

WETLANDS: Ecology, Benefits, and Management

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Center for Coastal Resources Management

Virginia Institute of Marine Science

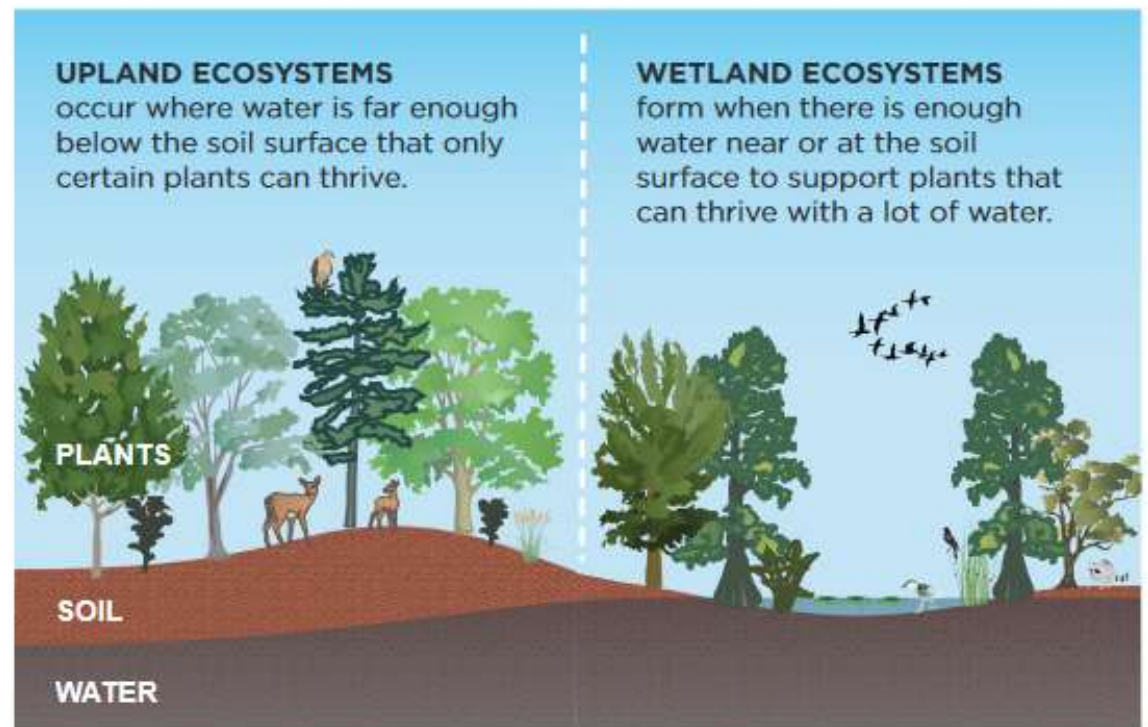


Wetlands 101

- Wetlands Definition & Components
- Wetlands Ecosystem Services/ Functions
- Wetlands Management
- Wetland Mapping
- Wetland Status and Stressors
 - Wetlands and Sea Level Rise

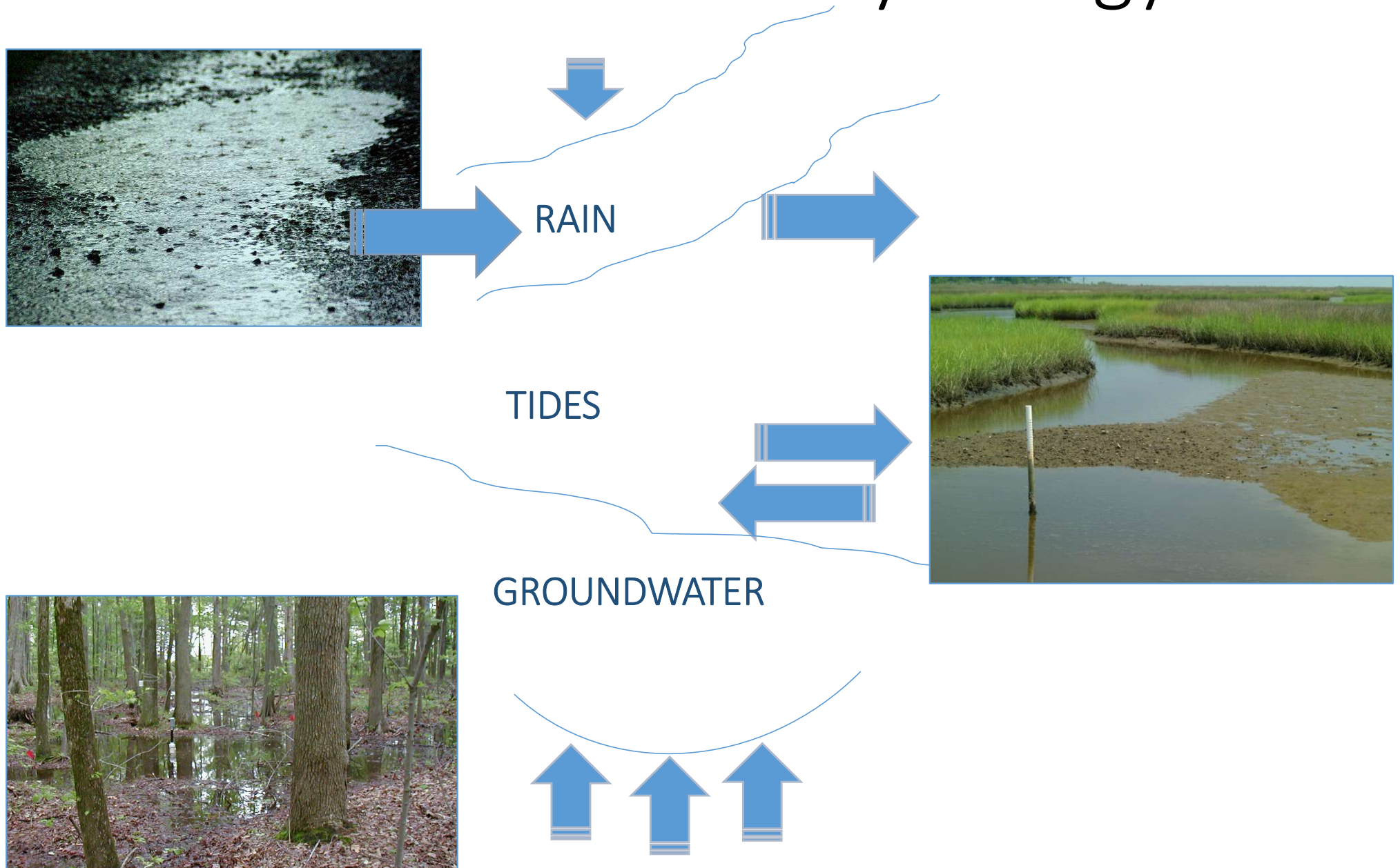
💧 Wetland Definition

Areas inundated or saturated by surface or ground **WATER** at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of **VEGETATION** typically adapted for life in saturated **SOIL** conditions. Wetlands generally include swamps, marshes, bogs and similar areas.



Uplands vs. Wetlands

Water Sources: Hydrology



VEGETATION

- Hydrophytes - water-loving
Adaptations: Reproductive, Morphologic, Physiologic
- Halophytes-salt-loving
Adaptations: Salt excretion, succulents



SOILS

- 💧 Saturated soils are anoxic and reduced
- 💧 Elemental metals and compounds are soluble under reduced conditions
- 💧 Soluble metals are leached over geologic time
- 💧 The resulting soil color is black or grey, ie colorless



Ecosystem Services i.e. Functions

- Components of nature, directly enjoyed, consumed, or used to yield Human well-being.

Boyd and Banzhaf 2006. What are ecosystem services? The need for standardized environmental accounting units. Resources for the Future DP-0602. 26pp.



Wetland Ecosystem Services

- 💧 Erosion regulation
- 💧 Water Quality
- 💧 Greenhouse gas reduction
- 💧 Production of fish, grains, ie. Habitat
- 💧 Soil formation
- 💧 Nutrient cycling
- 💧 Cultural
- 💧 Aesthetics
- 💧 Recreation



Why is water quality in need of improvement?

Water quality in nearly 80% of Virginia's tidal waters is impaired due to a variety of pollutants*

Virginia Department of Environmental Quality. Draft 2012
305(b)/303(d) Water Quality Assessment Integrated Report.

Pollutants affect:

- The ability of the tidal waters to support aquatic life and wildlife
- The safety of fish and shellfish consumption
- The ability of humans to use the water as a drinking water source and for recreation



Wetlands Improve Water Quality

Sediment, nutrients and other pollutants are filtered from surface water runoff, groundwater and tidal water



Wetlands: Water Quality Processes



- ☹ Pollutants
- ☹ Nutrients
- ☹ Sediment
- ☹ Toxicants
- ☹ Pathogens

Water Quality Processes

💧 Sediment

Wetlands act as sediment sinks or basins. Wetland vegetation slows water velocity and particles settle out.

💧 Erosion Control

Wetlands can dissipate up to half normal wave energy within the first 3 meters of marsh grass



Pollutant Trapping

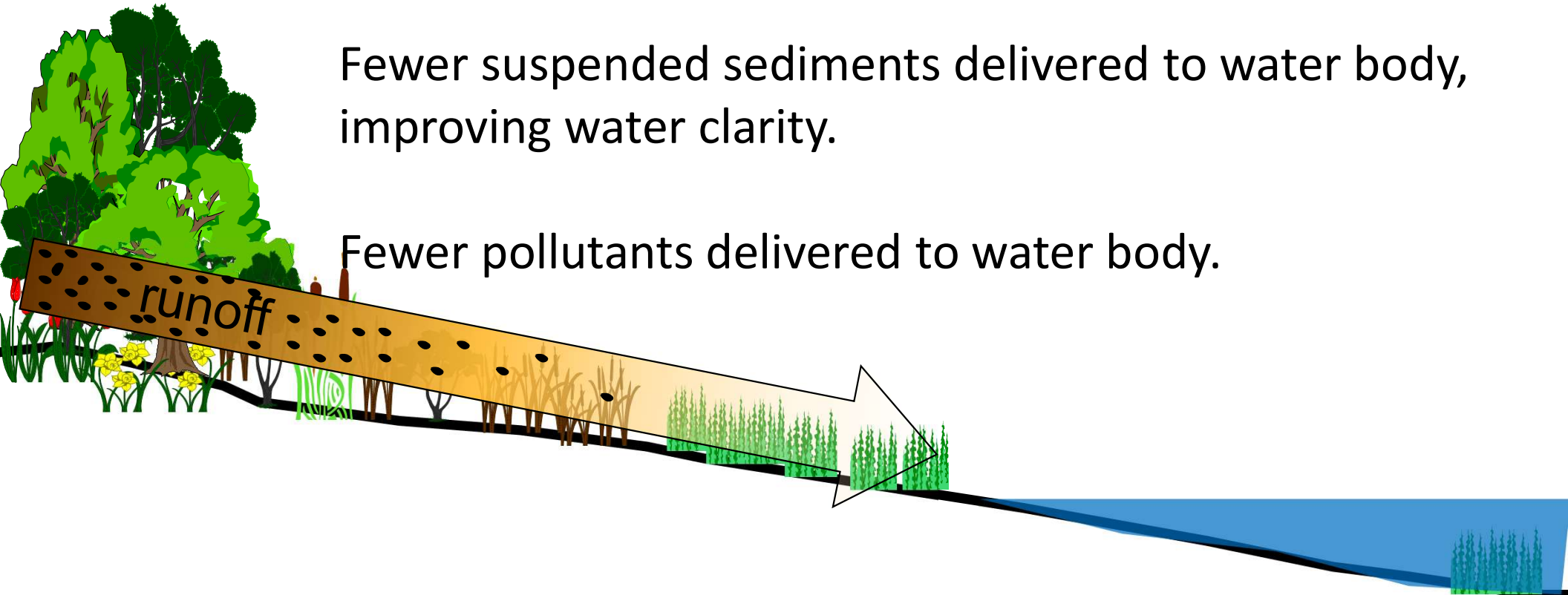


Vegetation slows runoff rate with lots of stems above ground, and a complex root system below ground.

Reduced rate of flow leads to pollutant.

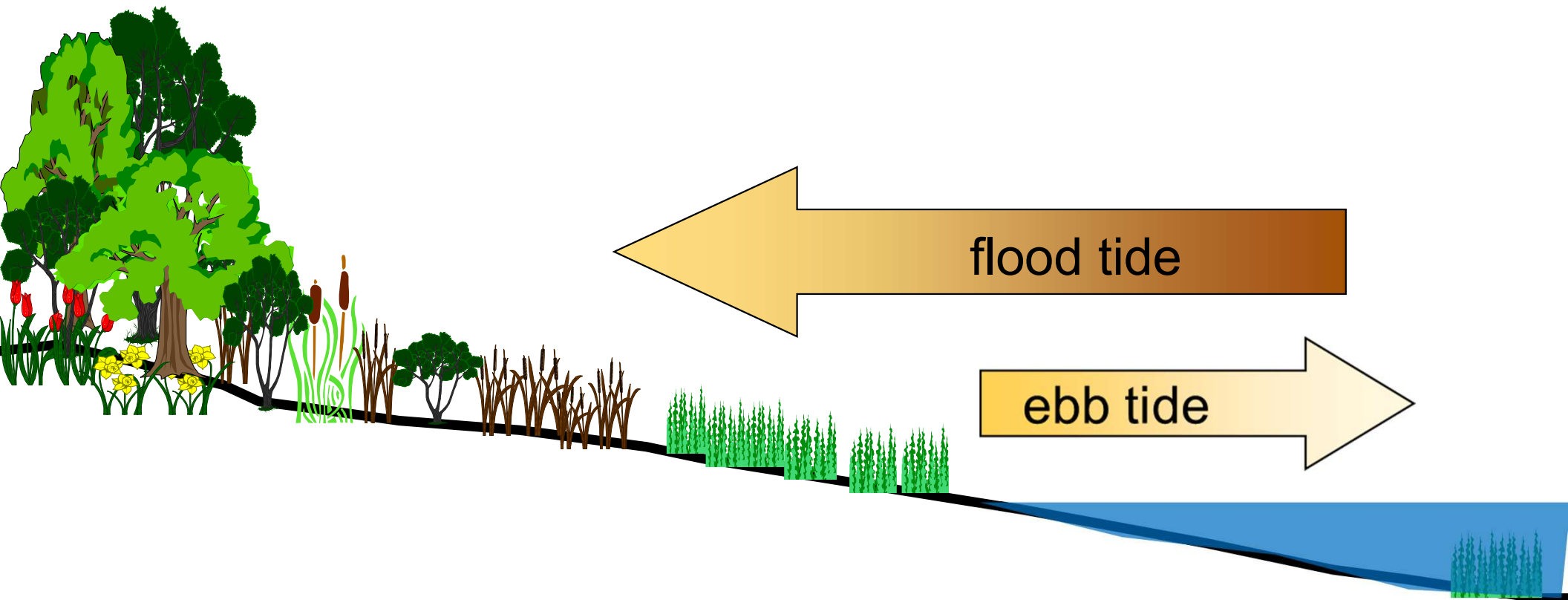
Fewer suspended sediments delivered to water body, improving water clarity.

Fewer pollutants delivered to water body.

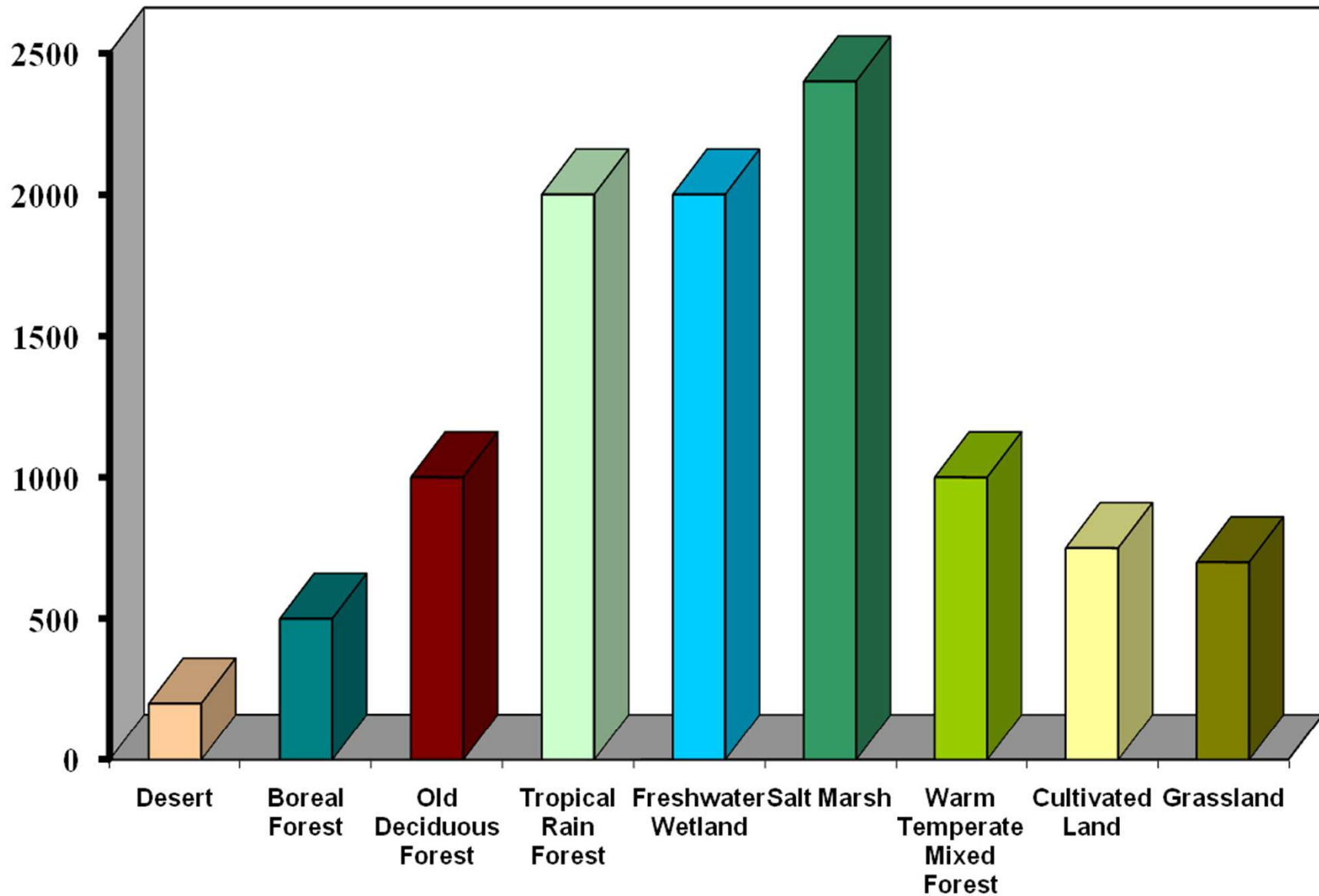


Pollutant Trapping

Dense shoreline vegetation can also dissipate energy and trap sediments and pollutants from tidal waters



Wetlands Produce Organic Matter



Primary Production ($\text{g/m}^2 \text{yr}^{-1}$)

Vegetated Marsh Productivity

Tidal marsh plants are the primary source of organic matter and nutrients that form the basis of the aquatic food chain.

Tidal wetland plants convert sun's energy into glucose stored in plant tissues.



Plant structure and marsh detritus (decaying plant material) supports microorganisms like bacteria, algae, and fungi.



Detritus and microorganisms provide food for marsh snails, worms, fiddler crabs and shrimp. These small animals are food for blue crabs, fish, birds, and mammals.



Tidal Shoreline Ecosystem: Habitat Types



Wetlands Habitat

- 💧 **Spawning Area**
- 💧 **Nursery For Juvenile Fish/Crabs**
- 💧 **Shelter From Predators**
- 💧 **Food/ Forage Area**
- 💧 **Nesting Sites**



Tidal wetlands provide foraging, shelter, nesting, spawning and nursery areas for a variety of birds, fish, mammals, reptiles, and invertebrates.



Vegetated Tidal Marsh Habitat

Tidal marshes provide **shelter** and **nursery** areas.

Ribbed mussels attach to plant roots and to each other on the marsh surface.



Wading birds and mammals, like muskrat and otters, find shelter and hiding places in marshes.



Tidal marshes are extremely important feeding & nursery areas for fish, including valuable commercial and recreational species.





Non-Vegetated Tidal Wetlands Habitat

High value due to the number of **benthic** animals
(animals that live on or under the sand and mud surface)

Intertidal Beaches

Amphipods
Mole crabs
Donax clams

Sand & Mud Flats

Amphipods
Bloodworms
Clams
Sandworms
Mud snails

Intertidal Oyster Reefs

Oysters
Hard clams
Curved mussels
Amphipods
Mud crabs



Amphipod

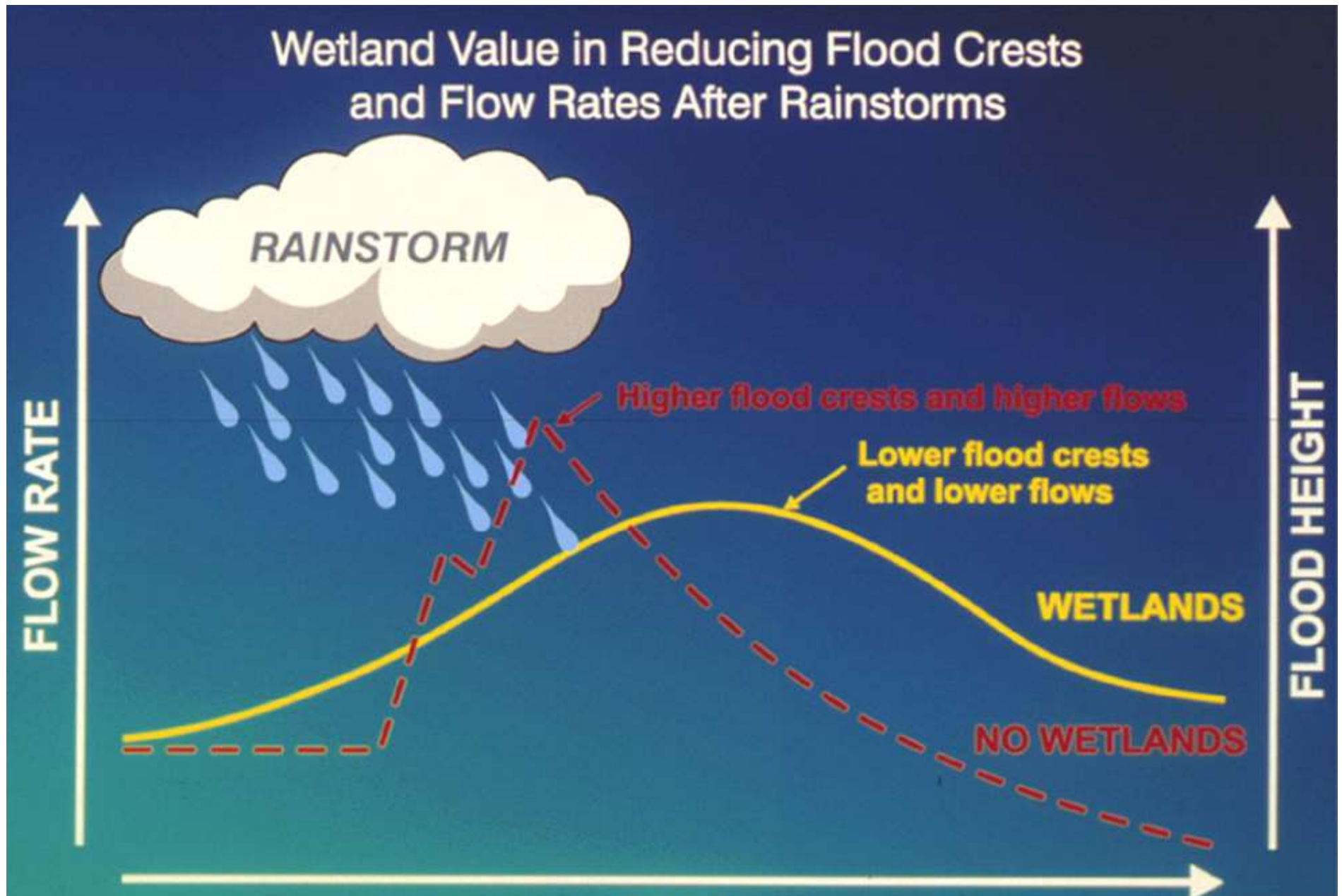


Common Clamworm

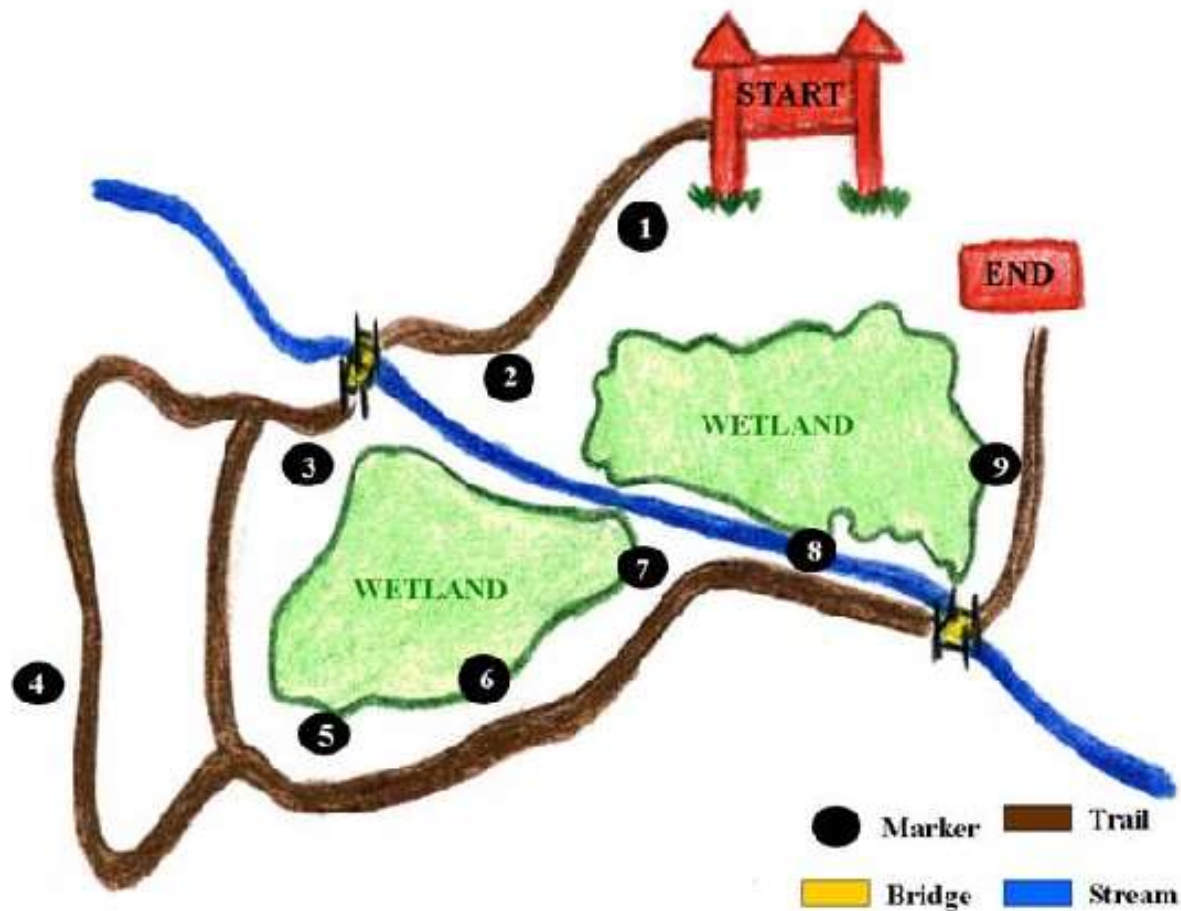


Stout razor clams

Regulation: Floods



Cultural: Aesthetics and Education



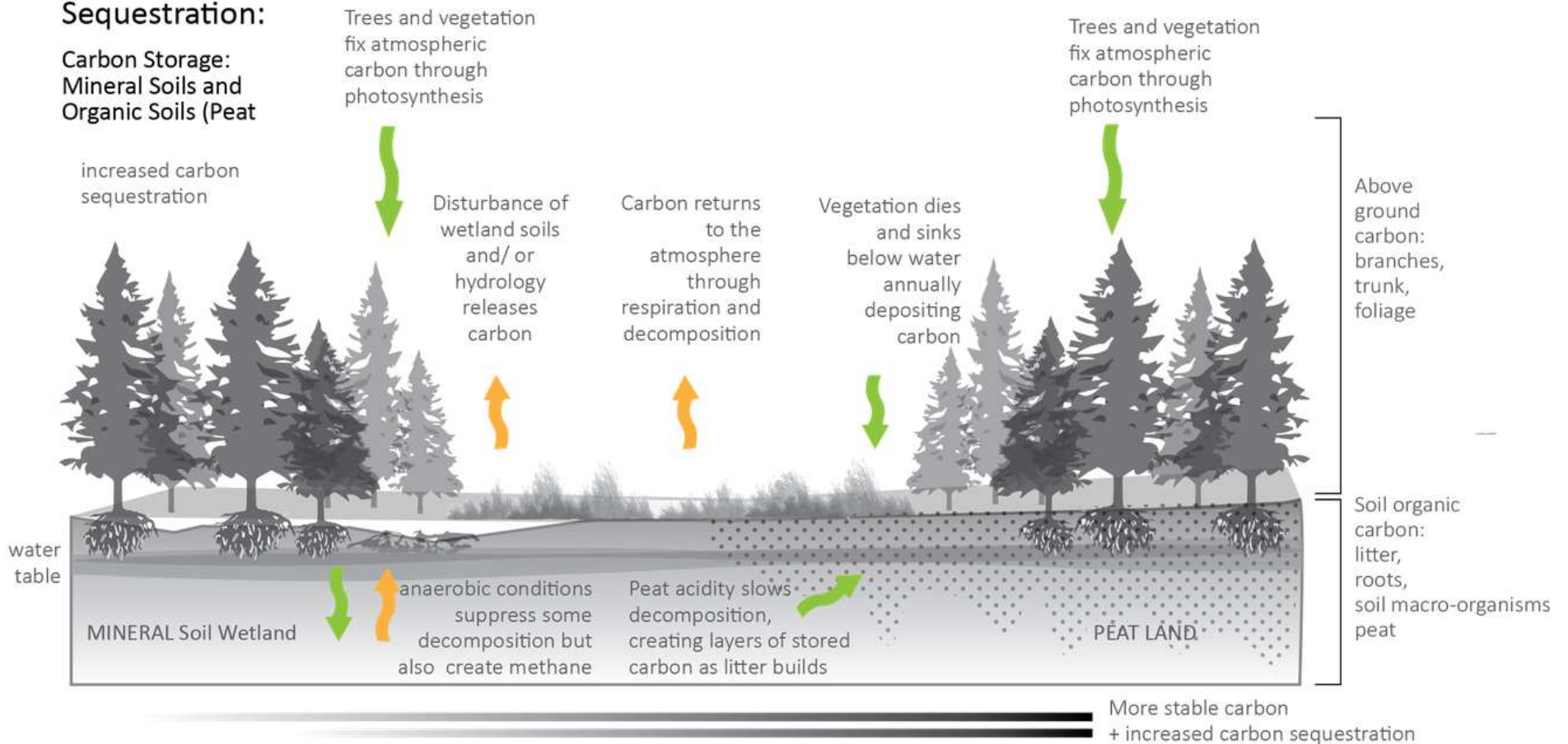
Charles Brown Park WISE trail

Wetlands and Climate

- Wetlands Store Carbon
- Wetlands offset greenhouse gases

Wetland Carbon Sequestration:

Carbon Storage:
Mineral Soils and
Organic Soils (Peat)



Threatened and Endangered Species

The U.S. Fish and Wildlife Service estimates that up to **43% of the federally threatened and endangered species rely directly or indirectly on wetlands for their survival (e.g., whooping crane, swamp pink, saltmarsh sparrow and Canby's dropwort).** Many other species use wetlands at some point in their lives.



Wetlands Provide Food

Blueberries *Vaccinium corimbosum*



Cranberries *Vaccinium macrocarpon*

Rice: *Zizania*. Wild rice.
Found throughout Eastern US
Oryza. “Asian” rice.
Cultivated in subtropical
locales worldwide



Taro Native to Southeast Asia,
cultivated worldwide. Poi in Hawaii

Wetlands Provide Building Material, Fuels, Fodder



<https://www.iheartbritain.com/25-lovely-english-thatched-roof-cottages/>

Common Reed:
Roofing material
Fuel



Salt Meadow Hay
Used as Pasture for Grazing
Used as landscape material
Used as fuel



Atlantic White Cedar
Found in coastal swamps
Timbered for building material
Locally rare and under restoration

Wetlands Management: the four Ws

- Activities in Wetlands Require a Permit
- Jurisdiction, Determination and Delineation
 - Who
 - What
 - When
 - Where
 - And How

Tidal /Nontidal Wetlands Determination: Virginia

Tidal

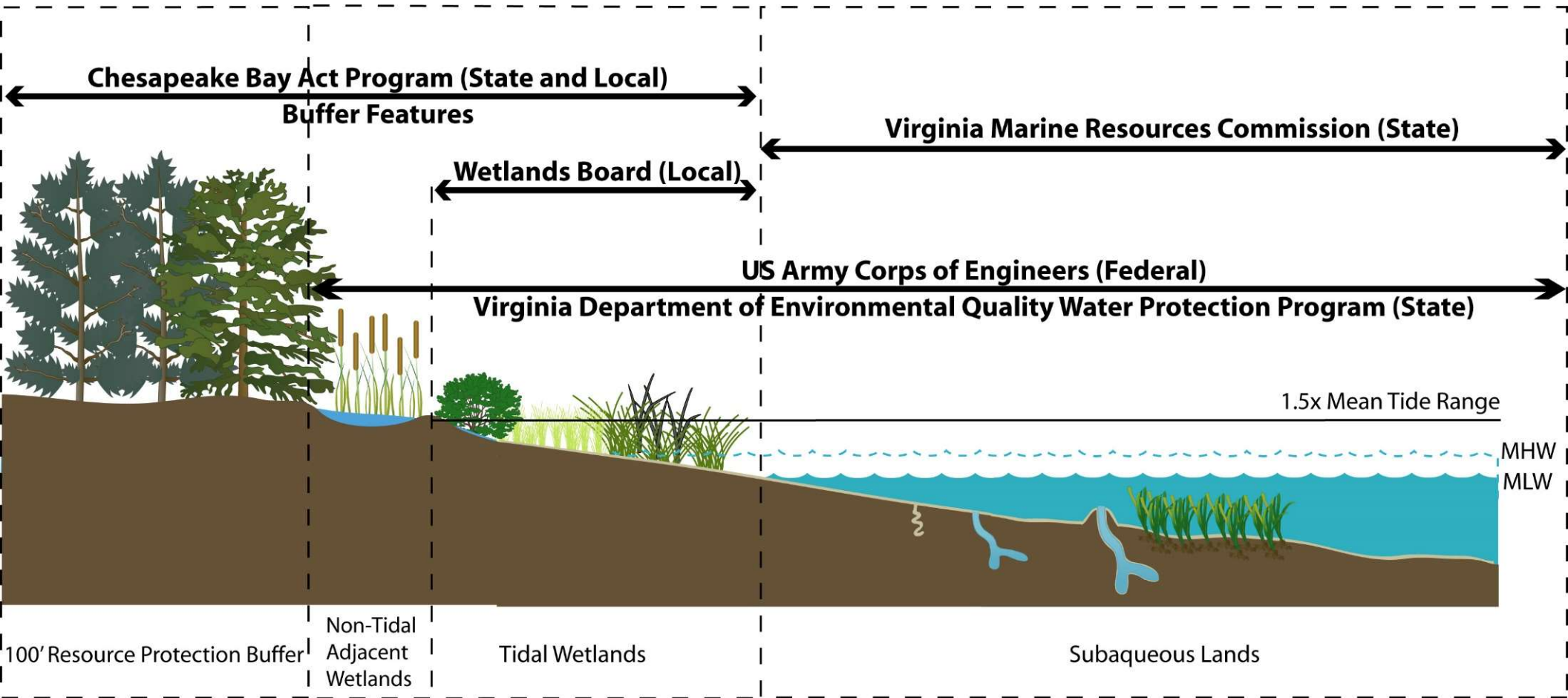
- ◆ Contiguous to MLW
- ◆ Elevation
- ◆ Plants listed in Act
- ◆ Non-vegetated:
 - ◆ Elevation



Nontidal

- ◆ Hydrology
- ◆ Soils
- ◆ Certain plant
- ◆ Special aquatic sites

Wetland Jurisdictions in Virginia



Virginia Shorezone Jurisdictions: legally defined shoreline resources and the relevant local, state and federal authorities. Note that some authorities cross resource boundaries and most resources have at least two responsible regulatory authorities. Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science.

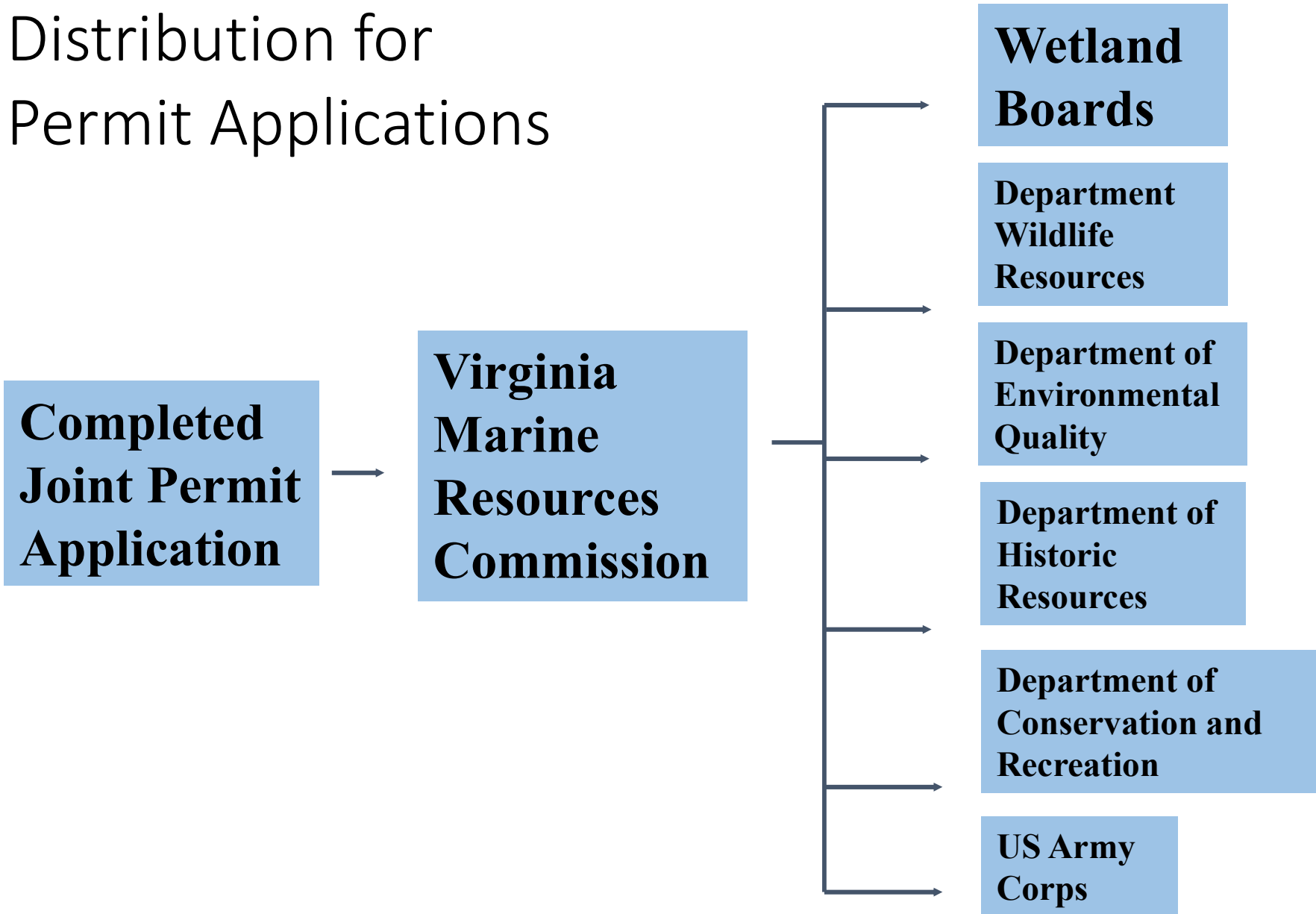
Federal Wetland Changes and Virginia Law

- *Sackett v. Environmental Protection Agency* reduced the number of wetland acres that are protected under the federal Clean Water Act (CWA).
- Virginia law prohibits excavating, filling, draining, or other activities that cause significant alteration or degradation of existing wetland acreage or functions without a permit
- In contrast to the CWA, Virginia has a very broad and comprehensive statutory definition of state waters. Since at least 1968, state waters have been defined to include “all water, on the surface and under the ground, wholly or partially within or bordering the [Commonwealth] or within its jurisdiction.”
- This definition was expanded in 2000 to include “all water, on the surface and under the ground, wholly or partially within or bordering the Commonwealth or within its jurisdiction, including wetlands.”
- Virginia regulates activities in surface waters (i.e., wetlands and streams) through the Virginia Water Protection Permit (VWPP) program.
- *Sackett* does not affect the definition of Resource Protection Areas (RPAs) and Resource Management Areas (RMAs) as defined in the Chesapeake Bay Preservation Act and associated regulations.
- Neither the State law nor the VWPP regulation is affected by the *Sackett* decision.

Legislation	Administration	Over-Sight/ Review	Determination and Delineation
Tidal Wetlands Act	Local: Wetlands Board VMRC if no Board	VMRC	Locality Determines 1. Contiguous to MLW 2. Elevation MLW to 1.5 x tide range or to MHW 3. Plants listed in 28.2-1300
Coastal Primary Sand Dunes & Beaches Act	Local: Wetlands Board VMRC if no Board	VMRC	Locality Determines 1. Mounds of unconsolidated sand 2. Contiguous to MHW 3. Limits marked by a change in grade from >10% to <10% 4. Plants listed in 28.2-1400
Chesapeake Bay Preservation Act	Local: Wetlands Board, "Bay" Board or Staff	DEQ	Locality Determines 100 ft riparian buffer landward of RPA features (Tidal wetlands, tidal shores, nontidal wetlands connected by surface water, other lands as specified)
Subaqueous Lands	VMRC		VMRC Determines Beds of the bays, rivers, creeks, or shores of the sea channelward of the MLW
Virginia Water Protection Permit	DEQ	Courts	DEQ Determines 1. Hydrology 2. Plants 3. Soils
Clean Water Act	Corps of Engineers	EPA and Courts	Corps Determines Urban/ Residential/ Commercial NRCS Determines Agricultural

The Permit Process

Distribution for
Permit Applications



Permit Process, continued

**Advisory Review
(Virginia)**
VIMS
DWR
DCR
DHR

**Advisory Review
(federal)**
Environmental
Protection Agency
Natural Resources
Conservation Service
National Marine
Fisheries Service
Advisory Council on
Historic
Preservation/ DHR

**Wetlands
Board**

VMRC

DEQ

Corps

**Public
Interest
Review**

**Public
Hearing**
**Wetlands
Boards/
VMRC**

Agency Permit
**DEQ/ Corps/
VMRC**

Decision

To learn more:

<https://www.vims.edu/ccrm/ccrmp/handbook/index.php>

The website focus is tidal wetlands
There is information about nontidal too!

Center for Coastal Resources Management

Home > CCRM > Shoreline Management > Shoreline Management Handbook

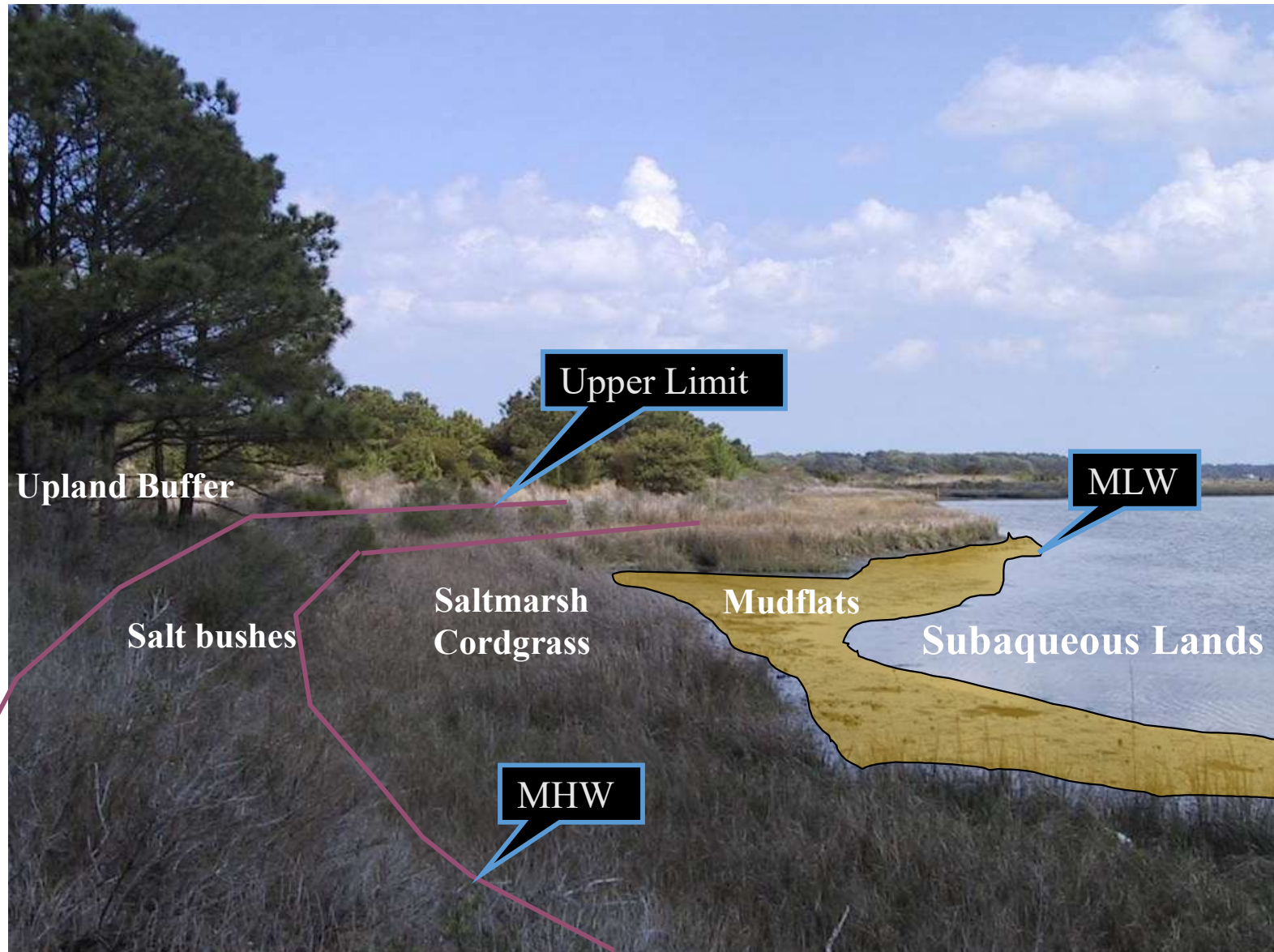
Shoreline Management Handbook

everything wetlands boards ...

- SHORELINE MANAGEMENT**
 - Background & Purpose
 - Laws & Jurisdictions
 - Permit Information
 - Being on a Board
 - Conduct a Hearing
 - Decision Support & Technical Assistance
 - Restoration for Resilience & Funding
 - Compliance & Other Legal Information
 - Know Your Resources

 <p>BACKGROUND & PURPOSE Why protect and manage tidal wetlands, beaches and dunes?</p>	 <p>LAWS & JURISDICTIONS What is the wetlands board jurisdiction, laws that apply, and guidance for following them?</p>	 <p>PERMIT INFORMATION Application forms, permit data and information requirements ...</p>
 <p>BEING ON A BOARD Charge of the board, roles and responsibilities, meeting times and contacts ...</p>	 <p>CONDUCT A HEARING Public interest review, procedures, emergency and violation, letter templates ...</p>	 <p>DECISION SUPPORT & TECHNICAL ASSISTANCE Shoreline maps, decision tools, reports and more ...</p>
 <p>RESTORATION FOR RESILIENCE & FUNDING What about habitat restoration and climate adaptation projects?</p>	 <p>COMPLIANCE & OTHER LEGAL INFORMATION Following permitted projects to the end ...</p>	 <p>KNOW YOUR RESOURCES Print this handbook and other items to help; website map, glossary, FAQ's, contacts, and more ...</p>

Typical Shoreline Profile



Wetland Mapping in Virginia

Maps are guidance- likely wetland location and type. Not to determine jurisdiction

- National Wetland Inventory
 - Who: US Fish and Wildlife Service
 - What: All wetlands- Tidal and Nontidal
 - Based on remote imagery
 - Misses smaller wetlands, those under tree canopy, underrepresents
- Tidal Marsh Inventory
 - Who: Center for Coastal Resources Management/
Virginia Institute of Marine Science
 - What: Tidal wetlands and beaches
 - Based on aerial photography and field observation
 - Underrepresents non-vegetated mud flat and beaches

Virginia Coastal Resources Tool

The screenshot displays the Virginia Coastal Resources Tool interface. At the top, it states "Virginia has 8,916 miles of tidal shoreline...". Below this, four panels show different shoreline types: Natural Shoreline (7,858 miles), Tidal Marsh Shoreline (4,237 miles), Defended Shoreline Living Shorelines (68 miles), and Defended Shoreline All (including living shorelines) (1,000 miles). A central section titled "EXPLORE YOUR COASTAL COMMUNITY" features a large map of Virginia's coastline. To the right of the map is a "Dashboards" section with several data visualizations:

- Onshore Protection Structures:** 43.3 miles. A donut chart shows: Bulkhead (45%), Dike (4%), Dredged (3%), Riprap (42%), Unconventional (7%), and Wood (7%).
- Riparian Land Use/Land Cover:** A bar chart shows: Agriculture (0.4), Bare (0.1), Commercial (19.5), Forest (34.4), Government/military (0.2), Grass (13.2), Industrial (0.1), Pasture (14.4), Residential (51.1), and Riprapped/Turbid (27.3).
- Defended and Natural Shoreline:** A donut chart shows: Defended (30%) and Natural (70%).
- Tidal Marsh Shoreline:** 110.9 miles.
- Tidal Marsh Area:** 2,324 acres.
- Tidal Marsh Community Types:** A horizontal bar chart shows: Submerged cordgrass/marsh (88.2), Submerged/high marsh (0), Salt Reed/Bayweed (2.7), Saltgrass (0.1), Big cordgrass (0), Cattail (0), Arrowweed/potamogeton (0), Ruppia/marsh cordgrass (0.1), Potamogeton (0), and Brackish marsh (443.8).
- Unsurveyed Tidal Marsh:** 775.1 acres.

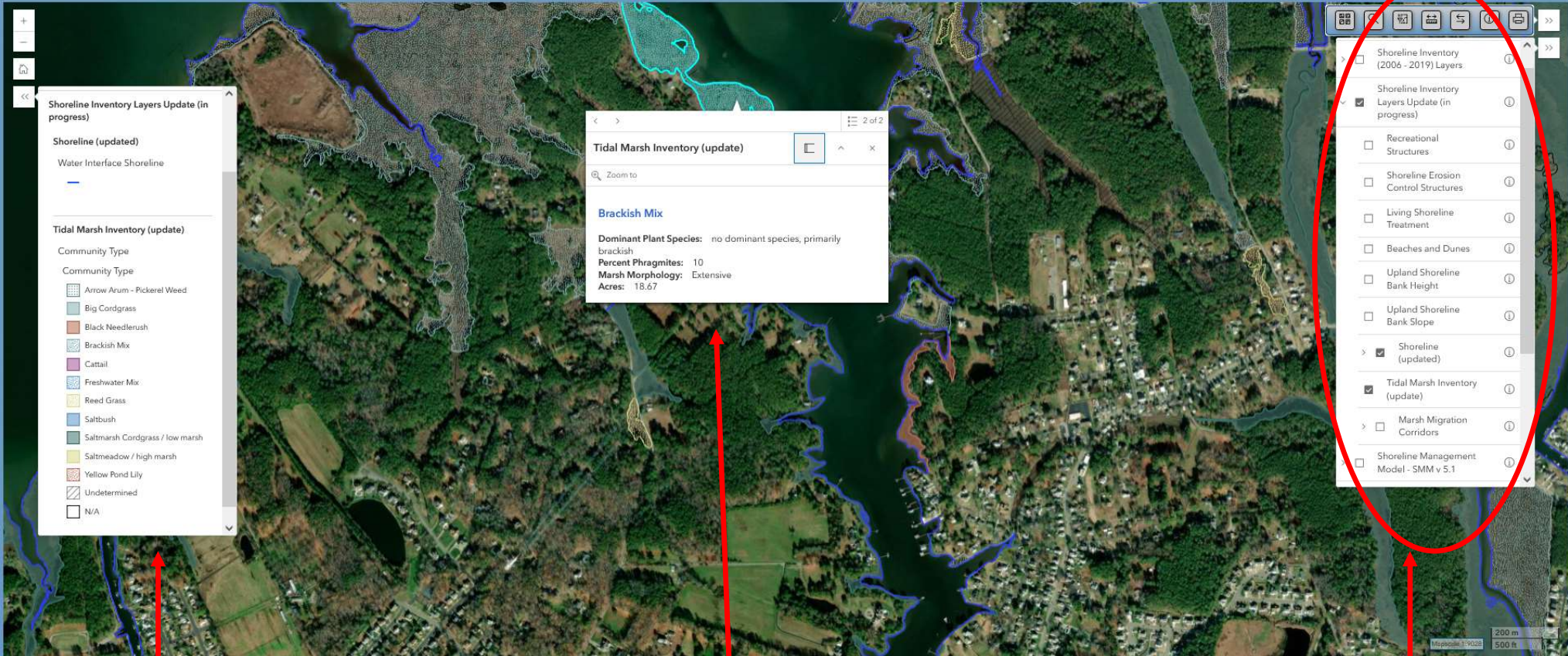
The interface also includes a "Select a Locality" dropdown menu listing various Virginia counties and cities, and a "Virginia Coastal Viewer" label at the bottom left.

Center for Coastal Resources Management, Virginia Institute of Marine Science
Coastal Viewer and Dashboard

<https://cmap22.vims.edu/VACoastalResourcesTool/>

Virginia Coastal Viewer

★ Updates



Legend

Click to select
View Inventory details

Data Layers:
Shoreline Inventory
Tidal Marsh Inventory

On-line Wetland Maps Adaptva.com

ADAPTVA FORECASTS ADAPTATIONS TOOLS RESILIENCE RESOURCES PLANNING & POLICY

Tools

Evidence-based planning for changing climate

TOOLS are available to help assess risk and vulnerability to climate impacts, build community resiliency against extreme events, and provide guidance to prepare and respond to a changing environment.

- FLOOD RISK**
Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. Learn more about flooding and floodplains in maps, models, documents and websites.
Virginia's Flood Risk Information System
Locality Road Flood Tool
- SHORELINE MANAGEMENT**
What is the best management strategy for your shoreline?
Learn more
- ADAPTVA INTERACTIVE MAP**
View water levels, social vulnerability, infrastructure and natural capital in one viewer.
Launch Viewer

Adapt VA Interactive Map

Find address or place

Sea Level Rise / Flooding / Storm Surge | Vulnerability / Risk | Infrastructure | Shoreline Management | **Natural Resources** | Protection / Restoration Opportunities | Legend | Tools | How To

1/1/2020

2010 2020 2030 2040 2050 2060 2070 2080 2090 2100

Help/Information

How do I ...

- Move or resize a panel? +
- Show layer on map? +
- Find information about map layers? +
- Clear ALL selected layers? +
- Identify a feature in the map? +

Adapt VA Interactive Map

Find address or place

Natural Resources

- Tidal Marsh
- Natural and Nature-Based Features (NNBFs) less than 10 feet land elevation
- Shoreline Conditions
- Nontidal NWI Wetlands (all Virginia)
- Submerged Aquatic Vegetation (SAV)
- Hydrology

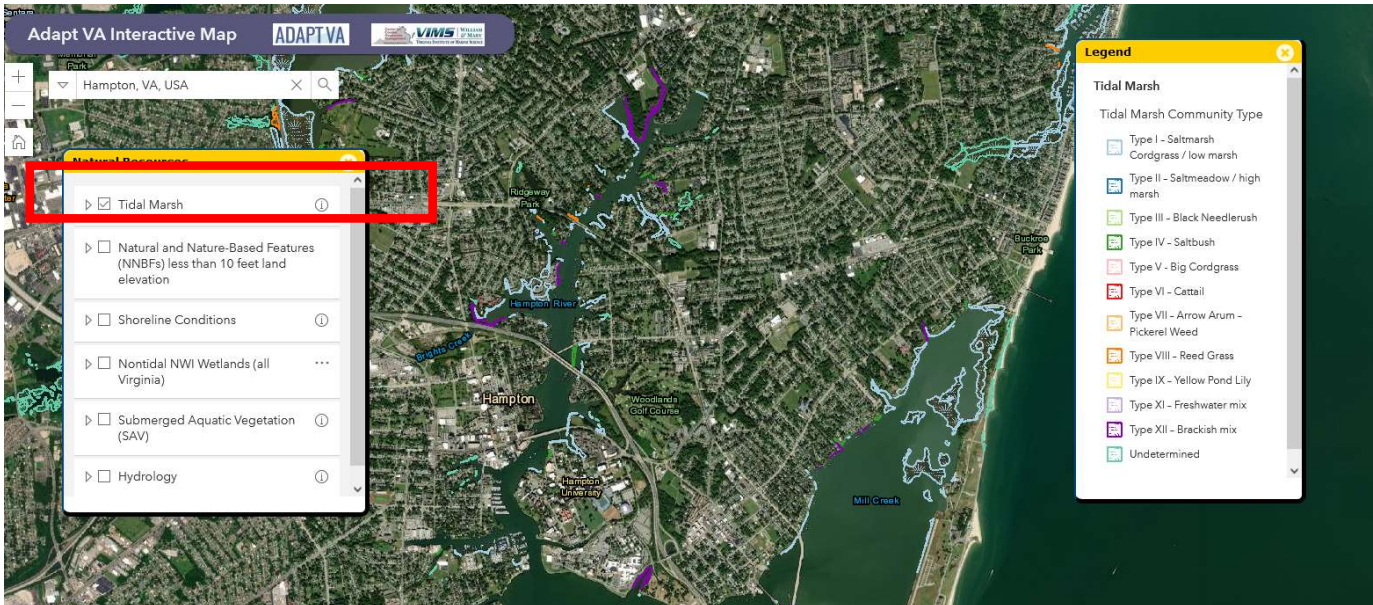
Sea Level Rise / Flooding / Storm Surge | Vulnerability / Risk | Infrastructure | Shoreline Management | **Natural Resources** | Protection / Restoration Opportunities | Legend | Tools | How To

Help/Information

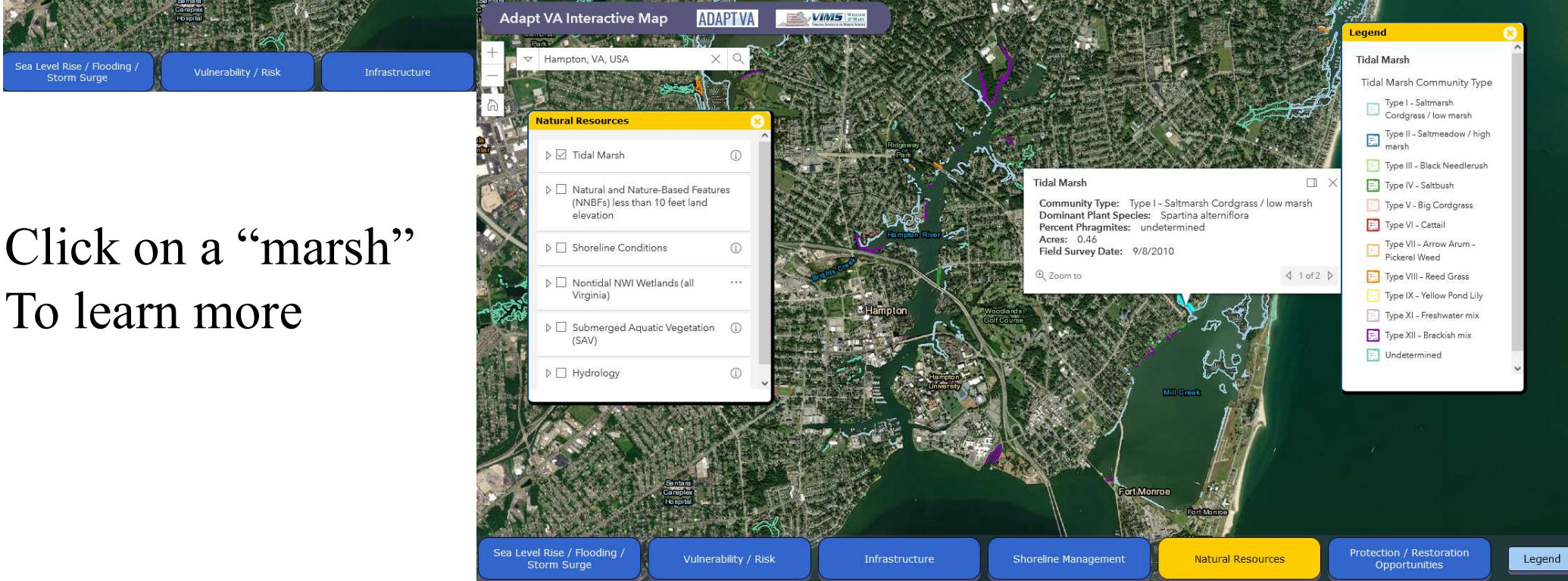
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On-line Wetland Maps Adaptva.com

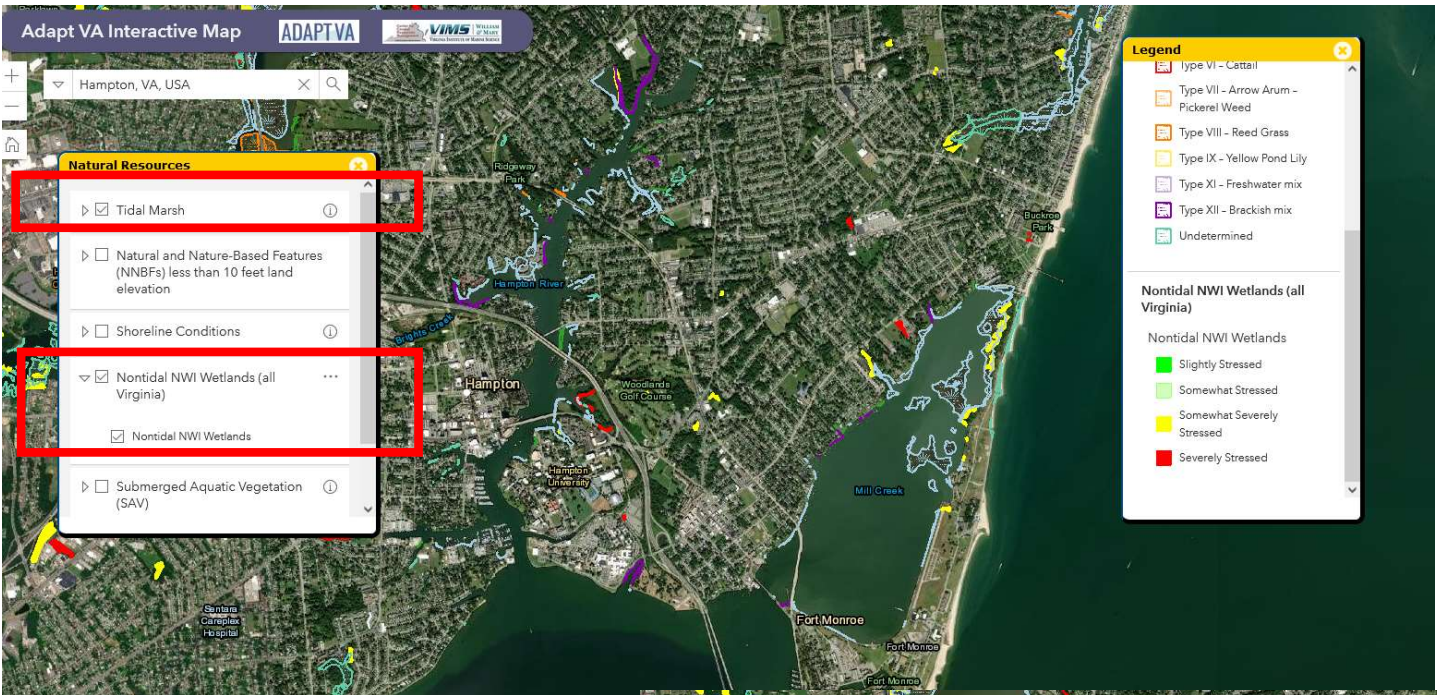


Selected Tidal Marsh TMI



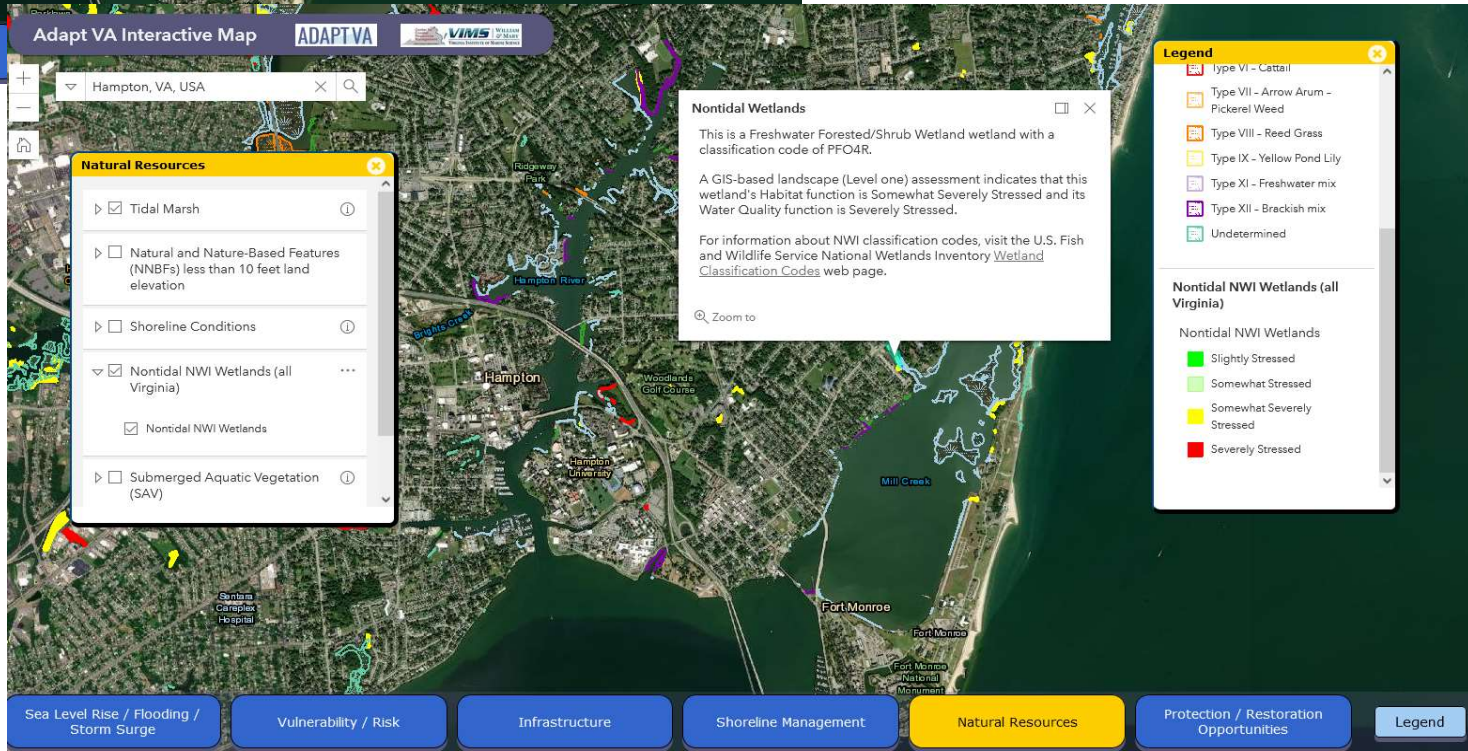
Click on a "marsh"
To learn more

On-line Wetland Maps Adaptva.com



Selected Tidal Marsh & Nontidal Wetlands NWI and TMI

Sea Level Rise / Flooding / Storm Surge Vulnerability / Risk Infrastructure



Click on a “wetland”
To learn more

Sea Level Rise / Flooding / Storm Surge Vulnerability / Risk Infrastructure Shoreline Management **Natural Resources** Protection / Restoration Opportunities Legend

Real Property Assessment

1. § 58.1-3284.3. Wetlands to be specially and separately assessed.

A. Whenever real property is assessed or reassessed, the commissioner of the revenue or other assessing official shall consider, at the request of the property owner, specially and separately assessing at the fair market value all **wetlands** on such property, as defined in § [62.1-44.3](#).

2. § 58.1-3230. Special classifications of real estate established and defined.

... "Real estate devoted to open-space use" shall mean real estate used as, or preserved for, (i) park or recreational purposes, including public or private golf courses, (ii) conservation of land or other natural resources, (iii) floodways, (iv) **wetlands** as defined in § [58.1-3666](#), (v) riparian buffers as defined in § [58.1-3666](#),

3. § 58.1-3666. Wetlands and riparian buffers; living shorelines

A. Wetlands and Riparian Buffers

Wetlands, as defined herein, that are subject to a perpetual easement permitting inundation by water, and riparian buffers, as defined herein, that are subject to a perpetual easement permitting inundation by water, are hereby declared to be a separate class of property and shall constitute a classification for local taxation separate from other classifications of real property.

Approved living shoreline project satisfies the definition of a living shoreline consistent with § [28.2-104.1](#) shall qualify for full exemption

- "Wetlands" means an area that is inundated or saturated by surface or ground water at a frequency or duration sufficient to support, and that under normal conditions does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, and that is subject to a perpetual easement permitting inundation by water.

Virginia's Wetland Status

Virginia has approximately 1,207,270 acres of wetlands; 23% tidal, 77% nontidal¹

Tidal Marsh

- **Tidal Marshes (entire state): 195,040.37 acres**
- **Tidal Marshes within the Chesapeake Bay watershed: 108,445.52 acres**

Nontidal Wetlands

- **Freshwater Emergent Wetlands :** **89,750 acres**
- **Freshwater Forested/Shrub Wetlands:** **917,830 acres**
- **Freshwater Pond:** **4,043 acres**
- **Lake:** **608 acres**
- **Total Virginia Vegetated Non-Tidal NWI:** **1,012,230 acres**

About 58% of these wetlands are located in the Urban Crescent between D.C. to Norfolk

Majority are in Tidewater, or the Coastal Plain

Piedmont and Ridge and Valley wetlands tend to be located along and near the headwaters- at the upper ends of waterways

 ¹ Based on 8/2024 data from Virginia Institute of Marine Science

Virginia's Wetland Status

It has been estimated that Virginia lost more than half of the pre-colonial extent of wetlands. Loss due to:

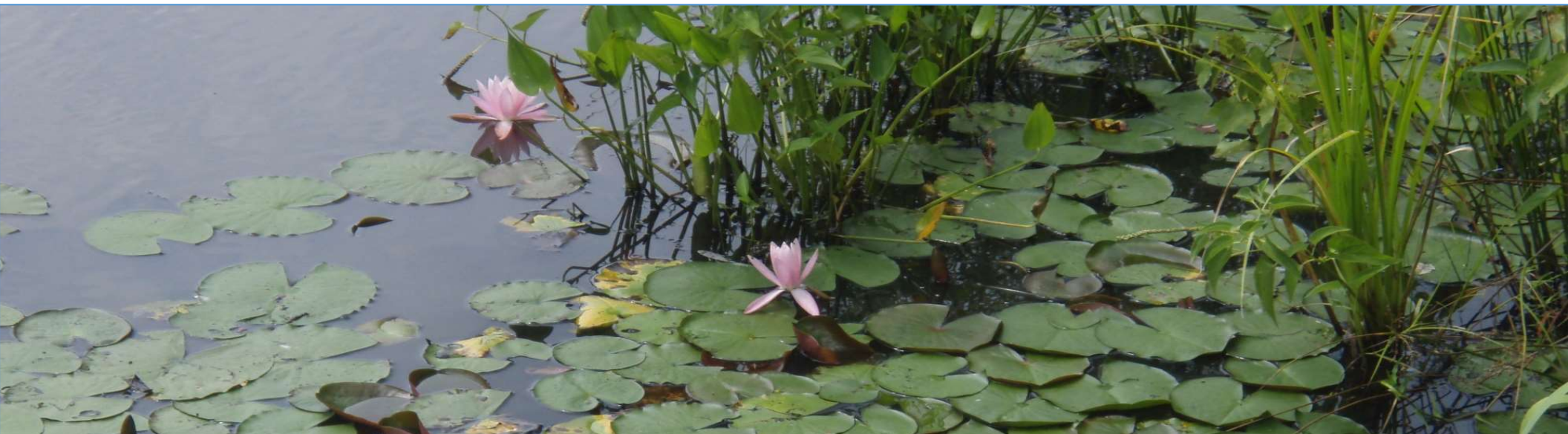
Agricultural filling and draining

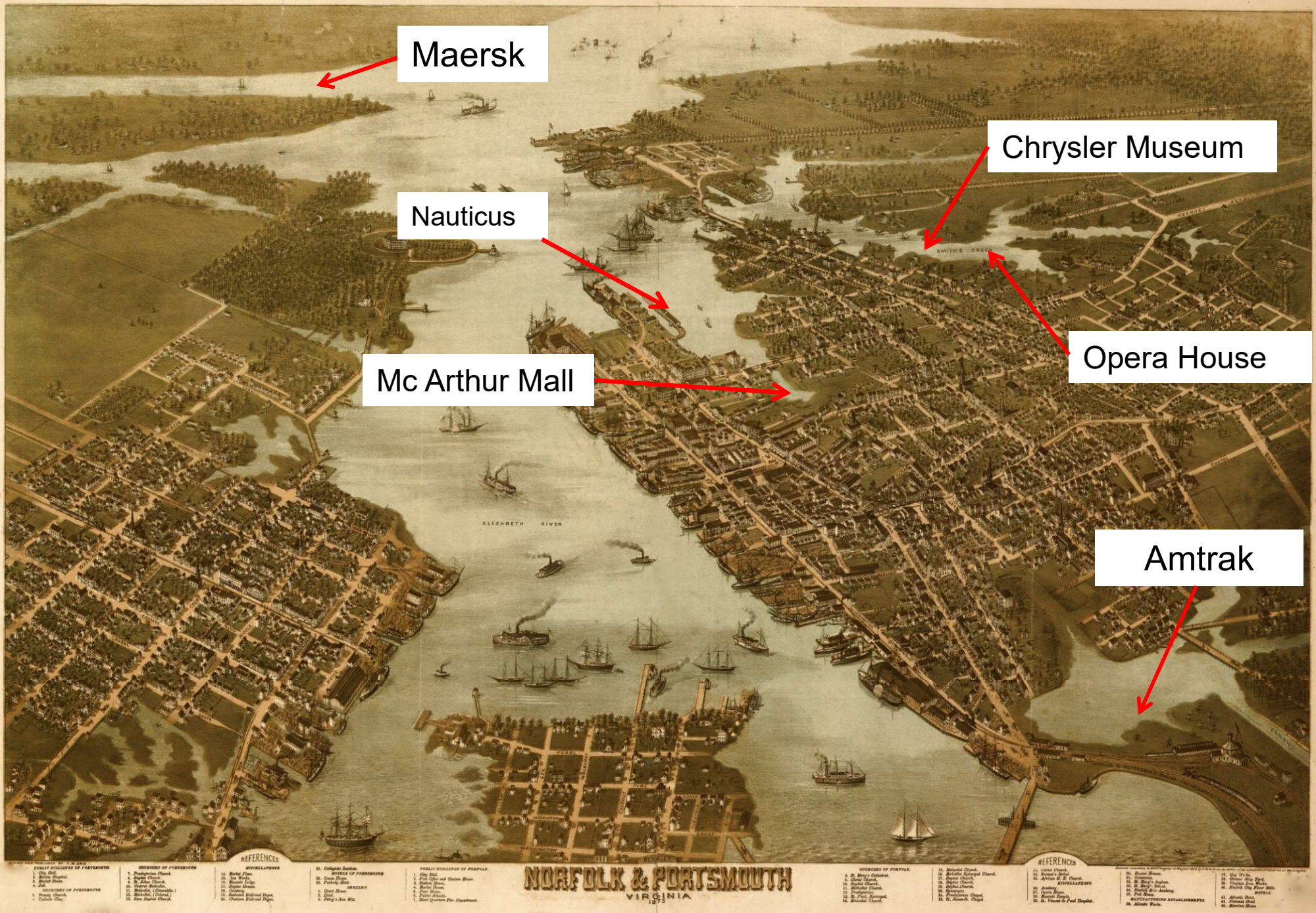
Development

More than 6,000 acres of tidal and inland wetlands loss in Tidewater between 1956 and 1977. Loss due to:

Urban development

Dredging





21st Century Building Locations on filled Wetlands and Shallow Water

Areas historically filled are areas that flood today

City of Norfolk

Federal Emergency Management Agency Flood Maps



Wetland Stressors

- **Development**

- Building Sites
- Roads
- Agricultural conversion
- Dredging for water access
- Mowing and other upland management activities (yard debris, filling)

- **Climate Change / Sea level rise**

- Too much or too little water
- Wetland plants withstand certain inundation. Too much water and plants will drown. Too little will convert to upland
- Storms. More frequent and stronger storms modify hydrology, impact plant community and cause erosion



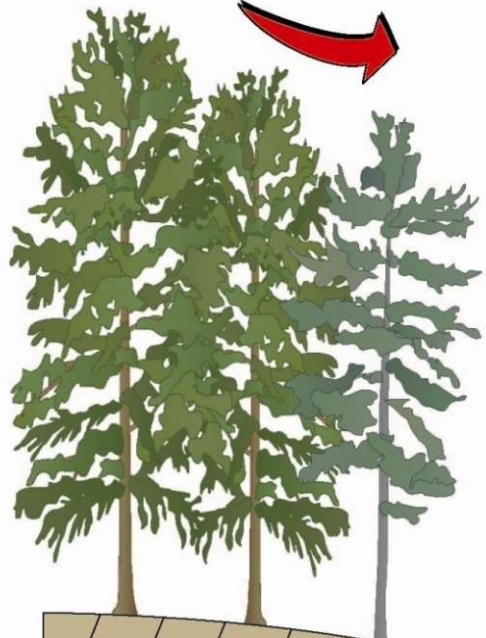
Wetland Stressors con't

- **Water Management**

- Ditching and draining
 - Mostly in farm land, but throughout the landscape
- Water withdrawal
 - Changes in the available water effects the wetland health
- Reservoir construction
 - Wetlands are flooded and inundated



Barriers to Migration
(human development, topography)



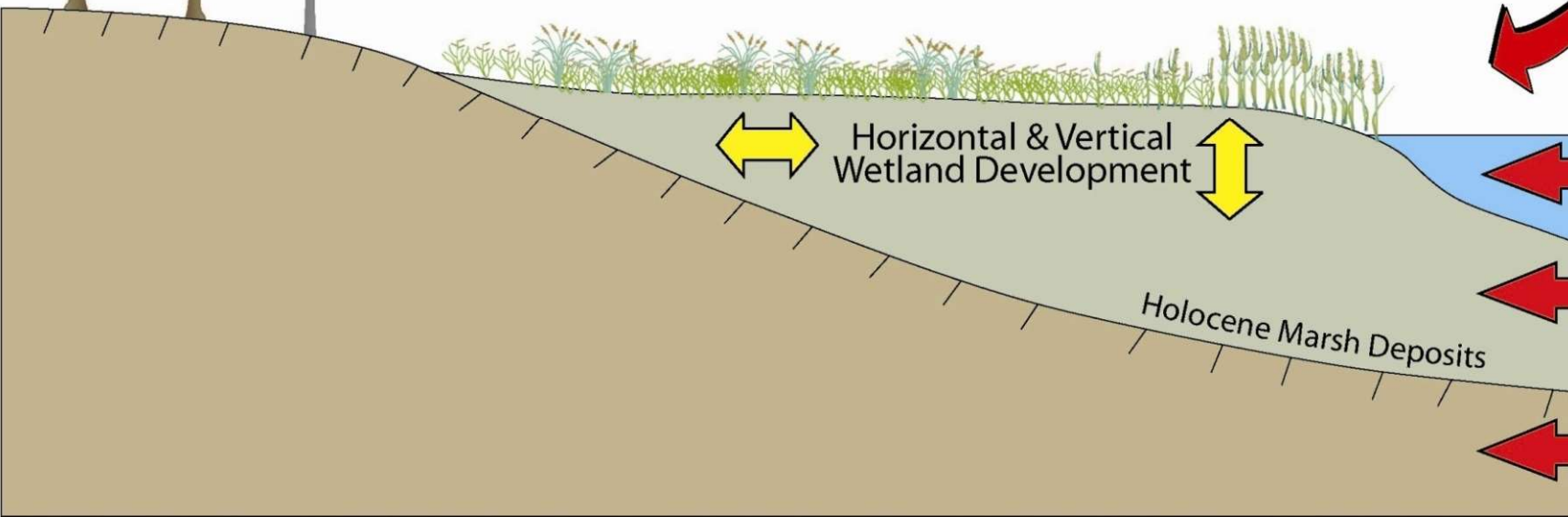
Altered River Flows
(freshwater & sediment)

Nutrient Input
(eutrophication)

Elevated
Atmospheric
CO₂

Disturbance
(herbivory, fire)

Storms



Sea-Level Rise

Shallow
Subsidence

Deep
Subsidence

Tidal Wetlands and Sea Level Rise



Erosion Protection and Sea Level Rise

Problem: Coastal Squeeze
Wetlands retreat restricted
by structures down in place

Solution: Protect against
erosion while preserving
wetlands and allowing retreat



LIVING SHORELINES

- Provides erosion control
- Water quality benefits;
- Protects, restores or enhances natural shoreline habitat
- Maintains coastal processes
- Uses Plants, stone, sand fill, and other materials.



Wetland Restoration Goals

- Virginia signatory on the Chesapeake Bay Agreement
- Agreement calls for 85,000 acres restored, 150,000 improved
 - Acreage not distributed or assigned to any jurisdiction
 - New outcomes for beyond 2025 in discussion
- 27,000 acres wetlands restored called for in the Virginia Watershed Implementation Plan Phase III for the CB Total maximum daily load
 - Mostly in agricultural lands
- Department of Wildlife Resources has internal goal 5,000 acres
- Wetland Program Plan: 6,000 acres in the Bay watershed, 4,000 outside
- York River Plan: 50 acres created or restored
- Rare bird habitat require large acreage for healthy populations

Valuation/ Financial Benefits

- Virginia Cost Assistance Program
 - Administrated by Soil and Water Conservation Districts
 - Living shoreline cost-share
 - Wetland creation cost-share
- Restoration/ Creation/ Living Shoreline Funding via:
 - National Fish and Wildlife Foundation
 - National Oceanic and Atmospheric Administration
 - Federal Emergency Management Agency
 - more/...
- Nutrient Market via DEQ permit
- Carbon Market....

More Info: Websites

- VIMS <http://www.ccrm.vims.edu/>
 - Shoreline Management: <https://www.vims.edu/ccrm/ccrmp/handbook/index.php>
- Alliance for the Chesapeake Bay
 - Restore Virginia's Wetlands
 - <http://www.acb-online.org/pubs/projects/deliverables-239-1-2006.pdf>
- Virginia Tech Status Publication
 - <http://www.ext.vt.edu/pubs/waterquality/448-106/448-106.html>
- Wetlands Watch
 - <http://www.wetlandswatch.org/>

More Info: Books

- Wetlands. 4th ed. 2007. W. Mitsch and J. Gosselink. John Wiley and Sons, Inc. Hoboken, NJ.
- Common Plants of the Mid-Atlantic Coast: A field guide. 1999,. G. Silberhorn. The Johns Hopkins University Press. 308 pp.
- Wildflowers of Tidewater Virginia. 1982. O. Gupton and F. Swope. University Press of Virginia. Charlottesville, VA. 208 pp.
- Field Guide to Coastal Wetland Plants of the Southeastern United States. 1993. R. Tiner. University of Massachusetts Press. 328pp.