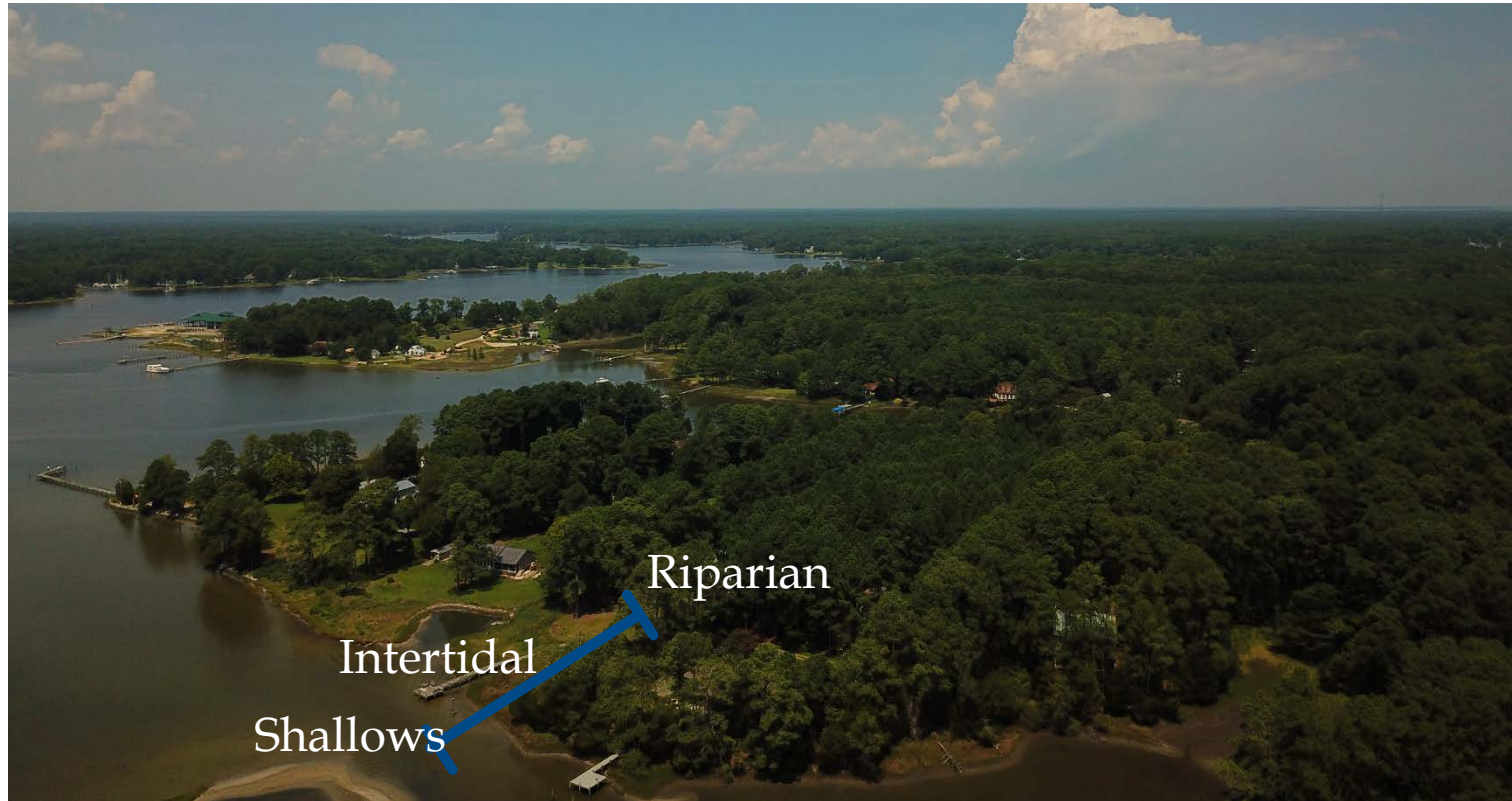


# RESTORING AND PRESERVING THE SHORELINE ECOTONE

Donna Marie Bilkovic  
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[www.vims.edu/ccrm/](http://www.vims.edu/ccrm/)



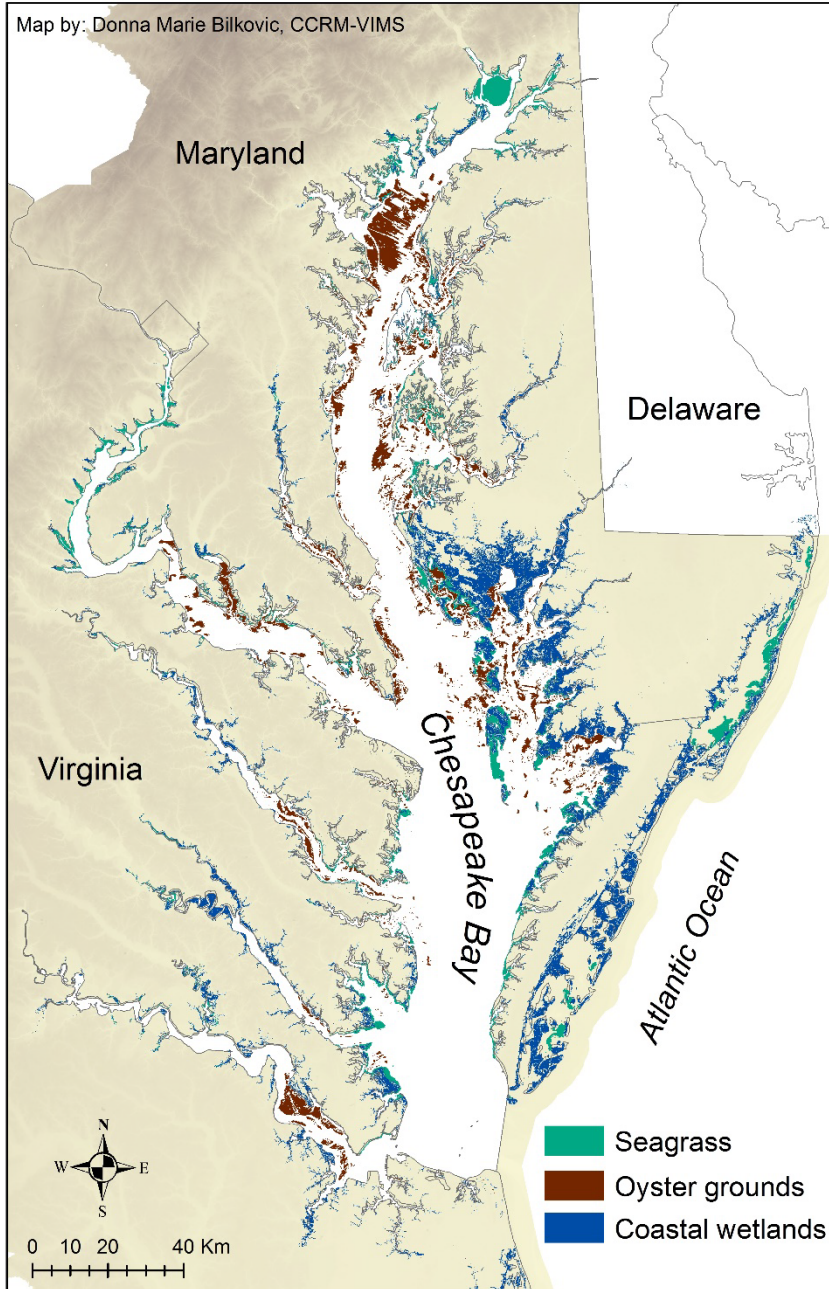
# SHORELINE ECOTONE: WHERE THE LAND MEETS THE ESTUARY



Shorescapes, a shoreline zone which includes riparian, intertidal, and shallow waters

- Ecosystems overlap, rich with species
- Areas where the human and natural systems meet and interact
- Frontlines for rising seas

# SHORELINE MARSHES



Switch  
Grass

Saltmeadow  
Hay

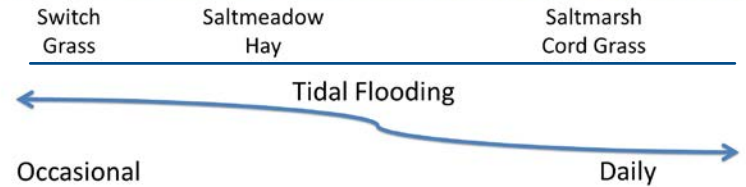
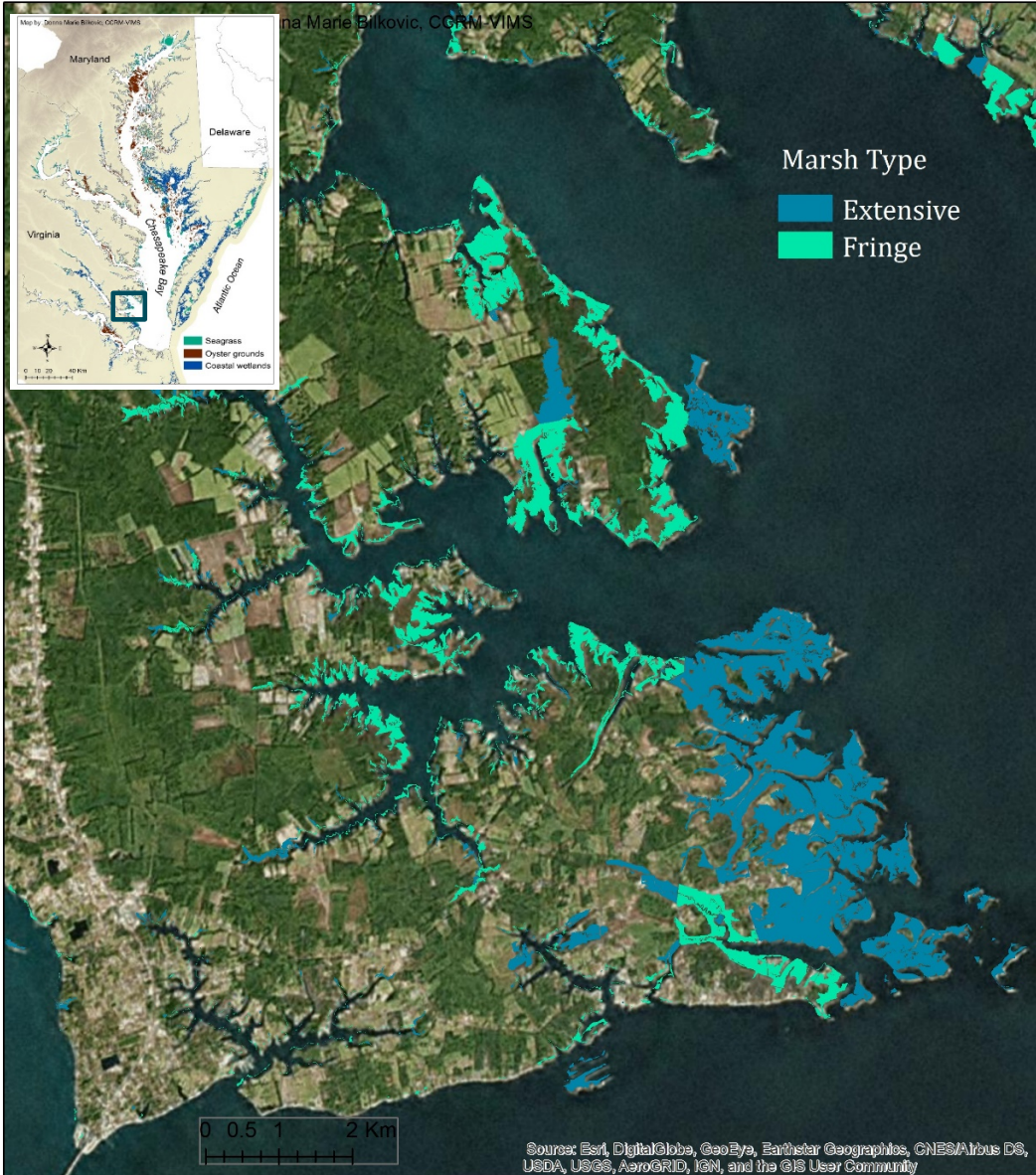
Saltmarsh  
Cord Grass

## Chesapeake Bay by the numbers

~ **1,500 km<sup>2</sup>** of tidal emergent salt  
and brackish marsh area

**14,026 km** of shoreline marshes  
(~60% of tidal shoreline surveyed)

# FRINGING MARSH VALUE

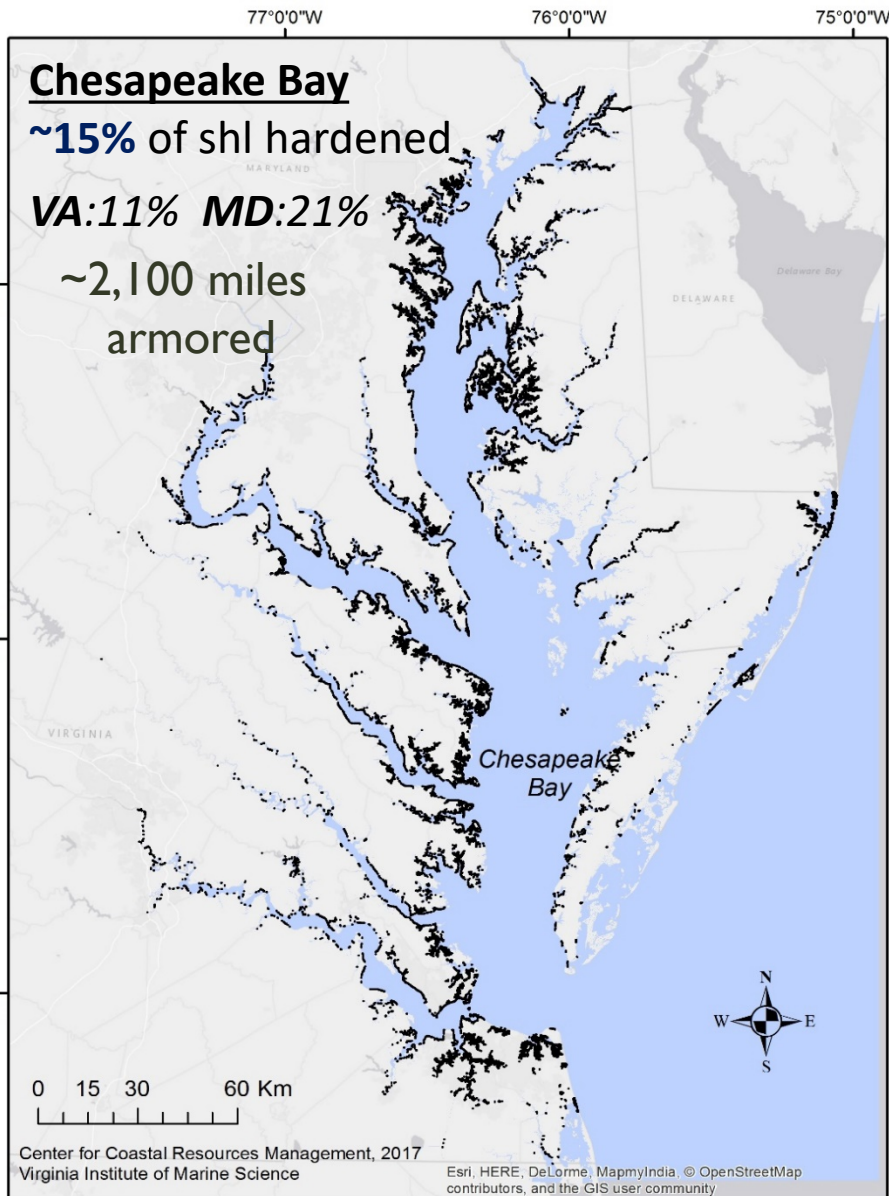


## Ecosystem services include:

- Attenuate waves <sup>1</sup>
- Trap sediment <sup>2</sup>
- Nitrogen removal <sup>3</sup>
- Support fish & invertebrates <sup>4</sup>
- Connectivity

<sup>1</sup>Shepard et al. 2011, Knutson et al. 1982, Morgan et al. 2009; <sup>2</sup>Neubauer et al. 2002, <sup>3</sup>Tobias et al. 2001, Koch & Stevenson 2005, Beck et al. 2017. Chambers et al. 2021, <sup>4</sup>Currin et al 2008, Minello et al. 1994, Peterson & Turner 1994, Micheli & Peterson 1999, Bilkovic et al. 2021, Guthrie et al, 2021, Isdell et al 2021

# SHORELINE MANAGEMENT - WHERE WE ARE NOW



Habitat loss & fragmentation – forest, wetlands <sup>1</sup>

Sediment supply & transport altered, increased scouring, turbidity <sup>2</sup>

Increase in invasive species <sup>3</sup>

Declines in fish, invertebrate, & marsh bird diversity, terrapin presence <sup>4</sup>

Prevents natural migration of habitats with SLR

Decline in seagrass resilience <sup>5</sup>



<sup>1</sup> Peterson and Lowe 2009; Dugan et al 2011, <sup>2</sup> Bozek and Burdick 2005, NRC 2007, <sup>3</sup> Chambers et al 1999, <sup>4</sup> Peterson et al 2000, Chapman 2003, King et al 2005, Bilkovic et al 2006, Seitz et al 2006, Bilkovic & Roggero 2008, Morley et al 2012, Isdell et al. 2015, Kornis et al. 2017a,b <sup>5</sup>Patrick et al. 2014

# CONTINUUM OF SHORELINE PROTECTION APPROACHES

## Natural features



Marshes, Beaches,  
Dunes, Reefs,  
Forests

## Nature-based



E  
n  
e  
r  
g  
y

## Enhanced



## Hardened



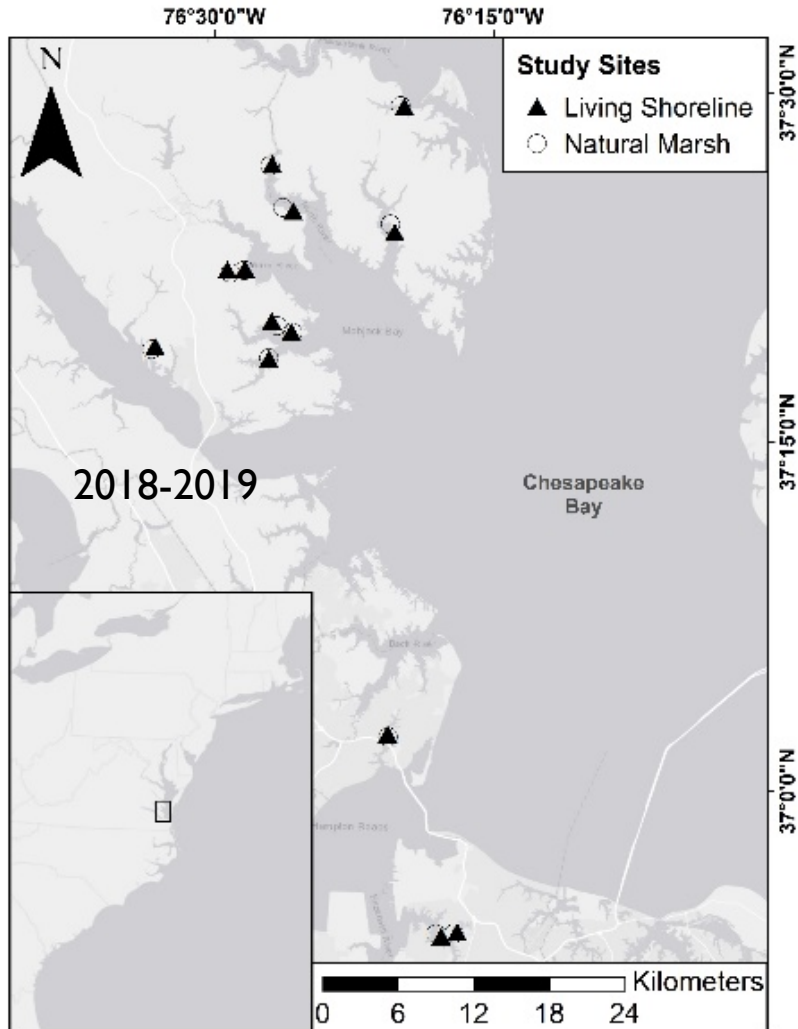
Natural  
features

Nature based  
features

Ecologically enhanced hard  
structural features

Hard structure  
features

# ECOSYSTEM BENEFITS OF LIVING SHORELINES



Compared ecosystem services of living shorelines (2-16 yrs) with natural marshes

- Primary Productivity
- Habitat Provision
  - *birds, fish, crabs, bivalves, terrapin*
- Carbon Storage
- Nutrient Storage



**VIMS** | WILLIAM & MARY  
VIRGINIA INSTITUTE OF MARINE SCIENCE



Center for Coastal Resources Management  
Virginia Institute of Marine Science

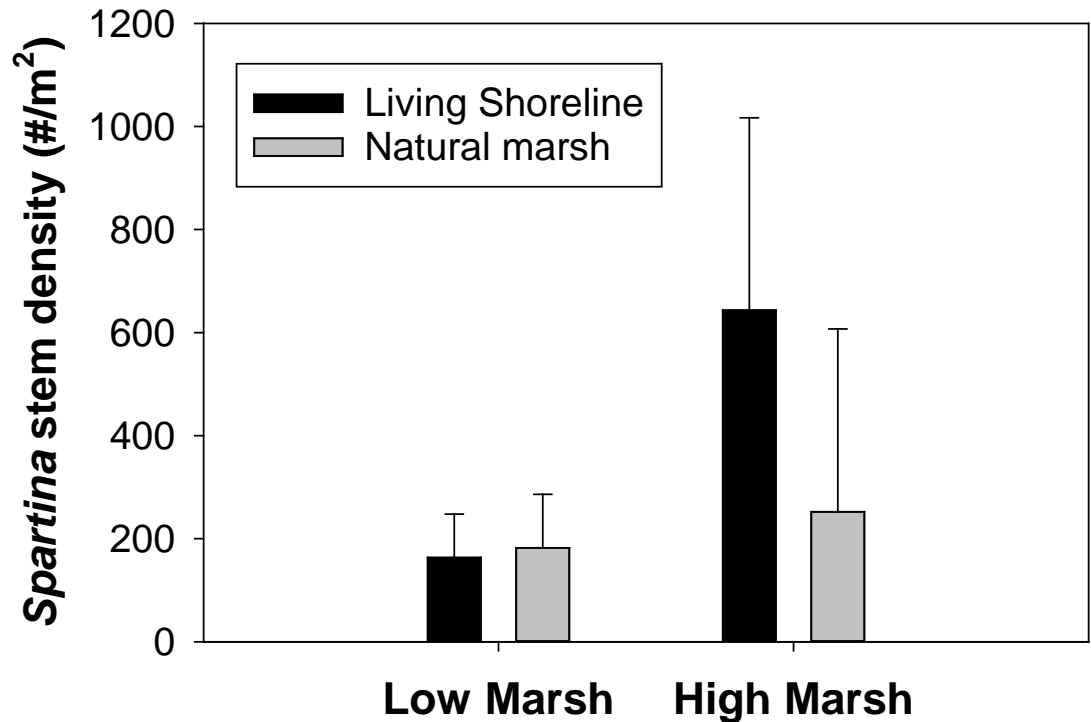
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Carl Vinson Institute of Government  
UNIVERSITY OF GEORGIA

[https://www.vims.edu/ccrm/research/climate\\_change/adaptation/nsf-2/index.php](https://www.vims.edu/ccrm/research/climate_change/adaptation/nsf-2/index.php)

## SHORE PROTECTION BENEFITS: MARSH PLANTS

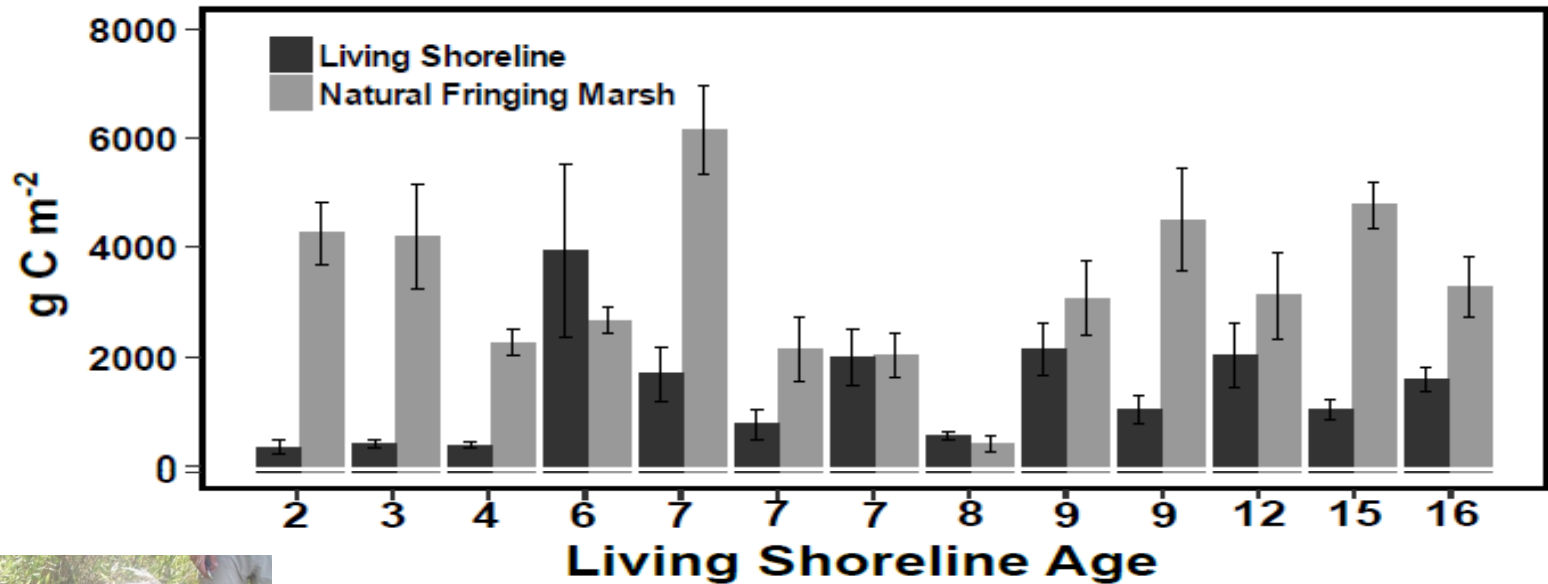
- Marsh plant stem density, stem height, & aboveground biomass influence the marsh's ability to trap sediments & attenuate wave energy



Living Shoreline marsh plants look a lot like natural marshes within 2 years post construction



# WATER QUALITY BENEFITS: SOIL STORAGE OF CARBON, NITROGEN & PHOSPHORUS



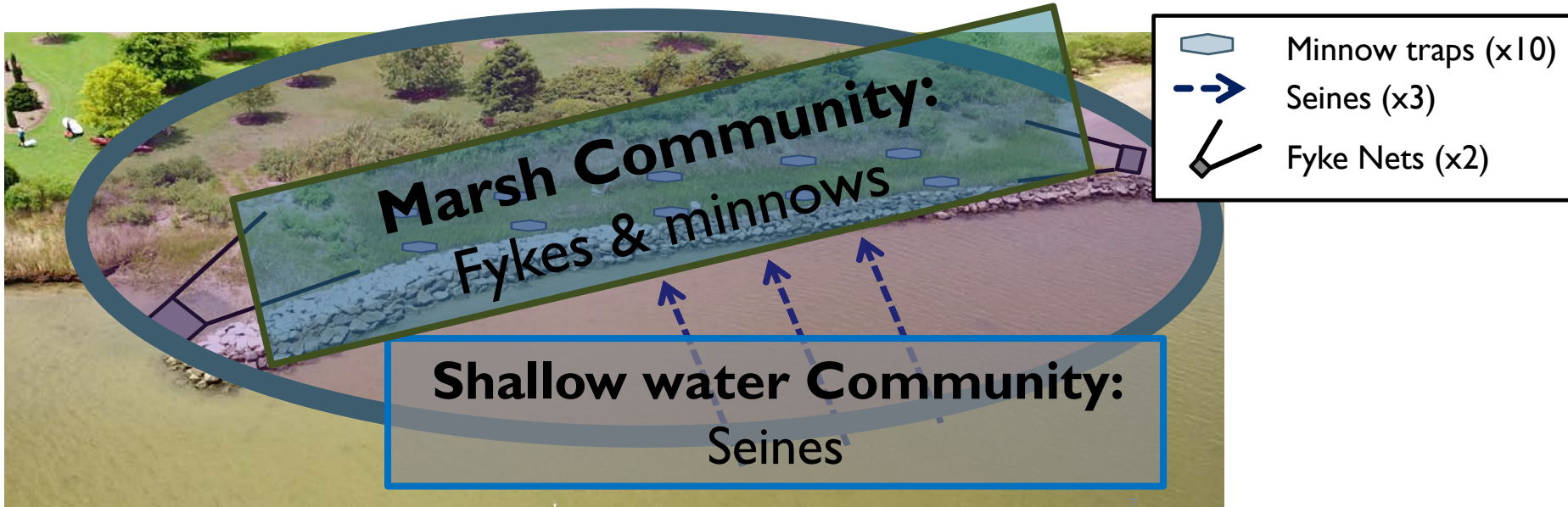
As living shoreline marshes age, NP, and carbon storage becomes more similar to natural marshes.

Avg # Years to Equivalence with natural marsh:

- Carbon: 24 ( $\pm 6$ ) years
- Nitrogen: 13 ( $\pm 3$ ) years
- Phosphorus: 6 ( $\pm 2$ ) years

Figures/data: Randy Chambers, [rmcham@wm.edu](mailto:rmcham@wm.edu),  
Chambers et al. 2021 *Ocean & Coastal Management*


# HABITAT BENEFITS: FISH, BLUE CRABS AND SHRIMP



- Nekton assemblages similar at natural fringing marshes and living shorelines
- Juveniles and small-bodied forage species predominate, using these habitats for refuge and feeding
- Early juvenile blue crabs use living shorelines as primary nurseries



95%

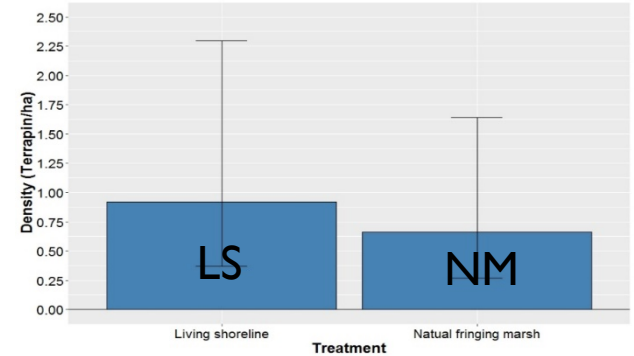


Mummichog
Shrimp
Atlantic silverside
Bay anchovy
Blue crab

# HABITAT BENEFITS: DIAMONDBACK TERRAPIN



## Terrapin use living shorelines



Living shorelines similar to Reference marshes

Terrapins observed 3 times for 30-min between mid-May and August (nesting season) each year



*Drs. Randy Chambers  
& Matthias Leu, W&M*

# HABITAT BENEFITS: WADING BIRDS

Great Egrets  
Great Blue Herons  
Yellow-crowned Night Herons  
Spotted Sandpipers  
Green Herons



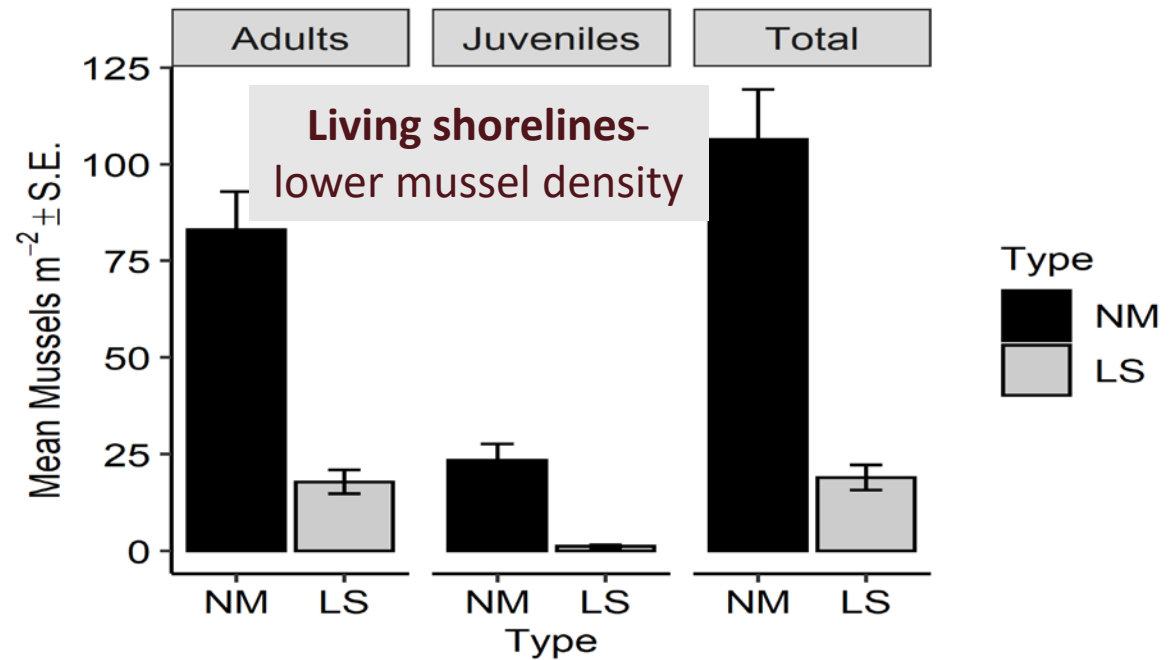
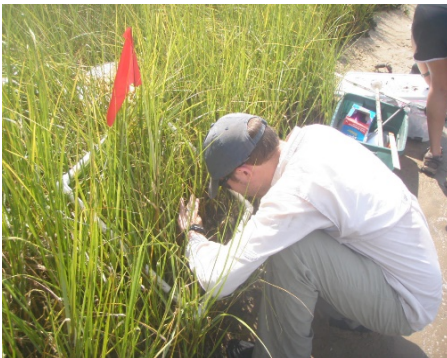
Living shorelines similar to Reference marshes



M. Leu (mleu@wm.edu), R. Galvin, W&M, R. Isdell, VIMS; in prep

# HABITAT AND WATER QUALITY BENEFITS: RIBBED MUSSELS

## *Geukensia demissa*



### Survival after settlement

- Lack of high quality refuge area
  - Lower plant density (newly restored sites)
  - Lack of adult mussels
- Sediment quality –
  - low OM, moisture

# WATER QUALITY & HABITAT BENEFITS: OYSTERS AND MUSSELS

## *On Hard Structural Features*



Breakwater- large quarry stone



Low profile, small stone sill



Oyster bags for sill



Oyster castles

# COASTAL DEFENSE BY OYSTERS REEFS - OPTIMIZING ECOLOGICAL & ENGINEERING GOALS

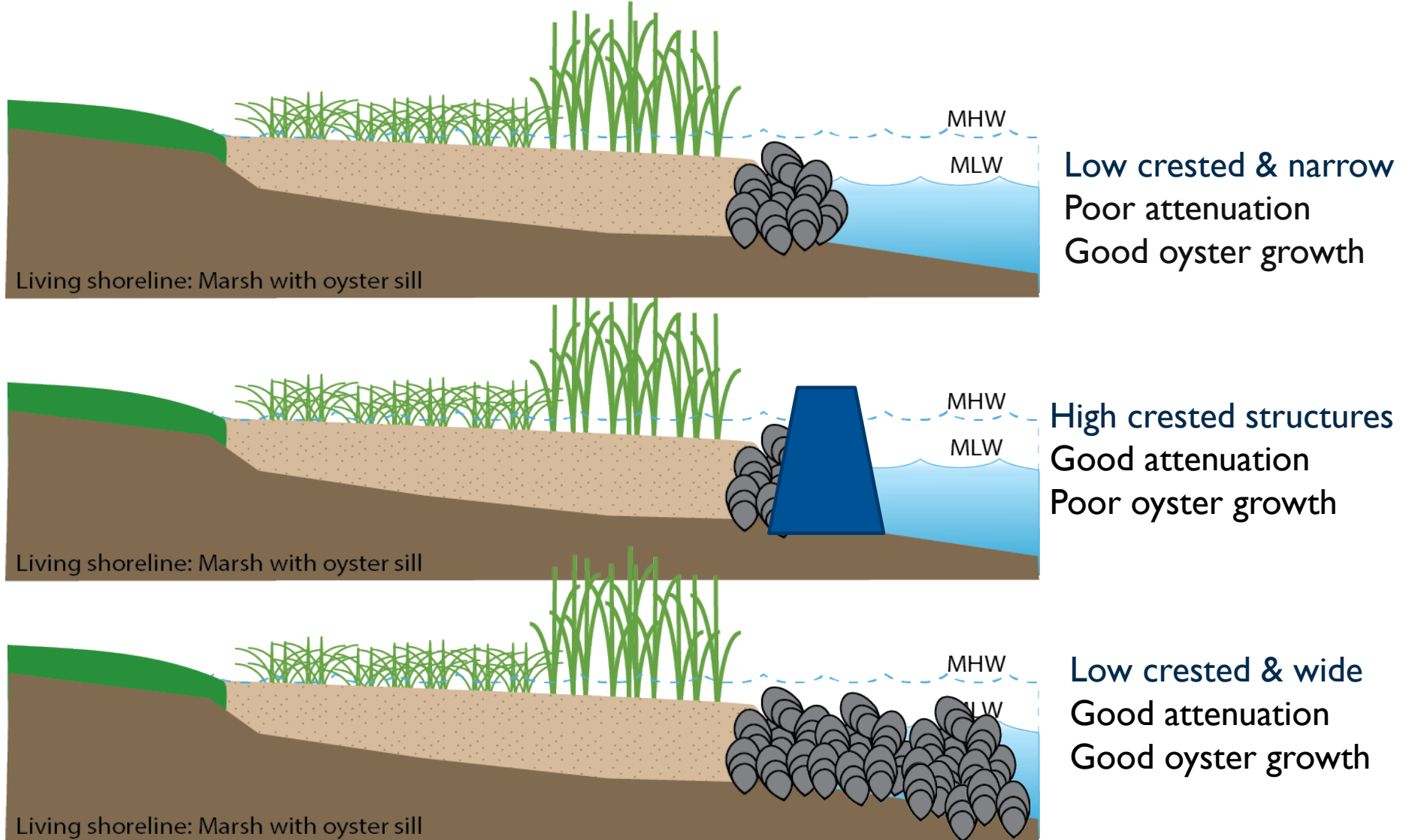
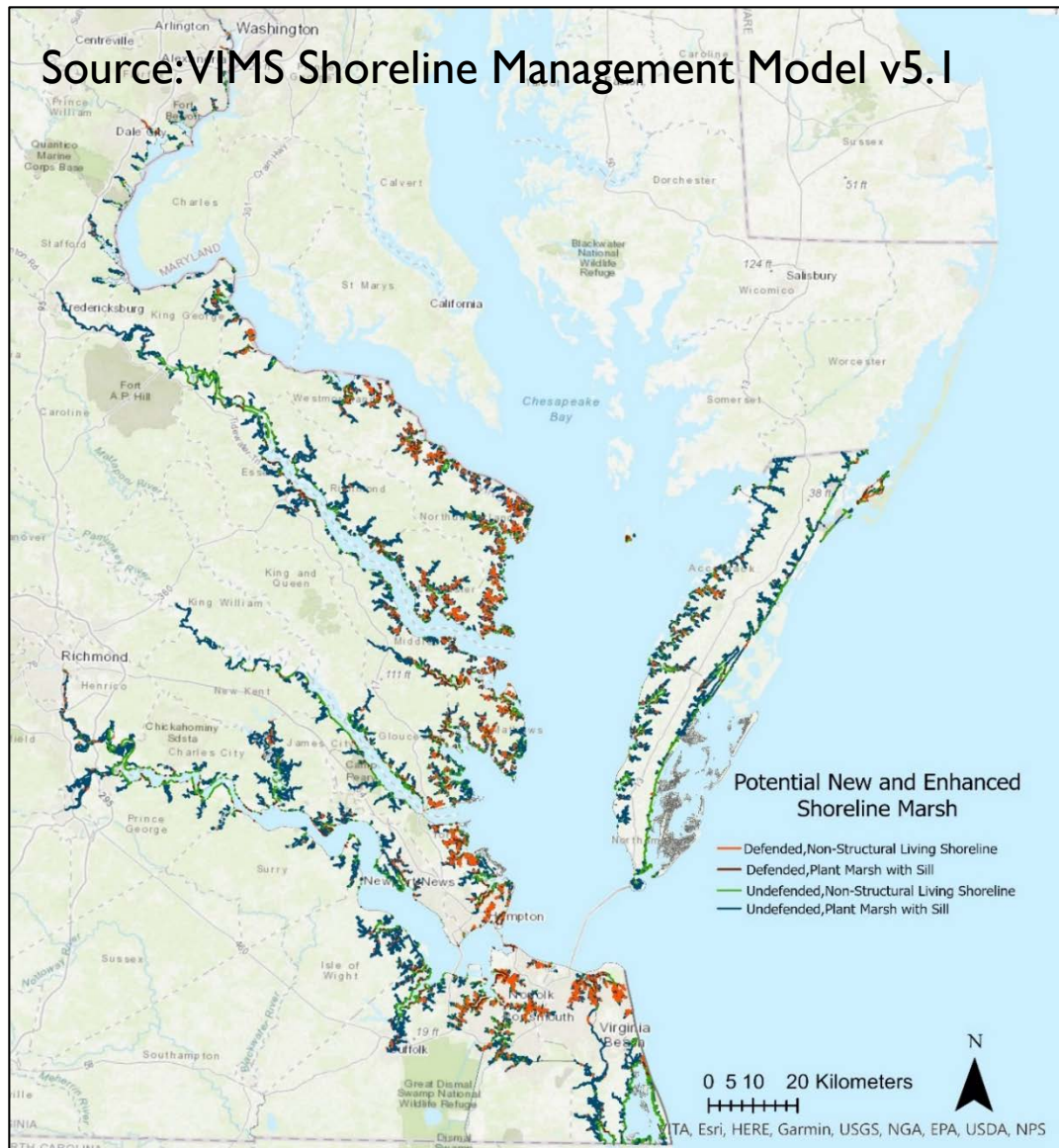


Figure by Molly Mitchell, Mitchell & Bilkovic 2019

Morris et al 2021, Ecol Appl

# CONCLUSION. OPPORTUNITIES TO RESTORE AND ENHANCE SHORELINE MARSHES

Source: VIMS Shoreline Management Model v5.1



- ✓ Both created and natural shoreline marshes provide numerous valued ecosystem services
- ✓ Over 10,000 km of shl in VA have opportunities to restore and enhance shoreline marshes. Some of those shores are currently armored.
- ✓ Adding natural elements to hardened shorelines may provide ecological benefits – this workshop



## QUESTIONS?

For more info on Living shorelines:

- [ADAPTVA.ORG](http://ADAPTVA.ORG)
- [www.vims.edu/ccrm/](http://www.vims.edu/ccrm/)
- [www.vims.edu/ccrm/outreach/living\\_shorelines/index.php](http://www.vims.edu/ccrm/outreach/living_shorelines/index.php)

**VIMS** – Carl Hershner, Donna Marie Bilkovic, Molly Mitchell, Joseph Zhang, Karinna Nunez, Julie Herman, Jian Shen, Amanda Guthrie, Robert Isdell

**W&M** – Randy Chambers, Matthias Leu, Sarah Stafford, Bob Galvin, Sam Mason

**ODU** – Michelle Covi, Wie Yusuf

**UGA** – Shana Jones

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