



Estuarine Shoreline Stabilization Design & Techniques

Dr. Mariko Polk *Coastal Processes Specialist*



@ncseagrant



@ncseagrant

ncseagrant.ncsu.edu

NC Sea Grant

Research, Education, and Outreach

Focus on:

- **Resilient communities and economies**
- **Sustainable fisheries and aquaculture**
- **Healthy coastal ecosystems**
- **Enhance environmental education**
- **Foster workforce development**



Why do we live on the coast?



Why do we live on the coast?

- 
- **Access to resources** =  **Economics**
 - **Goods** Fisheries, Resources
 - **Services** Recreation, Tourism
 - **Cultural** Heritage, Intrinsic Value

COASTAL COMMUNITIES

Coastal populations will
continue to grow

56 to 245 million
people
at risk IPCC 1-5m Sea Level
Rise Scenarios

IPCC = International Panel on Climate Change





COMMUNITIES AT RISK

On the front lines of impact and
produce new and innovative
solutions to coastal management

CAUSES OF COASTAL WETLAND EROSION

- **Spatial and Temporal Scale**
- Wind and wave energy
- Drought & Drowning
- Population dynamics
- Habitat conversion
- Coastal squeeze
- *and more!*



How do we manage the shoreline?



3 CATEGORIES OF MANAGEMENT

1. Hold back the water

Push the water away, armoring, flood prevention engineering

2. Retreat

Move back

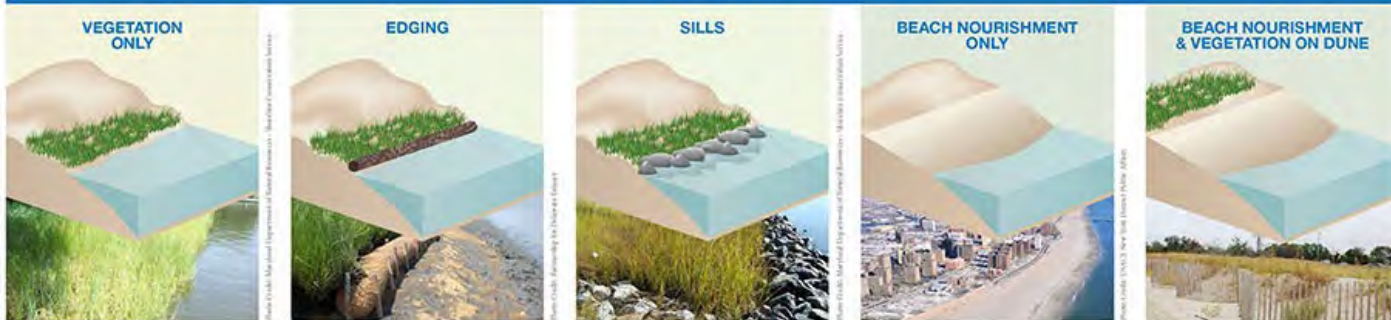
3. Adapt

Increase structure height, nature-based solutions

(Titus et al., 2009b)



LIVING SHORELINE



COASTAL STRUCTURE





Shoreline Hardening

Japan by Katsushika, Hokusai circa 1833



Smithsonian article
on ancient seawalls



SHORELINE HARDENING

- Used for millennia
- Static shoreline
- Over 14% of the US hardened
(Gittman et al. 2015)
- ↑ 173% increase in hardening
(Correll-Brown et al. 2022)



Seawall



Revetment



Bulkhead



Image (USACE, Polk, USACE)

HARD STRUCTURES

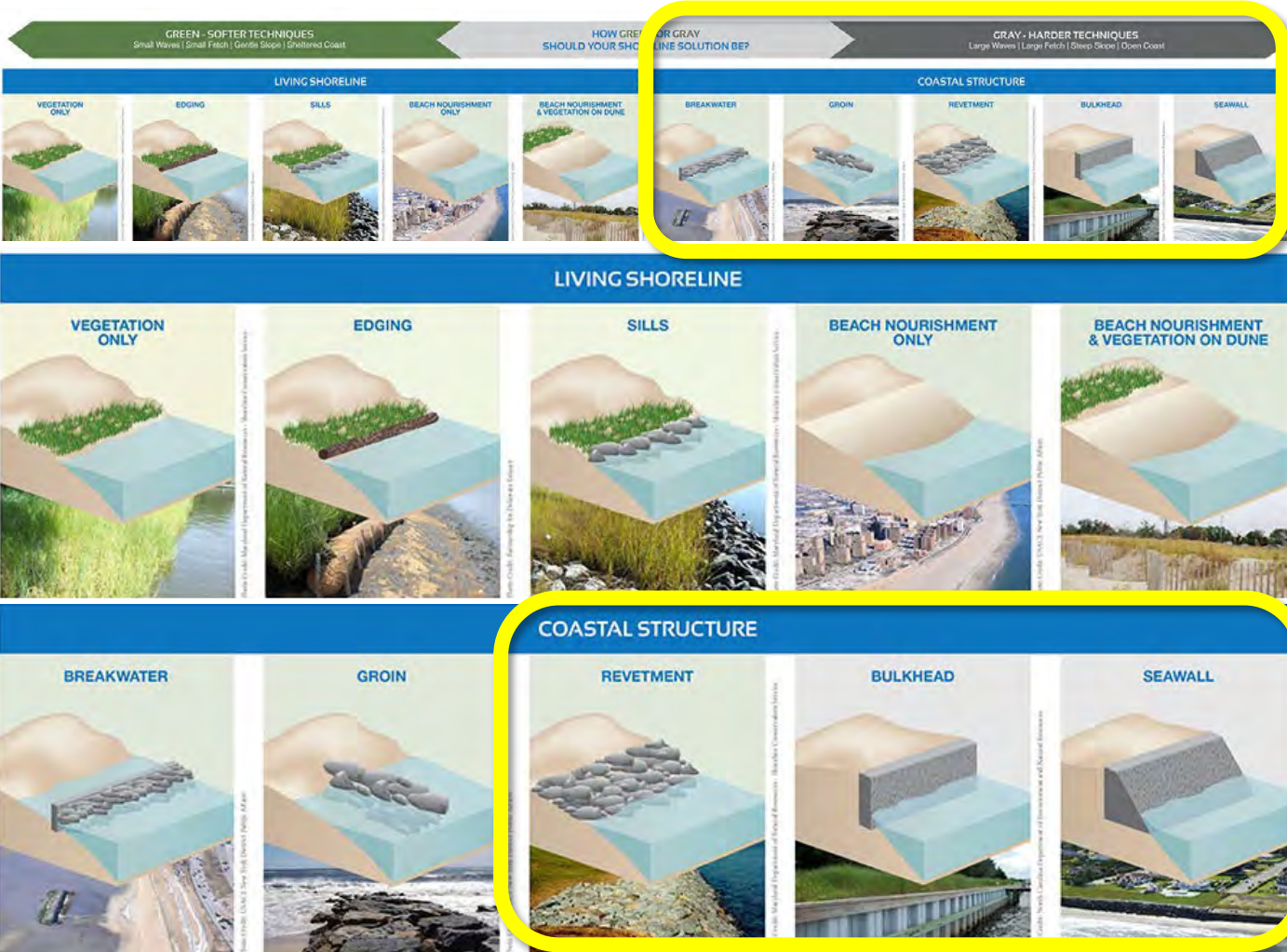
Long history of use.

Can be the only option when building up or upland retreat is not an option.

14%

Of contiguous US has been hardened⁹





BULKHEAD

- Wood, Vinyl, Concrete
- May be only solution for narrow canals and marinas/harbors



BULKHEADS

Benefits

- Static Shoreline
- Durable (in low energy conditions)
- Initial installation can sometimes cost slightly less

Drawbacks

- Expensive to Maintain
- Short life expectancy
- Disconnect land & water
- Erosion & habitat loss

RIPRAP REVETMENT

- Granite, marl, concrete
- Used on sediment banks



RIPRAP REVETMENT

Benefits

- Static Shoreline
- Suited for high energy
- Less scour issues
- Can sometimes provide habitat for a few species

Drawbacks

- Large footprint
- Disconnect land & water
- Erosion & habitat loss

Hardening Shorelines

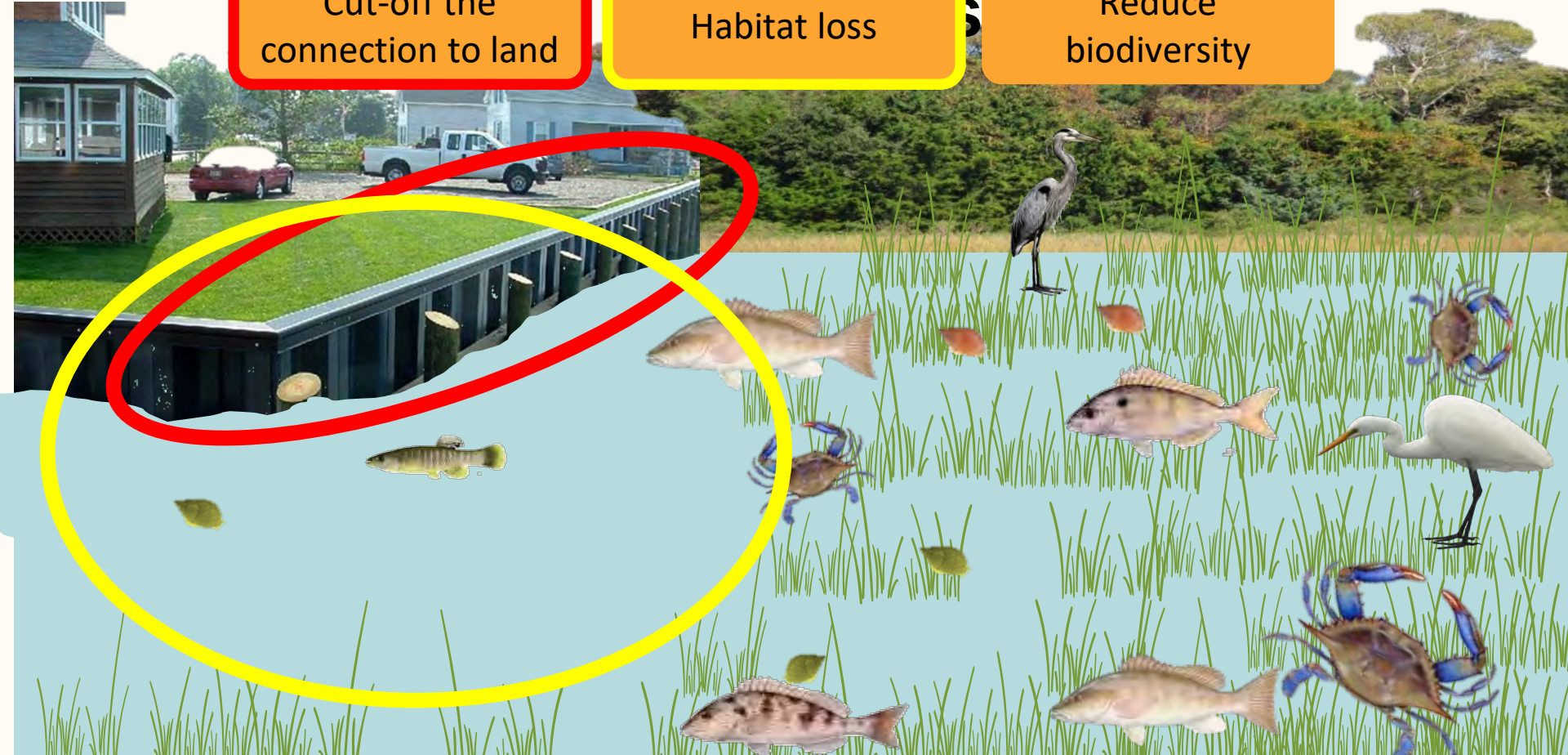


Hardening

Cut-off the
connection to land

Habitat loss

Reduce
biodiversity

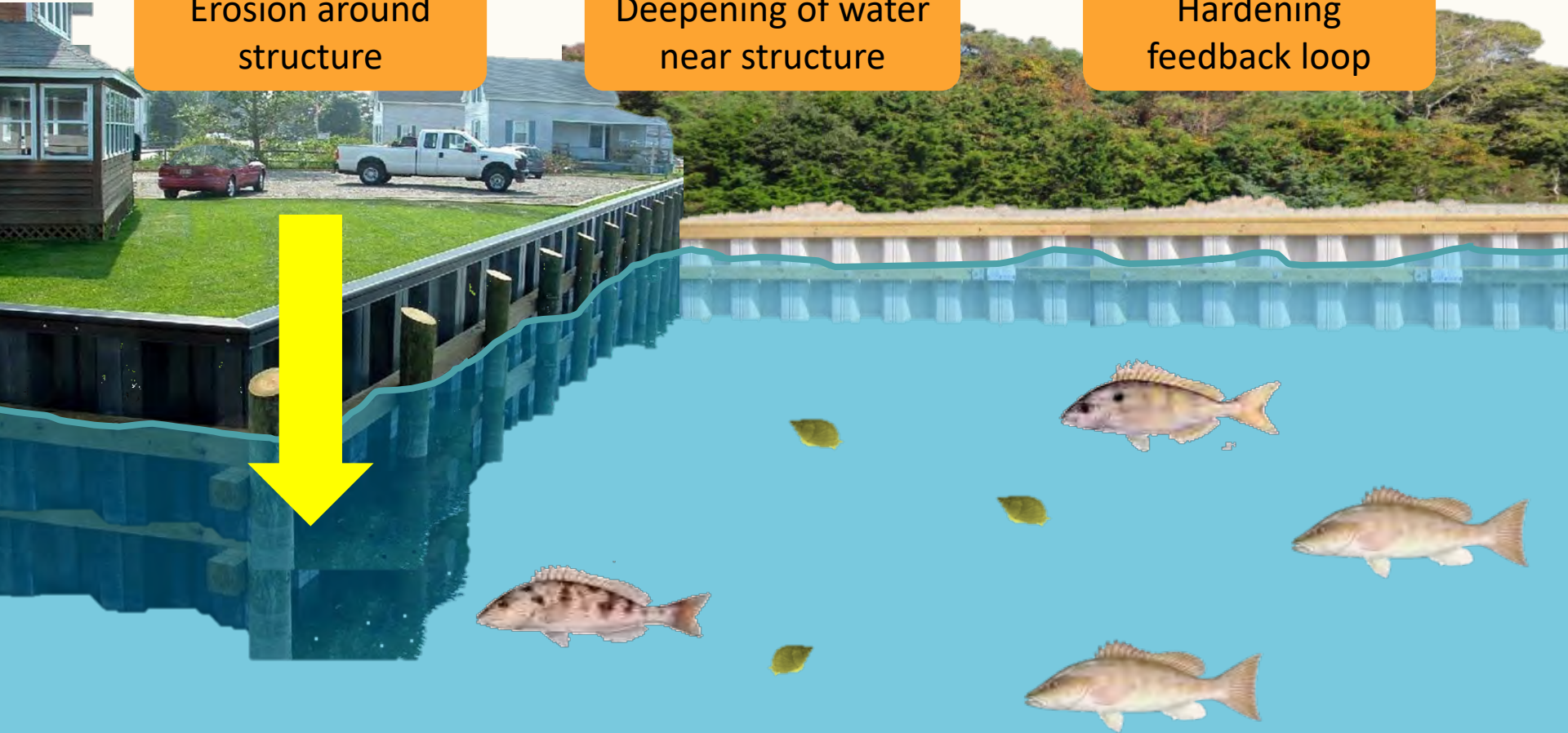


Hardening Shorelines

Erosion around
structure

Deepening of water
near structure

Hardening
feedback loop

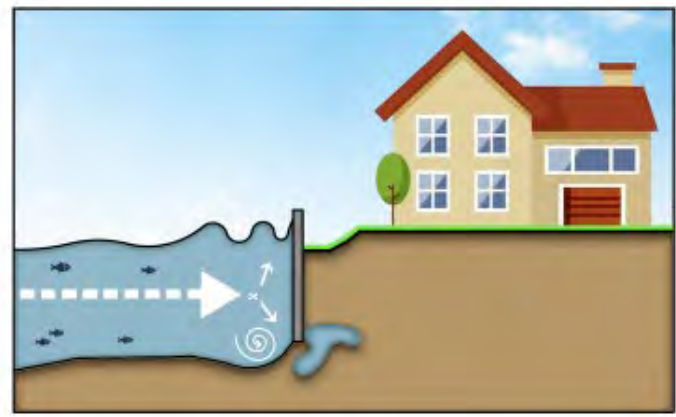
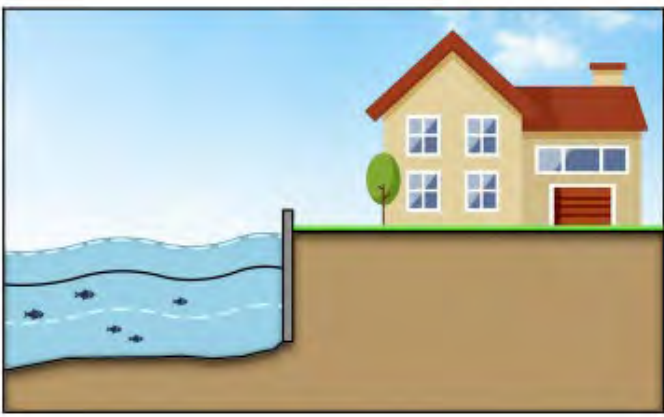


Hardening Shorelines

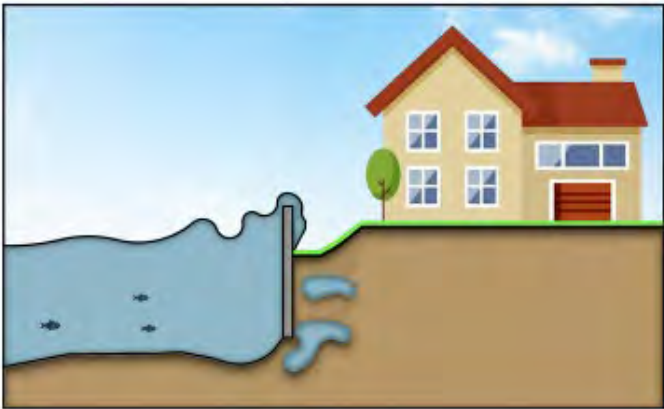
Encourages development
in high-risk spaces

Increased usage





Influence of high wave energy on a bulkhead



SALT MARSHES

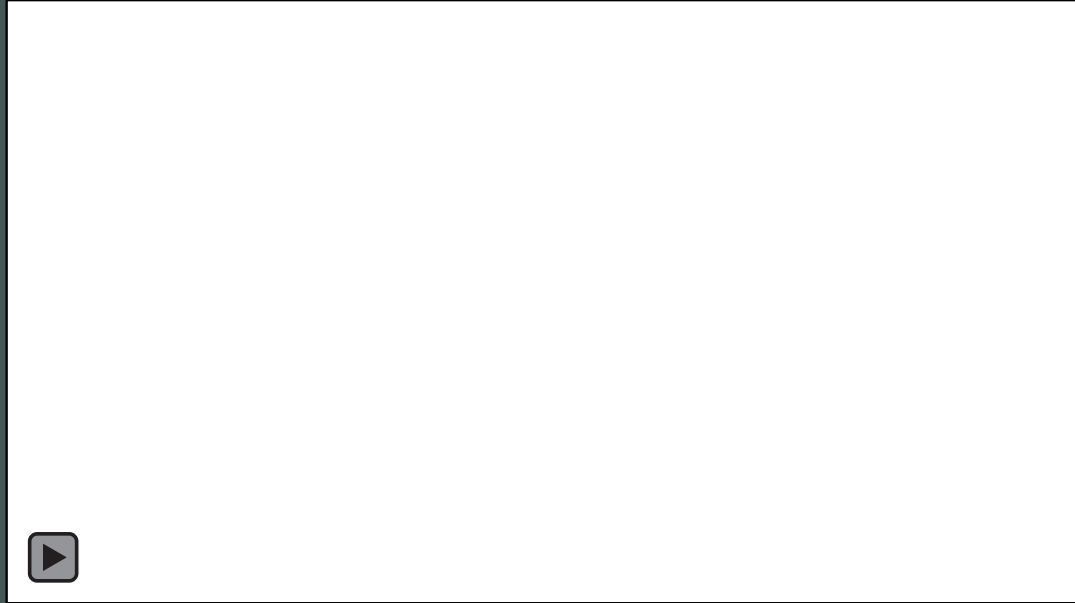
Provide **ecosystem services** such as nursery habitat provisioning, water quality enhancement, nutrient cycling, pollutant filtration, storm and flood amelioration, and carbon sequestration^{1,2}

10 m

Many of these critical ecosystem services occur within the first 10 m of marsh edge³

17,234 km²

of salt marshes are in the contiguous US

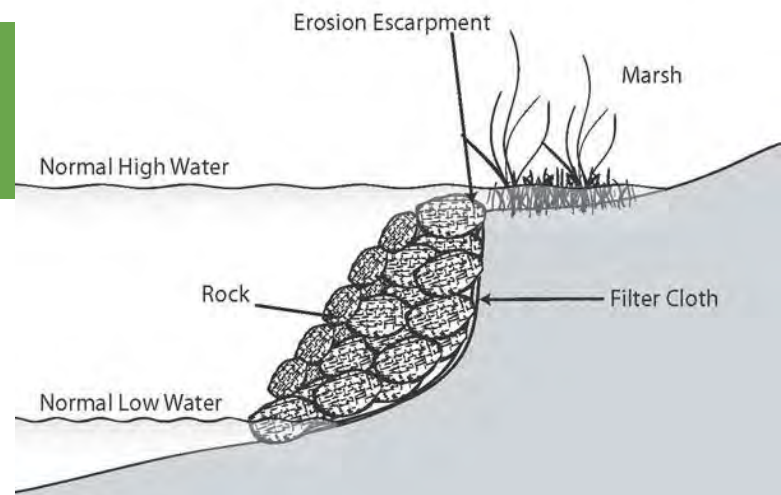


SMOOTH CORDGRASS
(*SPARTINA ALTERNIFLORA*)



MARSH TOE REVETMENT

- Granite, marl
- Used in front of a marsh



Images (NC Coastal Federation, NC DCM)

MARSH TOE REVETMENT

Benefits

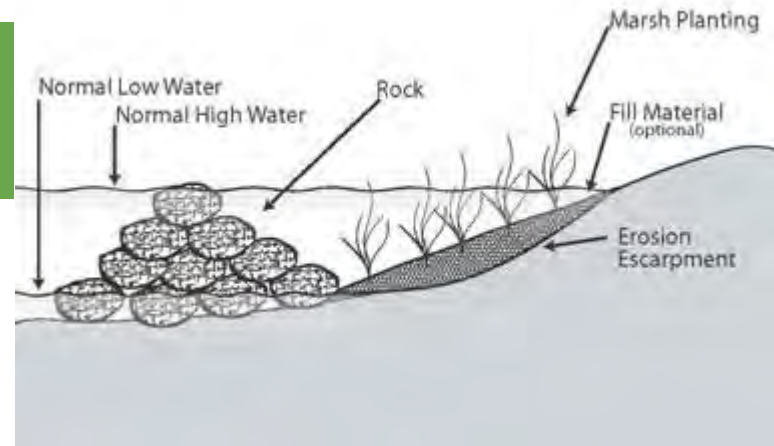
- Erosion control
- Suited for high energy
- Land & Water Connection
- Maintains salt marsh

Drawbacks

- Large footprint
- Prevents waterward growth
- Can sometimes have scour

SILL

- Granite, marl, oyster bag, loose shell, concrete, sheetpile



Images (Smith, NCDQM.)

SILL

Benefits

- Erosion control
- Land & Water Connection
- Maintains salt marsh
- Low-cost maintenance

Drawbacks

- Some designs can be costly
- May require adjustments
- Not a cure-all

BREAKWATER

- Granite, marl, concrete, wood, vinyl sheet – with gaps



SILL

Benefits

- Erosion control
- Land & Water Connection
- Maintains salt marsh

Drawbacks

- Not ideal for high energy
- May result in scour in front of the structure



Benefits of Living Shorelines

- Protection from wave energy and storm events: Up to **60%** reduction in energy



Benefits of Living Shorelines

- Reduction in erosion short and long term
- Accumulate sediment and grow shorelines



Benefits of Living Shorelines

- Habitat provisioning
- Habitat complexity
- Multi-habitat connectivity
Habitat continuum
- Multifunctionality

Considerations

- Custom site designs and configurations
- Not a magical cure all, need a better understating of limits
- Up and coming living shoreline products





**Synthetex
Hydrotex Enviromats**



**Coastal Technologies Corp
Marsh Oyster Units**



**Native Shorelines
QuickReef**



Atlantic Reefmaker



**Sandbar Company
Oyster Catchers**



**Allied Concrete
Oyster Castles**



**Tampa Bay Watch
Oyster Balls/Domes**



**Empty or Filled
Gabion Baskets**

Why aren't living shorelines as popular?

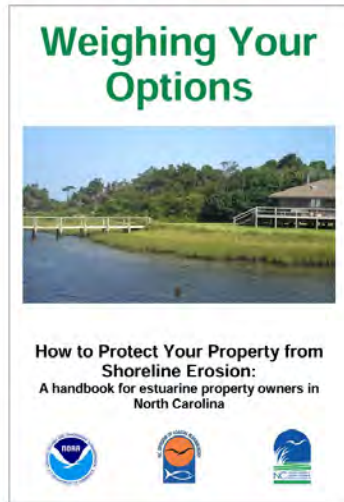
- Perception that bulkheads are more effective
- Neighboring property influence
- Knowledge: Landowners, Marine Contractors
- Early on over-use of bulkheads
- Perception that living shorelines aren't appropriate for high energy



Resources

NC Division of Coastal Management

Contact your DCM Field Representative
to know your options



Where Can I see a Living Shoreline?



Sunset Beach Town Park

206 Sunset Blvd N, Sunset Beach, NC 28468

Oak Island Veterans Park

1408 E Yacht Dr, Oak Island, NC 28465

St James Waterway Park

2713 St James Dr SE, Southport, NC 28461

Brunswick Town Ft Anderson

8884 St Phillips Rd SE, Winnabow, NC 28479



Images (Roger)



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mapolk2@ncsu.edu



@ncseagrants



@ncseagrants



@seagrantsnc