Living Shorelines
for Property Owners and Decision Makers

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Living Shorelines
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Part 1

- Ecosystem Services of Tidal Shorelines
- Why More Living Shorelines Are Needed
- Erosion Types
- How to Choose Best Design Option(s)
- Living Shoreline Methods
- Construction and Maintenance
- Permit Process

- Field Site Visit

Ecosystem Services
&
Why We Need More Living Shorelines

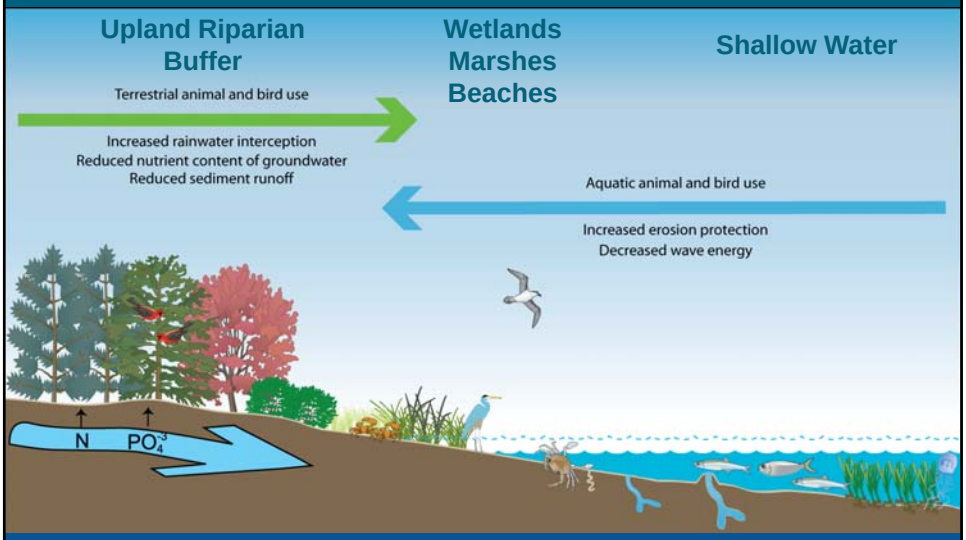
Cumulative Impacts
Integrated Shoreline Management

Ecosystem Services are:

"Components of nature,
directly enjoyed, consumed, or
used
to yield human well-being"

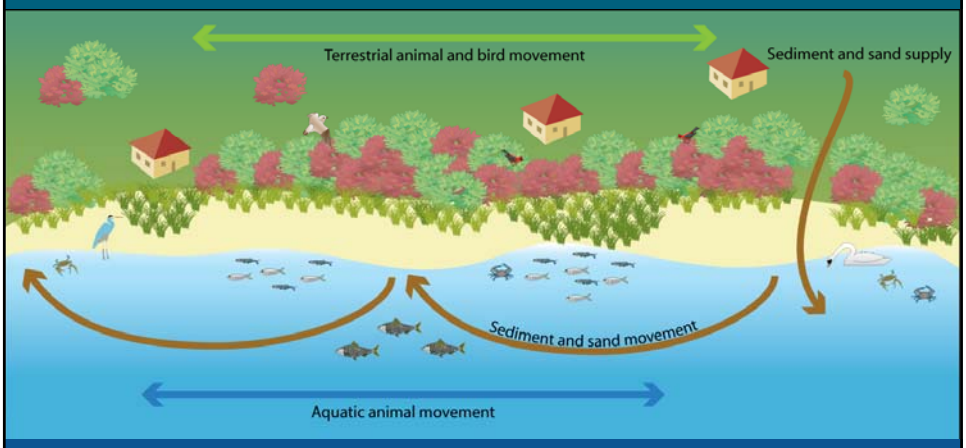
(Boyd & Banzhaf 2006 Resources for the Future DP-0602)

Integrated Shoreline Ecosystem



Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science.

Alongshore Connections



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Water Treatment Services
provided by integrated shoreline ecosystem

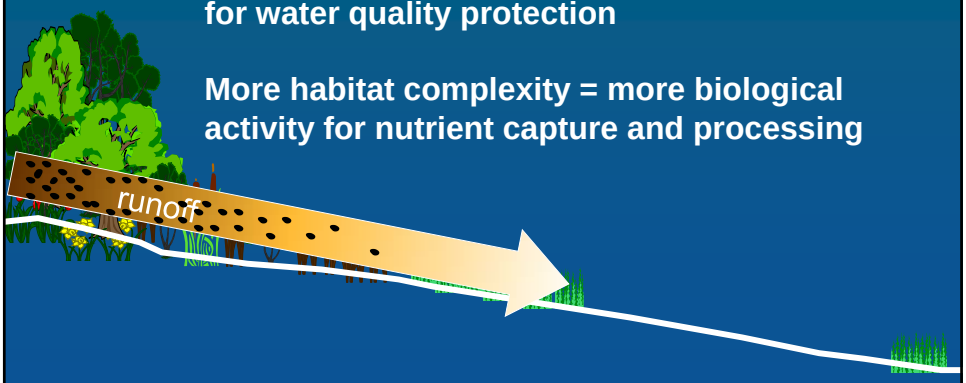
- Interception of surface runoff, groundwater and flood waters
- Pollutant removal
- Nutrient uptake
- Slowing rate of flow

Surface Runoff

Plants remove sediment and pollutants from runoff

More plant communities = more opportunities for water quality protection

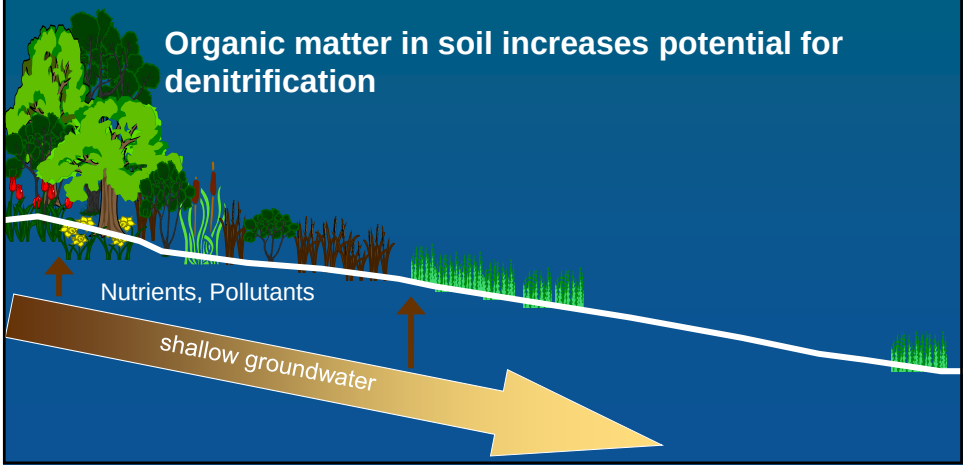
More habitat complexity = more biological activity for nutrient capture and processing



Groundwater

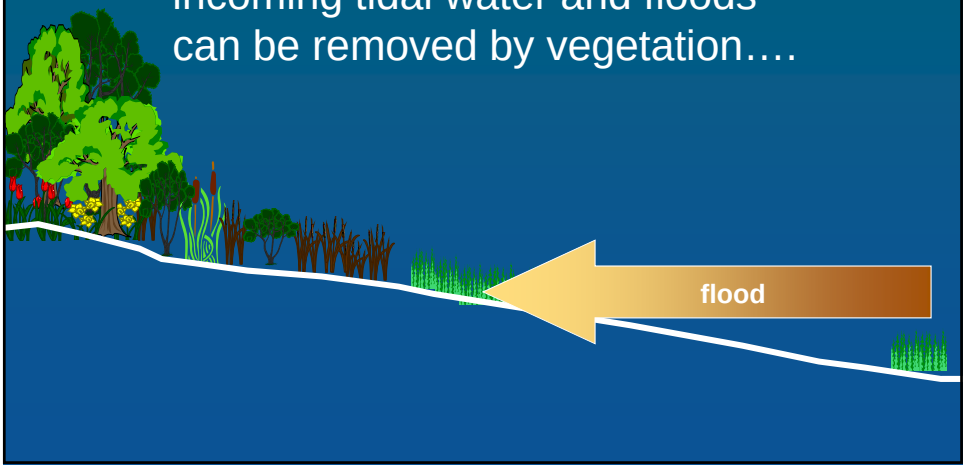
Plants also remove nutrients and pollutants from groundwater if it moves through the root zone

Organic matter in soil increases potential for denitrification



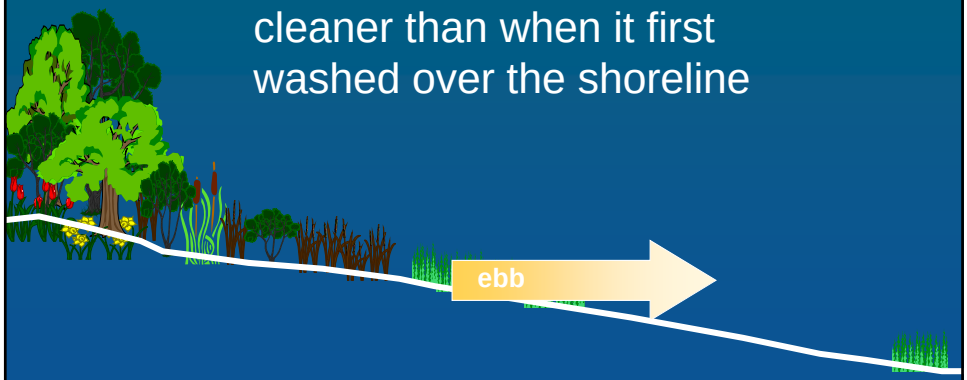
Flooding

Sediments suspended in the incoming tidal water and floods can be removed by vegetation….

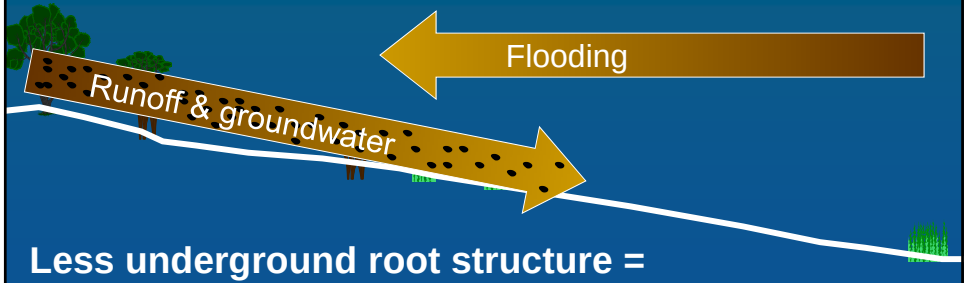


Flooding

…leaving the outgoing water cleaner than when it first washed over the shoreline



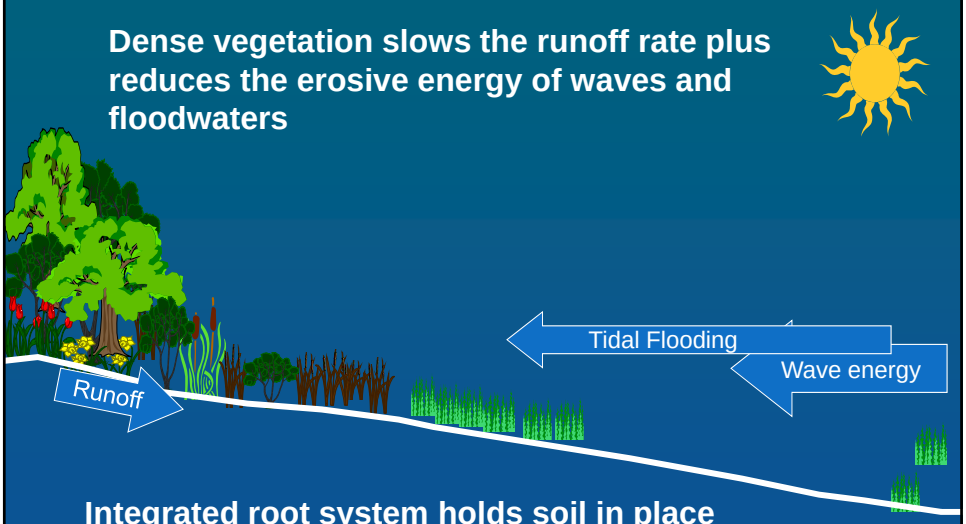
Less vegetation = Less sediment and pollutants removed



Less underground root structure = Less nitrogen removed, more sediment runoff

Stabilization / Erosion Control

Dense vegetation slows the runoff rate plus reduces the erosive energy of waves and floodwaters



Integrated root system holds soil in place

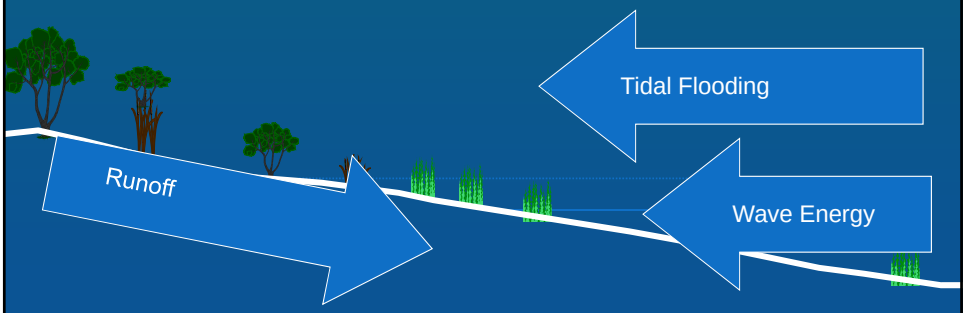
Soil Stabilization and Flood Protection
Woody Plant Functions

- **Root Reinforcement** – root tensile strength mechanically reinforces soil
- **Soil Moisture Depletion** – remove excess soil water through evapotranspiration
- **Buttressing and Arching** – anchored and embedded stems/roots counteract downslope shear forces
- **Flexible Stems** – deflect erosive energy

Source: C. Miller, USDA –NRCS Cape May Plant Materials Center

Stabilization / Erosion Control

Less vegetation = More water volume, higher flows, more erosion



Habitat Services

Riparian Buffer

Food, shelter

Organic matter input (leaf fall, large woody debris

Temperature regulation

Wetlands

Food, shelter

Primary production

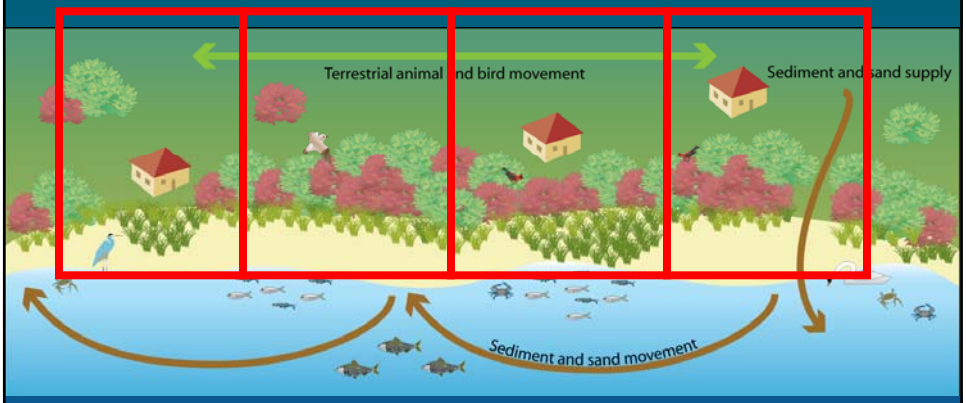
Shallow Water

Food, shelter

Secondary production

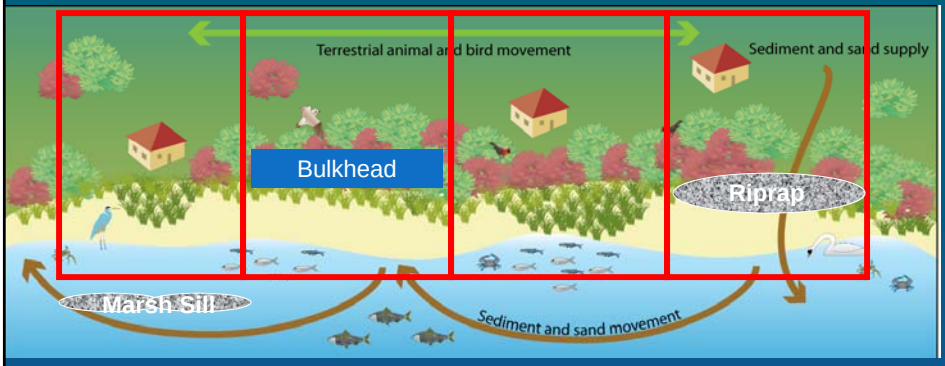
Healthy Fisheries Depend on Healthy Forest Buffers

Artificial Human Boundaries



- **Legal parcel boundaries**
- **Private vs. public property**

Piecemeal Human Actions

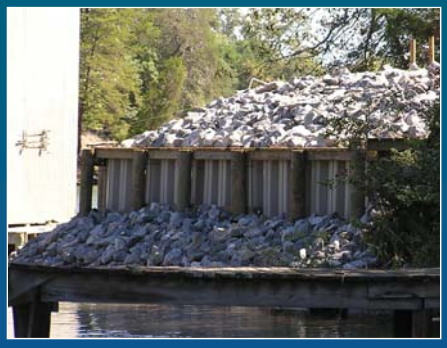


- **Individual parcel choices for shoreline landscape**
- **"Piecemeal" effect interrupts ecosystem services, including shoreline stabilization and water quality protection**

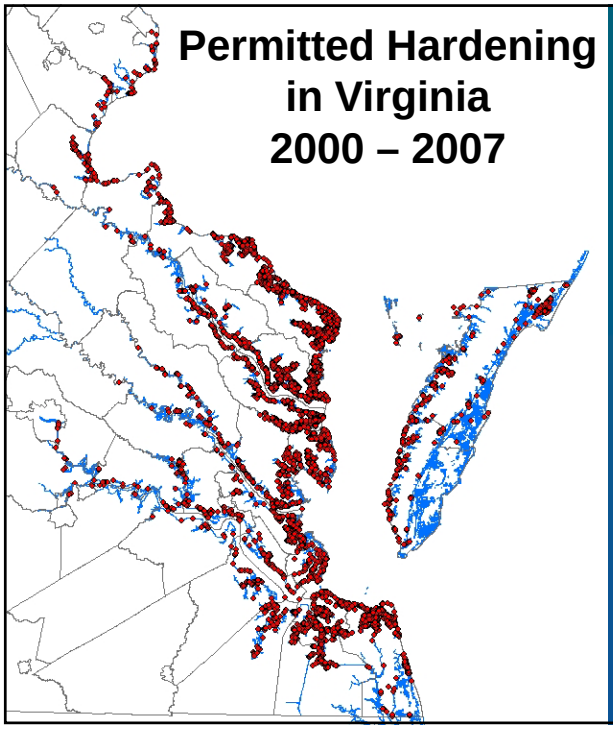
Land Use Choices

Upland structures close to water's edge with cleared buffers and lawn and without adequate stormwater runoff treatment

Shoreline Hardening



the replacement of "soft" natural shoreline habitats with "hard" human structures in and adjacent to waterways



36.3 miles bulkhead

113.2 miles revetment

Average 16.5 miles new hard shoreline permitted each year

Cumulative Impacts

Collective impact of many individual projects on entire ecosystem

Upland Development

+

Shoreline Stabilization Structures

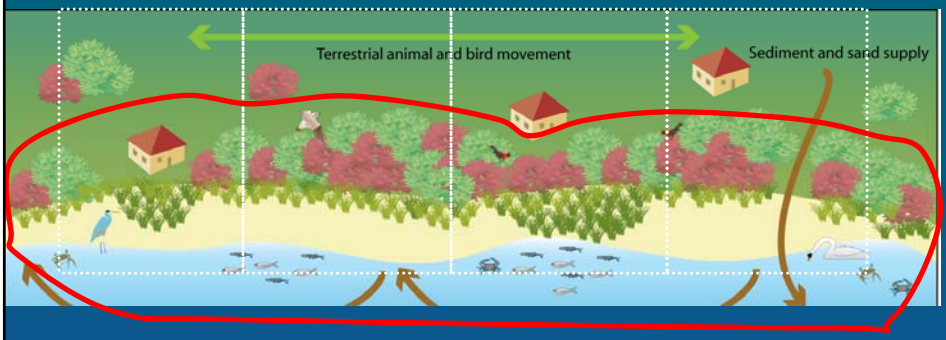
Cumulative Impacts on Living Resources

Riparian Buffer removal and suppression
+
Upland-Wetland habitat interruptions
+
Wetland and Beach Loss
from unnecessary structures & reflected waves

=

Degraded Water Quality
+
Poor Fisheries Habitat

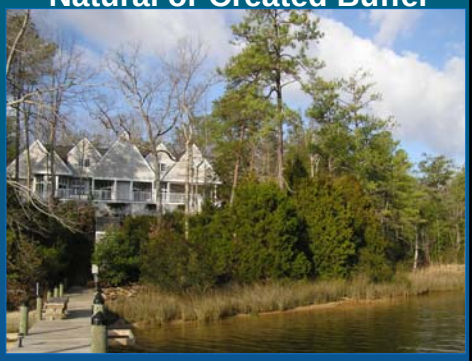
Integrated Shoreline Management



- **Mutually beneficial approach**
- **Take advantage of natural erosion and flood buffers across property lines**

Guiding Principles for Living Shoreline Projects
Preserve and Restore Riparian Buffers

Waterfront Lawn **vs.** **Natural or Created Buffer**



Nothing to intercept wave action or floodwaters

Runoff of lawn fertilizers and pesticides

Storm and flood buffering

Surface and groundwater interception

Guiding Principles for Living Shoreline Projects
Gradual Slopes and Connected Habitats

Instead of bulkhead or revetment....

Disconnected habitats

Gradual loss of intertidal area

Reflected wave action and sediment re-suspension

...Create or enhance integrated vegetation buffers with gradual slopes

Connected habitats

Dense plant cover

Active biological community

Erosion Types

Not all erosion is equal and not all erosion is a problem

Tidal Shoreline Erosion is Caused By....

Land Origin

- Upland runoff
- Gravity
- Groundwater flow
- Bank freeze / thaw cycles
- Bank clearing

Water Origin

- Wind-driven waves
- Tidal currents
- Storm surges
- Sea level rise (accelerated)
- Boat wakes

Types of Erosion
Catastrophic

Storm-driven waves
2003 TS Isabel

Heavy rainfall events
1999 Hurricane Floyd

Types of Erosion
Natural Geology & Elevation

Sand bluff
High bank subject to gravity, groundwater, wave attack forces

Floodplain
Low bank subject to sea level rise and retreat of land-water edge

Types of Erosion

Upland Runoff

Rills and gullies

Top of bank is failing

Bank toe near water is stable with no erosion

Types of Erosion

Bank Clearing

Cleared forest slope

Cleared creek bank

Types of Erosion

Undercutting

Caused by regular rise and fall of tides, groundwater movement
Indicates mean high water at bank

Deep undercutting can lead to tree fall

Types of Erosion

Minor Undercutting

Gradual process typical at base of steep forested slopes in quiet creeks

Various tree ages and dense understory indicate top of bank is stable

Types of Erosion

natural or anthropogenic?

Shading and natural bank

Previously cleared based on adjacent shoreline condition

Types of Erosion

Boat wakes?

Previously stable forest slope

Recent soil loss around tree roots in previous 5 years

Types of Erosion
Marsh edge

Marsh edge erosion is typical response to sea level rise and storms

Special methods are needed to address this type of situation with house so close

Types of Erosion
Perceived

Low forest bank with dense marsh
No exposed soil, no obvious erosion

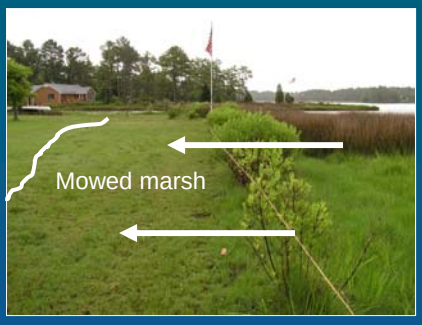
Flooding may be actual problem or concern, not erosion

Flooding vs. Erosion

Flooding shoreline has a gradual intertidal zone

Eroding shoreline has scarp or undercut base

Indications of flooding



Marsh vegetation retreating landward indicates flooding

Proposed low bulkhead would not stop flooding from other directions

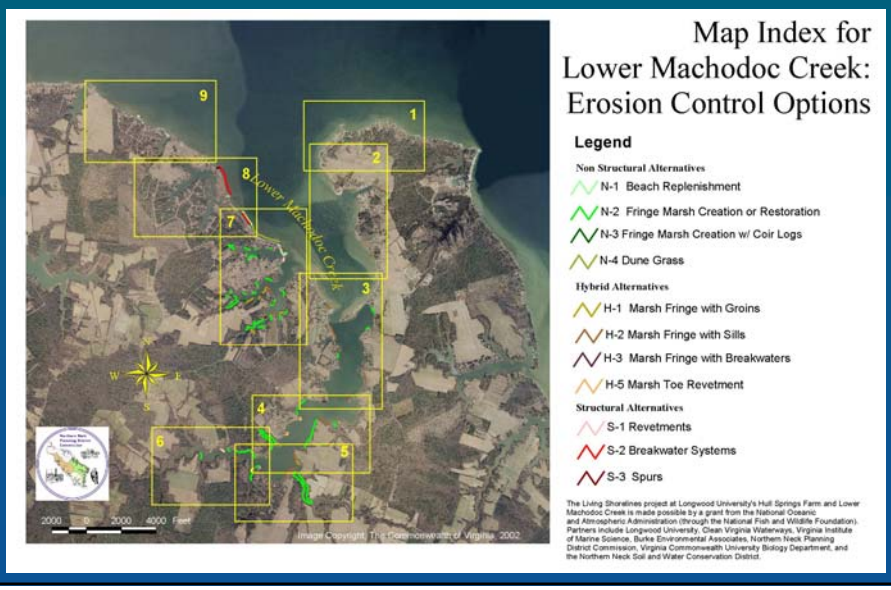
A marsh sill doesn't stop flooding

Common Solution for Flooding Problem

Elevating structures threatened by flooding is more effective than using erosion control structures

How to Choose Design Options

Consult VIMS Special Reports
where available – more coming soon



What is the Nature of the Problem?

Upland Erosion caused by water runoff toward the shoreline?

- Manage water in the upland and riparian zones using vegetation, swales, rain gardens, berms, dry wells, etc

Flooding ?

- Use a wide intertidal area to move land-water interface offshore
- Plant the intertidal zone with vegetation to slow and absorb flood waters
- Raise or move structures to reduce flood risk

Tidal Erosion caused by waves or currents at water level ?

Use the appropriate living shoreline design where possible

What level of protection is needed?

Lower protection

- Has:
  - No structure at risk
  - Milder wave climates
  - Shorter fetch
- Use:
  - Vegetation only
  - Bank grading
  - Narrow intertidal zones possible

Higher protection

- Has:
  - Structure at risk
  - Higher wave climate
  - Longer fetch
- Use:
  - Hybrid or structural
  - Bank grading
  - Wide intertidal zones

Types of Living Shoreline Methods

Non-Structural

- Create wide gradual slopes
- Enhance vegetation cover

Hybrid

- Strategically use structures to support vegetation growth
- Integrated vegetation areas are primary element
- Structures are secondary element

Where are Living Shoreline projects appropriate? It depends on these factors:

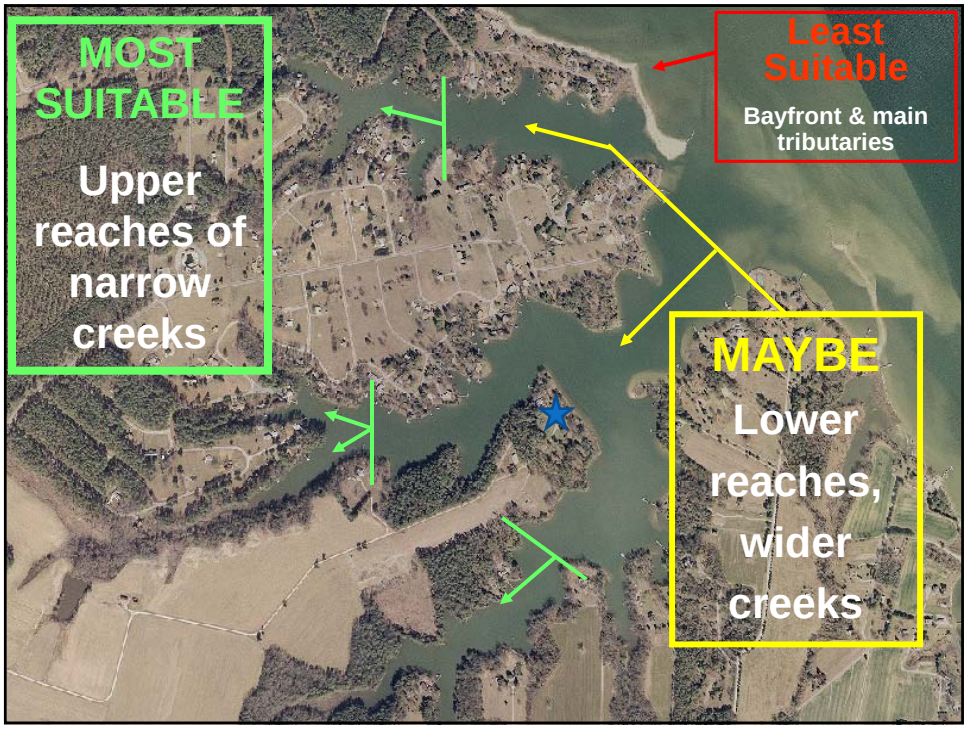
- **Landscape setting**
- **Erosion condition**
- **Wave climate**
- **Gradual slope**
- **Existing erosion buffers**
- **Willing property owner**

Site suitability increases when more than one of these factors is present.

Good places for living shorelines

Landscape Setting

- Surrounding land and water uses are compatible
  - No upland improvements in close proximity (e.g. road, house, driveway, well, septic tank or drainfield)
  - No conflicts with navigation interests
- Shoreline orientation
  - Plenty of sunlight, infrequent storm exposure
- Predictable salinity range & freshwater influence



Good places for living shorelines

Erosion Condition

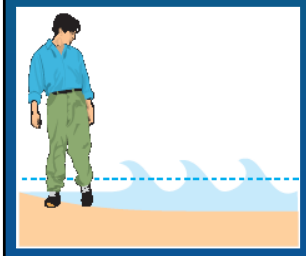
- Minor bank erosion and undercutting that needs to be reduced
- Erosion caused by upland runoff, rather than tide and wave action
- Gradual rate of landward retreat
- Minor groundwater flow

Good places for living shorelines

Wave Climate

Overall wave energy that impacts the project shoreline, averaged through time.

Fetch + Wind Direction + Storm Frequency + Tide Range



- Low to moderate wave energy
- Regular high tides do not reach the upland bank
- Few boat wakes

High Energy Shorelines not as suitable

Bayfront
Potomac River
Rappahannock River

- Large waves on a frequent basis
- High risk if structures are close to shoreline
- High level of protection may be needed

Good places for living shorelines

Gradual Slope

Topography (land) + Bathymetry (under water)

- Bank height less than 30 feet
- Bank sloped, not vertical
- Wide and flat intertidal area
- Wide & shallow subaqueous area

A gentle bank slope combined with a wide, flat intertidal area and shallow subaqueous area will dissipate wave energy AND support plant growth.

Good places for living shorelines

Existing Erosion Buffers

- Riparian Buffer
- Tidal Marsh
- Sand Beach
- Sand Dunes

Existing erosion buffers can be enhanced to increase the level of protection

OR created where they do not naturally exist if substantial alterations are not required.

Good places for living shorelines

Willing Property Owner

- Understands level of protection
- Accepts dynamic shoreline condition
- Tolerates wildlife attracted by habitats
- Willing and able to monitor and maintain

If erosion is present
and
it cannot be tolerated….

first consider what actions can be taken in the upland area and on private property

consider actions that encroach into the water only as a last resort

Forest Buffer Protection
OR
Bank Grading?

Existing forest condition is highly desirable and should be preserved and managed

Existing riparian buffer is disturbed, cleared lawn, and/or not providing stabilization or water quality services

Enhance Tidal Marshes
if present

Wide Marsh
protect marsh edge

Narrow marsh
increase marsh width
Landward if possible
Channelward if necessary

May need marsh sill structure

Enhance Sand Beaches if present

Wide Beach
protect sand supply

Narrow beach
increase beach width

May need "sand containment structures"
nearshore sill or offshore breakwaters

End of Part 1

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