Estuarine Shoreline Stabilization Design and Techniques

by Steve Trowell, Coastal Management Representative, Washington Regional Office

Estuarine Shoreline Stabilization Design and Techniques

- "While various methods are available to combat erosion and land loss, none are permanent solutions, and all have significant environmental tradeoffs. Recognizing and understanding the complex causes and dynamic processes involved in shoreline erosion is the first step toward minimizing the impact of erosion and managing shoreline resources and economic investments."
- Stanley R. Riggs, The Soundfront Series, Shoreline Erosion In North Carolina Estuaries. UNC-SG-01-12.

ESTUARINE SHORELINES

The Estuarine Shoreline is were the water meets the surface topography of the land. The waterline is constantly changing due to either astronomical or wind tides and wave action caused by weather events or boat wakes.

<u>Broad Estuarine Shoreline Types</u>

Marsh

Swamp Forest

Sediment Bank

Modified

ESTUARINE SHORELINE TYPES

MARSH

Defined as low lying areas of salt tolerant plants that occur along the shorelines of our sounds, bays, rivers and streams subject to regular or irregular flooding by lunar and/or wind tides.

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ESTUARINE SHORELINE TYPE

SWAMP FOREST

Swamp Forest are poorly drained forested wetlands or scrub/shrub areas that are regularly, occasionally flooded by lunar or wind tides or seasonally flooded. Occur in the margins of freshwater or brackish sounds and lower reaches of coastal rivers and streams.

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ESTUARINE SHORELINE TYPES

SEDIMENT BANK

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ESTUARINE SHORELINE TYPES

MODIFIED

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ESTUARINE SHORELINE TYPES

Combination of Shoreline Types

- Low Sediment Bank with Marsh
- Low Sediment Bank with Woody Debris
- Marsh with Oysters
- Low Sediment Bank with Swamp Forrest
- High Sediment Bank
- Low Sediment Bank with Oysters/SAV
- Low Sediment Bank with Sand
- Overwash Barrier/Inlet Areas

Low Sediment Bank with Marsh

Low Sediment Bank with Woody Debris

Marsh with Oysters

Low Sediment Bank with Swamp Forest

High Bank "Bluff" with Sandy Estuarine Beach

Sediment Bank with Maritime Forrest

Estuarine Shoreline Functions

Hydrological Functions

-Surface and Ground Water Storage

-Storm/Buffer Energy Dissipation

-Filtration of Particulates/Baffling

Biochemical Functions

-Nutrient Retention/Cycling

-Biotic Productivity

-Detrital Export/Retention

Habitat Plant and Animal

-Habitat Diversity/Connectivity

-Foraging/Nursery

-Unique Habitat

-Nesting/Spawning

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Estuarine Shoreline Erosion Dynamics

Long Term Erosion

- Sea Level Rise
- Day to Day Normal Wave Action
- Natural Sediment Transport and Deposition

Short Term Erosion

- Extreme Storm Events

Factors Affecting Erosion Rates

- Shoreline Orientation
- Fetch
- Storm Frequency
- Shoreline Type

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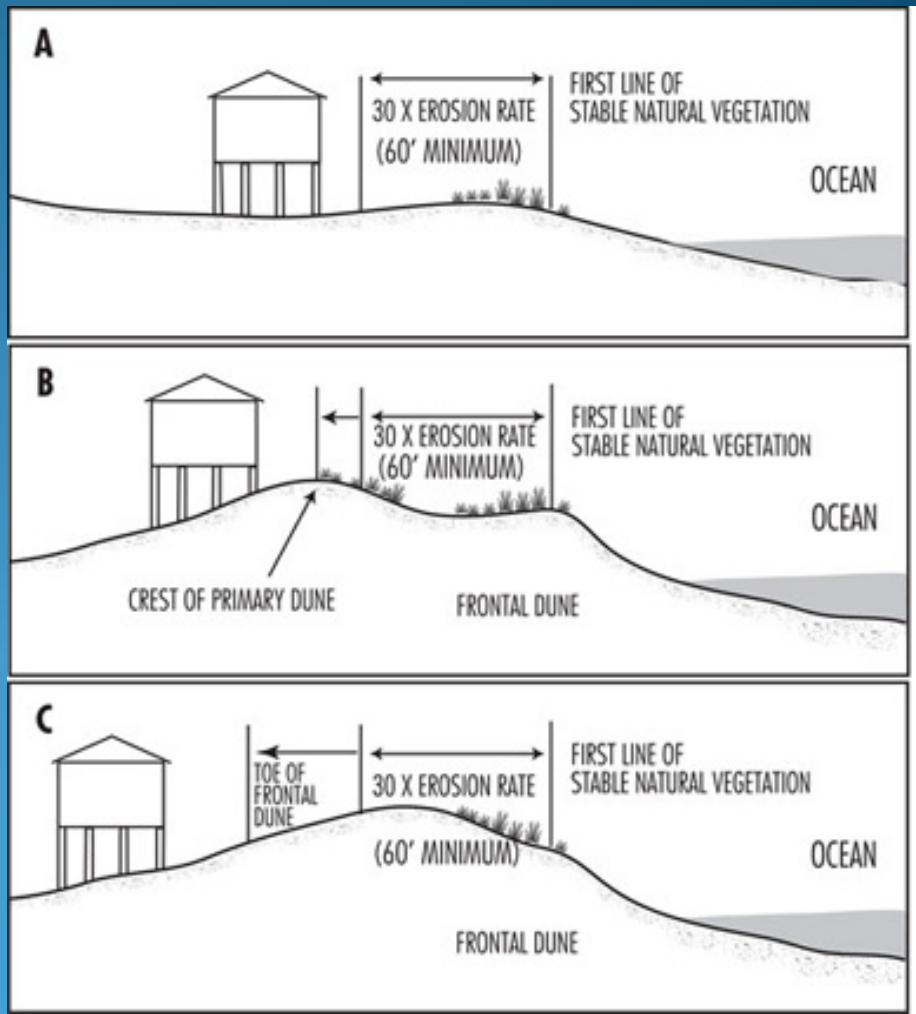
OPTIONS FOR CONTROLLING EROSION

- Land Planning/Management
- Vegetation Planting
- Beach Fill or Nourishment
- Shoreline Hardening

LAND MANAGEMENT

Advance planning of building location so that these structures will not be threatened.
Depends on the rate of erosion and is easiest to apply in low energy environments.



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Vegetation

Normally consists of planting a marsh fringe estuarine beach where shoreline is not exposed. Usually a fetch less than 1 mile.

Beach Fill or Nourishment

Beach fill is the addition of clean sand (very little clay or silt) to a beach to compensate for the expected or realized losses. Works best where erosion rates are relatively low reducing the volume and frequency of maintenance events.

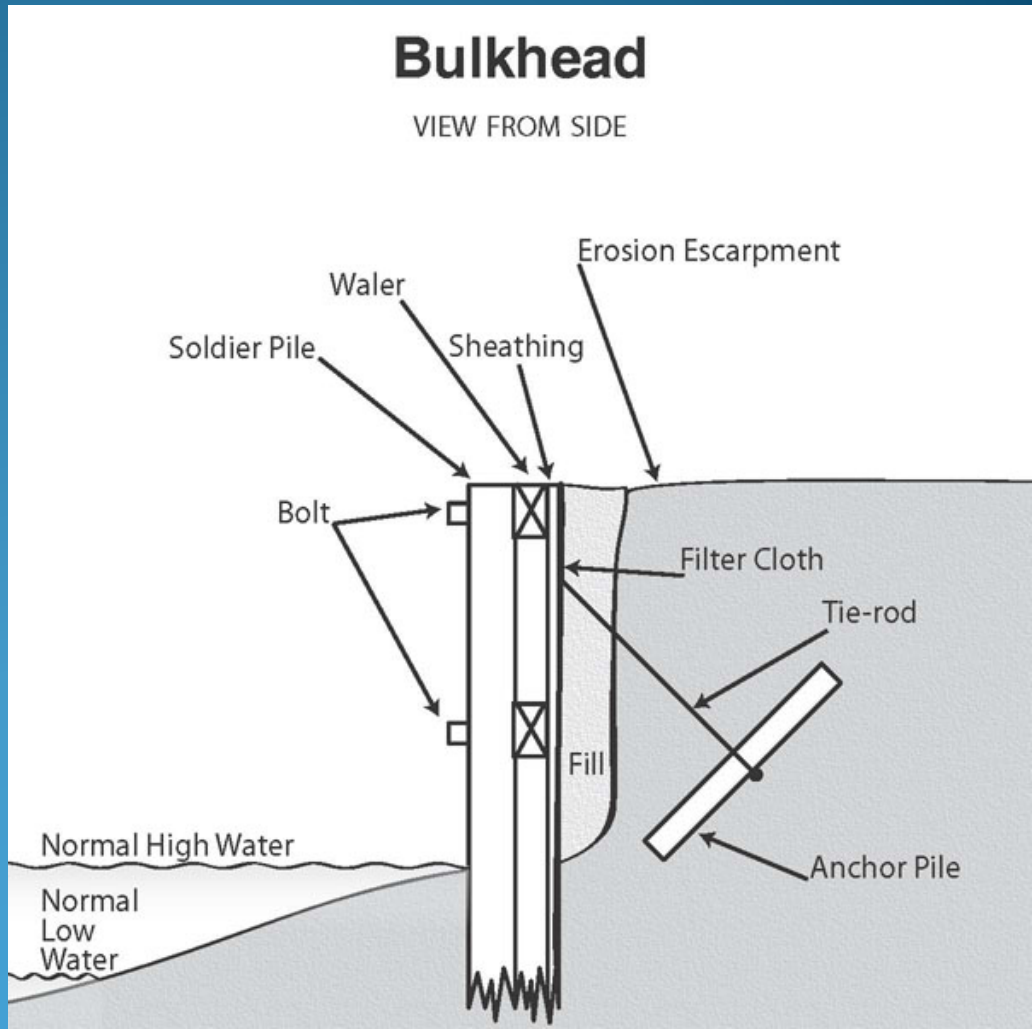
SHORELINE HARDENING

Has and continues to be the most common estuarine erosion-control method in North Carolina. The most commonly used methods include the following:

- Bulkheads
- Riprap Revetments
- Groins or Jetties
- Breakwaters
- Sills

BULKHEADS

Vertical structure constructed parallel to shore. Typically constructed out of wood or vinyl in most residential applications. Industrial sites typically use steel sheet pile. It is not uncommon for bulkheads to be constructed of concrete.



BULKHEADS

Bulkheads are typically used on sediment banks with an erosion escarpment. They have a reduced or shortened life span and require more maintenance adjacent high energy shorelines.

Are effective in man made canals and basins constructed for navigation and mooring. Bulkheads are better suited for sites with a fetch less than a mile.

BULKHEADS

Benefits

- Does slow or reduce erosion when sited properly.
- Durable.
- Provides hard substrate for attachment of barnacles, oysters and other organisms.
- Structure may also provide feeding habitat for estuarine fishes.

Drawbacks

- Exacerbates erosion seaward of structure.
- Loss of beach, marsh and intertidal habitat.
- Increases turbulence in nearshore aquatic habitats.
- Alters shoreline dynamics. May increase erosion immediately adjacent and downstream of structure.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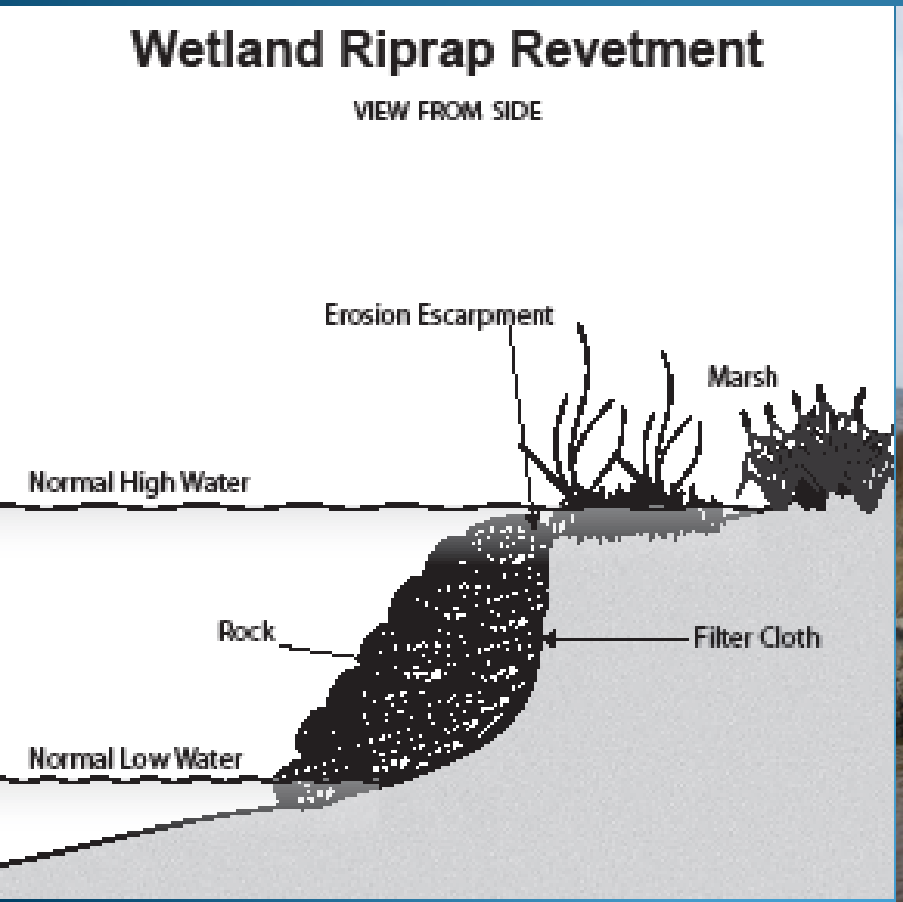
RIPRAP REVETMENTS

Most riprap revetments are constructed to have a slope of 2’ horizontal to 1’ of vertical rise. Approved riprap materials include granite, marl and clean broken concrete of sufficient size free of protruding metal wire or rebar. Most often used on sediment bank, modified and marsh shorelines in high energy environments.

RIPRAP REVETMENTS

RIPRAP REVETMENTS
MARSH TOE



RIPRAP REVETMENTS

Benefits

- Better suited for high energy shorelines requiring less maintenance.
- Does not create as much turbulence thus has less toe scour.
- Provides more hard surface area for attachment of marine life.
- Structure may also provide feeding habitat for estuarine fishes and blue crabs.

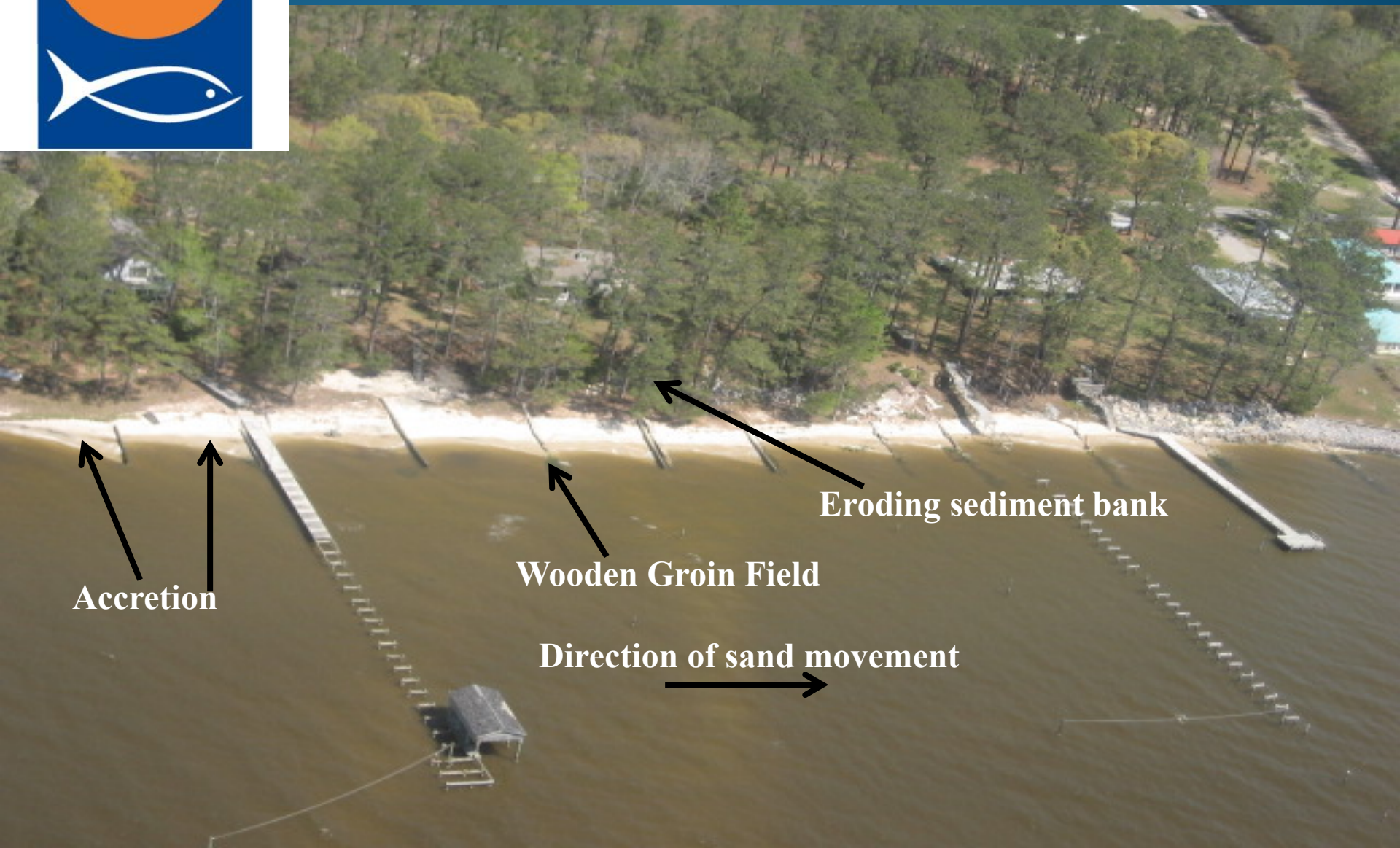
Drawbacks

- Potential increase erosion rates adjacent to and downdrift of structure.
- Requires larger footprint and it's associated impacts.
- Installation disturbs greater area of vegetated buffer landward of structure.

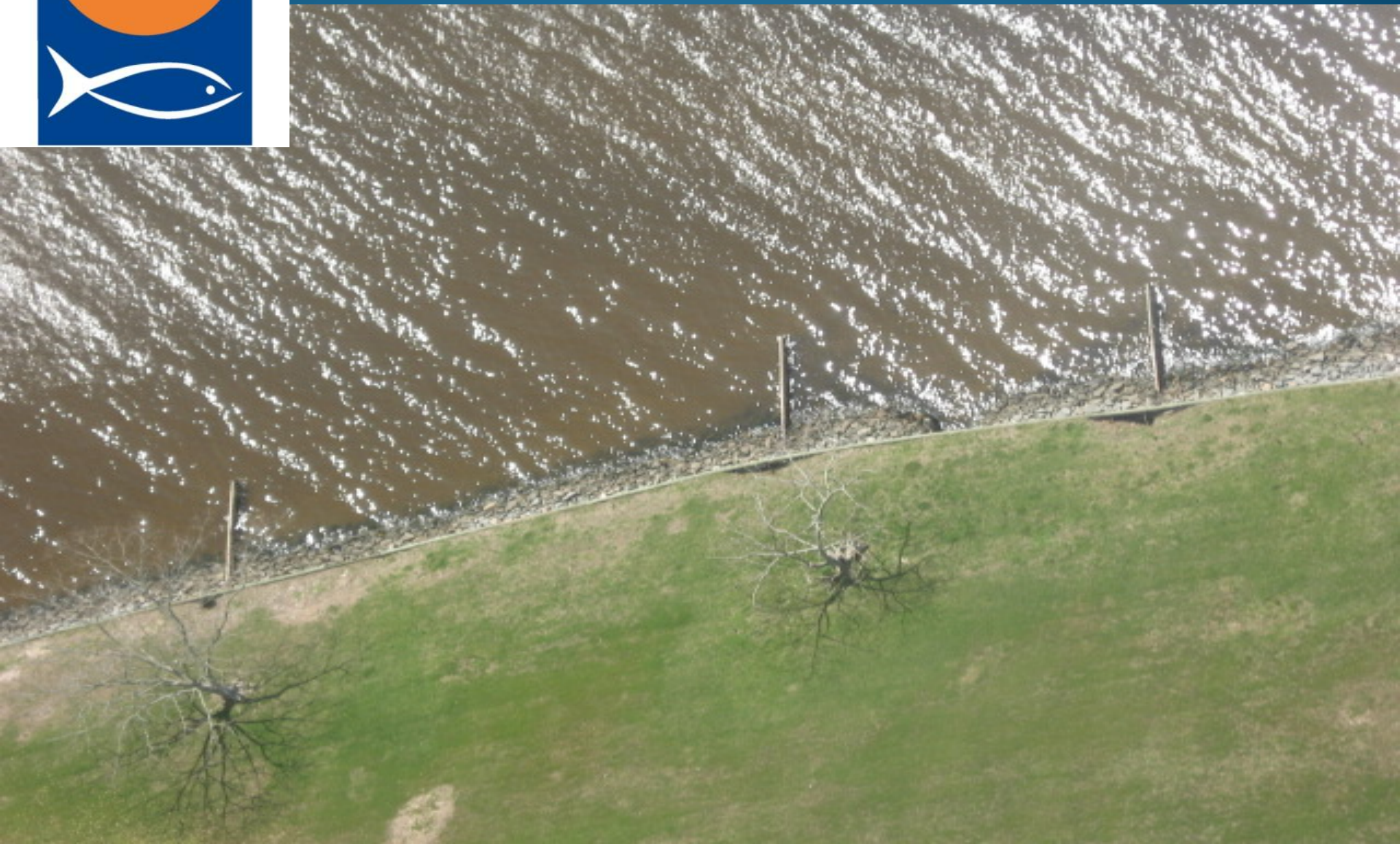
GROINS

- Groins are sand traps used on beaches adjacent sediment banks that trap sediment as it is being transported along the shoreline by breaking waves. Groins are constructed perpendicular to the shoreline through the active surf zone. Construction materials include wood, vinyl, or riprap. Groin height typically 6 inches to a foot above normal high water or normal water level.

GROINS


Eroding sediment bank
Wooden Groin Field
Accretion
Direction of sand movement

GROINS



GROINS

Benefits

- Protect upland areas by providing or preserving a wide beach to break storm waves.

Drawbacks

- Create sand deficit down drift of structure.
- May impact the early life stage movement some estuarine dependent fishes.
- Must have an adjacent eroding sediment bank.
- Do not typically work when constructed as part of a harden shoreline.

BREAKWATERS

Constructed offshore and parallel out of wood, vinyl or riprap stone. Wood or vinyl sheets have gaps that equal one inch per linear foot. The vertical wood or vinyl breakwater not suited for high energy shorelines. Height of structure similar groins 6 inches to a foot above normal water level.

BREAKWATERS

Benefits

- Prevents erosion due to normal day to day wave action.
- Provides hard attachment substrate for marine organisms such as oysters and barnicles.

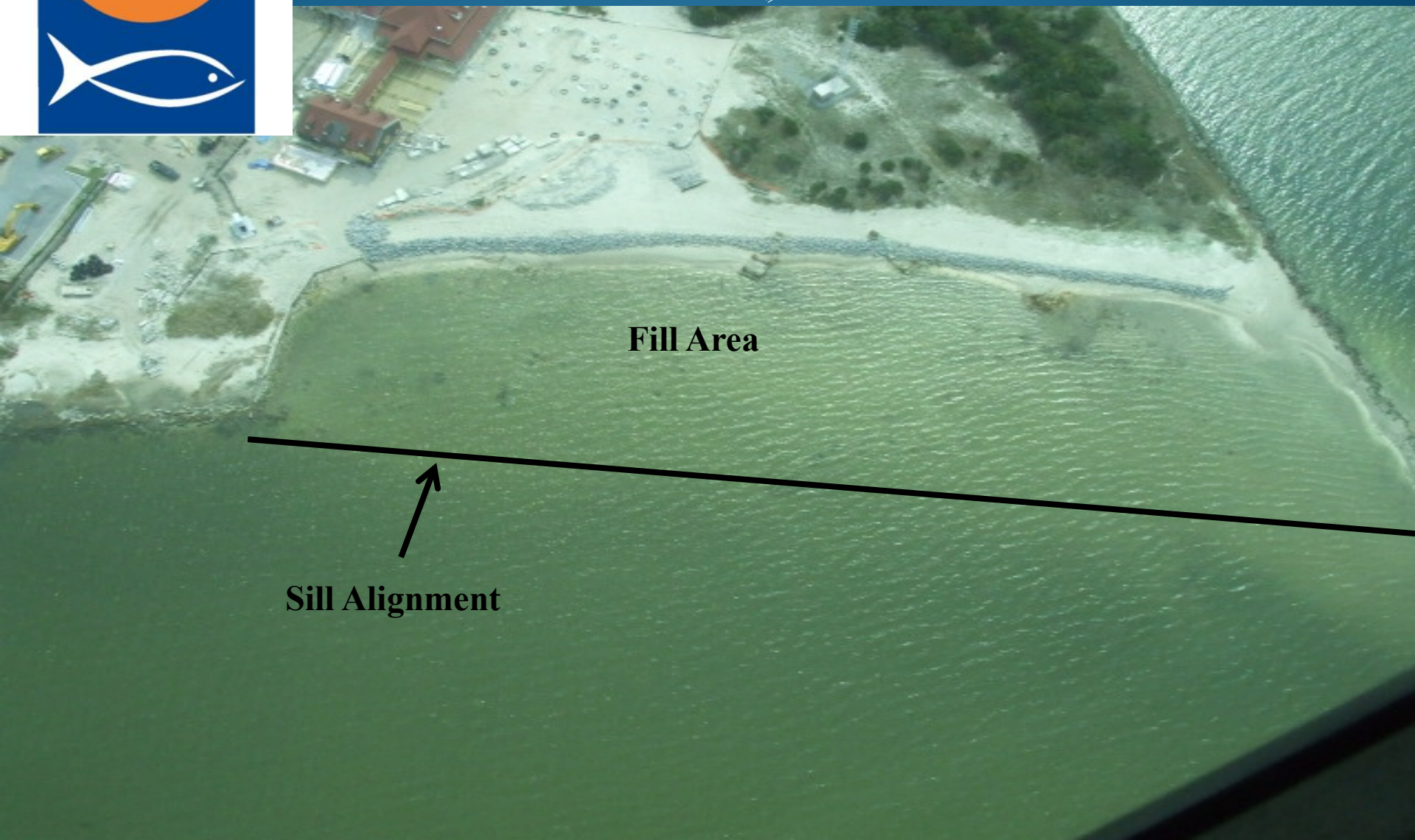
Drawbacks

- Does not provide as much upland protection during large storm events.
- When constructed out of stone there is a loss of aquatic bottom under structure.
- Aquatic bottom will also be lost if sand accumulates landward of structure.

MARSH SILLS

- Constructed out of sloping riprap stone including granite, marl, oyster shell bags or broken concrete placed offshore and parallel to shore to reduce wave energy to protect existing and or newly planted wetland/marsh grasses.

MARSH SILLS
NCCAT OCRACOKE



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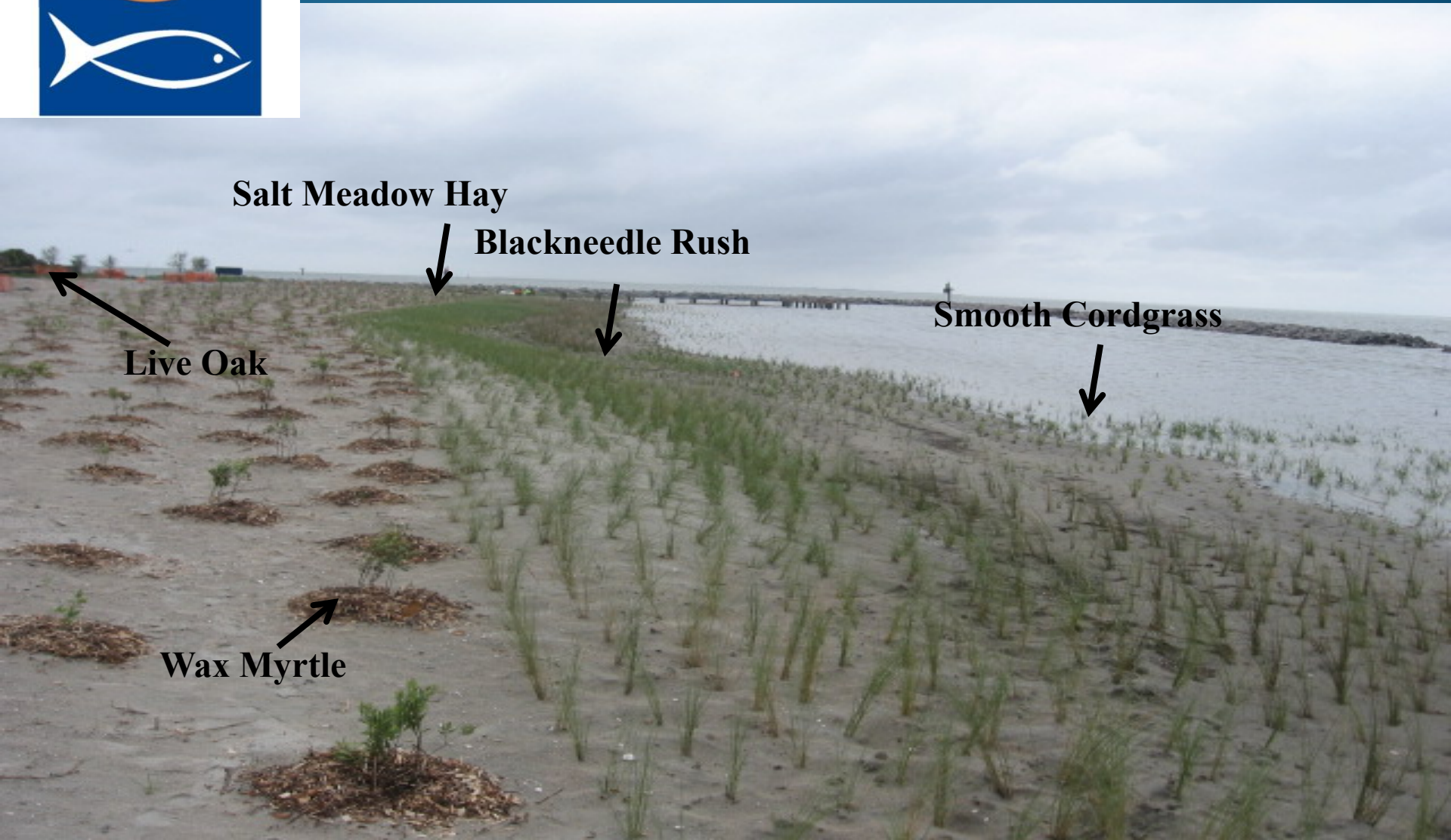

Marsh Sill
NCCAT Ocracoke

MARSH SILLS
NCCAT OCRACOKE

MARSH SILLS
SPRINGERS POINT OCRACOKE

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SPRINGERS POINT OCRACOKE

MARSH SILLS
OCRACOKE

MARSH SILLS
OCRACOKE

MARSH SILLS
OCRACOKE

MARSH SILLS

Benefits

- Provides large area of hard substrate for attachment of oysters and barnacles.
- Creates forage area for fish and blue crabs.
- Maintains and enhances biotic productivity.
- Traps sand for establishment of wetland plants.

Drawbacks

- Fill placed landward of structure kills benthic animals.
- Placement of stone sill covers aquatic bottom habitat.
- Habitat tradeoff from shallow water habitat to tidal marsh. Shallow water habitat may include submerged aquatic vegetation, shellfish, etc.
- Sand trapped may result in upland habitat versus wetland.

Estuarine Shoreline Stabilization Techniques

Summary

Four types of shoreline stabilization options

- Land Planning
- Vegetation Planting
- Beach Fill
- Shoreline Hardening
  - Bulkheads
  - Riprap Revetments
  - Groins
  - Breakwaters
  - Marsh Sills

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QUESTIONS?