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Nature-Based Solutions for Coastal Resilience

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Nature-Based Solutions for Coastal Resilience

Coastal communities are dealing with multiple threats from more frequent and intense storms, rising sea levels, and increased flooding. Virginia's Coastal Resilience Master Planning Framework defines resilience as "the capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, health, the economy, and the environment." Nature-based solutions feature prominently in Virginia's strategies to ensure a resilient, thriving coast for future generations.

Nature-based solutions for coastal resilience include protecting natural resources plus adding engineered habitats and restoration practices where development has replaced natural features. Collectively, these are referred to as Natural and Nature-Based Features, or NNBFs. Green infrastructure is a similar term used to describe connected networks of natural and human-built features designed to protect valuable community assets.

Coastal forests, wetlands, beaches, dunes, restored streams, riparian buffers and living shorelines provide multiple benefits for coastal communities, including storm protection, soaking up floodwaters, improving water quality, providing recreation areas and maintaining important habitats. Virginia has emphasized nature-based solutions in several management programs because of their effectiveness and economic benefits for society have proven to be worthwhile investments.

Virginia Programs with Nature-Based Solutions

- Coastal Resilience Master Plan
- ConserveVirginia
- Community Flood Preparedness Fund
- Chesapeake Bay Watershed Implementation Plan
- Floodplain management
- Stormwater management
- Tidal shoreline management

Protected and restored natural features can reduce the cost of flood insurance, improve water quality for economic and social gains, plus help achieve Chesapeake Bay restoration goals. Localities that plan for community-scale implementation of nature-based solutions can qualify to receive support from Virginia's Community Flood Preparedness Fund. This issue provides information and guidance to help citizens and localities implement nature-based solutions for coastal resilience.

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Natural & Nature-Based Features

The coastal plain of Virginia has upland, wetland and aquatic features mixed with human occupied areas and development. A diversity of natural and nature-based features across the landscape provides multiple opportunities to intercept flowing water and flooding (Page 3, Figure 1).

To guarantee that NNBF benefits can persist, first priority should be protecting existing natural features that effectively buffer the coast, reduce flooding and filter water pollution. Nature-based, engineered features are also introduced to replace natural features where they are absent or highly compromised due to human activity.

Natural Features evolve over time through processes operating in nature.

- **Coastal Forests** intercept, filter and store floodwaters while also protecting adjacent wetland habitats
- **Beaches & Sand Dunes** provide physical barriers to waves and storm surge flooding
- **Tidal & Non-Tidal Marshes** capture nitrogen, phosphorus and sediment while also storing and slowly releasing floodwaters

Nature-Based Features are created by human design and engineering for specific services, such as coastal hazard risk reduction and water quality improvement.

- **Living Shorelines**

  Non-Structural planting and slope changes

  Marsh Sills strategic structures to support marshes

  Shellfish Reefs living walls to intercept waves

  Offshore Breakwaters to support sand beaches
- **Riparian Buffer Restoration** replaces trees and other plant layers along waterways
- **Stream Restoration** returns natural channels and hydrology
- **Stormwater Best Management Practices** intercept and filter stormwater runoff using vegetation

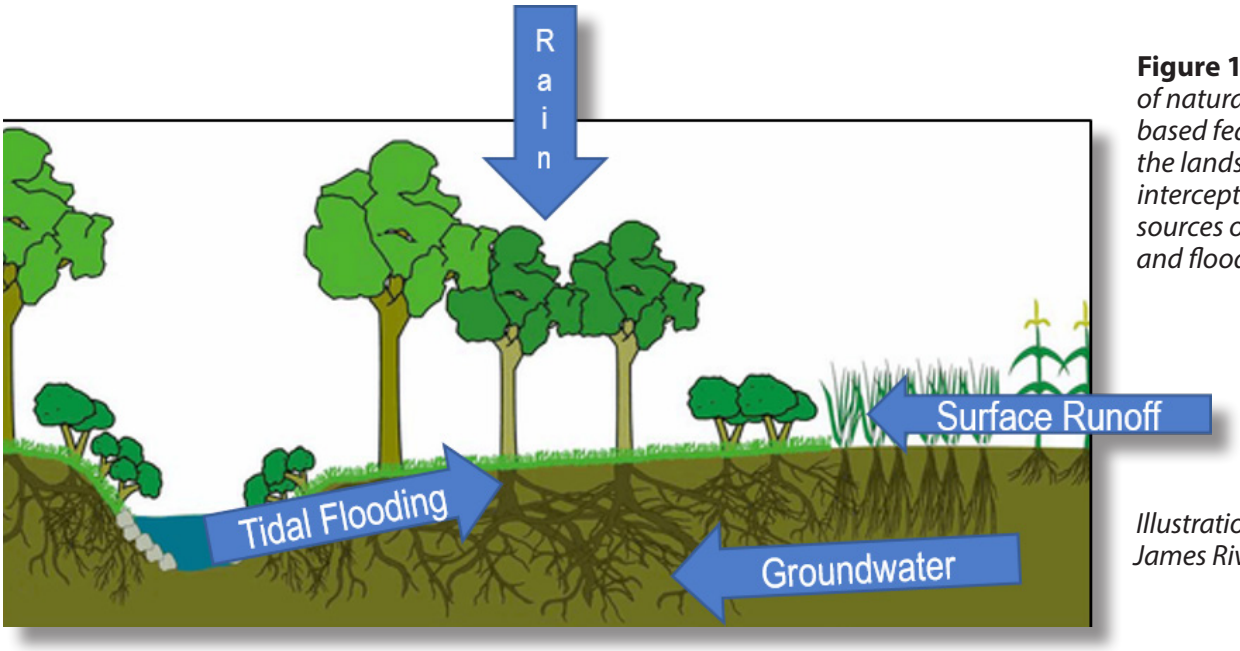

Figure 1. *A diversity of natural and nature-based features across the landscape can intercept multiple sources of flowing water and flooding.*

Illustration courtesy of James River Association

Multiple Benefits for Coastal Resilience

Flood Risk Reduction for Coastal Buildings – Natural features intercept and reduce the energy of rainfall, storm surge and tidal flooding before they reach built infrastructure. Floodwaters are stored and slowly released by trees and wetlands.

Water Quality Improvement – Forests, trees, and wetlands effectively filter contaminants and excess nitrogen, phosphorus, and sediment from air pollution, stormwater runoff and tidal floodwaters.

Floodplain Protection & Restoration – Natural floodplains store floodwaters, filter pollution, and provide habitat. Floodplain restoration reestablishes a more natural hydrological regime that connects wetlands, waterways and adjacent land.

Flood Insurance – Protecting and restoring natural features can earn credits for reduced insurance premiums through the National Flood Insurance Program's Community Rating System.

COASTAL FOREST & TREES

Upland Forest

Wetland Forest

Coastal forests are covered by trees more than 20 feet tall. Most coastal plain upland forests are heavily altered with a mix of native and non-native tree species. Forested wetlands are also called swamps. Some wetland forests have both tidal and non-tidal characteristics.

Forests with multiple plant layers promote evaporation of water into the air and gradual infiltration of water into the soil to reduce flooding and surface runoff (Page 5, Figure 2). Even single trees or clusters of trees and shrubs provide some of the same benefits. Shade provided by tall trees and shrubs also helps mitigate elevated air and land temperatures, especially in urban areas dominated by heat-reflecting impervious surfaces.

Coastal Forest Restoration Tips

- Protect intact forests and connect forest patches, especially along shorelines
- Protect natural hydrology in forested wetlands
- Convert riparian buffer turf and impervious areas to forest
- Choose native trees similar to local forests
- Provide layers of plant height between tree canopy and ground
- Allow leaves and sticks to remain for healthy soil and infiltration
- Remove and control invasive plants
- Consult with arborist about tree health and care

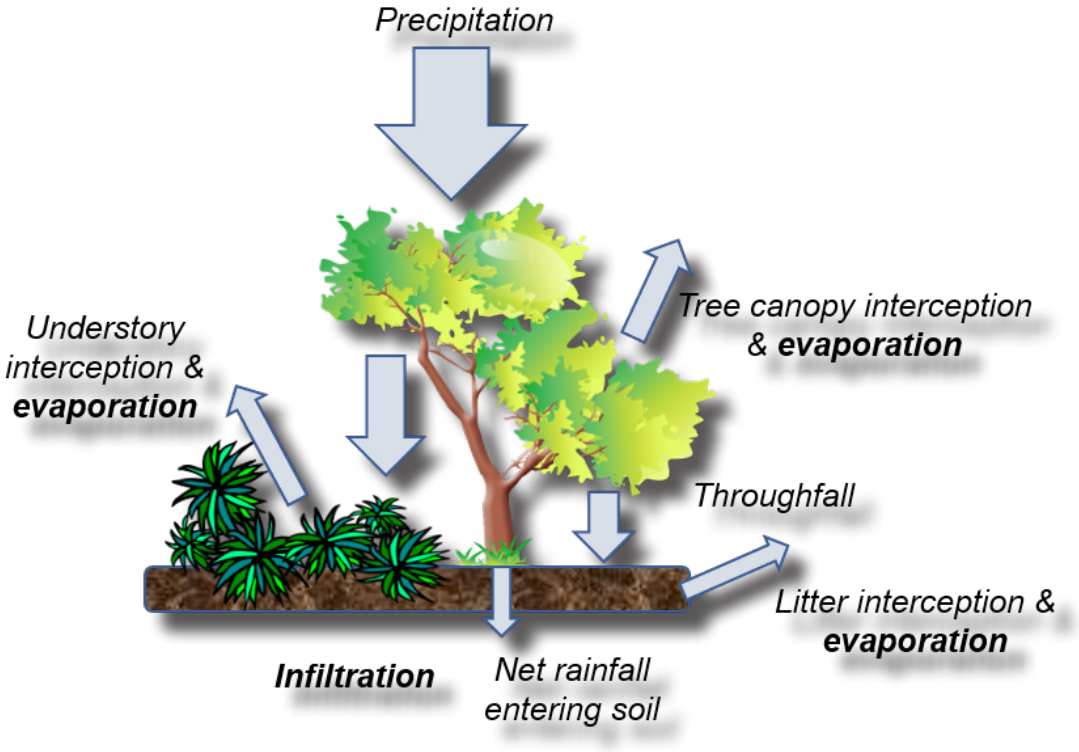

Figure 2. *Forests with multiple plant layers and a build-up of organic matter on the ground promote evaporation and infiltration of water to reduce flooding and runoff.*

BEACHES & SAND DUNES

Beaches are sandy areas next to oceans and tidal waters. Dunes are sand mounds next to beaches with vegetation able to grow in loose, shifting sand. Beaches and sand dunes are effective storm buffers helping to protect development next to the beach. These natural features also provide significant economic benefits as recreation and tourism attractions.

Beaches & Dunes Restoration Tips

- Try to match existing sand grain size when adding new sand
- Use only clean sand fill free of trash, toxics, invasive species
- Avoid harm to protected species like nesting sea turtles, shorebirds, Northeastern beach tiger beetle
- Choose dune plants similar to local beaches
- Manage foot traffic through planted dunes
- Reserve adjacent land upslope for future beach and dune location

TIDAL & NON-TIDAL MARSHES

Marshes are wetlands covered by herbaceous plants or shrubs without many trees. Tidal marshes can be large extensive features, marsh islands, or a fringe along the shoreline in either brackish saltwater or freshwater locations. Non-tidal marshes are located along rivers, lakes and streams or they can be isolated in the landscape. Like forested wetlands, marshes provide storm and flood mitigation by holding water and slowly releasing it through evaporation. Marshes also remove and trap nitrogen, phosphorus and sediment from adjacent waterways.

Marshes Restoration Tips

- Protect natural marshes with surrounding upland buffer
- Restore natural hydrology and eliminate drainage
- Protect and restore natural vegetation
- Choose wetland plants based on local salinity average
- Remove and control invasive plants

Tidal Marsh

Non-Tidal Marsh

LIVING SHORELINES

Living shorelines are nature-based approaches to reduce erosion caused by waves, tidal currents and stormwater runoff (Figure 3). These stabilization techniques not only protect shorelines and adjacent development from erosion, they also conserve, create or restore natural shoreline habitats and ecosystem services. Living shoreline projects can be installed on tidal shorelines and freshwater lakes and ponds, wherever erosion can be reduced with vegetative solutions.

Figure 3. *Source: M Mitchell, DM Bilkovic. Embracing dynamic design for climate-resilient living shorelines. 2019.*

LIVING SHORELINES, (continued)

Different living shoreline techniques are based on the prevailing natural conditions. Dense vegetation and dynamic habitats are the foundation for living shorelines.

Non-Structural

Non-structural living shoreline enhance or create dominant natural features already present, such as tidal marshes, beaches, and shoreline forests. The most suitable sites for non-structural methods have only minor erosion problems, low wave action and few boat wakes.

Marsh Sills

Marsh sills combine natural and planted marshes with low-elevation stone structures called sills. The sills contain sand fill needed to create suitable marsh elevations and intercept wave energy that prevents a marsh alone from persisting.

Shellfish Reefs

Shellfish reefs are used in combination with other practices to increase habitat diversity, or as a substitute for stone sills. They are most successful where natural shellfish productivity is high, such as native oysters and ribbed mussels.

Offshore Breakwaters

Offshore breakwaters combine sand and dune plants with large structures that intercept incoming waves to support wide sand beaches. This approach is suitable for higher energy beach shorelines.

Living Shorelines Tips

- Locate normal and extreme tide elevations on land, including future scenarios
- Include upland vegetated buffer next to wetland habitats
- Make sure construction and future maintenance access is feasible
- Choose wetland plants based on local salinity average
- Plant low and high marsh, expect plant changes over time
- Reserve adjacent land upslope for future tidal marsh location
- Perform periodic inspections and maintenance, like removing trash

More Information

Nature-Based Solutions for Coastal Resilience

Virginia & Mid-Atlantic Region

- **Coastal Virginia Nature-Based Solutions** *includes Fact Sheets & Locality Summaries*
  www.vims.edu/ccrm/nnbf
- **Virginia Living Shoreline Design Guidelines** *scholarworks.wm.edu/reports/833/*
- **Virginia Coastal Adaptation & Resilience Master Plan**
  www.naturalresources.virginia.gov/initiatives/resilience--coastal-adaptation/
- **AdaptVA Climate Change Information Gateway** *adaptva.org*
- **AdaptVA Interactive Map** *cmap2.vims.edu/AdaptVA/adaptVA_viewer.html*
- **Green Infrastructure in Virginia** by Green Infrastructure Center *gicinc.org/virginia.htm*

USA & International

- **Engineering with Nature®** International Guidelines on Natural and Nature-Based Features for Flood Risk Management 2021 *ewn.erdc.dren.mil/*
- **Building Community Resilience with Nature-Based Solutions** 2021 FEMA
  www.fema.gov/sites/default/files/documents/fema_riskmap-nature-based-solutions-guide_2021.pdf
- **Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience** 2015 US Army Corps of Engineers *erdc-library.erdc.dren.mil/jspui/handle/11681/4769*
- **Nature-Based Solutions for Coastal Highway Resilience** 2019 Federal Highway Administration
  toolkit.climate.gov/reports/nature-based-solutions-coastal-highway-resilience-implementation-guide

"Communities that invest in nature-based approaches to reducing disaster risk can save money, lives, and property in the long-term AND improve quality of life in the short term."

— Federal Emergency Management Agency (FEMA)