Promoting living shorelines for shoreline protection: understanding potential impacts to and ecosystem trade-offs with adjacent submersed aquatic vegetation (SAV)

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Overview

The Problem: shoreline erosion

The Challenge: protecting shorelines with ecologically friendly and sustainable infrastructure

A Possible Solution: living shorelines

Key Knowledge Gaps for LS Implementation/Management:

1) Long-term performance (~10 years) – are they keeping up with sea-level rise?

The Approach: study design and preliminary data

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Key Knowledge Gaps for LS Implementation/Management:

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2) Impact to adjacent shallow-water submersed aquatic vegetation (SAV) habitats – trade-offs?

The Approach: study design and preliminary data

The Problem: Shoreline Erosion

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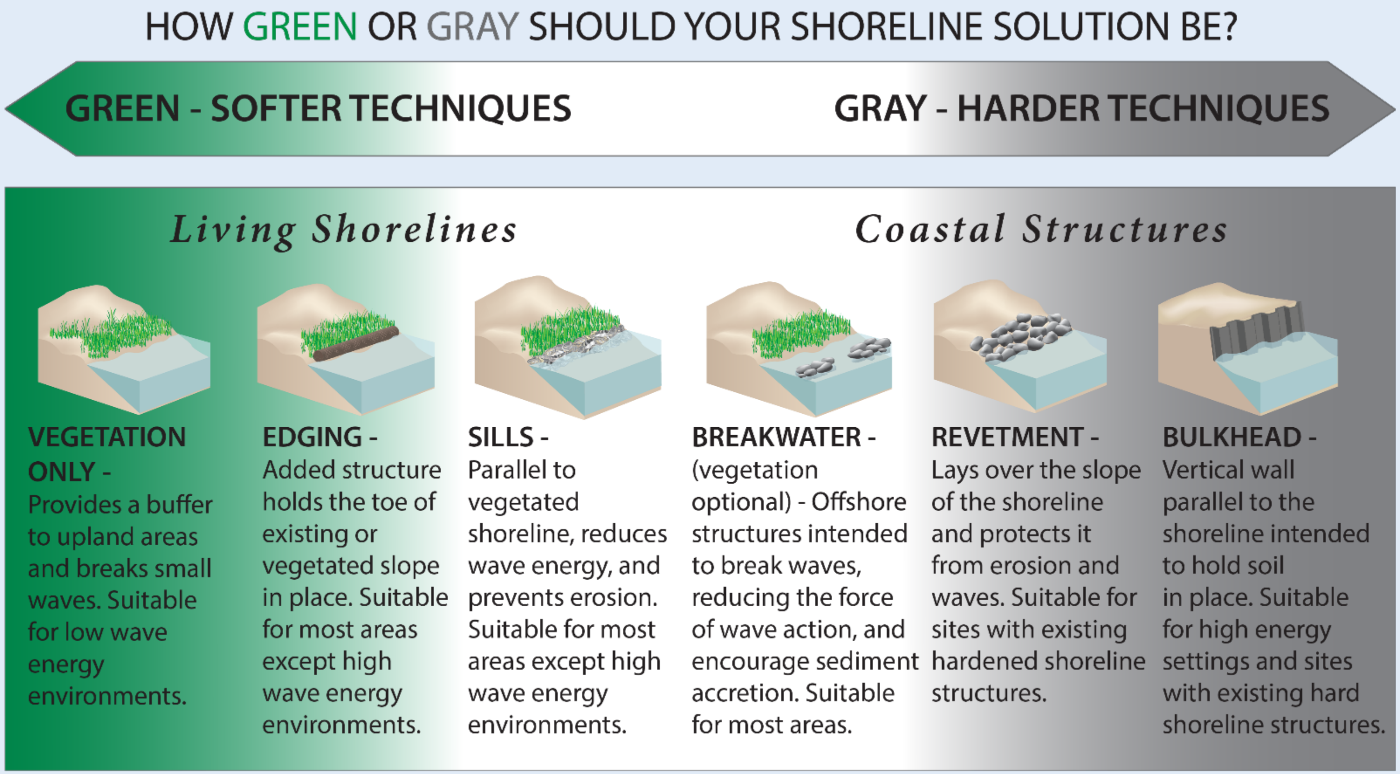

NOAA, https://www.habitatblueprint.noaa.gov/living-shorelines/

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3. Recent push for living shorelines as an alternative (including Maryland laws in 2003, Virginia General Permit, 2011), but what are the…
   - impacts to adjacent ecosystems, especially SAV (long term, short term)?
   - trade-offs in ecosystem services?

Specific Questions Addressed by this Study

How do living shorelines (LS) impact existing SAV habitat?

- *Hypothesis:* Depends on sediment accretion within the created marsh
    - **Accretion rates** ≥ sea-level rise: LS sequester land-derived sediments, decreasing supply to and subsequent burial in the subtidal
    - **Accretion rates** < sea-level rise: LS are not effective in trapping sediments and could even become a sediment source from wave attack and/or submergence, increasing supply to and burial in the subtidal

What are the trade-offs in ecosystem services?

- 3 groups of sites: natural shorelines, LS w/adjacent SAV, LS w/out adjacent SAV
- *Hypothesis:* LS installation reduces **shoreline-erosion rates**, with the lowest rates occurring at LS with SAV after installation
- *Hypothesis:* **Sediment and nutrient burial rates** differ in both the subtidal and intertidal among the 3 groups, with net burial highest at LS with SAV

The Approach: Site Selection, Field Work, Data Analysis!

Site selection – control for as many variables as possible (e.g. fetch, LS age, length and design)

- Obtained list of LS sites within age range (8-10 yr) from CBT, MD DNR, EC

Sediment cores and plant surveys in subtidal (SAV) and intertidal (LS)

Before and after (sites and paired controls):

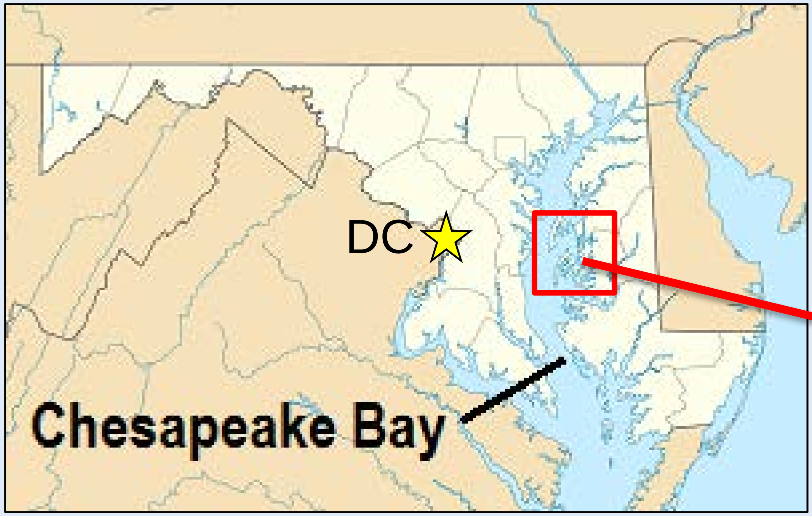
- Shoreline erosion rates
- SAV abundances (within context of larger trends)
- Sediment/nutrient character and accretion rates in subtidal

After:

- Sediment/nutrient character and accretion rates in living shorelines
- Species, stem density and height in living shorelines
- SAV presence and species in subtidal

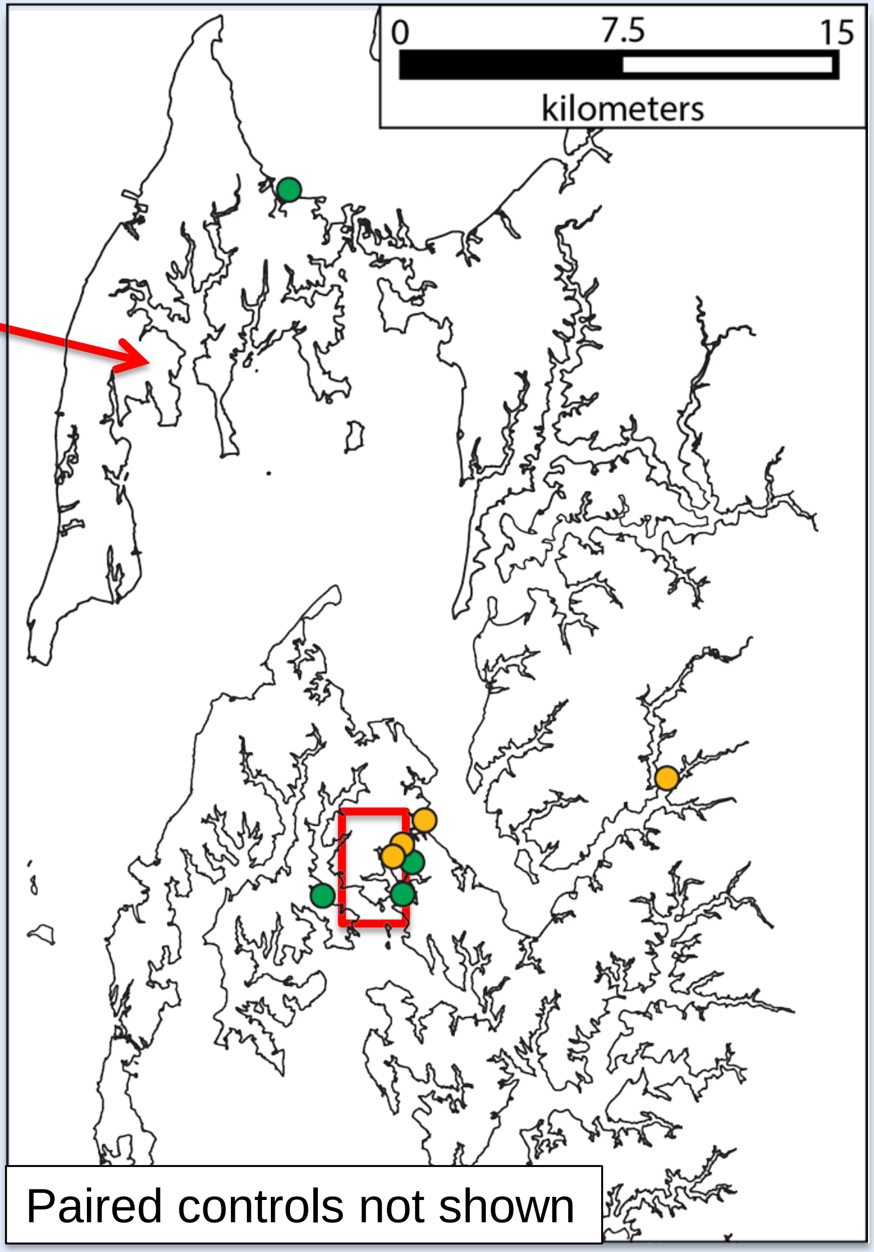


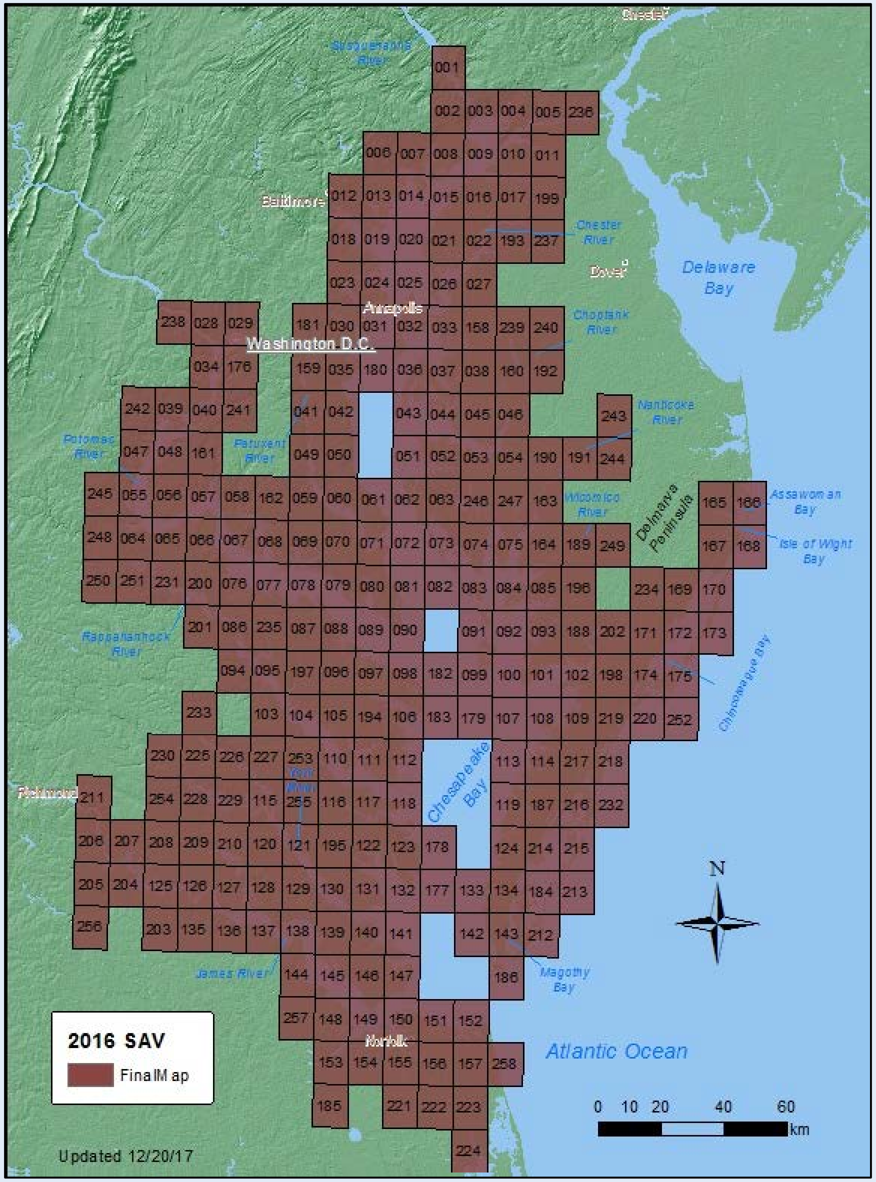

The Approach: Sites



8 sites with paired controls:

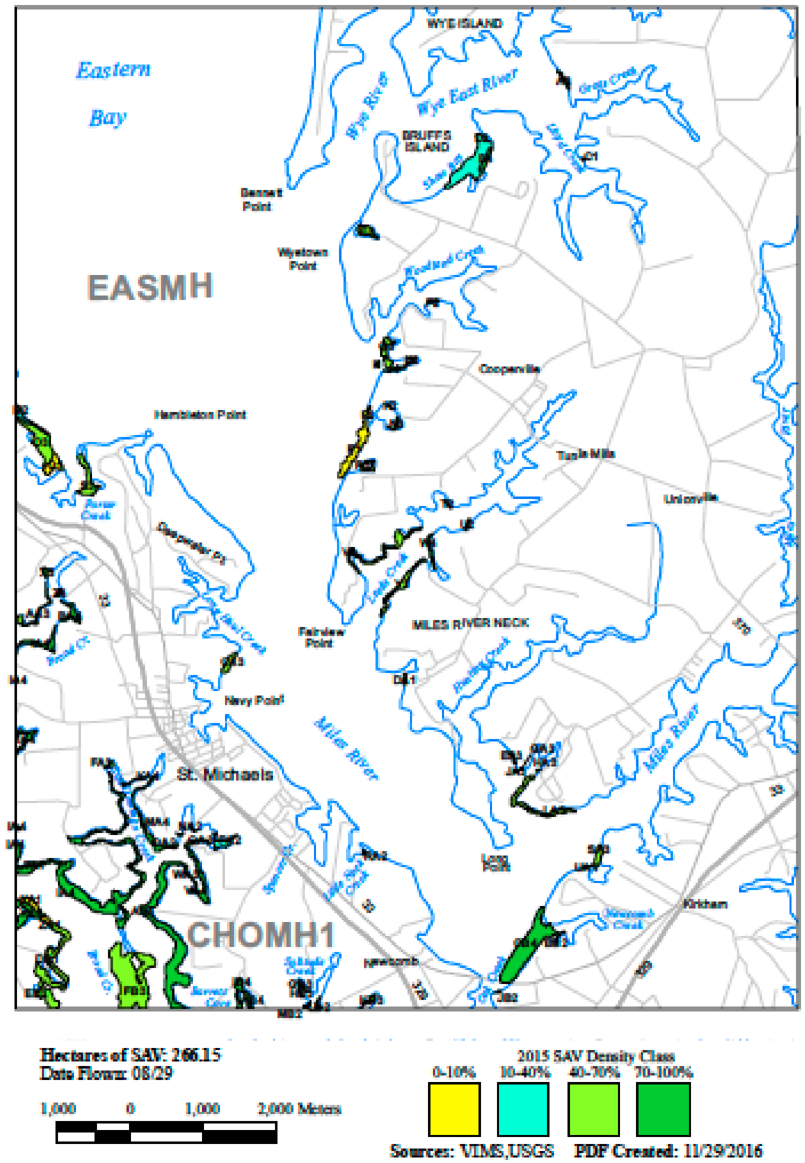
- Weighted-bed density of SAV from 1978-2005 (GIS analysis of VIMS aerial data)
- 4 sites with persistent, dense SAV (green)
- 4 sites without SAV (yellow)





Submerged Aquatic Vegetation 2015

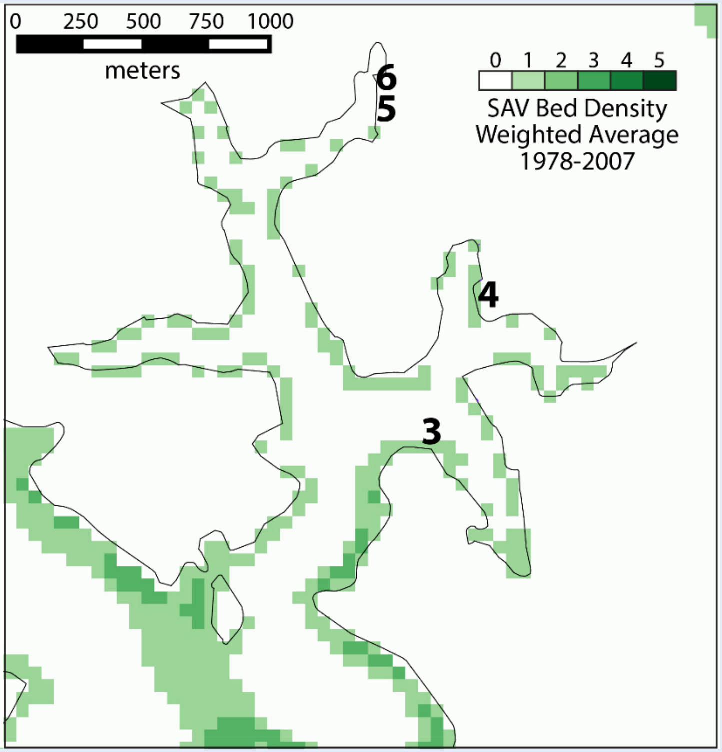
St. Michaels, Md. (37)



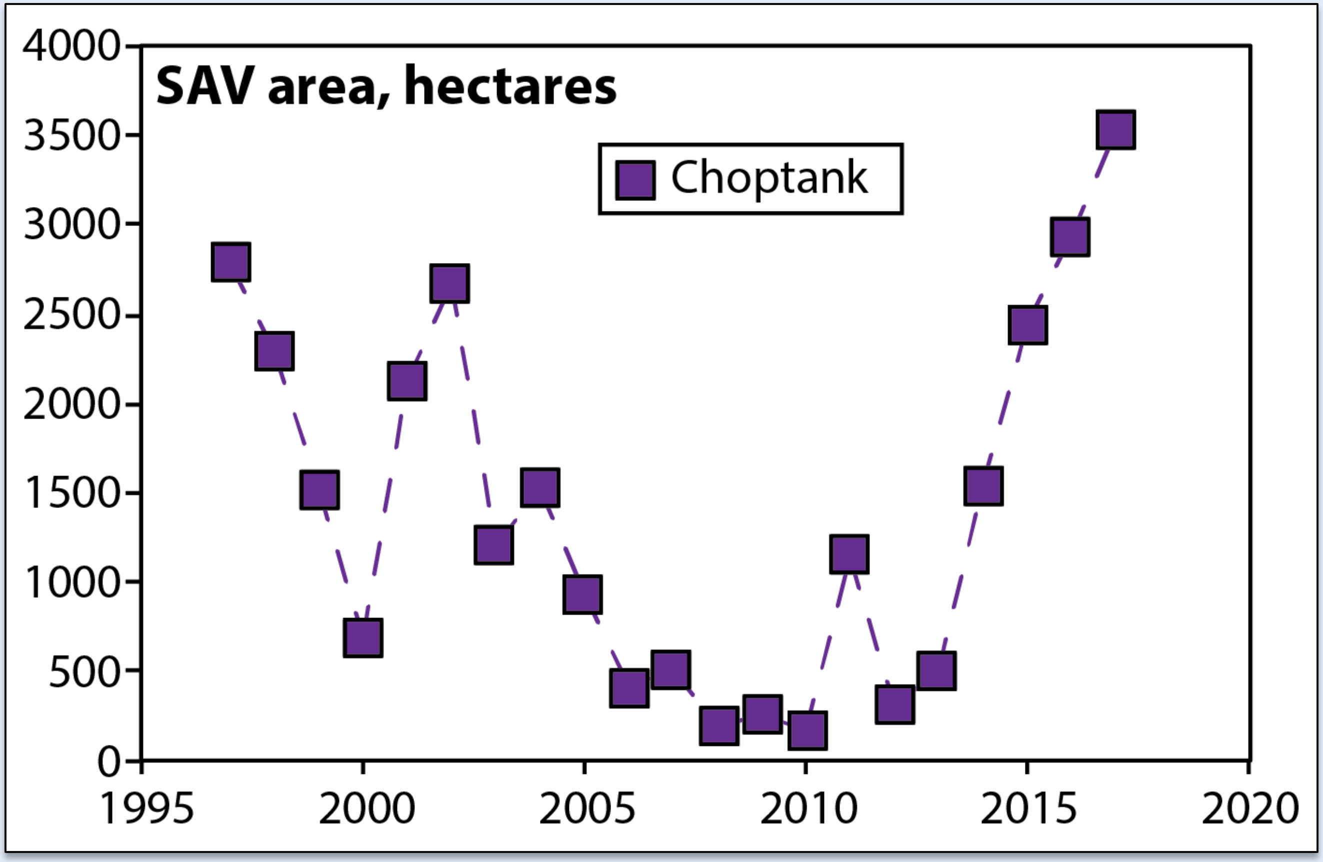
Sites (continued)

Site (#)	Install Year	SAV before?	Length, feet (meters)	Erosion rate*, ft/y (m/y)
QL (1)	2005	yes	600 (182.9)	0.90 (0.27)
OP (2)	2006	yes	440 (134.1)	0.69 (0.21)
RU (3)	2008	yes	1330 (405.4)	0.46 (0.14)
HG (4)	2007	yes	1860 (566.9)	0.10 (0.03)
SD (5)	2007	no	770 (234.7)	+0.07 (+0.02)
EC (6)	2005	no	550 (167.6)	0.07 (0.02)
MG (7)	2004	no	1500 (457.2)	0.50 (0.15)
MM (8)	2008	no	615 (187.5)	0.50 (0.15)

*Historical rate, ~1880s-1990s (MD Coastal Atlas)



SAV data – lots of variability!



- Area high at start of window (1997), decreases to 2000, recovery to 2002
- Decline after 2002, sustained low areas from 2005-2012, except for 2011
- Resurgence from 2012 to 2017

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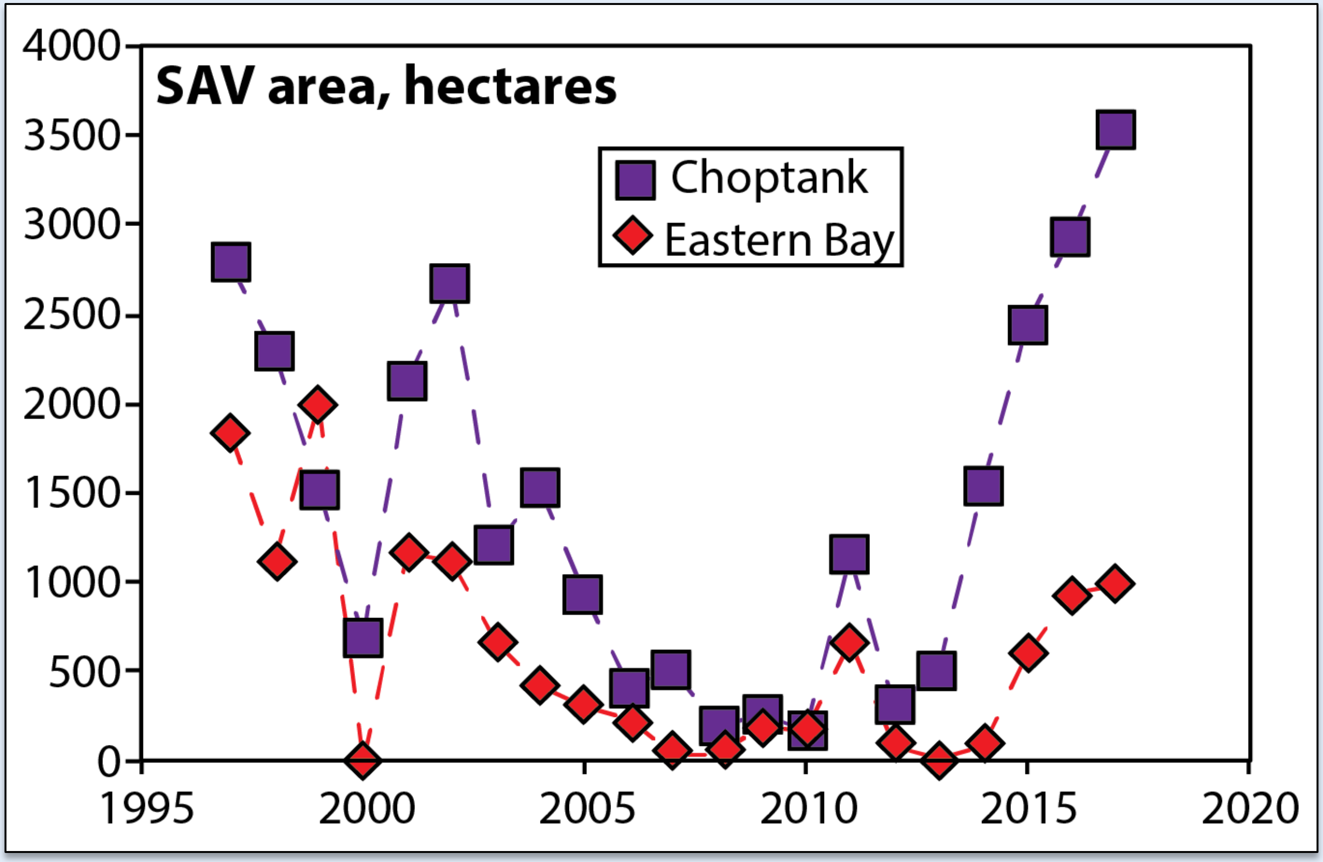

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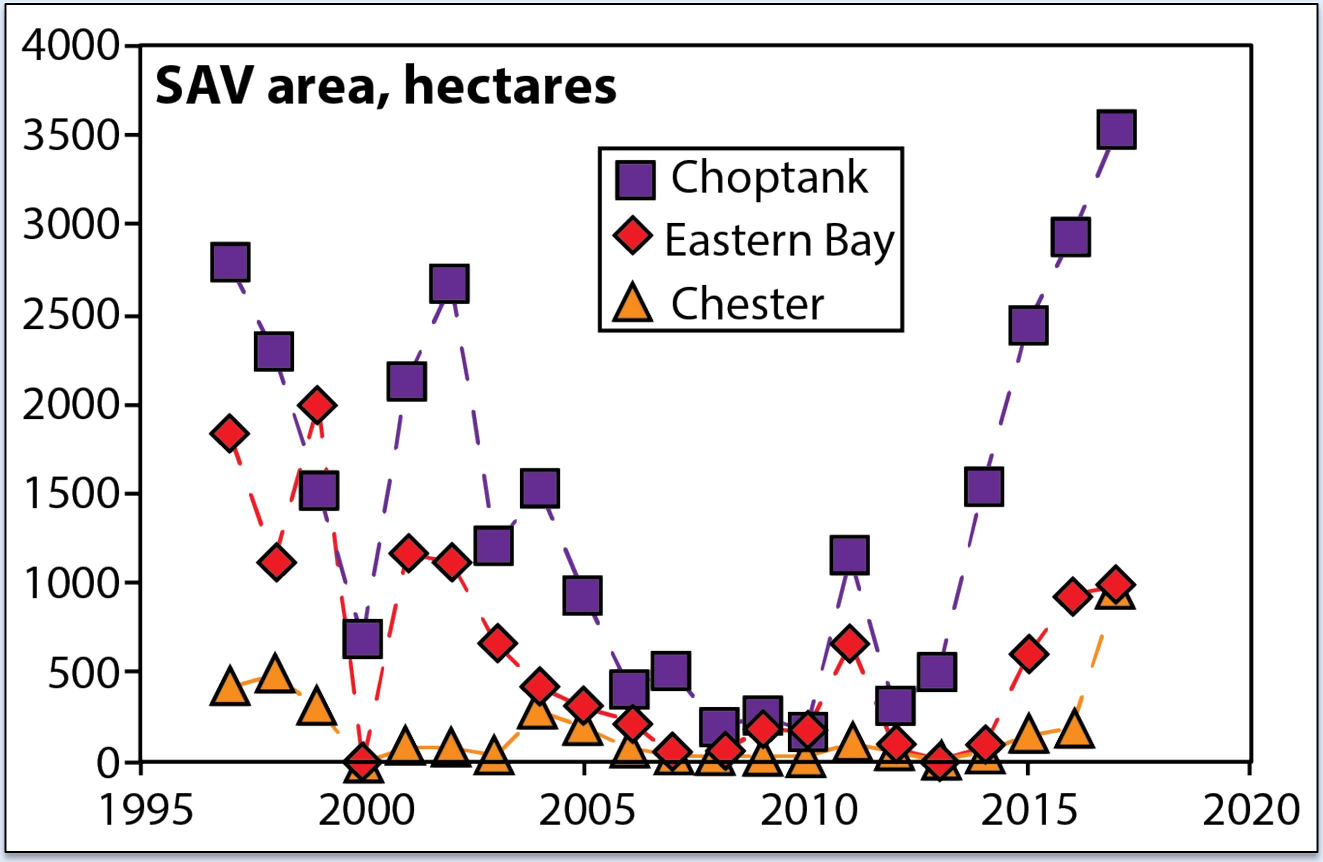

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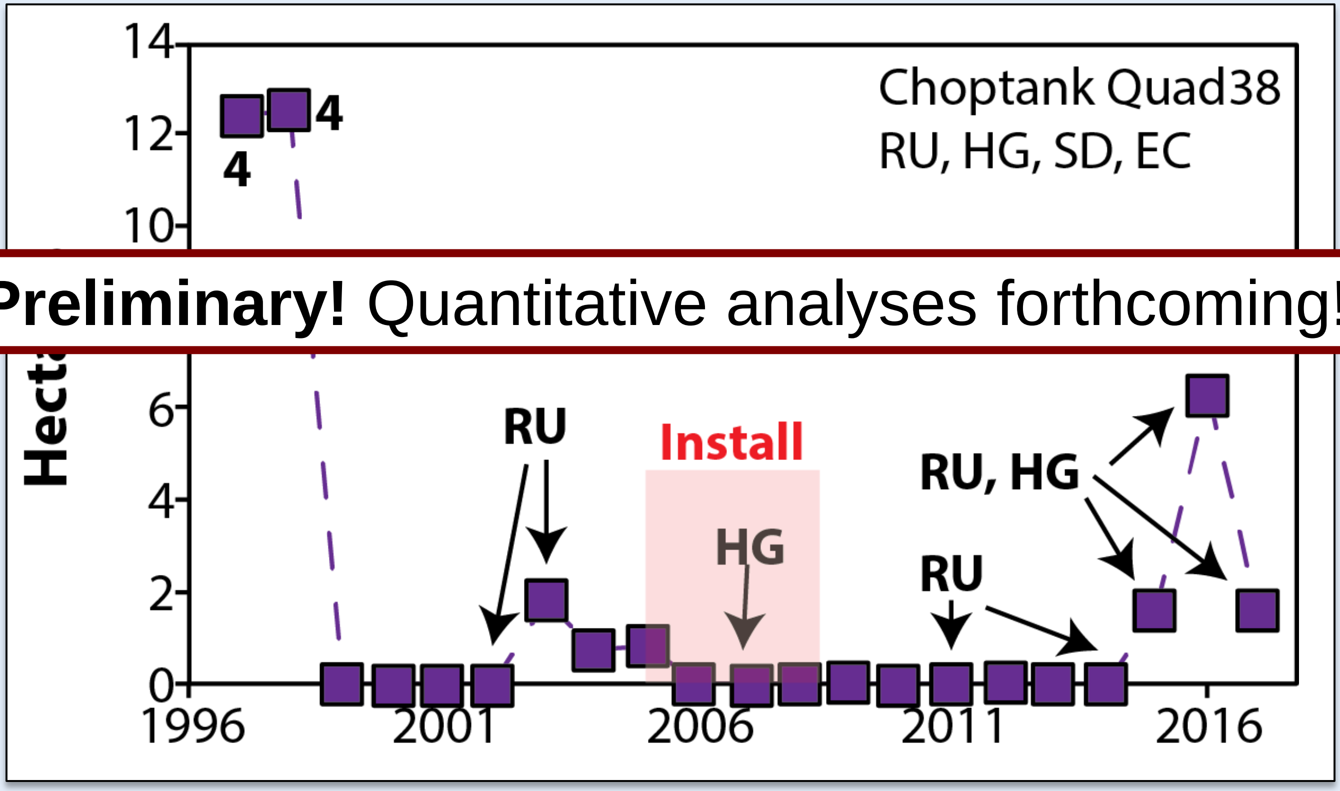
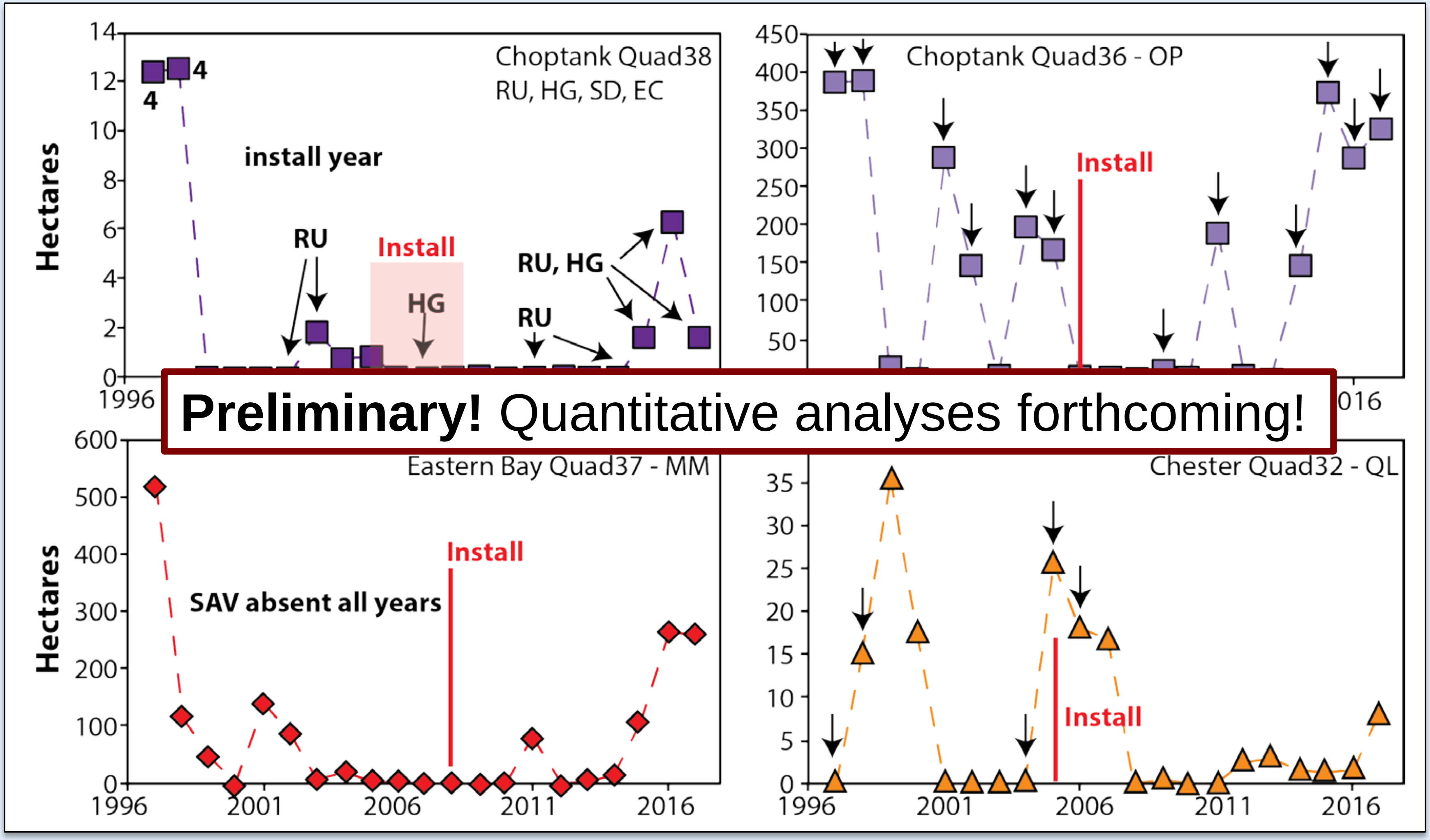


- Install window in red (2005-2008); letters indicate SAV present at site
- All 4 had SAV 1997-1998; SAV mostly absent afterwards; resurgence in 2014-2017 at RU and HG

SAV Data



Note: Arrows indicate presence at LS site, quad for MG not shown; no SAV at site or in quad 1997-2017

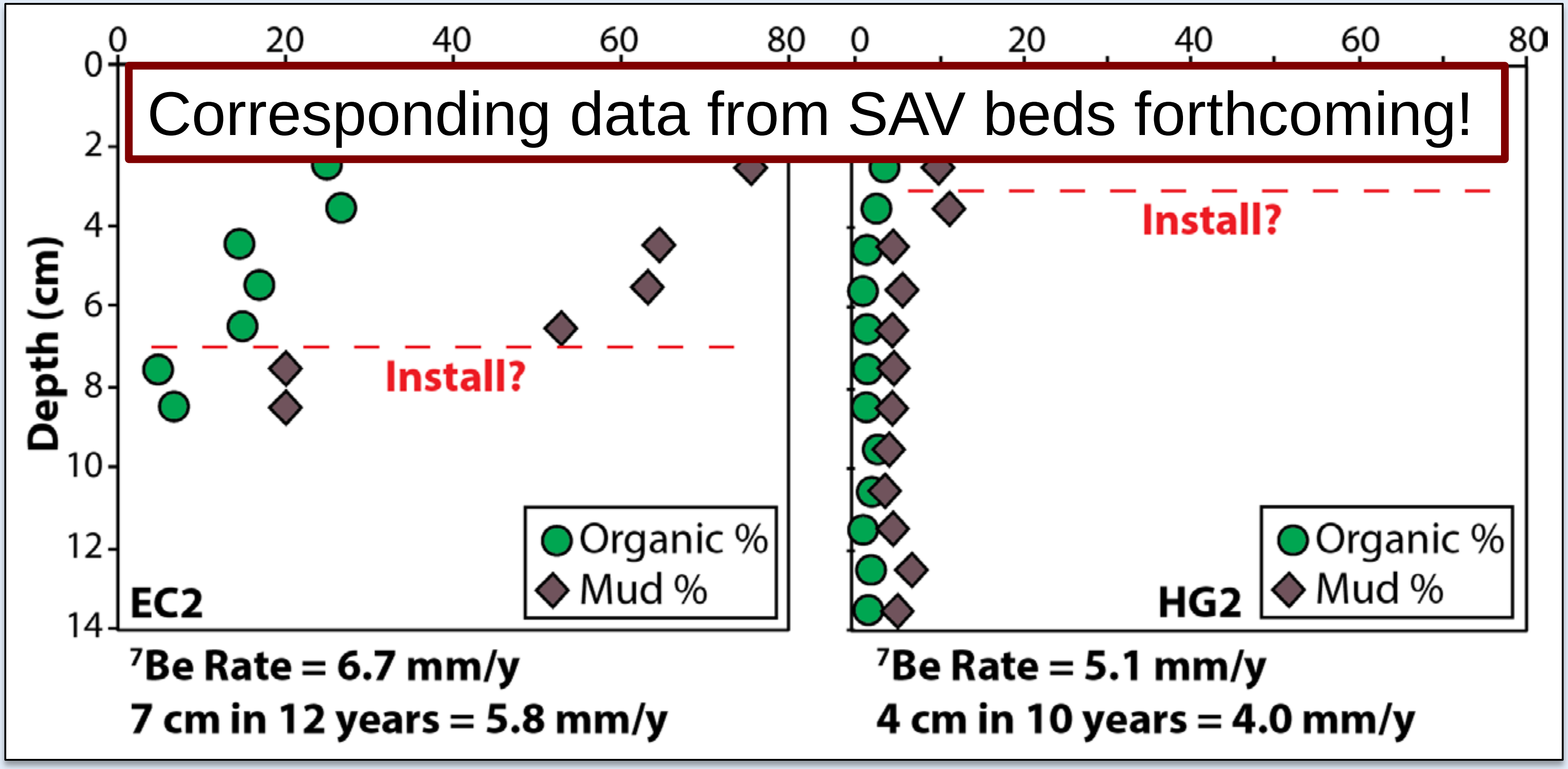
SAV Presence: LS vs. Control Sites (Year 1 of study)

(percent vegetated sampling locations per transect)

Site	Living Shoreline mean (± se, n = 3)	Control mean (± se, n = 3)
SAV before installation:		
QL	0	0
OP	89.7 (5.2)	73.8 (5.1)
RU	85.7 (0)	47.6 (12.6)
HG	52.4 (12.6)	76.2 (9.6)
No SAV before installation:		
SD	55.6 (11.1)	27.8 (14.7)
EC	35.6 (2.2)	33.3 (0)
MG	0	0
MM	6.7 (6.7)	0

- **LS and paired Control sites showed similar SAV presence**

Sediment data – living shoreline examples



- Change in sediment character (mud and organic content): sand layer during installation (below line) overlain by marsh accretion (above line)

- **Preliminary** accretion rates calculated via ^{7}Be (half-life 53.3 days): appear to ~rate of sea-level rise; agree with estimate from install horizon

Summary

Project in early stages – field surveys complete, lots of data to come!

Preliminary insights:

- SAV appear to follow trends in larger area, with no obvious long term impact of living shoreline installation

- Increase in mud and organic content of living shoreline sediments after install; accretion rates ~ sea-level rise

Stay tuned!

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Acknowledgements:

MD Department of Natural Resources

Maryland Department of Environment

Environmental Concern, Inc.

Chesapeake Bay Trust

University of Maryland Center for Environmental Science Horn Point Laboratory