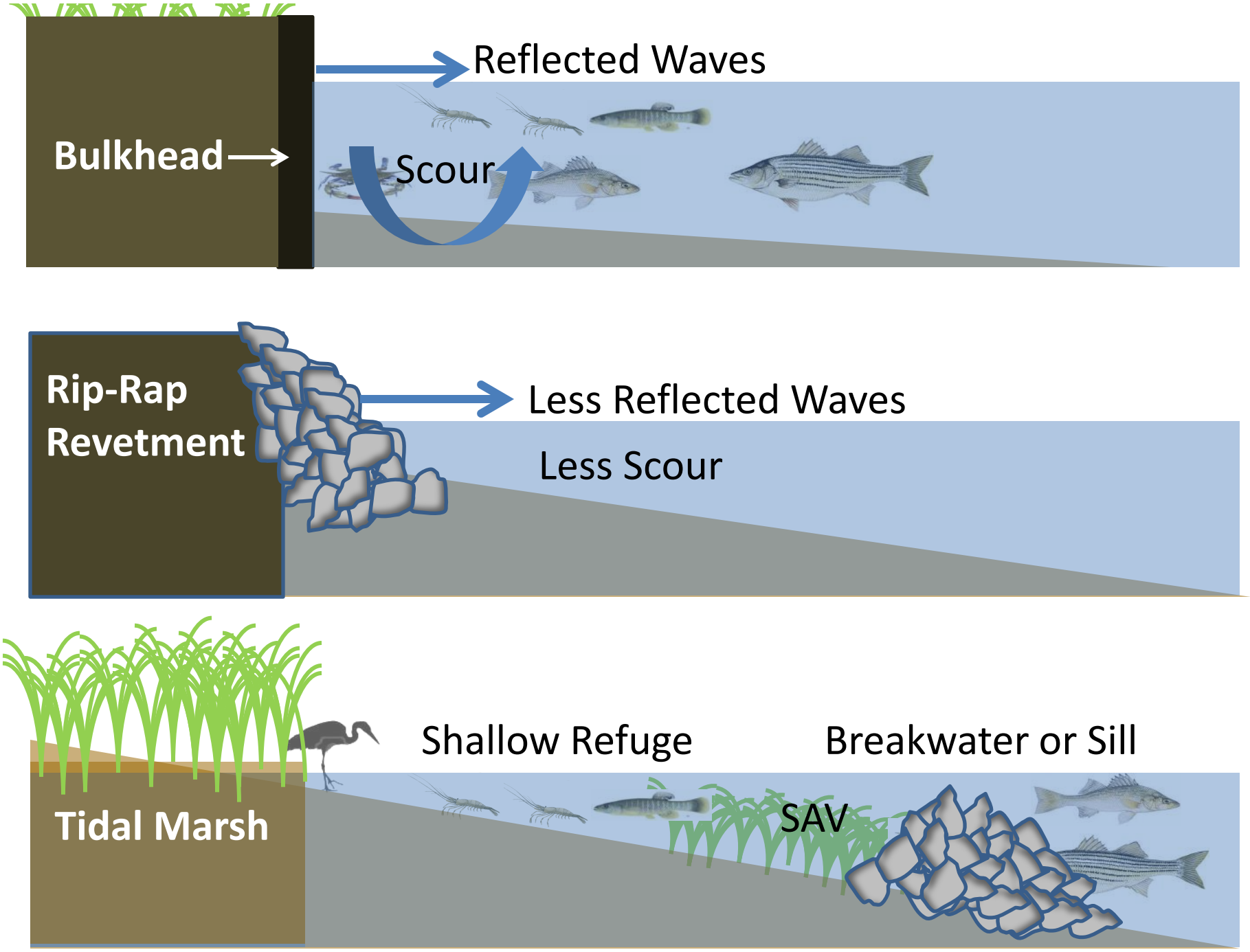

Beach
Shallow Refuge
SAV
Tidal Marsh
Shallow Refuge
SAV
Reflected Waves
Bulkhead
Scour


Reflected Waves
Bulkhead
Scour
Rip-Rap
Revetment
Less Reflected Waves
Less Scour
Shallow Refuge
Breakwater or Sill
Tidal Marsh
SAV

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

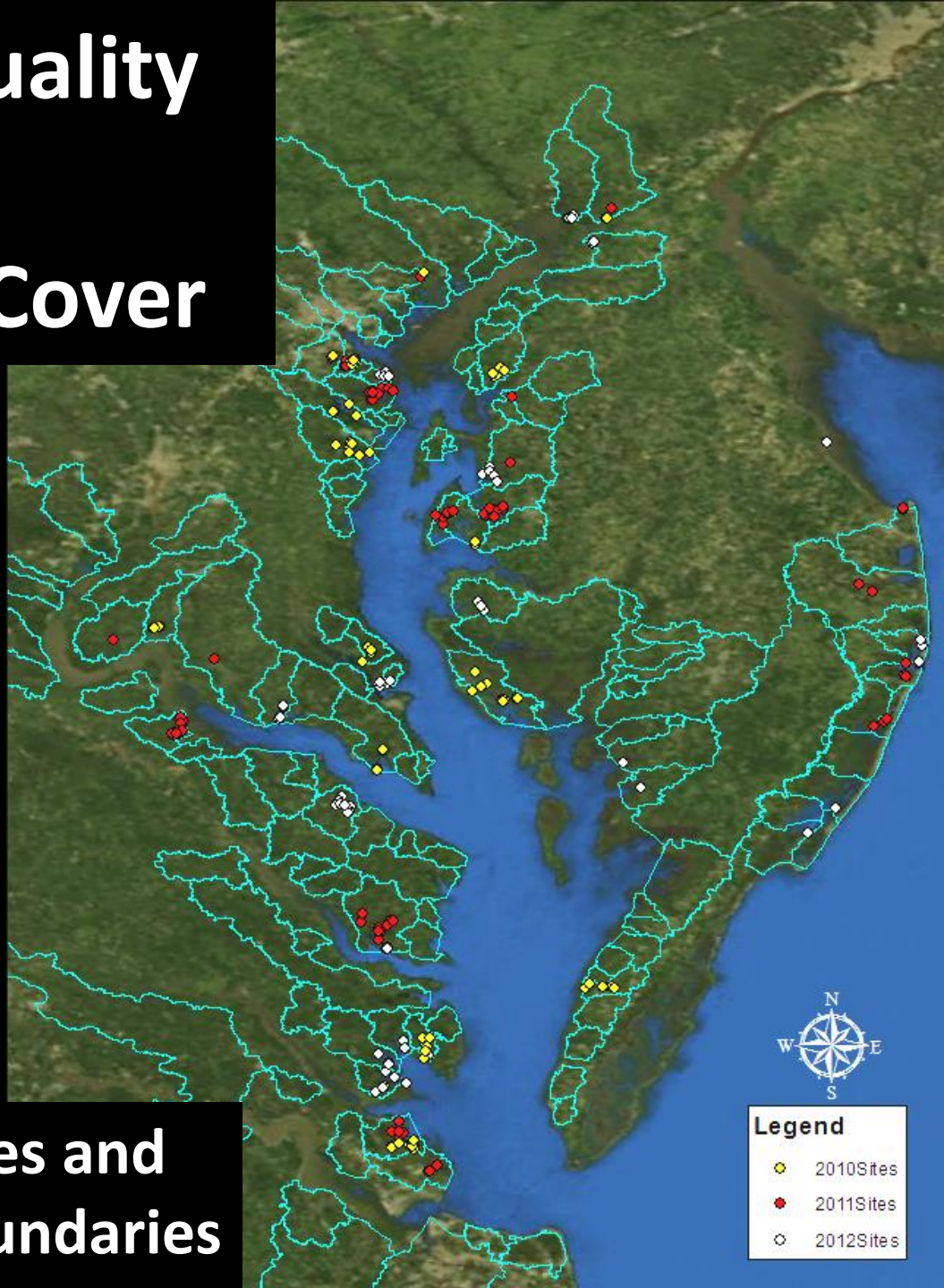
Compare shoreline types in bays and subestuaries with watersheds having differing land use.

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

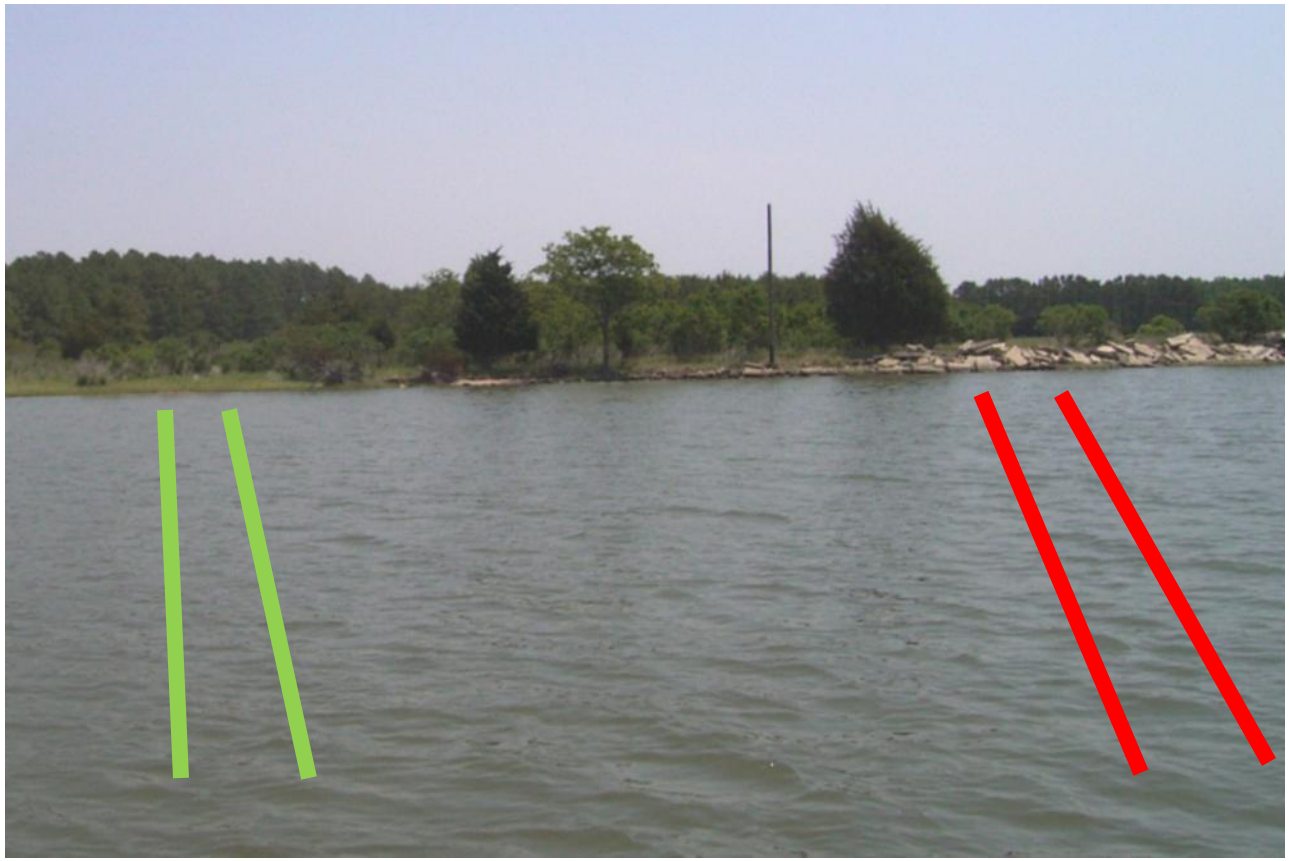
Conclusions

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

- Developed land increases N concentrations.

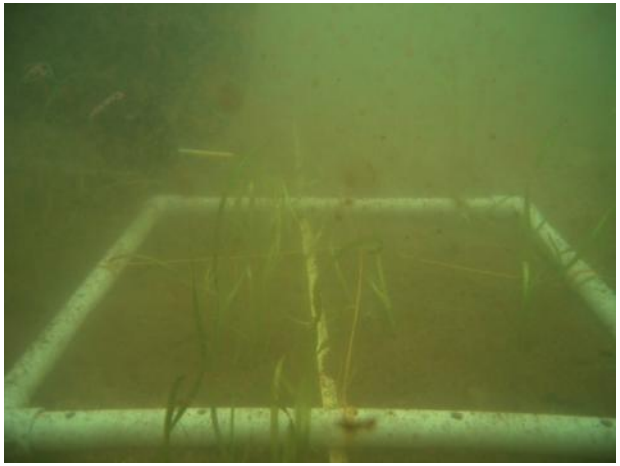
Submerged Aquatic Vegetation (SAV)

Field transect studies

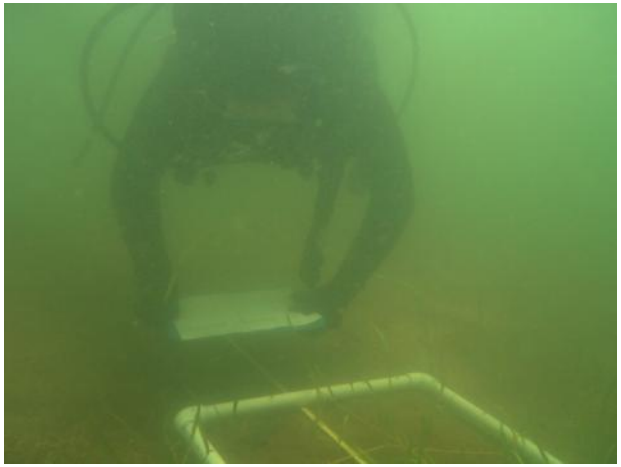


Transects perpendicular to shoreline at **riprapped site** and **adjacent natural** site

Sampling methods

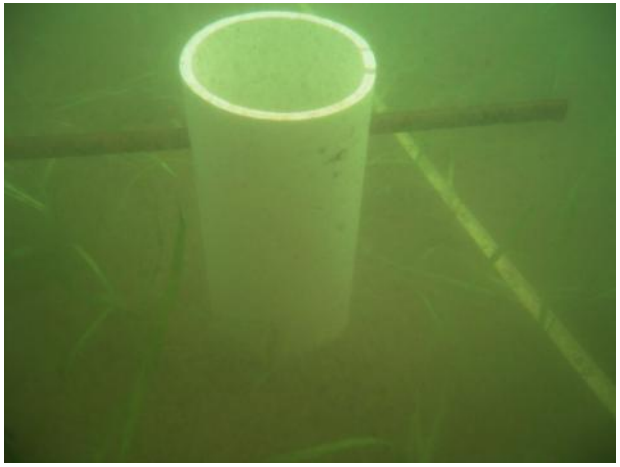


0.25m^2 quadrat



SCUBA survey

Sediment cores



Biomass core

SAV and water quality

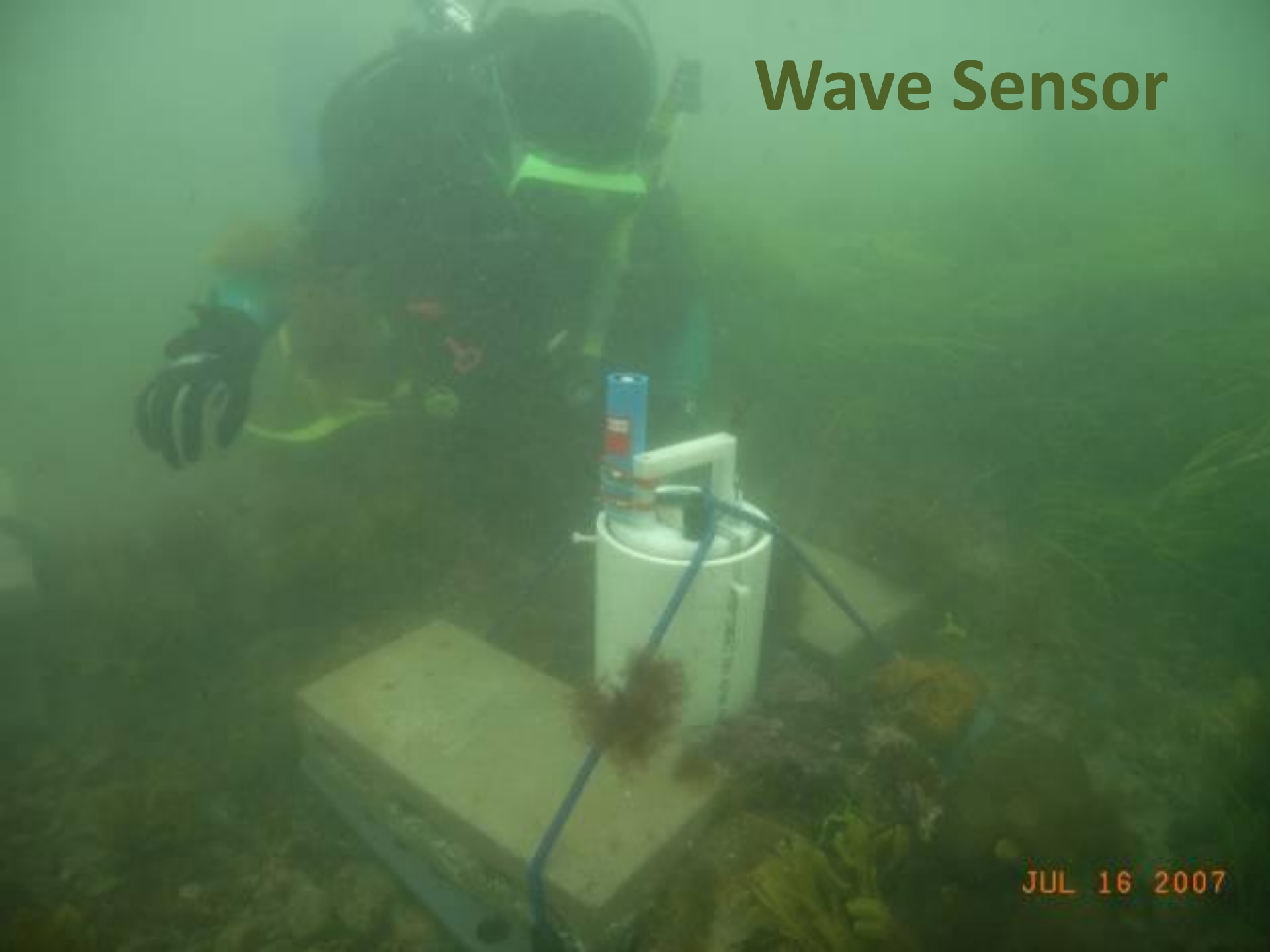
- Conditions in many oligohaline SAV beds are often poorer than published habitat limits.
- Coon Tail and Millfoil seem more sensitive to water quality than other oligohaline species.
- Horned pondweed and eel grass seem more sensitive than other polyhaline species.

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 Sensor



Findings and plans for wave studies

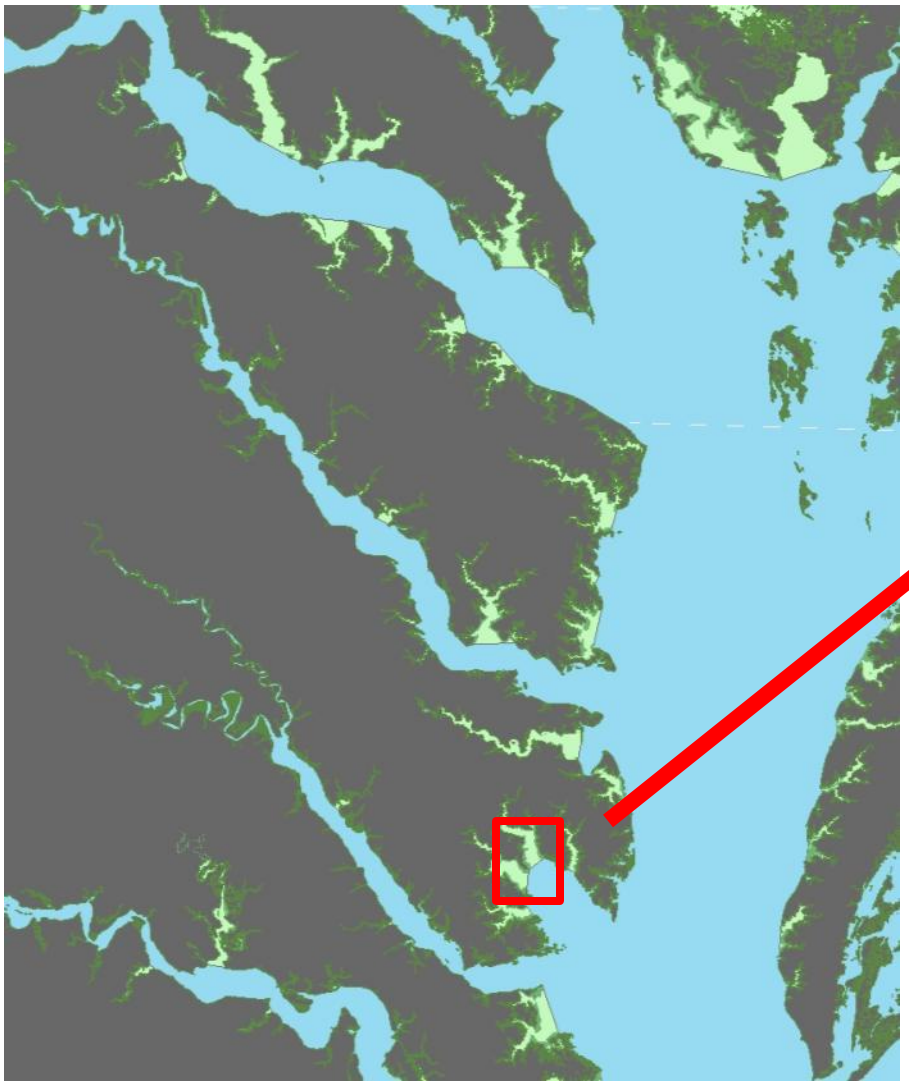
- Waves adjacent to rip rap appear to be higher at least part of the time

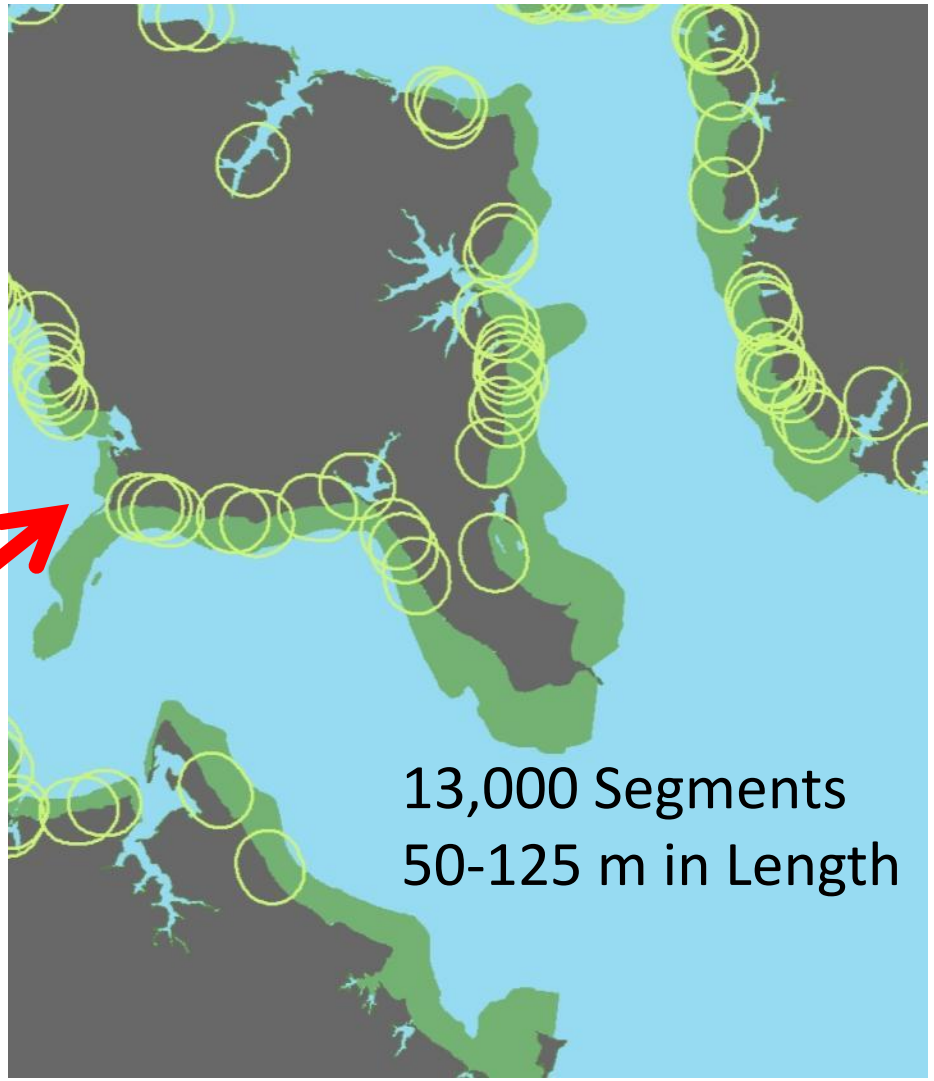
- This is also what happens adjacent to bulkheads

- Plan to compare waves adjacent to bulkheads versus rip rap

Spatial Analysis of Shoreline Segments

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



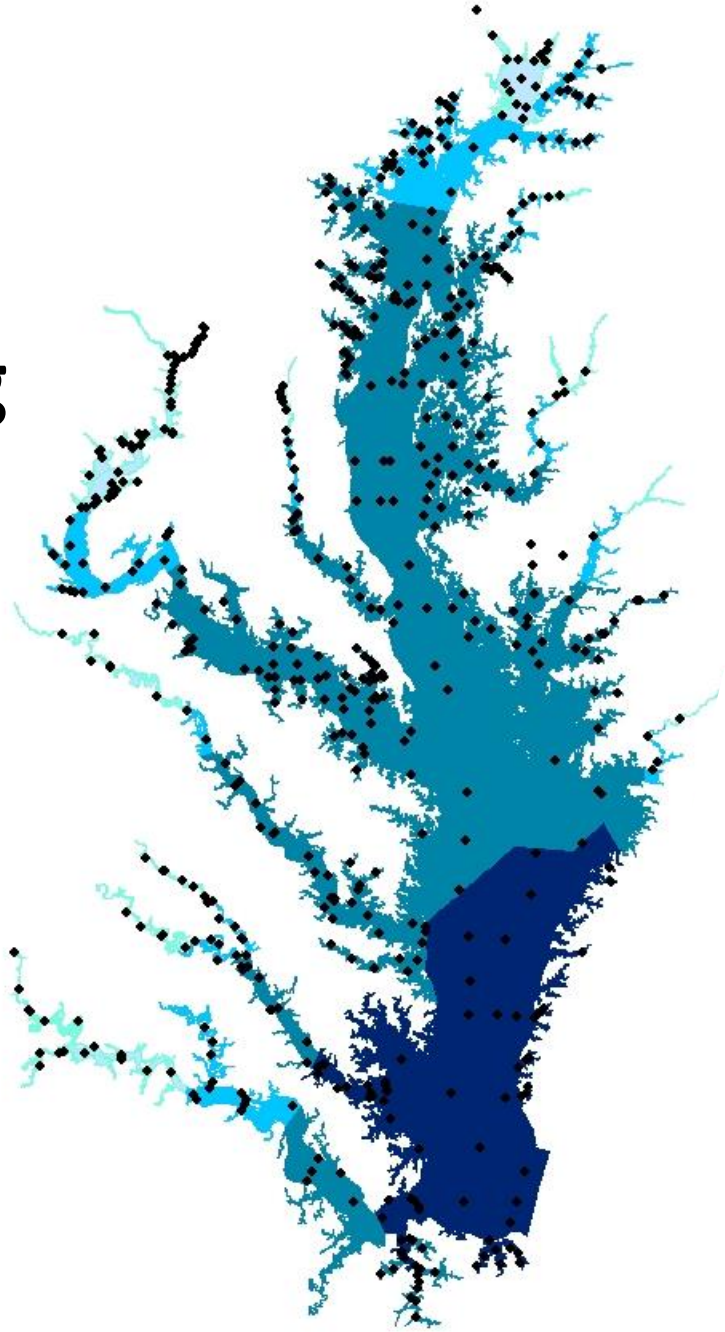


SAV: Spatial Analysis Summary

- 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

Chla Sampling Stations

614 Total



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

Timing may relate to shoot emergence

Macrofauna:

Benthic Invertebrates
Fish and Crabs
Waterbirds

Sampling Fish and Crabs

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

Habitat Associations in the Nearshore Zone (w/n 16m from shore)

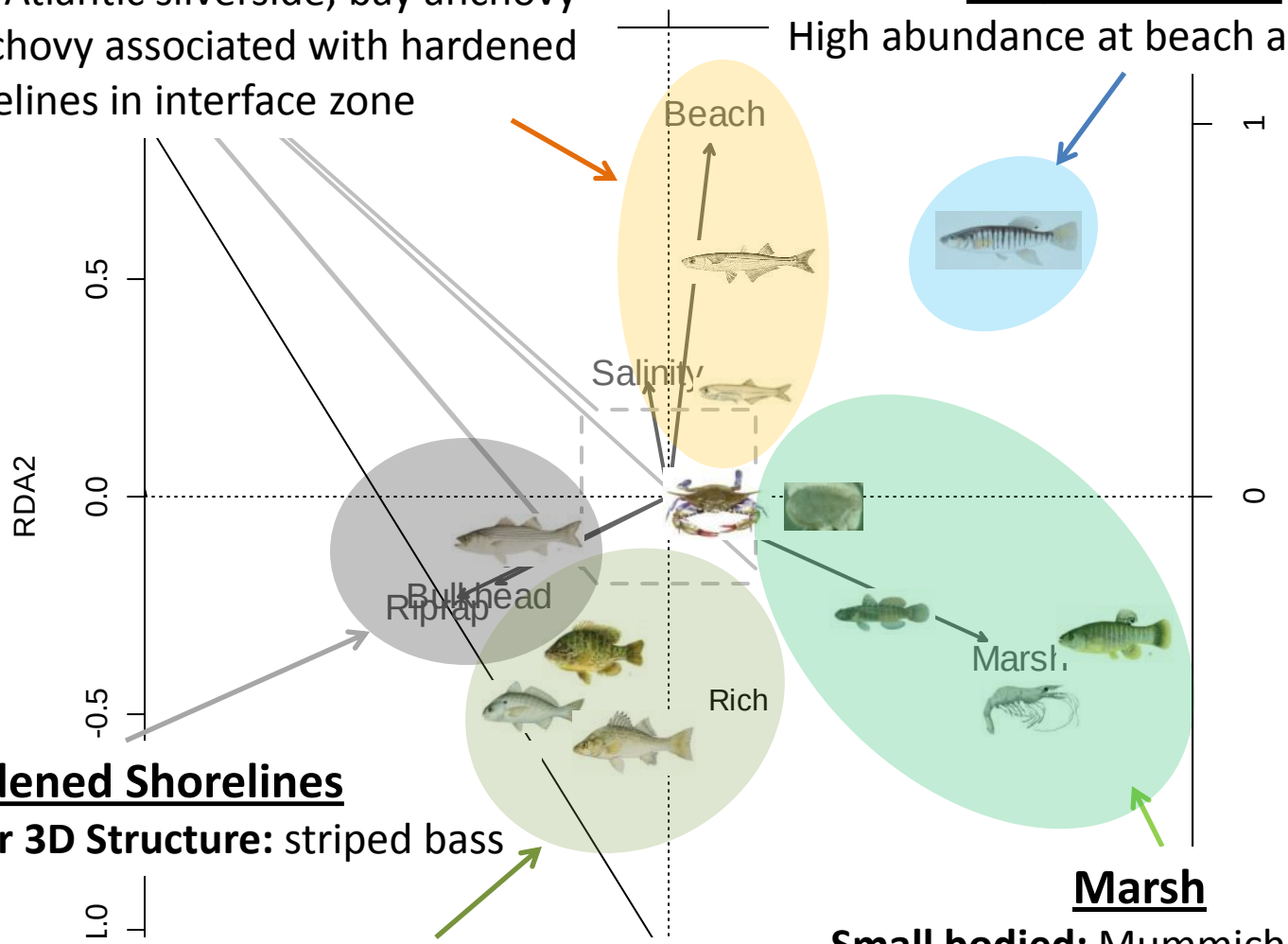
Beach

Planktivores: Atlantic silverside, bay anchovy

Note: Bay anchovy associated with hardened shorelines in interface zone

Striped Killifish

High abundance at beach and marsh



Hardened Shorelines

Preference for 3D Structure: striped bass

Marsh

Small bodied: Mummichog, grass shrimp, naked goby, hogchoker,

Marsh and Hardened Shorelines

Benthivores: Spot, pumpkinseed, and white perch

Note: These species are not abundant in marsh interface zones

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

Waterbird Surveys

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 Welands 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

Implications for management:

- Shoreline hardening contributes to *Phragmites* invasion.

- Perhaps the permitting process needs to include responsibility for monitoring (and controlling) *Phragmites* establishment.

- Patch diversity may continue to increase over time, so repeated monitoring may be essential.

To be continued…

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