Wetlands and Coastal Resilience

Center for Coastal Resources Management
Virginia Institute of Marine Science

VIMS | William & Mary
Virginia Institute of Marine Science

Looking Ahead

- Co-Benefits =
- Co-Partners
- Co-Funding
- Multiple Outcomes
- Minimal Adverse Impacts

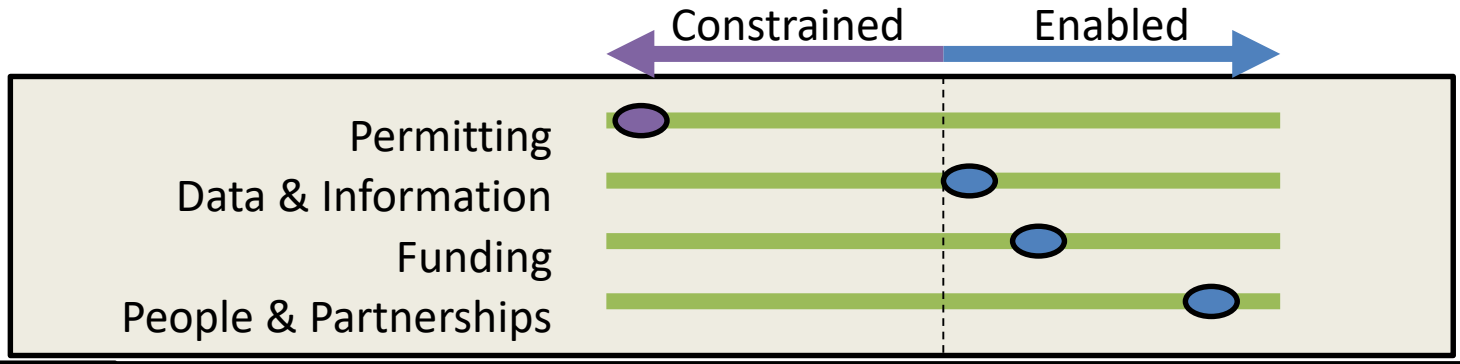
Learning From Sandy

Constraints

1. Insufficient Understanding
2. Lack of Engagement/ Partners
3. Regulatory Framework

Success Factors

1. Early engagement of regulators
2. Broad understanding
3. Partnerships



Examples

Recommendations

Permitting

- Expensive and time consuming
- Innovative and unfamiliar projects
- Demonstrate benefits not harm

- Programmatic permits
- Regulatory flexibility (e.g. pilots)

People & Partnerships

- Technical expertise
- Real world complexities
- Dedication and enthusiasm

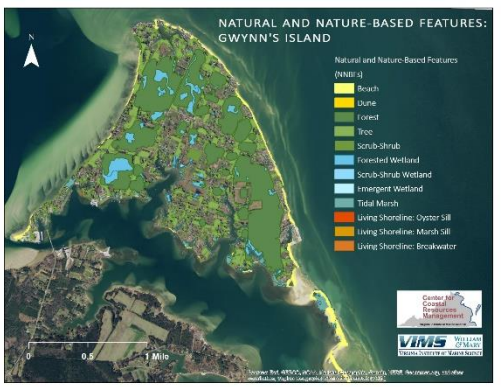
- Capacity building
- Cultivate relationships

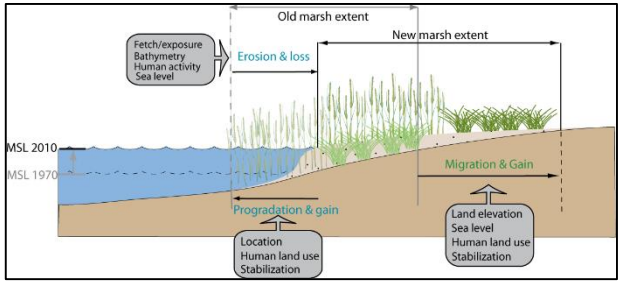
Overview

1. Wetlands for flood protection + multiple benefits

2. Marsh change

3. Tidal and non-tidal wetlands TMDL





Increasing use of natural and nature-based features to build resilience to storm-driven flooding

Step 1. Model flood benefits:

NNBF Capacity + Opportunity ⟶ Flooding Resilience

Step 2. Add water quality and socio-economic benefits

NNBF + TMDL/ Stormwater & Community Rating System/ FEMA Credits ⟶ Co-benefits

Step 3. NNBF Flood Protection + Co-Benefits = Priority land for protection

Step 4. Unprotected buildings/ communities + Co-benefits + Priority areas for Restoration & Creation




Step 1: NNBF for flood protection

Goals of the project:

- Map/Inventory of more than 350,000 NNBFs across the coastal region
- Identify those NNBFs that enhance flood resilience to about 190,000 buildings in coastal areas
- Identify the co-benefits generated by NNBFs
  - Ecologic – water quality
  - Socio-economic – Community Rating System FEMA
- Identify those NNBFs that provide multiple benefits for communities

Capacity of NNBF to mitigate flooding combined with Opportunity:

NNBF Flooding Protection Potential

NNBF Flooding Protection Potential

Green = low score *Red = high score*

Gwynn's Island, Mathews

Each NNBF is scored based on:

- Capacity: potential to mitigate coastal flooding
- Opportunity: frequency it will be intercept flooding waters based on elevation of the feature

Tidal Marsh NNBF:
Capacity for Tidal Marsh = 7
Opportunity: 1
Flooding Protection Potential = 7

Tree NNBF:
Capacity = 7
Opportunity = 0.001
Flooding Protection Potential = 0.007

How to we link NNBFs with the buildings they protect?

Inundation Pathways (IPs)

Gwynn's Island, Mathews

Inundation Pathways represent lowest areas where flooding waters would begin to flood onto the land and approach buildings (elevation derived from LIDAR data)

For each building, the number and types NNBFs that protect it

- *This building is protected by 1 NNBF (a tidal marsh)*

For each NNBF, the number of buildings it protects

- *This Wooded area protects 3 buildings*

NNBF Feature Types (in this map):
- Tidal Marsh
- Wooded

Relative importance of NNBF based on how many buildings it protects:

NNBF Flooding Protection Value

Flooding Protection Value

White = Zero score *Green = low score* *Red = high score*

Gwynn's Island, Mathews

Each NNBF is scored based on:

- Protection Potential
- # buildings the NNBF protects

Tidal Marsh:
Protects 32 buildings
Protection Potential = 7
Flooding Protection Value = 224

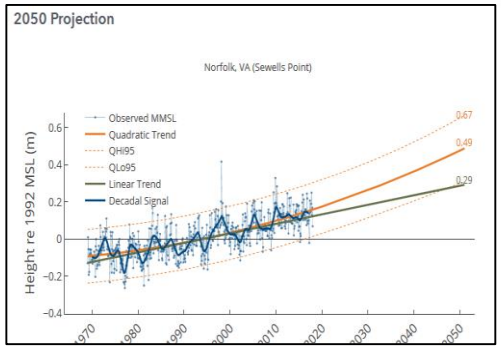
Tree area:
Protects 0 buildings
Protection Potential = 0.008
Flooding Protection Value = 0

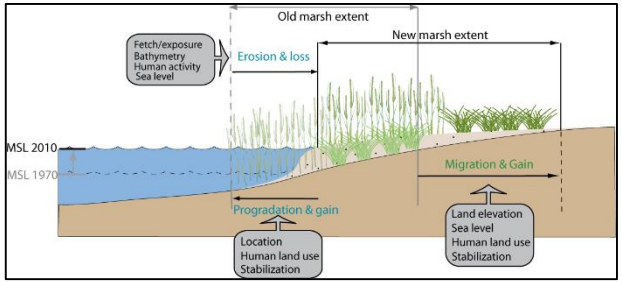
Tidal Marsh Futures

1. Sea level rise projections and variations around the Bay

2. Predicted SLR-related changes and their effect on marshes

3. Signals of change expected and observed in marshes

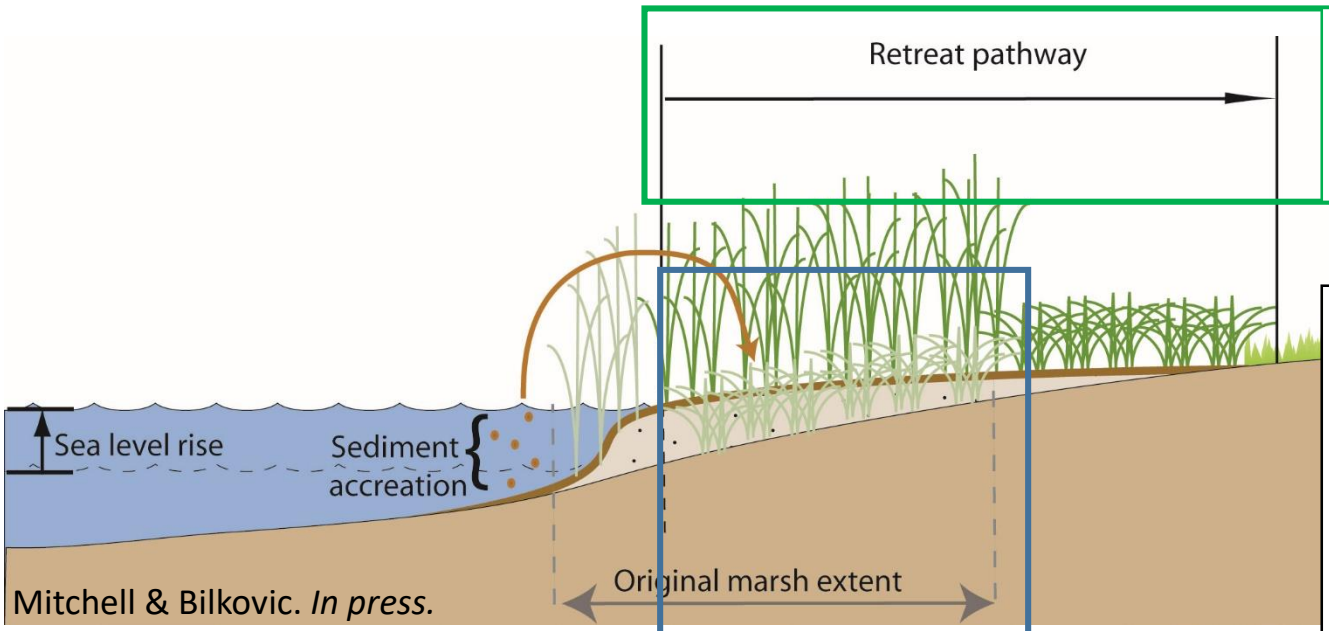




Generalized marsh change

To keep pace with sea level: a) Marshes migrate
b) Marshes accrete

Δ Water Levels



Controlled by:
SLR
Land elevation

Modified by human activities & decisions

Δ CO_2

Δ Water Levels

Δ Temperature

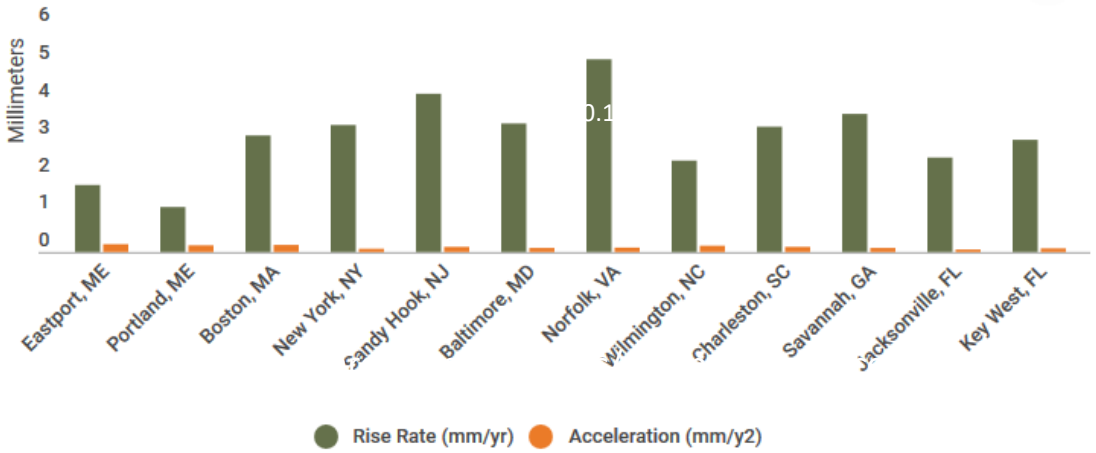
Controlled by:
Plant production
Sediment availability
Sediment respiration

Organic marsh accretion affected by:

1. Change in plant type affects **production rates** or **root:shoot ratio** and **decomposition rate** **(salinity & inundation)**
2. Responses are **species specific**
3. Changes in sediment decomposition rates due to changes in **temperature**

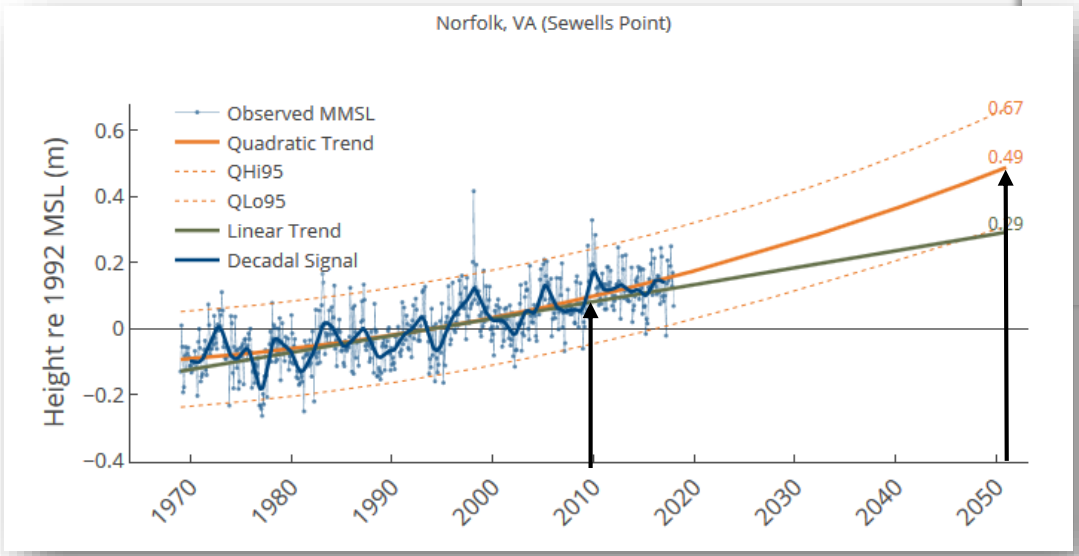
Theoretical maximum ~ 5mm/yr

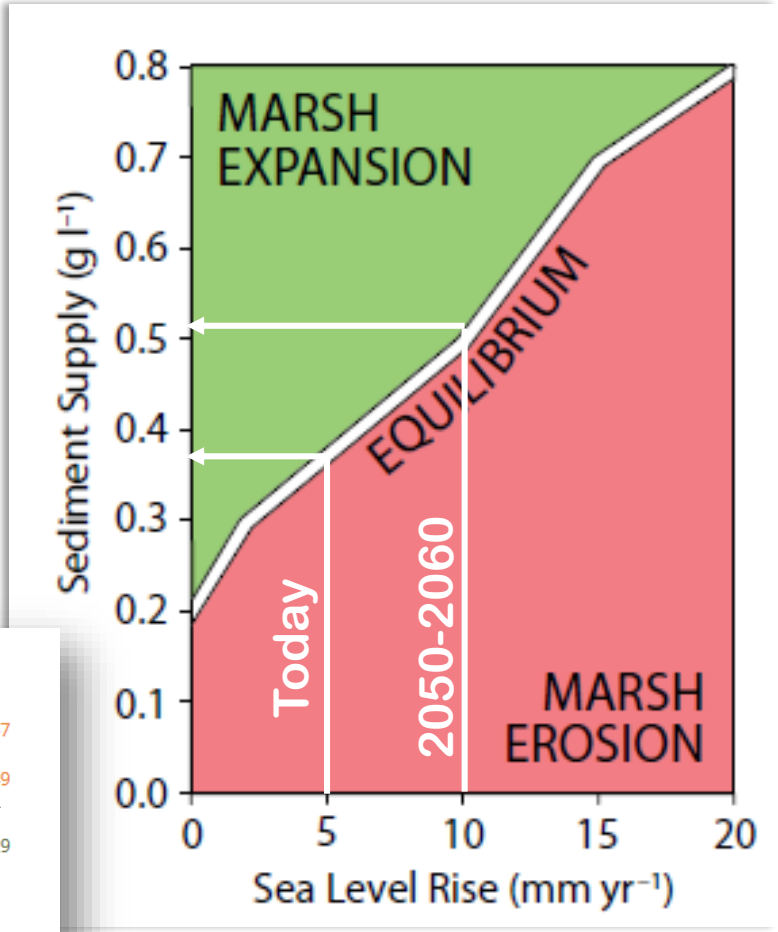
(Morris et al. 2016)



Inorganic marsh accretion affected by:

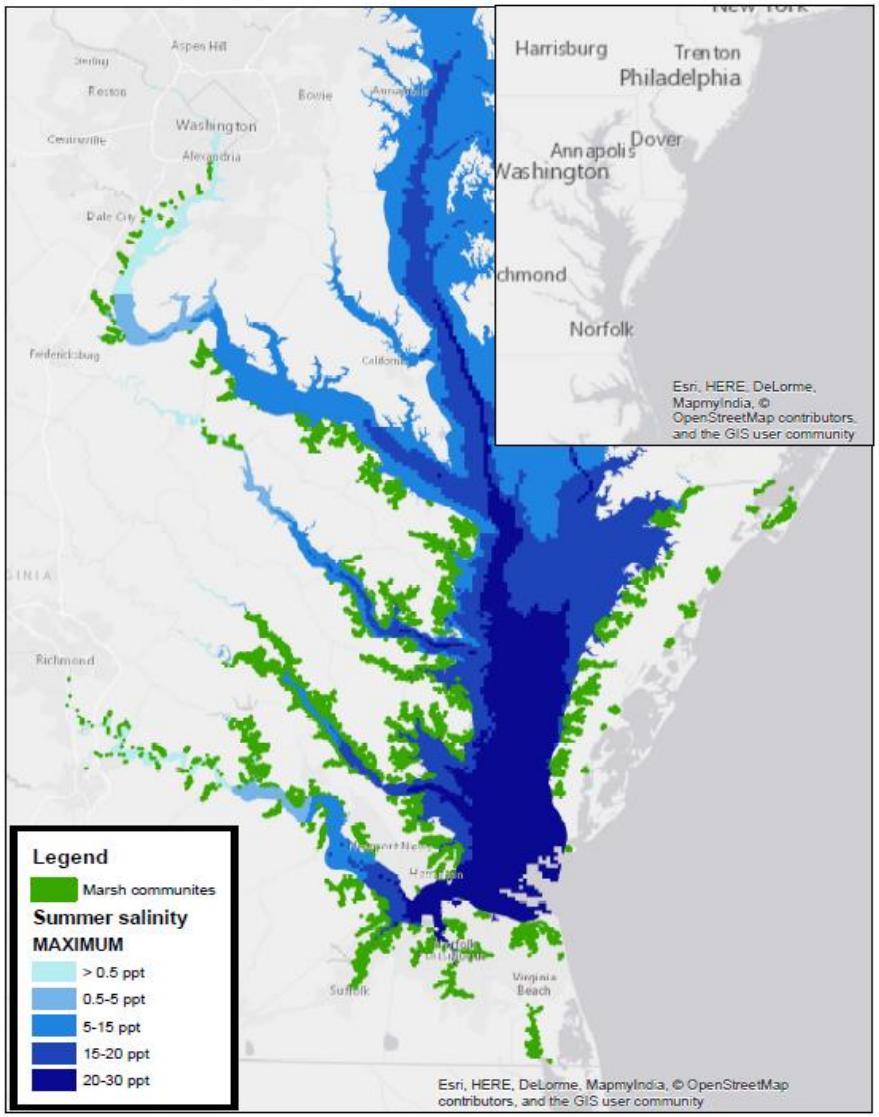
- Sediment supply coming from
  - Watershed
  - Adjacent lands (via runoff or tidal waters)
  - Marsh front edge erosion
- Current management goals are to restrict sediment in waters





Fagherazzi et al. 2013. *Oceanography*, *26*(3): 70-77.

VIMS Tidal Marsh Inventories



- Survey info:
  - Historic TMIs were surveyed and delineated from 1970s-1991
  - current TMIs were surveyed and delineated from 2010-2018
  - average time between surveys was 32 years

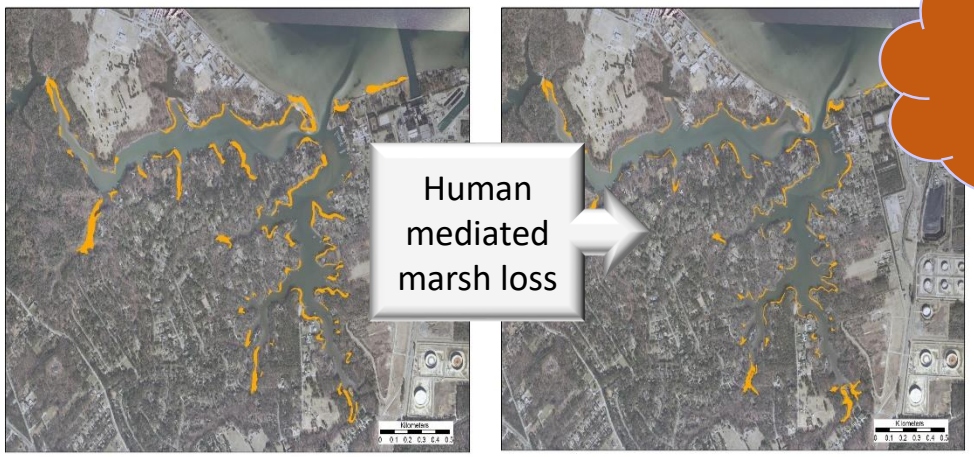
- Plant community comparison:
  - York River = **263** marsh plant species matrices
  - Chesapeake Bay = **17,658** marsh plant communities

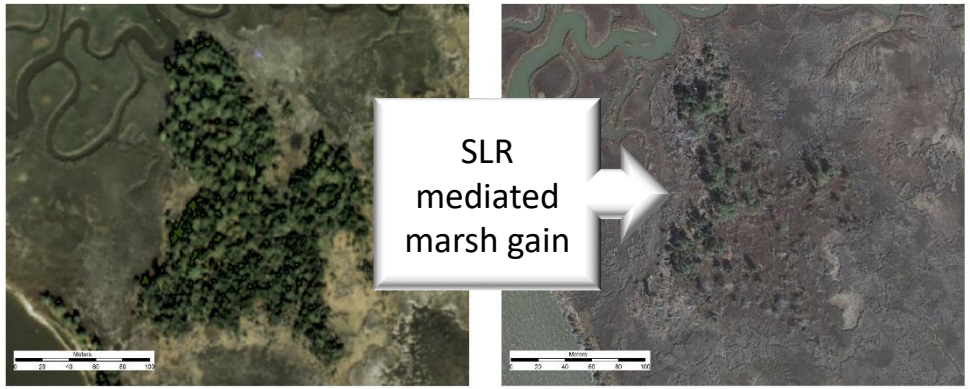
Marsh response varies by form as well as setting

Ecologically important fringe marshes are particularly vulnerable. So are marsh islands…

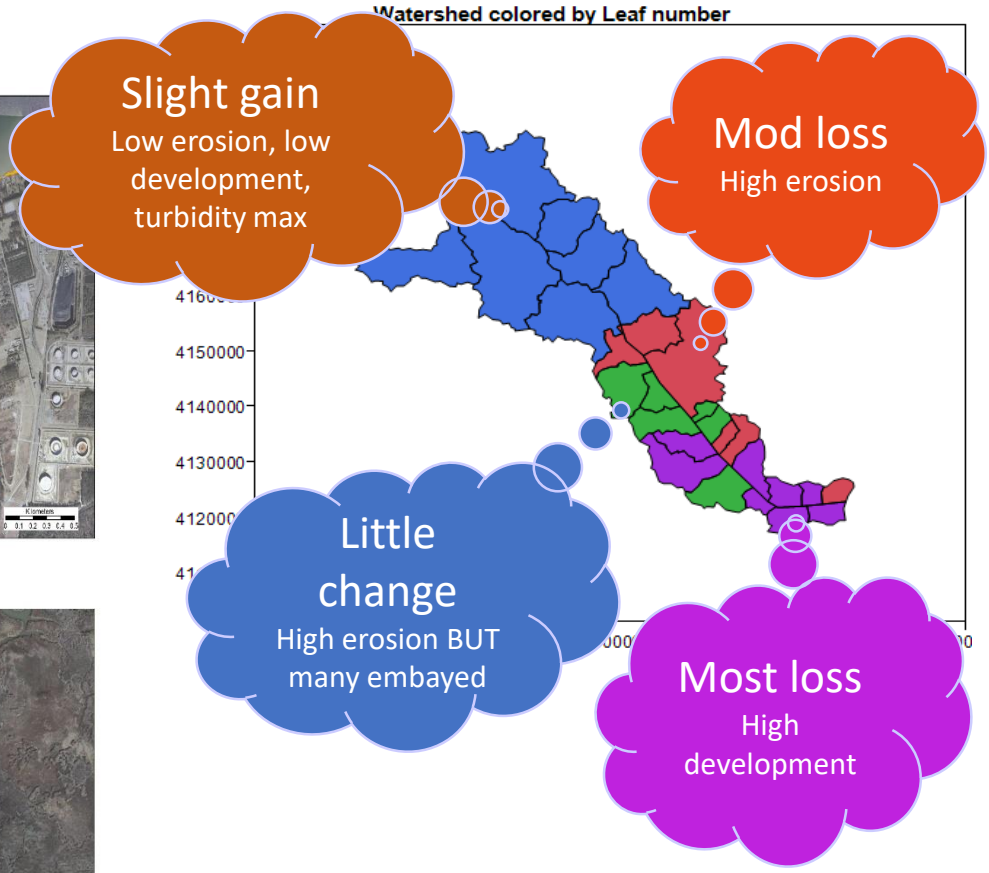
Historic marsh

Current marsh





York River, VA



Mitchell et al. 2017. Ecosystem Health and Sustainability, 3:10, DOI: 10.1080/20964129.2017.1396009

Wetlands TMDL Credits

- Driver for wetland restoration/ creation
- Driver for preservation?
- Incentive for multiple partnerships
  - Financial
  - Design
  - Implementation
- Trade-offs/ unintended consequences

Tidal Shoreline BMPs

Protocol	Submitted Unit	Total Nitrogen (lbs per unit)	Total Phosphorus (lbs per unit)	Total Suspended Sediment (lbs per unit)
Protocol 1 - Prevented Sediment	Linear Feet	Project-Specific*	Project-Specific*	Project-Specific
Protocol 2 – Denitrification	Acres of re-vegetation	85	NA	NA
Protocol 3 - Sedimentation	Acres of re-vegetation	NA	5.289	6,959
Protocol 4 – Marsh Redfield Ratio	Acres of re-vegetation	6.83	0.3	NA
Non-conforming/Existing Practices *	Linear Feet	MD = 0.04756 VA = 0.01218	MD = 0.03362 VA = 0.00861	MD = 164 VA = 42

- Basic qualifying conditions for BMPs/sites
- 4 general protocols to define load reductions associated with specific BMPs
- 5-year BMP life, renewable upon field verification

Shoreline BMP Qualifying Criteria

Shoreline Management Practice	The Practice Must Meet these Criteria for TMDL Pollutant Load Reduction[1]
Living Shoreline – a) nonstructural; b)hybrid system including a sill; and c)hybrid system including a breakwater	1. The site is currently experiencing shoreline erosion or is replacing existing armor. The site was graded, vegetated, and excess sediment was removed or used.[2] **AND** 2. When a marsh fringe habitat (a or b) or beach/dune habitat (c) is created, enhanced, or maintained.
Revetment AND/OR Breakwater system without a living shoreline	1. The site is currently experiencing shoreline erosion, **AND** 2. A living shoreline is not technically feasible or practicable as determined by substrate, depth, or other site constraints. **AND** 3. When the breakwater footprint would not cover SAV, shellfish beds, and/or wetlands.
Bulkhead/Seawalls	1. The site is currently experiencing shoreline erosion. **AND** 2. The site consists of port facilities, marine industrial facilities, or other marine commercial areas where immediate offshore depth (e.g., depths deeper than 10 feet 35 feet from shore) precludes living shoreline stabilization or the use of a breakwater or revetment.

[1]Projects that impact the Chesapeake Bay Preservation Act protected vegetation without mitigation receive no Chesapeake Bay TMDL pollutant load reduction. Further, WQGIT agreed to allow States to determine, on a case-by-case basis, when the unintended consequences of negative impacts to wetlands and SAVs caused by these shoreline management techniques, outweigh the benefits, in which case the practice will not be reported to the Bay Program for model credit.

Non-tidal Wetland Restoration Credits: Retention Efficiencies and Acres Treated

	Retention Efficiency			Upland Acres Treated	
Physiographic Subregion	TN	TP	TSS	Floodplain Wetlands	Other Wetlands
Appalachian Plateau	42	40	31	2	1
Appalachian Ridge and Valley	42	40	31	2	1
Blue Ridge	42	40	31	3	2
Piedmont	42	40	31	3	2
Inner Coastal Plain	42	40	31	6	4
Outer Coastal Plain- Poorly Drained	42	40	31	2	1
Outer Coastal Plain- Well Drained	42	40	31	3	2
Coastal Plain Lowland	42	40	31	3	2
Karst Terrain	42	40	31	3	2

***Other wetlands with low treatment potential due to small contributing area predominated by forest and/or strong potential for contaminated water to by-pass the wetlands: 1 ACRE**

****Other wetlands with high treatment potential, located in heavily impacted watersheds and having strong likelihood for hydrologic contact: 4 ACRES**

*****All other wetlands: 2 ACRES**

******Floodplain wetlands with additional overbank delivery: 150% of Other**

Concerns for Wetland BMP Incentive

- Review Processes for Qualifying Criteria: How and Who verifies

- Tidal BMP: Erosion is a natural process: Sand and sediment necessary for marsh and beach persistence. Significant credits from Protocol 1 : Non-vegetated approach
- Tidal BMP: Promoting shoreline management in locations with little or no risk. May promote unwarranted shoreline management and modification to natural processes
- Consideration of climate effects on efficiencies (Persistence and nutrient sediment removal)
- New WOTUS rules change process?
- Re-Arrange wetlands in the landscape: Little restoration in Urban

Take Home Points

- Wetland acreage, location and function will change from human and “natural” (climate) impacts
- Opportunities to restore/ create acres toward goals increase with multiple benefits
- CBP management priorities and strategies may result in unintended or cross-purpose outcomes
- Management approaches need be considered at multiple spatial and temporal scales