Living shorelines a sustainable option to protect shorelines in the face of sea level rise and erosive forces.

Troy Alphin

Oak Island Living shoreline workshop

April 2026

Welcome

Introduction: I am a benthic ecologist working with UNCW for more than 30years.

I have studied: **benthic community composition, impacts of beach renourishment, recovery of borrow sites, tidal creek ecology, influences of human activities on oyster characteristics, restoration of critical habitats including, juvenile blue crab habitat utilization, blue crab distribution, impacts of shellfish aquaculture, ecosystem services of critical habitats, ecological services of shellfish aquaculture, siting issues related to shellfish aquaculture, as well as the habitat function of living shorelines**

Current work that relates to Oak Island- Living shorelines and potential offshore sand sites.

What is?

- **From the beach to the waterway**
- **Regional sand management?**
- **Beach protect**
- **Living shorelines**

A few terms and questions

Where is the coast?

at the water's edge?

~a mile i land?

~ten miles

"For most people, their image of the coast is the place where the land meets the sea, most likely in the form of a beach. But it is more than just the narrow strip along the water line; technically the term "coast" refers to the range of land over which the ocean has an effect on climate, foliage, and other environmental processes. This range may extend for tens of kilometers inland from the water's edge."

Terms cont’d

What is an estuary?

a lagoon

a river mouth

the area where salt and freshwater meet.

An **estuary** is a partially enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea.

(Prichard 1967)

Estuaries and their surrounding wetlands are bodies of water usually found where rivers meet the sea. NOAA NOS

In General, there are 4 types of Estuaries

Tectonic Estuary San Fransciso Bay

Drowned River Valley

Chesapeake Bay is a good example

Fjords
Formed by the movement of glaciers

The NC Coast consists of many Bar built estuaries so a sea level rises we have problems

For Today:

We will focus on living shorelines

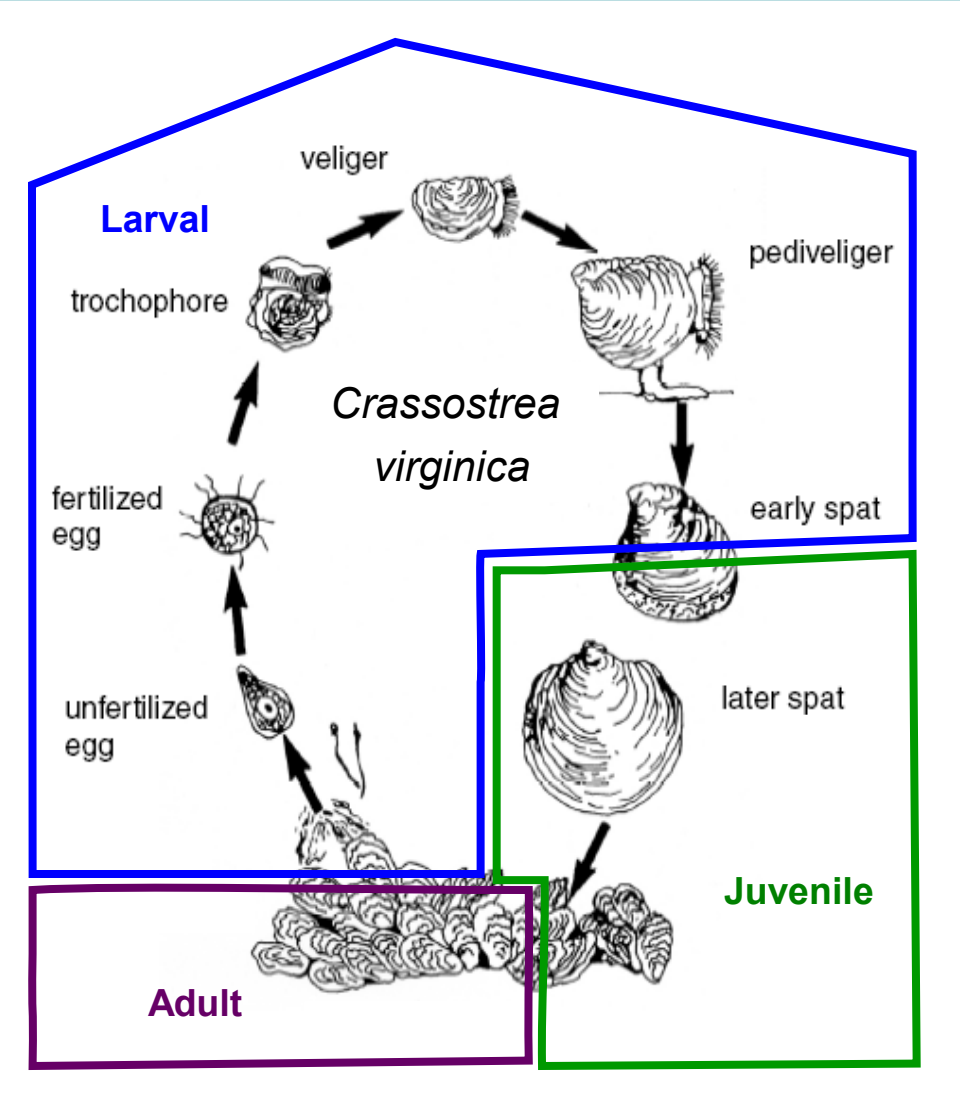
But first a bit about oyster biology

- What is the issue
- What are living shoreline
- Why living shorelines
- Where might they work best
- Briefly how we actually developed the idea of living shorelines as a means of erosion control

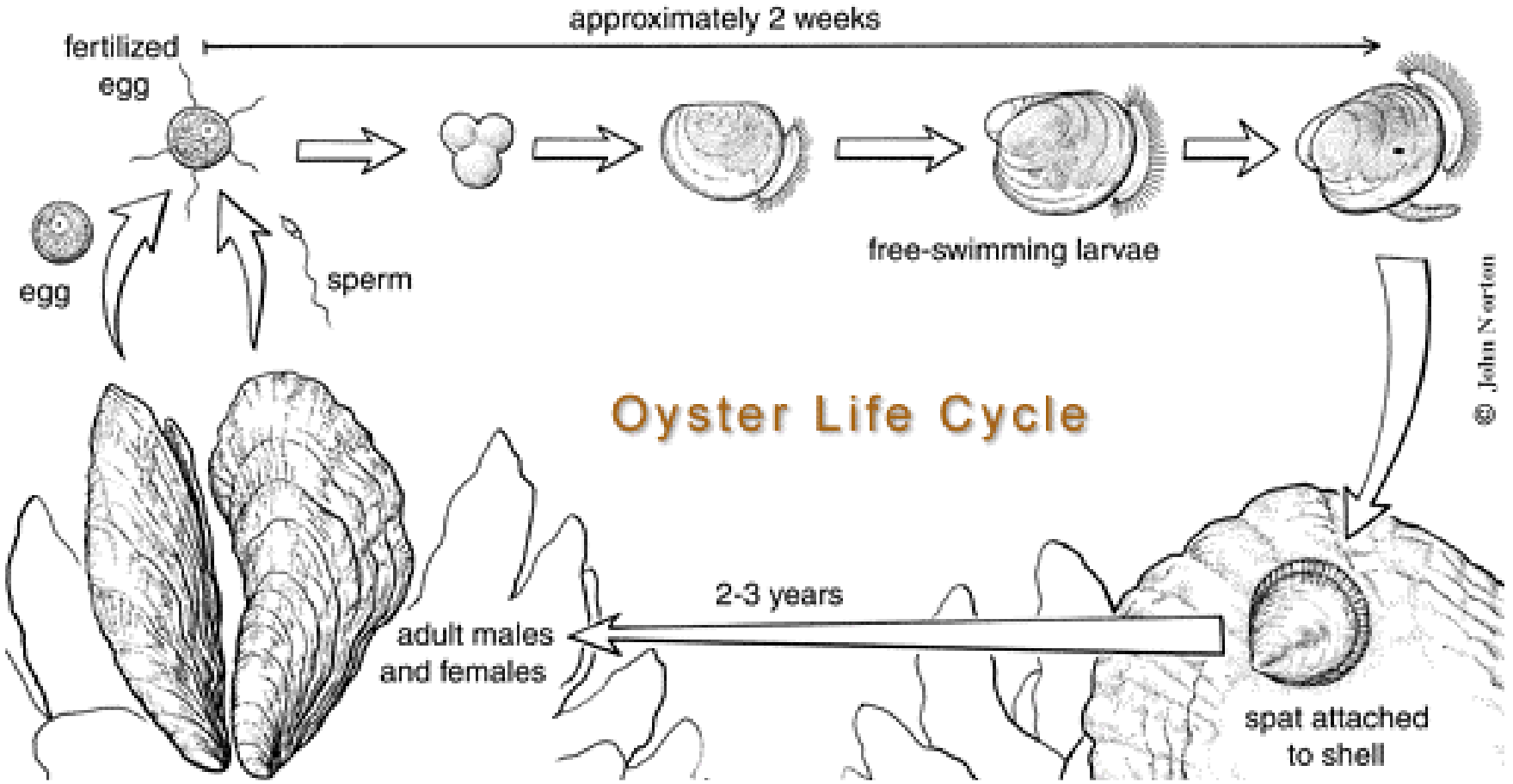
A project Here at Oak Island

Life cycle of an Oyster

- Life of a oyster in the wild…
  - Reproduce in early summer
    - A female oyster releases several million eggs
  - Develop and progress through a series of free-swimming larval stages as part of the plankton community
  - After a few weeks, larvae develop a “foot” and look for suitable substrate for attachment
  - Oysters mature in one year, reach harvestable size (~3 inches) in 18-36 months
  - Can live for decades



Oyster have 1 Decision



Settlement Habits

- Density-dependent lifestyle
  - aggregative settlement
  - clumps (culms) provide protection from siltation
  - upright reefs enhance feeding/escape from low DO
  - spawning
  - predator defense
  - keep from sinking
- I will comeback to do an in-depth discussion of oyster ecology

- Why do we need to protect our shorelines?

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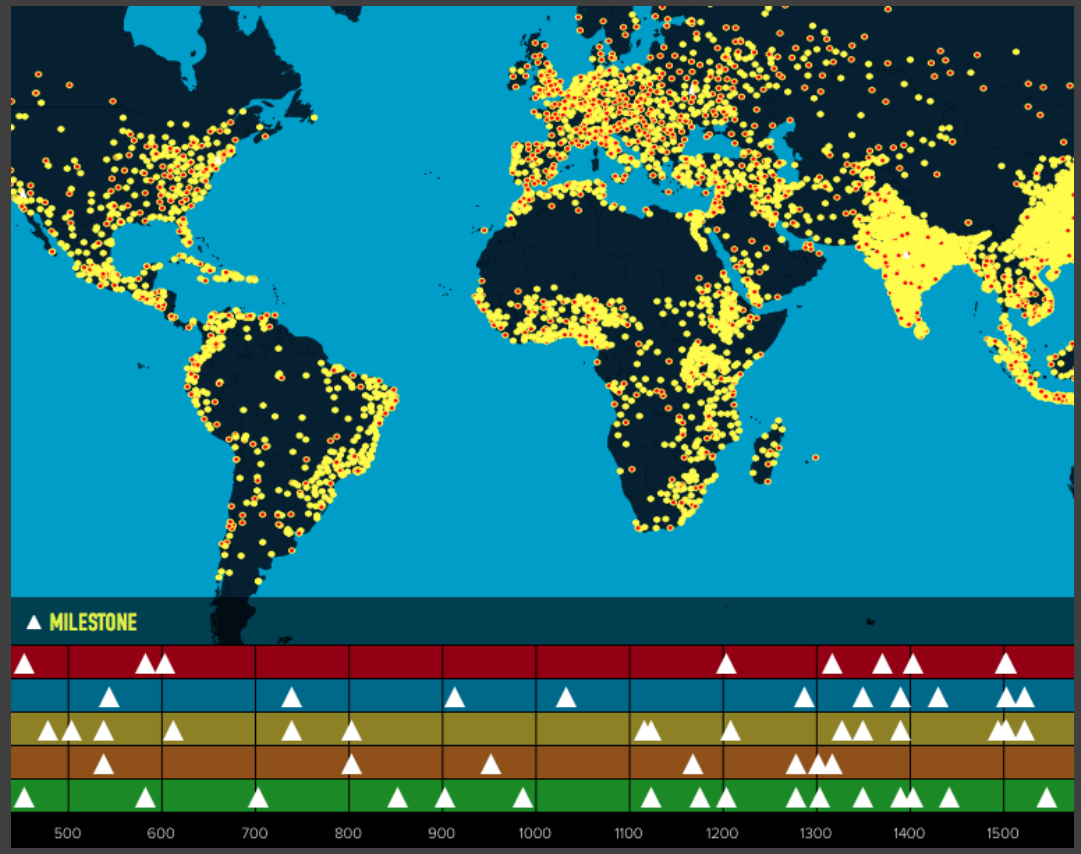
A project Here at Oak Island

Human populations are on the increase and the move

There are a number of trends that impact our coastal environments according to NOAA- 60%of the U. S. population lives in a coastal county



What is it that Attracts us to the Coast?

- Iconic images
- The energy
- Looks like Home

What is it that Attracts us to the Coast? cont’d

Entertainment

Sometimes we Get…

People

Coastal Erosion

Storms

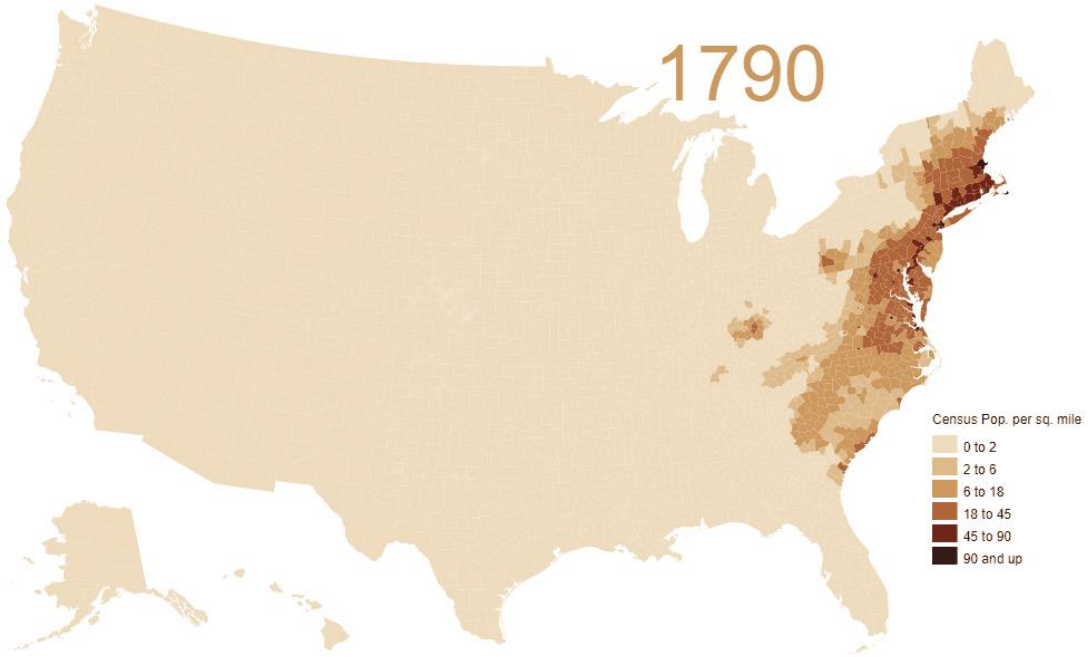
Flooding

In recent decades, the trend has been to move toward the coastal regions

Human populations are relocating

To the coast or along water bodies.

Utilization of resources leads to conflicts among users and impaired use but it also puts our development in the middle of areas under dynamic change.



Sources of Coastal Erosion

Storms

Wave energy (human and naturally created)

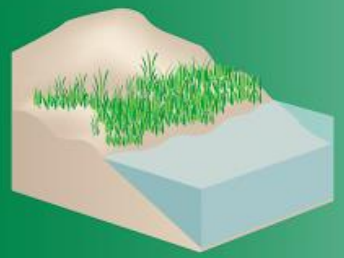
Currents

Result in sediment loss causing coastal retreat and beach erosion

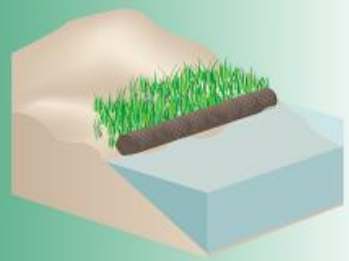
HOW GREEN OR GRAY SHOULD YOUR SHORELINE SOLUTION BE?

GREEN - SOFTER TECHNIQUES | **GRAY - HARDER TECHNIQUES**

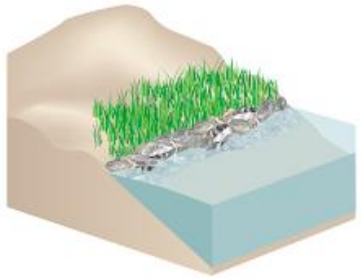
Living Shorelines



VEGETATION ONLY - Provides a buffer to upland areas and breaks small waves. Suitable for low wave energy environments.

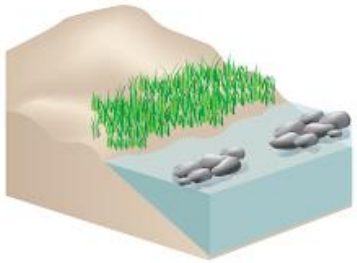


EDGING - Added structure holds the toe of existing or vegetated slope in place. Suitable for most areas except high wave energy environments.

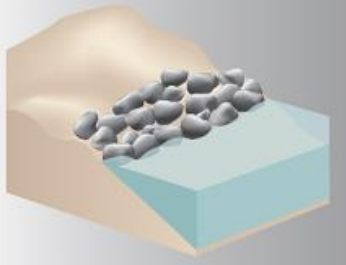


SILLS - Parallel to vegetated shoreline, reduces wave energy, and prevents erosion. Suitable for most areas except high wave energy environments.

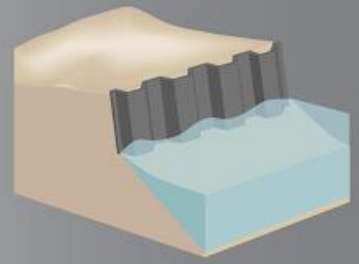
Coastal Structures



BREAKWATER - (vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action and encourage sediment accretion. Suitable for most areas.



REVETMENT - Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shoreline structures.



BULKHEAD - Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for high energy settings and sites with existing hard shoreline structure

Shoreline stabilization

Mitigating Erosion

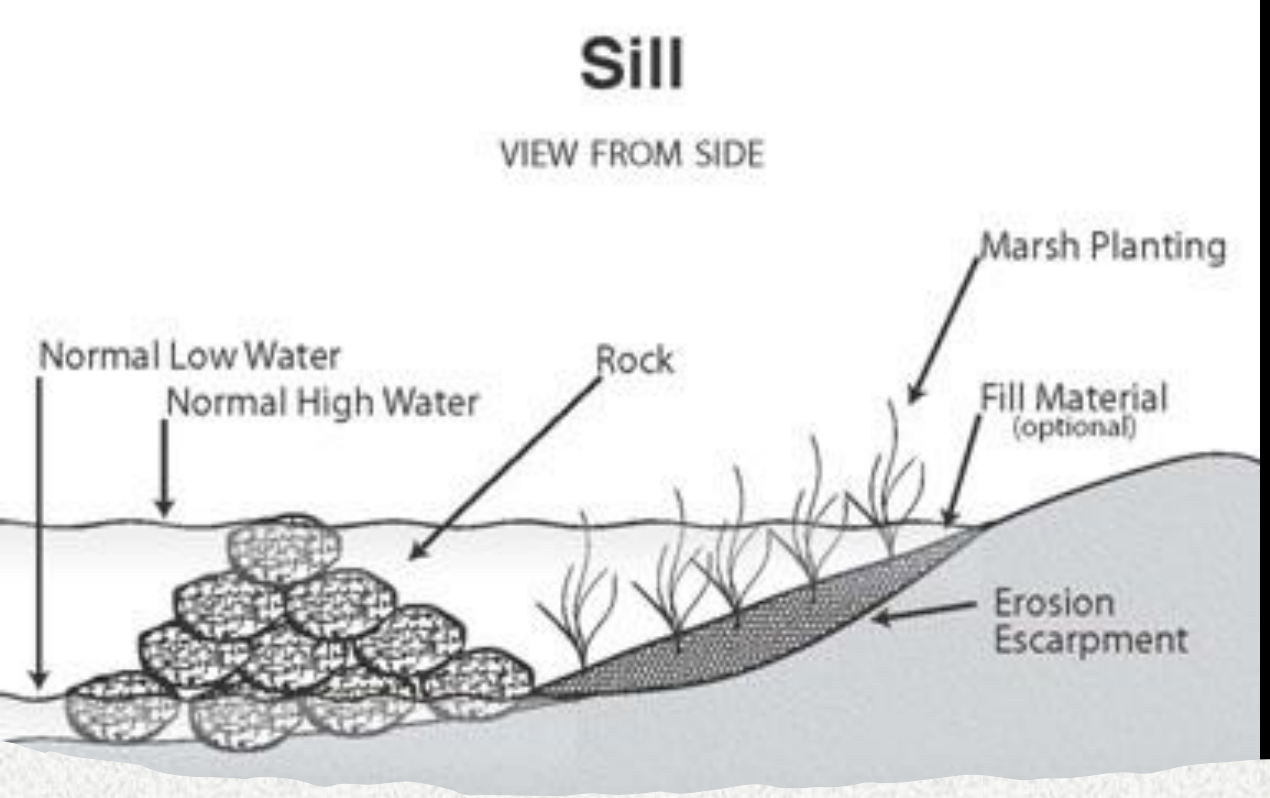
Bulkhead or seawalls or armored

For the sake of discussion, the term “seawall” refers to a structure that provides shoreline protection from waves but also retains soil. ... The term “bulkhead” refers to **a vertical shoreline stabilization structure that primarily retains soil**, and provides minimal protection from waves

Revetments

- Revetments in stream restoration, river engineering or coastal engineering, are sloping structures placed on banks or cliffs in such a way as to absorb the energy of incoming water

- Think shoreline armoring



Sills

- This is a structure placed waterward of the shoreline that reach near the high-water mark. These structures lend themselves well to promoting living shorelines

Living shorelines characteristics benefits

Inshore areas

- Waterways
- Tidal creeks
- In front of developed uplands
- Not generally suited for high energy areas
- Beach fronts too much energy
- Moderate levels of energy from erosive forces

Erosion along the waterways and natural areas

Loss of sediments

Loss of marsh coverage

Loss of critical habitat

Loss of ecosystem function

Living shoreline Benefits

Maintain connection (and exchange) between living resources and the waters.

Protect, restore and even enhance ecosystem functions of natural marsh edges

Utilize natural materials that either promote development of marshes or biodegrade through time.

Living shoreline concept originated in the ‘70’s “marsh sill”but has developed through time.

One of the biggest benefits from living shorelines that include marsh grass and biogenic substrates is the ability to alter shoreline elevation as sea level rises.

What does the Data show

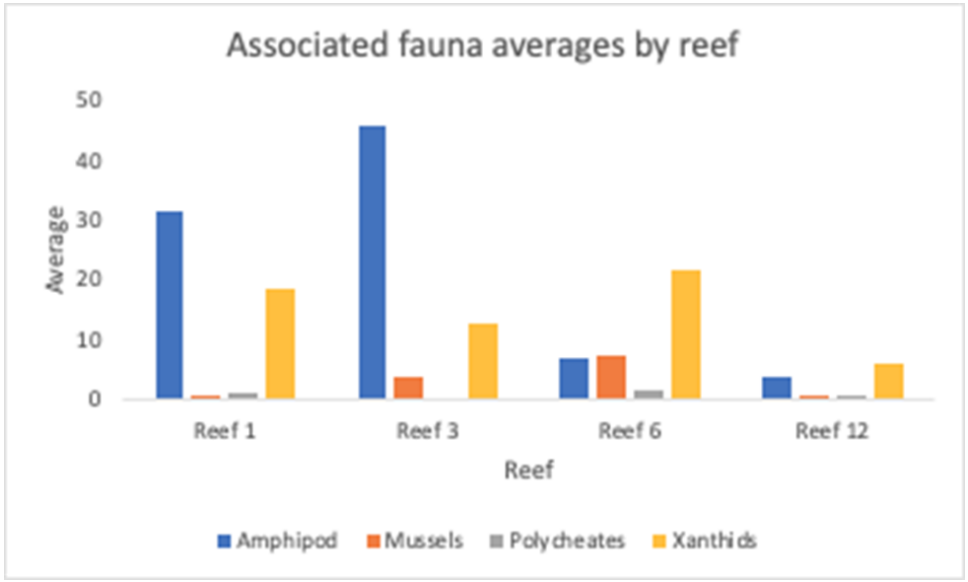
Work by NC coastal scientists like Carolyn Currin show that some living shorelines have increased elevation by nearly 4mm per year compared to actual sea level rise of ~3mm per year

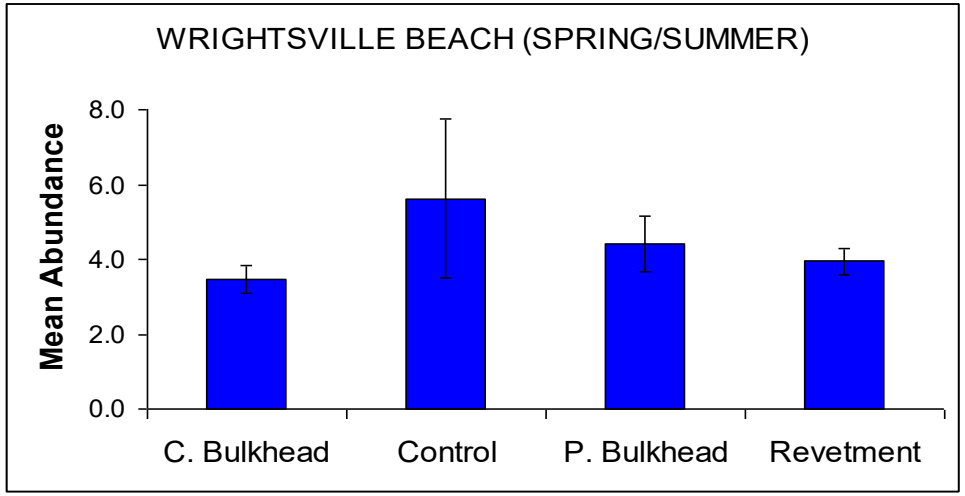
What about other Ecosystem services

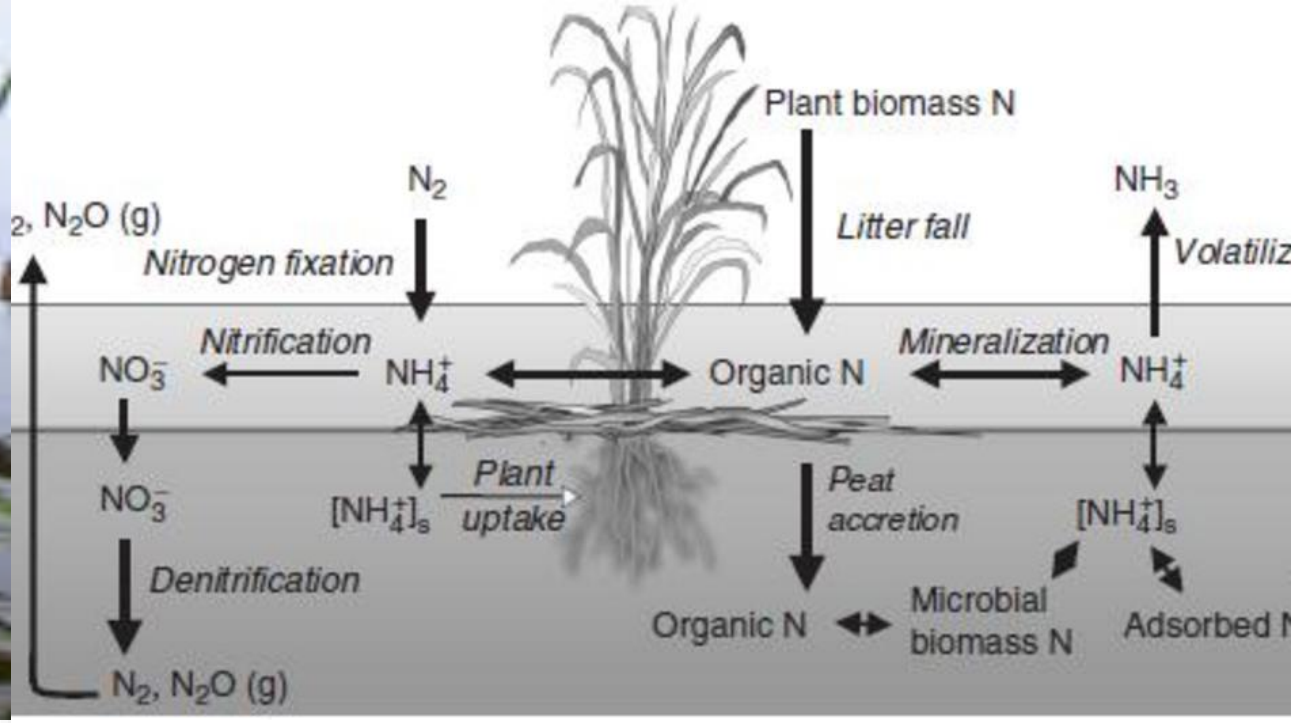
Greater habitat provision, compared to other forms of hard stabilization living shorelines provide significantly great habitat resources.

Bulkheads and revetments are not different from non structured reference areas

While oyster sill shows many times great density of organisms

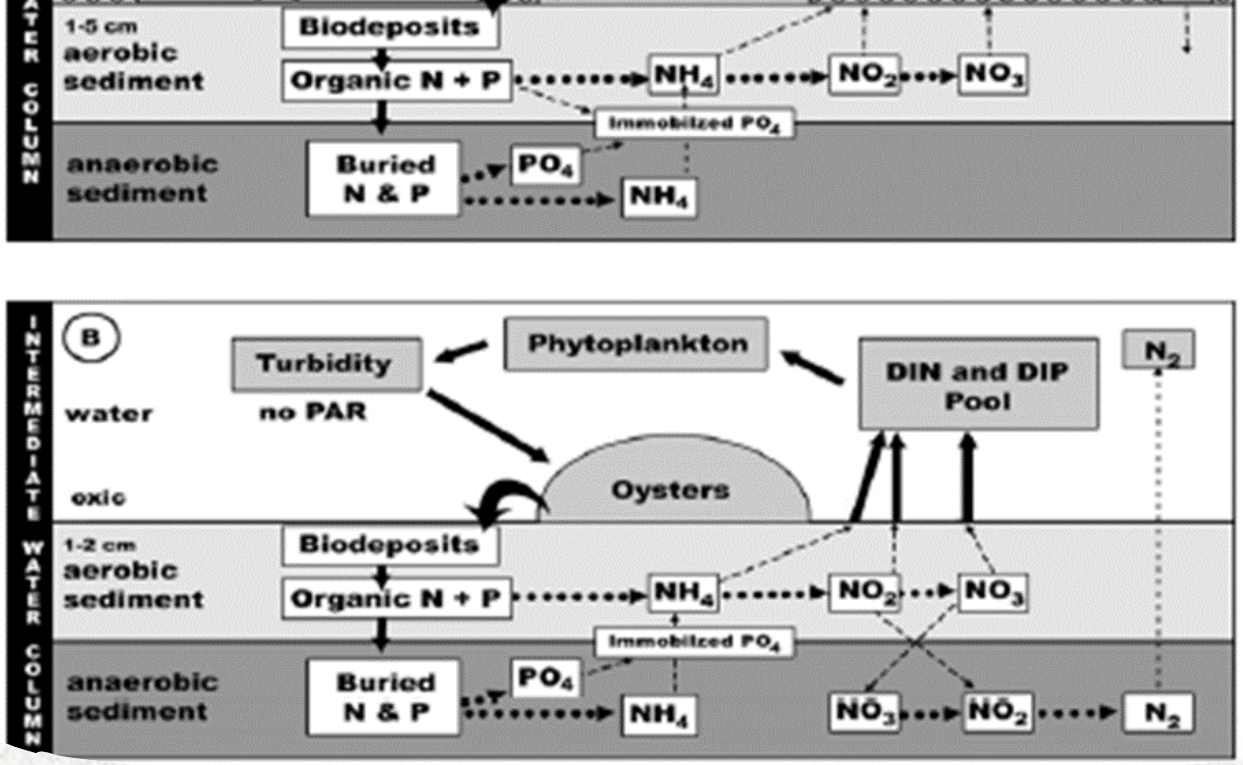






It's All About the Ecosystem Services

- Marsh grass provides habitat, refuge for small fish, shrimp and crabs, enhanced nutrient cycling and a source of detritus that fuels the estuarine food web



Ecosystem services cont’d

- Likewise Oysters provide a number of ecosystem services, including habitat, refuge, sediment stabilization, current alteration, filtration, reduced sediment loads, and enhanced nutrient cycling

As of 2021 living shorelines are a permit option

CAMA general permit- as of 2021 living shorelines are an option on the general permit.

Prior to that only hard stabilization methods were specified on the permit

What did it take to add living shorelines

The concept of marsh sills was introduced in the ‘70’s

And there has been work in a number of areas to quantify the value of living shorelines

Stabilization and Erosion Control Value of Oyster Cultch for Intertidal Marsh Meyer et. al. 1997

Many scientists are working on evaluating living shorelines

NERR staff worked on introducing the concept to the marine construction industry

NCDCM lists living shorelines as an option

Recognized as a viable means to provide shoreline stabilization and ecosystem services when combining oyster and marsh plantings

What about the Oak Island Project

- Several local companies have developed sustainable options
- Approaches that could improve ecosystem services and adjust to the sea level rise.

Emerald Isle, NC April 14, 2023

NC Aquarium, Pine Knoll Shores, NC; installed April 2019
Picture: January 2023

SANDBAR
OYSTER COMPANY | Shellfishly Motivated™

Important features of Oyster Catcher™

- Off-bottom framework deployment
- Structural complexity – surface to reef scales
- Oysters fill in open space among reef elements; let nature do the heavy lifting

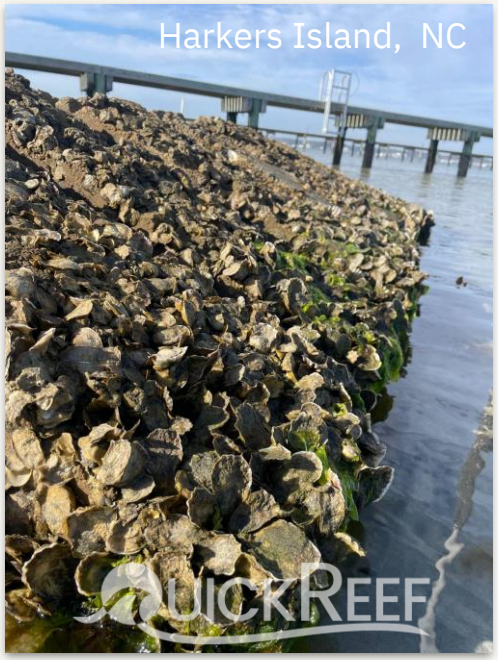
Living Shorelines

Living Protection for Coastal Communities

NATIVE SHORELINES

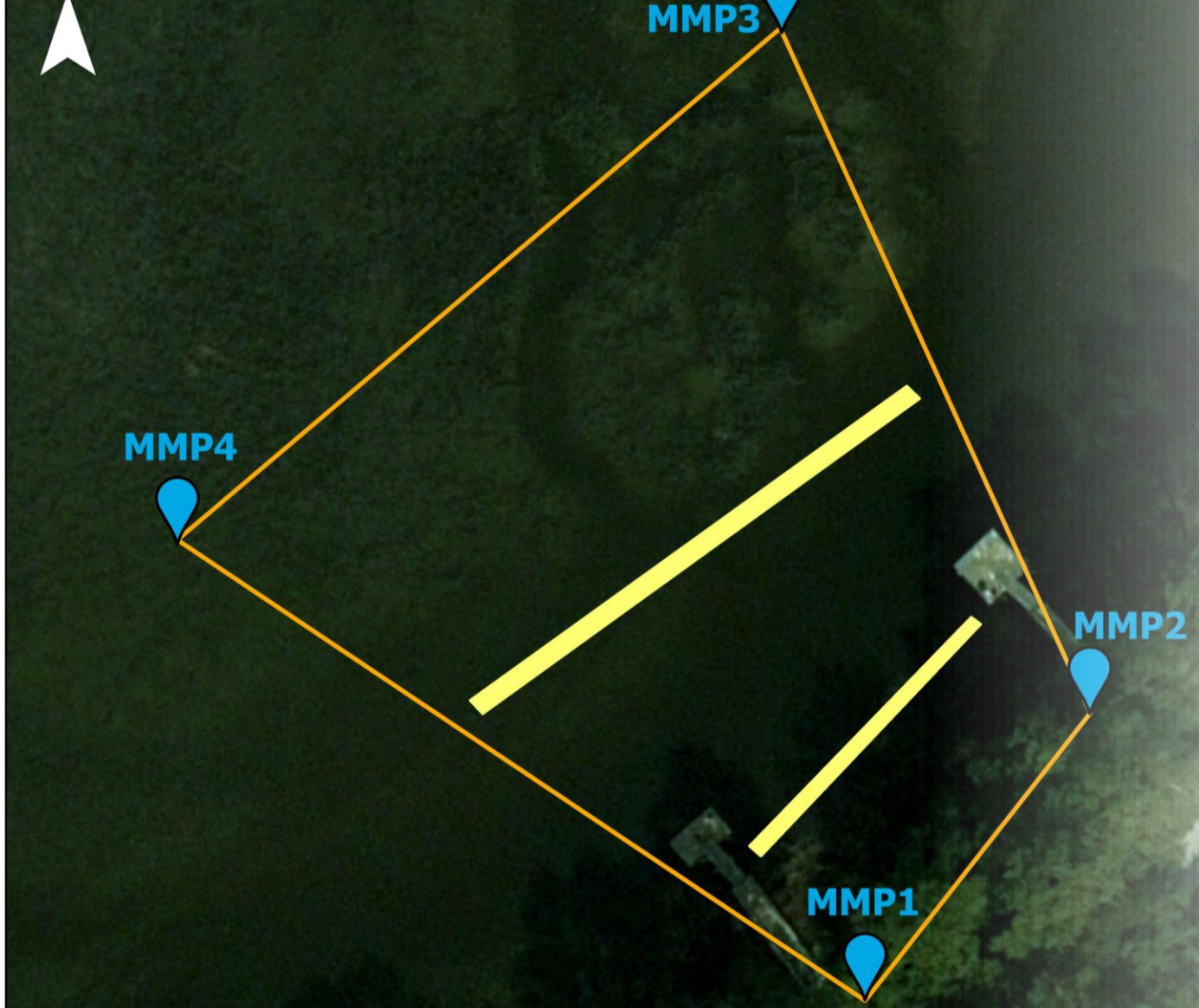
a DAVEY company

Installed 10/ 21; Photo 1/23



Installed 5/22; Photo 1/23

Native Shorelines has installed 20,000+ LF of living shorelines at 100+ properties in NC



2 starting sites

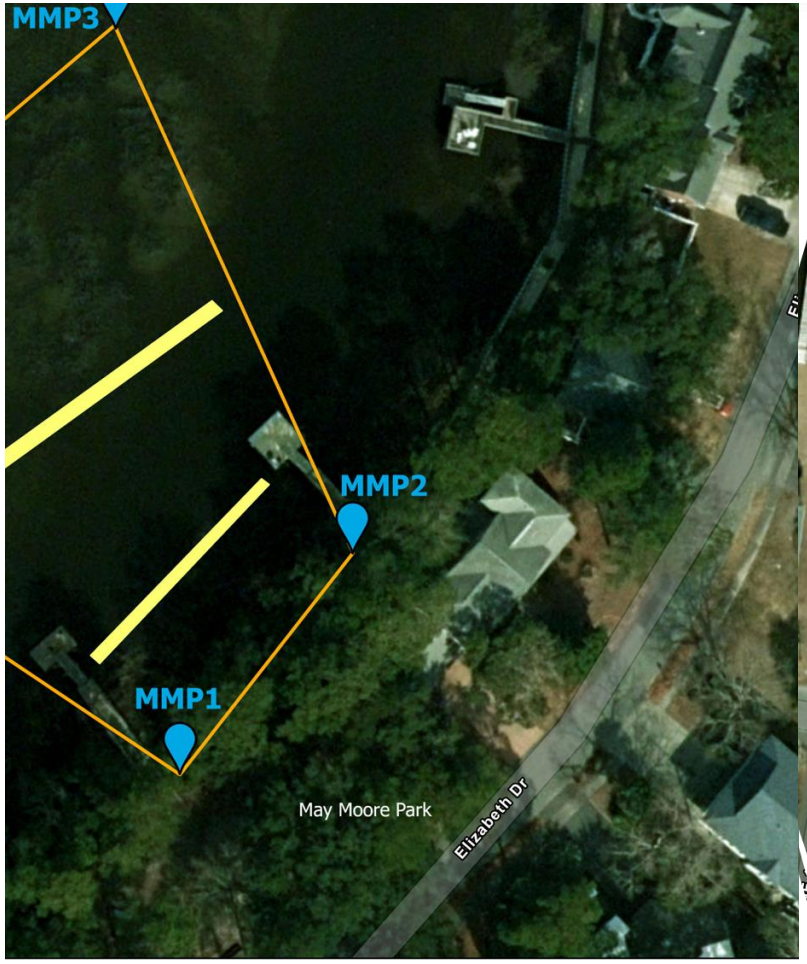
- MayMoore Park
- There are 2 sub-sites. 1 on the mainland shoreline the other along the sandflat across the channel

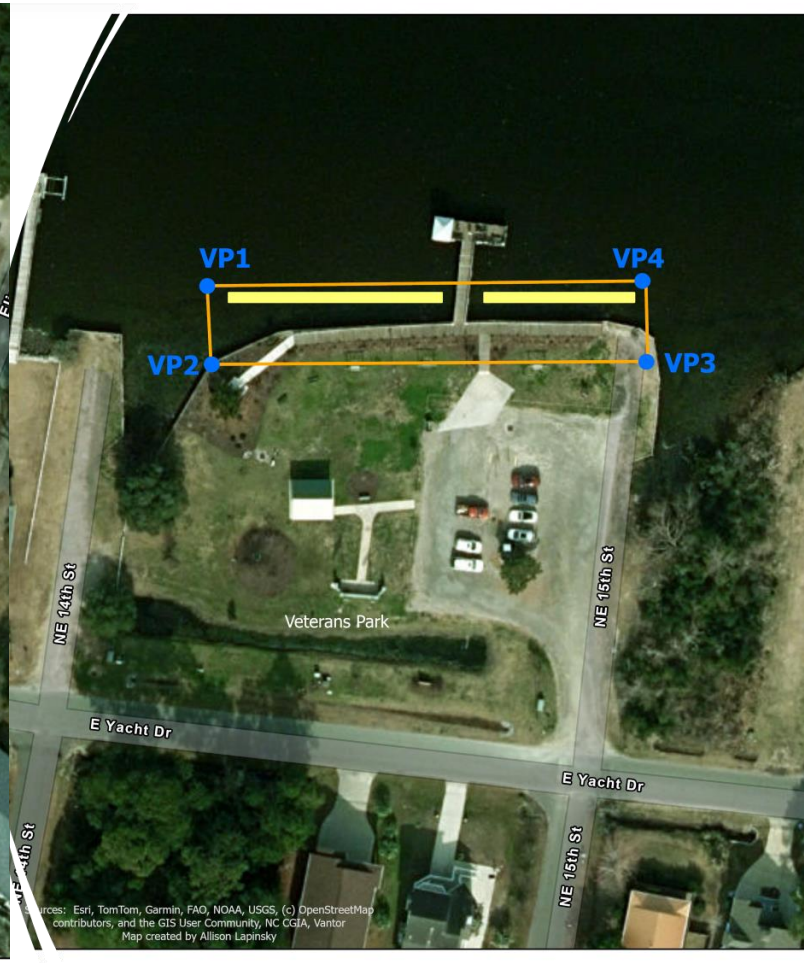
2 sites Veteran Park

- Great public access
- Good public entertainment access
- Easy access to the site
- High visibility

We will construct small sections of at least 3 shoreline types

- We will monitor each shoreline for
  - Biological community development
  - Sediment characteristics
  - Nekton utilization (fish and crabs)
  - Marsh characteristics





Summary

- Living shorelines that utilize biogenic structures such as oyster and marsh plantings provide ecosystem service (habitat, current disruption, sediment stabilization,
- These structures can adjust elevation to keep pace with sea level rise.
- As of 2021 living shorelines are an option on the NC Division of Coastal Management's general application. Just check the box.
- If Oak Island residents or municipal staff are going to evaluate living shoreline approaches then we need data
- How do these approaches compare?
- This needs citizen scientist to help complete