

VIMS · CENTER FOR COASTAL RESOURCES MANAGEMENT



The Science Behind Virginia's Living Shoreline Standards

A plain-language guide to the science behind Virginia's living shoreline definition — and what separates a high-performing design from the rest.

Adapted from: The Science Behind Virginia's Living Shoreline Standards — Resource for Coastal Decision-Making (CCRM–VIMS, April 2026)

The Science Behind Virginia's Living Shoreline Standards:
Resource for Coastal Decision-Making



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VIMS | WILLIAM & MARY
VIRGINIA INSTITUTE OF MARINE SCIENCE
CENTER FOR COASTAL RESOURCES MANAGEMENT

What Is a Living Shoreline?

A nature-based way to manage shoreline erosion AND gain ecosystem co-benefits — leveraging the ability of natural habitats to dampen wave energy, buffer storm surge, capture sediment, recover from storms, and adapt to changing conditions.



Tidal Wetlands



Beaches & Dunes



Oyster Reefs

*The central idea: living shorelines are defined by what they DO — not what they're built from.
Code of Virginia § 28.2-104.1 defines them by function.*

Virginia's Definition: Four Interconnected Elements

All must be present. No single feature or material qualifies a project on its own.

1



Erosion Control & Water Quality

Uses natural habitat to absorb waves and improve water quality

2



Protects, Restores, or Enhances Habitat

Natural elements dominate over structural ones

3



Maintains Coastal Processes and the Natural Continuity of the Land-Water interface

Strategic placement of plants, stone, sand & other materials

4



Enhances Resilience (when practicable)

Enhance coastal resilience and attenuation of wave energy and storm surge

“Function over materials.”

*A pile of rocks can serve as a **revetment** if placed on an upland slope OR a **sill** if placed in shallows to allow a marsh to establish. **What matters is whether the design lets water, sediment, and plants and animals keep moving the way they naturally would.***

- Erosion control comes from natural habitat, not concrete or rock alone
- Water quality benefits happen through plants, soil, roots, benthic invertebrates, and microbes
- Tidal flow and sediment exchange must continue moving across the shore



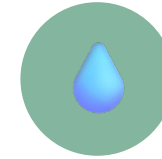
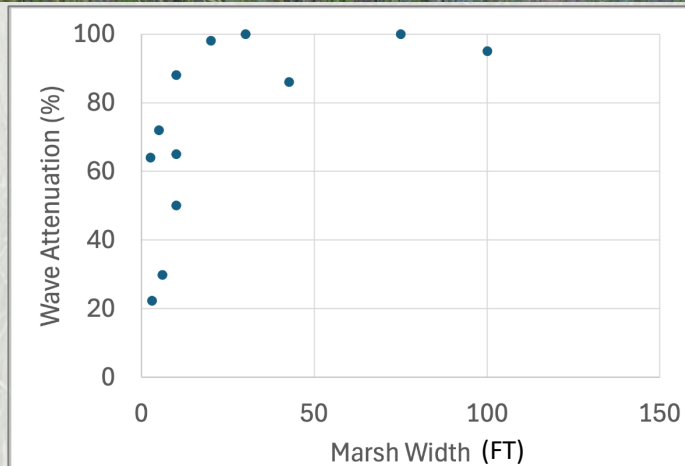
1. Erosion Control & Water Quality



Absorbing the Waves

- Wetland and dune vegetation reduce current speed and dissipate wave and storm-surge energy
- Marshes can attenuate up to ~60% of wave energy in the first few meters, and ~100% within about 80 feet
- Oyster reefs placed offshore add another layer of protection with marshes behind them

Video by: C. Currin, NOAA



Filtering the Water

- Wetland vegetation slows water flow, letting sediment settle out and trapping contaminants before they reach the estuary
- Plants and soils take up excess nitrogen and phosphorus from groundwater, tidewater, and runoff

2. Protect, Enhance, or Restore Natural Habitat

Three ways living shoreline techniques support natural shoreline habitat:

PROTECT



Stabilize an existing natural habitat

e.g., bagged oyster shell along an eroding marsh edge



ENHANCE

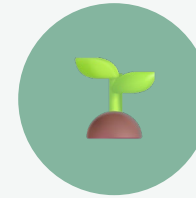


Promote existing habitat expansion or improve quality

e.g., sill or coir logs placed waterward of the habitat; add plantings/remove invasives



RESTORE



Directly construct or restore new habitat

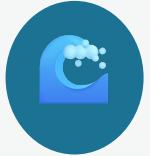
e.g., tidal wetland plantings, with stabilization if needed



Key rule: natural elements should predominate over artificial ones because the habitat is foundational to a functioning living shoreline.

3. Maintaining Coastal Processes

A living shoreline works **WITH** natural forces instead of disrupting them. Three types of processes must keep functioning:



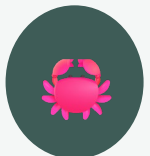
Physical

Unimpeded movement of sediment, water, and water-borne materials, and aquatic and terrestrial fauna, along and across the shore



Chemical

Natural nutrient and carbon cycling, strong benthic–pelagic coupling, and two-way exchange of water, dissolved and particulate carbon and nutrients between living shoreline habitats and adjacent ecosystems



Biological

Protect, restore or enhance habitat that supports native plants and animals — from microbes to birds



Armoring disrupts all three. Living shorelines are designed to keep them running.

3a. Physical Processes



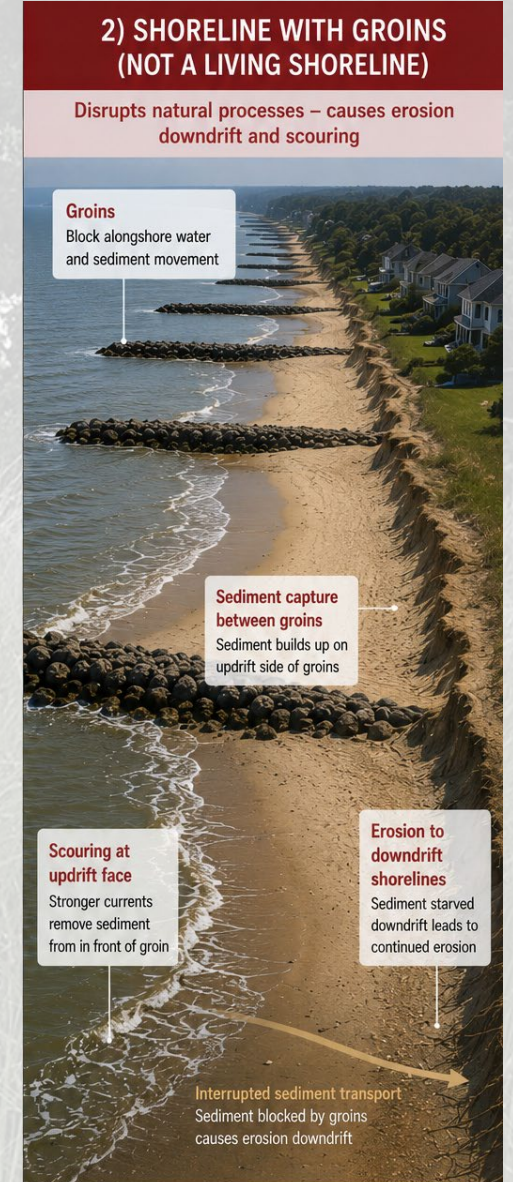
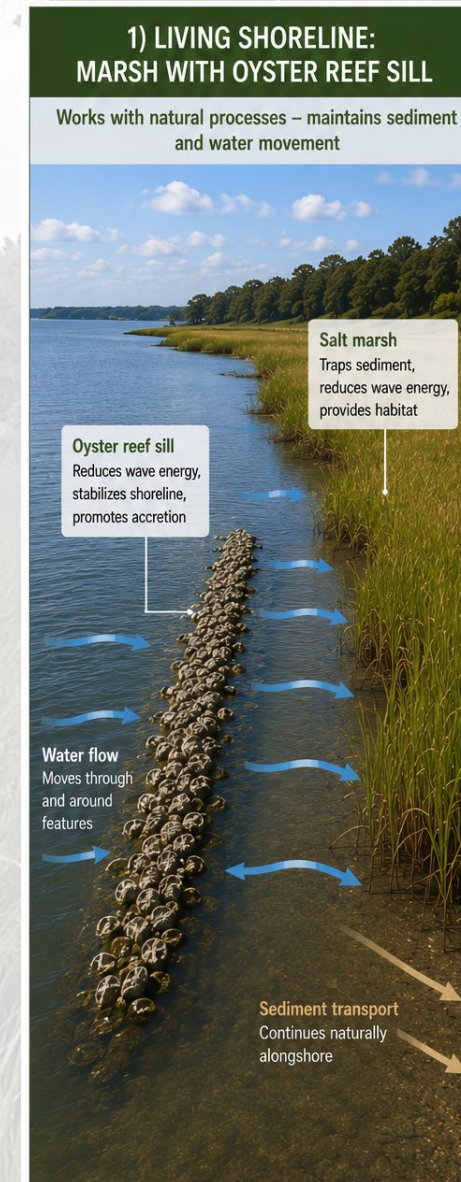
Physical: Sediment & Water Movement

Water flow: tidal exchange to the habitat is maintained

Sediment movement: waves, tides, and runoff move sediment along (longshore) and across (cross-shore) the shore — living shorelines work with this flow, not against it

Wave attenuation: dense vegetation slows water, drops sediment out, and builds elevation over time —critical for keeping pace with sea-level rise

Self-sustaining design: the best designs need no routine sand or plant replenishment

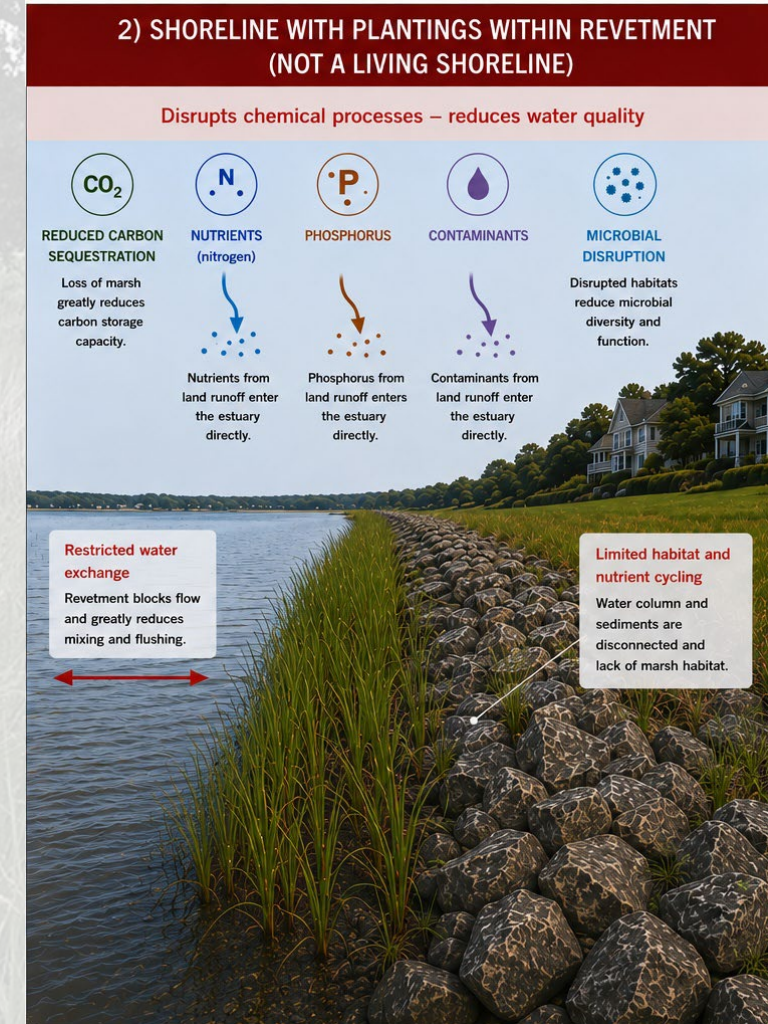
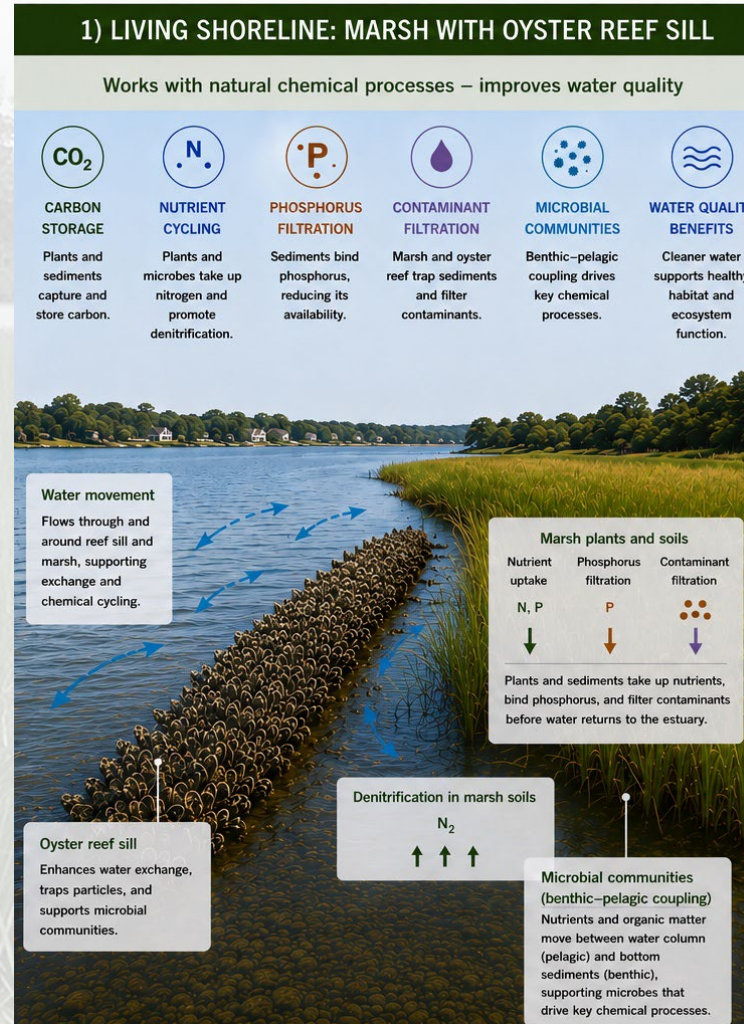


3b. Chemical Processes

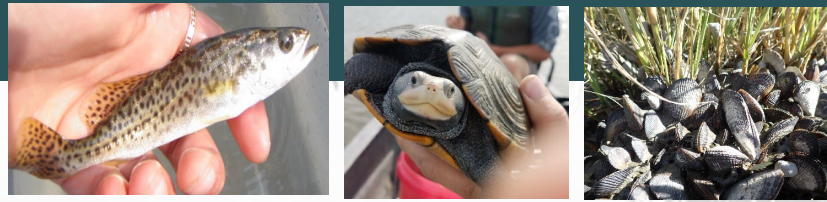


Chemical: Nature's Water Filter

- **Carbon storage:** marshes act as carbon sinks in plants and soil
- **Nutrient cycling:** nitrogen & phosphorus are captured or transformed (denitrification converts nitrate to harmless gas)
- **Contaminant filtration:** traps heavy metals and pollutants before they reach the estuary
- **Land-water connection** is essential to enable nutrient and carbon cycling



3c. Biological Processes

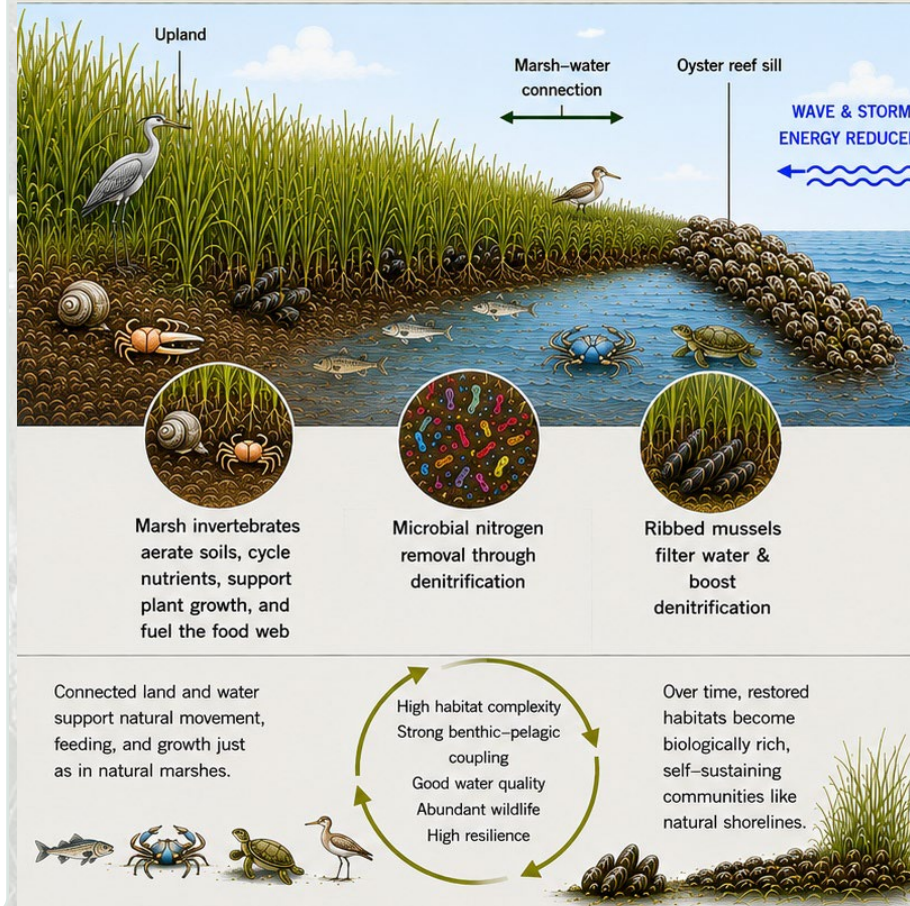


Biological: The Ecosystem

- **Foundation species** (marsh grass, oysters) create habitat for everything else
- **Land–water connectivity** allows plants and animals to move, feed, and grow naturally.
- **Birds, fish, crustaceans, and terrapin** use living shorelines like natural marshes within ~3 years
- Over time, these restored habitats become **biologically rich, self-sustaining** communities like natural shorelines.

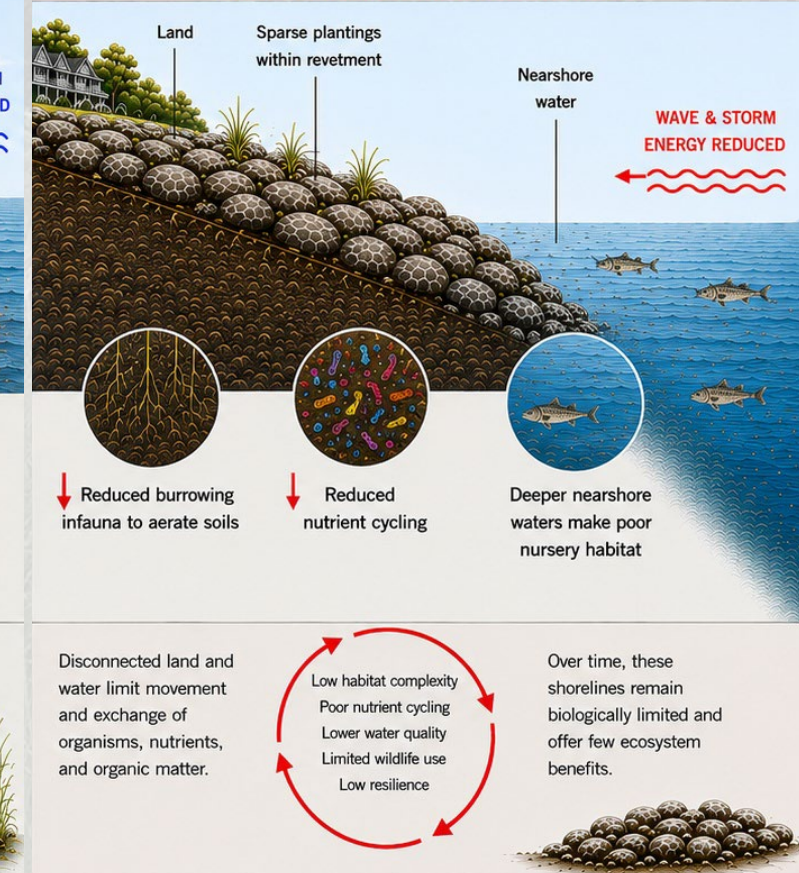
1) LIVING SHORELINE: MARSH WITH OYSTER REEF SILL

BIOLOGICAL PROCESSES MAINTAINED



2) SHORELINE WITH PLANTINGS WITHIN REVETMENT (NOT A LIVING SHORELINE)

BIOLOGICAL PROCESSES DISRUPTED

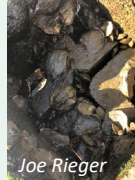
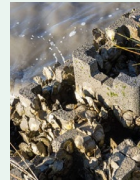


Ways to Design Hybrid Projects to Support Coastal Processes

Plants, stone, sand fill, and other materials can be part of a living shoreline.
What matters is how and where they're placed.

✓ Supports Coastal Processes

- ✓ Low profile — allows tidal overtopping
- ✓ Porous — water flows through, reducing scour & provides more habitat
- ✓ Includes tidal openings / gaps for fish & wildlife access and tidal flushing
- ✓ Minimized footprint — limits habitat conversion

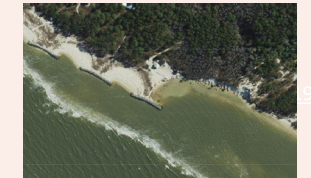


Joe Rieger

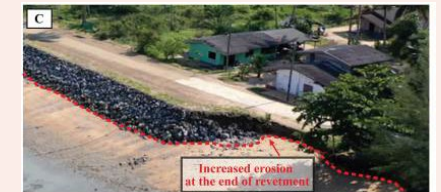


✗ Disrupts Coastal Processes

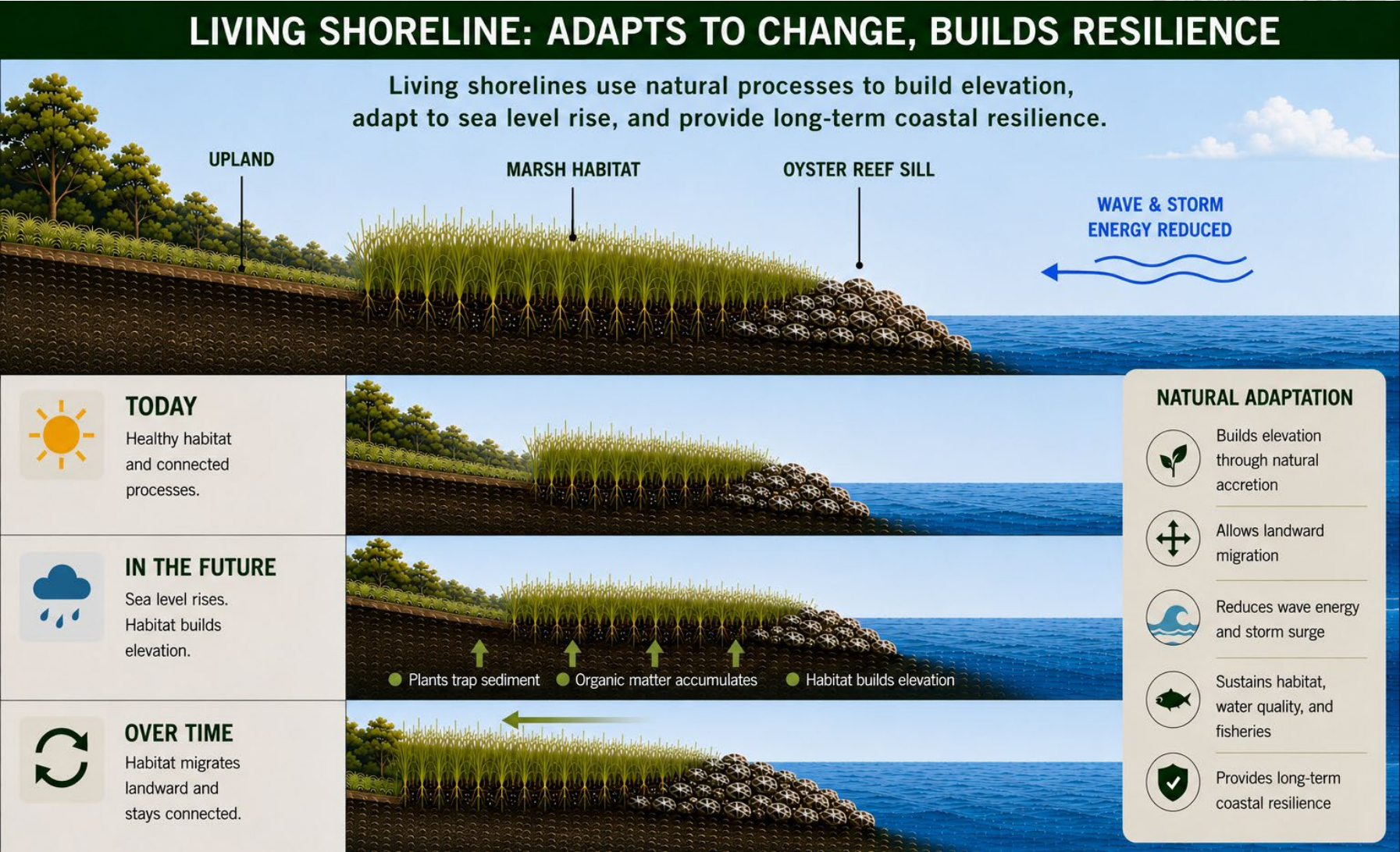
- ✗ Continuous hard structure, no tidal gaps
- ✗ Interferes with downdrift sediment transport
- ✗ Increased turbidity or scouring near the structure
- ✗ Blocks longshore or cross-shore water movement/poor flushing



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4. Enhance coastal resilience



Living shorelines are able to recover from storms and adapt to changing conditions, enhancing coastal resilience



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VIMS boat basin 40+yr old living shoreline that has outlived 2 replacement bulkheads on the other side of the canal

*C. Croswell, 2003,
Baltimore Co. DEPRM*



**Bulkhead failure and fastland scour associated with storm surge ebb.
Chesapeake Bay, Baltimore Co**

Warning Signs

Signals that a project may NOT be functioning as a living shoreline:



Continuous hard structure with no tidal openings



Increased turbidity or scouring in the nearshore area



Vegetation added to a mostly armored shoreline



Reduced sediment capture on the marsh surface, limiting vertical growth



Structural components dominate over natural habitat



Blocked or redirected water movement that fragments habitat or impairs tidal flushing



Interference with downdrift sediment transport — erosion appears on neighboring shores



Fish, crabs, and other wildlife can't move freely in and out of the site

YOUR TURN

Spot the High Performers

1. *Pick which is a high performing living shoreline*
2. *Give a reason why*
3. *For the unselected shoreline, make suggestions to improve performance*

Ask yourself:

- Does natural habitat do the primary work of erosion control?
- Do natural elements dominate over structural components?
- Is tidal exchange maintained across the shore?
- Are sediment transport pathways preserved, not blocked?
- Can the design adjust to storms and sea-level rise over time?