Living Shorelines 101

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WETLAND PROTECTION AND/OR SHORELINE STABILIZATION

**Delta Management**
As the Nueces River goes, so goes the health of the entire Corpus Christi Bay system. At present, the river and delta are stressed by variability in the water quantity (either excessive flooding or extreme drought) and repeated water quality issues (including high levels of bacterias, rising concerns for drinkability). In addition to progressing wetland erosion along the bay shoreline, this action requires increasing work to restore inflows, to protect water quantity and leave room for the consideration of the delta in future development plans.

**Responsible Development**
Mustang Island is a unique area of development mixed with native barrier island ecosystems. The manner that development inevitably proceeds on the island will define the area’s coastal resiliency. Finding balance between human development and preserving untouched natural systems is a major consideration. Building residential and commercial developments that work with the natural protections afforded by coastal ecosystems - such as expansive Gulf facing beaches and high dunes that protect against storm surge or bayside wetlands that hold and filter floodwaters – deserves the utmost consideration and necessitates a multi-disciplinary approach.

[2019 Texas Coastal Resiliency Master Plan p. 51]
COASTAL ECOSYSTEM BENEFITS

Habitat

Shoreline Stabilization

Tourism, Recreation, Aesthetics

Sediment, Nutrient & Carbon Storage
WE NEED TO WORK TOGETHER TO MAINTAIN A SUSTAINABLE COASTAL ENVIRONMENT DUE TO:

- Increased population growth in coastal regions
- Increased risk of water quality problems
- Loss of beaches
- Loss of marshes/wetlands
- Sea Level Rise
- Subsidence
- **Coastal erosion**
  - Once beaches and sediment are lost, the cost to rebuild is enormous
COASTAL EROSION
COASTAL EROSION

Schicke Point, Matagorda Bay, Texas [Freese and Nichols]
WHAT FACTORS CREATE EROSION?

- Wind velocity
- Wave energy and duration
- Fetch (distance that waves can be generated by winds)
- Width and shape of beach/shoreline
- Boat wakes
- Storm water runoff
- Unprotected land on property
- Lack of sediment for longshore transport
WHAT ARE THE PROBLEMS ASSOCIATED WITH COASTAL EROSION?

• Causes loss of residential and commercial property
• Loss of storm buffering capacity
• Water quality degradation
• Soil loss
SHORELINE MANAGEMENT

HOW **GREEN** OR **GRAY** SHOULD YOUR SHORELINE SOLUTION BE?

**GREEN - SOFTER 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 structures.

[Diagram from NOAA Living Shorelines]
DISADVANTAGES OF HARDENED SHORELINES?

• Seawalls can cause erosion to adjacent structures
• Vertical erosion in front of seawall
• Decreased amount of organic matter and biological organisms needed for maintenance of wetlands
• Loss of intertidal habitat (shallow refuge for juvenile fish)
• Need for maintenance after storms
• Loss of beach
WHAT ARE LIVING SHORELINES?

• A “Living Shoreline” is a natural shoreline stabilization approach designed to mimic nature and serve as an alternative to bulkheads, seawalls and other hardened shoreline stabilization methods.

• Living Shorelines utilize natural or recycled materials along with the strategic placement of plants and/or other organic material to reduce erosion and protect property.

• Not a one size fits all solution but a suite of options
BENEFITS OF LIVING SHORELINES

• Reduce wave energy and associated shoreline erosion
• Buffer the effects of storms, especially tropical storms and hurricanes
• Build-up shoreline areas by trapping sediments and stabilizing coastal land.
• Ensure natural sediment movement along shorelines
• Improve water quality in bays and estuaries by filtering pollutants
• Provide for shorelines that are resilient to storms and sea level rise
• Create and connect diverse animal habitats, provide migratory pathways for plants and animals and support valuable fisheries
• Provide recreational opportunities (e.g., fishing and birdwatching)
• Beautify shorelines
Living shorelines use plants or other natural elements—sometimes in combination with harder shoreline structures—to stabilize estuarine coasts, bays, and tributaries.

- One square mile of salt marsh stores the carbon equivalent of 76,000 gal of gas annually.
- Marshes trap sediments from tidal waters, allowing them to grow in elevation as sea level rises.
- Living shorelines improve water quality, provide fisheries habitat, increase biodiversity, and promote recreation.
- Marshes and oyster reefs act as natural barriers to waves. 15 ft of marsh can absorb 50% of incoming wave energy.
- Living shorelines are more resilient against storms than bulkheads.
- 33% of shorelines in the U.S. will be hardened by 2100, decreasing fisheries habitat and biodiversity.
- Hard shoreline structures like bulkheads prevent natural marsh migration and may create seaward erosion.

The National Centers for Coastal Ocean Science | coastalscience.noaa.gov

Some graphics courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/symbols/)
SHORELINE CROSS-SECTION EXAMPLE

SHORELINE CROSS-SECTION EXAMPLE

UPLAND
Native Trees/Shrubs

BANKFACE
Deep rooted native grasses & shrubs on banks
Natural Fiber Matting

COASTAL WETLANDS & BEACH STRAND
Wetland plants matched to tidal hydrology & salinity
Sills, stone surface groins, marsh toe revetments, marshy islands, etc...
matched to wave, climate & shoreline environment

SAV
Submerged aquatic vegetation (SAV)
Artificial oyster reefs
Living Breakwaters

LIVING BREAKWATER

Shoreline Cross-Section [Allen Engineering and Science]
Shoreline Management Options
TYPES OF SHORELINE MANAGEMENT

**No Action** – Leave shoreline in natural condition; enhance native habitats; reduce risk through land use changes.
TYPES OF SHORELINE MANAGEMENT

Vegetative Cover

- Marsh/Wetland Plants
  - Smooth Cordgrass
  - Saltmeadow Cordgrass
  - Black Needlerush

- Dune Plants
  - Sea Oats
  - Coastal Panic Grass

Maintenance: Remove debris, make sure to keep people out of the protected area.

[Florida Living Shorelines]
MARSH/WETLAND PLANT EXAMPLES

- Black Needlerush
  \textit{(Juncus roemerianus)}

- Smooth Cordgrass
  \textit{(Spartina alterniflora)}
WAVE ATTENUATION BY SMOOTH CORDGRASS (SPARTINA ALTERNIFLORA)

- 50% of wave energy reduced within 5m (16’+/-) of marsh edge; >90% over 20m (65’+/-) of marsh
- Wave energy reduction increases with plant biomass
- Wave energy reduction decreases as inundation depth exceeds canopy height
TYPES OF SHORELINE MANAGEMENT

**Marsh Grass Plantings** – Native plants introduced at the shoreline to minimize erosion
TYPES OF SHORELINE MANAGEMENT

Dune Restoration

Dune Restoration South Padre Island, Texas [Galveston Bay Foundation]
TYPES OF SHORELINE MANAGEMENT

**Coir Logs** – Anchored natural fiber log with marsh grass planting

Lake Austin, Austin, Texas

Wrights Landing
St. Johns County, Florida
TYPES OF SHORELINE MANAGEMENT

Natural Fiber Matting – Stabilize slope and allow for regrowth of vegetation
TYPES OF SHORELINE MANAGEMENT

**Oyster balls** – Structures designed to create oyster habitat and reduce wave energy

“1 adult oyster can filter up to 50 gallons of water per day”
TYPES OF SHORELINE MANAGEMENT

**Concrete reef balls** – Concrete structures used to reduce wave energy and create oyster habitat

*Stratford Point, All Habitat Services*
TYPES OF SHORELINE MANAGEMENT

**Oyster shell/Oyster shell breakwater** – Reuse of oyster shells to reduce wave energy

*Trinity Center, Pine Knoll Shores, North Carolina Coastal Federation*

*Jones Island, North Carolina Coastal Federation*
TYPES OF SHORELINE MANAGEMENT

Wave Attenuation Devices – Structures used to reduce wave energy and/or build up a beach
TYPES OF SHORELINE MANAGEMENT

**Wave Attenuation Devices** – Structures used to reduce wave energy, build up a beach and/or provide oyster habitat

Oyster Castles
Chincoteague NWR, Virginia
TYPES OF SHORELINE MANAGEMENT
TYPES OF SHORELINE MANAGEMENT

Submerged Oyster Shell Beds, Little Bay, Rockport, Texas [AECOM]
TYPES OF SHORELINE MANAGEMENT

**Limestone Breakwater** – Structure used to reduce wave energy

Maryland [Kingfisher Environmental Services, Inc.]

Texas General Land Office

Chesapeake Bay Area
LIVING SHORELINE EXAMPLE

Breakwater

Restored Marsh

Morris Landing, North Carolina
Types of Shoreline Management

**Wooden Sills** – Structure used to reduce wave energy

Dog River Shoreline, Alabama

Sheetpile Sill, North Carolina
**TYPES OF SHORELINE MANAGEMENT**

**Sill with Planted Marsh** – Low-profile stone structure used to contain sand fill to create a new planted marsh where one does not naturally occur.

Allow at least 1-2 weeks of settlement before planting the sand fill area.

Hybrid Living Shoreline, Delaware

VIMS, [K. Duhring]
TYPES OF SHORELINE MANAGEMENT

**Sill with Planted Marsh** - Protect eroding shoreline, restore shoreline wildlife habitat
TYPES OF SHORELINE MANAGEMENT

Marsh Toe Revetment – Freestanding, low-profile structures typically made of stone and placed at the eroding edge of a marsh near the mean low water elevation.
TYPES OF SHORELINE MANAGEMENT

**Breakwater with Transitional Wetland** – Similar to Sill, but used in the event of greater water depth, slope of shoreline, higher wave action
TYPES OF SHORELINE MANAGEMENT
TYPES OF SHORELINE MANAGEMENT

Great Marsh Island, Jacksonville, Florida [Google Earth]
Shoreline Revetment – a protective covering on an embankment of earth designed to maintain the slope or to protect it from erosion.
**Bulkheads**

- Vinyl
- Vinyl with toe protection
- Wooden
- Wooden with toe protection

Maintenance: Scour typically occurs, so toe protection might be needed, additional fill and vegetation will need to be installed over time.
WHICH SHORELINE WOULD YOU WANT?

or

or
WHERE ARE LIVING SHORELINE PROJECTS APPROPRIATE?

It depends on several 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.
WHERE ARE LIVING SHORELINE PROJECTS APPROPRIATE?

**Landscape Setting**

- Surrounding land and water uses are compatible
  - No upland improvements in close proximity (e.g. road, house, driveway, etc.)
  - No conflicts with navigation interests

- Predictable salinity range & freshwater influence

- Tidal range (small vs. large)

- Shoreline orientation
WHERE ARE LIVING SHORELINE PROJECTS APPROPRIATE?

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
WHERE ARE LIVING SHORELINE PROJECTS APPROPRIATE?

Wave Climate

- Low to moderate wave energy
- Regular high tides do not reach the upland bank
- Few boat wakes
WHERE ARE LIVING SHORELINE PROJECTS APPROPRIATE?

Gradual Slope

- Bank slopes, not vertical
- Wide and flat intertidal area
- Wide and shallow subaqueous area

A gentle bank slope combined with a wide, flat intertidal area and shallow subaqueous area will dissipate energy and support plant growth.
WHERE ARE LIVING SHORELINE PROJECTS APPROPRIATE?

Existing Erosion Buffers

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

Existing erosion buffers can be enhanced to increase the level of protection.
WHERE ARE LIVING SHORELINE PROJECTS APPROPRIATE?

Willing Property Owner

- Understands level of protection
- Accepts dynamic shoreline condition
- Tolerates wildlife attracted by habitats
- Willing and able to monitor and maintain
GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT
GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT

1. Determine project budget
   – Do you need a phased approach?

<table>
<thead>
<tr>
<th>Project</th>
<th>Size</th>
<th>Method</th>
<th>Price per Liner foot</th>
<th>Total Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Lake Forest Park Living Shoreline</td>
<td>750 Linear Feet</td>
<td>Rock Wave break, Newly graded shoreline, wetlands vegetation plantings</td>
<td>$43.00</td>
<td>$32,000.00</td>
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<tr>
<td>Shipe Woods Living Shoreline</td>
<td>900 Linear Feet</td>
<td>Rock Breakwater</td>
<td>$38.00</td>
<td>$34,000.00</td>
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<tr>
<td>Oyster Lake Living Shoreline</td>
<td>5,200 Linear Feet</td>
<td>Reef Dome Breakwaters</td>
<td>$33.00</td>
<td>$170,000.00</td>
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<tr>
<td>East Galveston Bay Living Shoreline – Phase 3</td>
<td>3,000 Linear Feet</td>
<td>Offshore Breakwater</td>
<td>$31.00</td>
<td>$91,000.00</td>
</tr>
<tr>
<td>East Galveston Bay Living Shoreline – Phase 2</td>
<td>1,900 Linear Feet</td>
<td>Breakwater Fence (removed once vegetation established)</td>
<td>$6.00</td>
<td>$11,000.00</td>
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<tr>
<td>East Galveston Bay Living Shoreline</td>
<td>2,000 Linear Feet</td>
<td>Offshore Breakwater</td>
<td>$20.00</td>
<td>$39,000.00</td>
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<tr>
<td>Sportsman Road Living Shoreline – Phase 3</td>
<td>1,035 Linear Feet</td>
<td>Reef Ball Breakwater</td>
<td>$25.00</td>
<td>$25,000.00</td>
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<tr>
<td>Sweetwater Living Shoreline and Marsh Restoration – Phase 2</td>
<td>500 Linear Feet</td>
<td>Reef Ball Breakwater</td>
<td>$30.00</td>
<td>$15,000.00</td>
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</tbody>
</table>

NOAA’s Restoration Center Funded Living Shorelines Projects [www.habitatblueprint.noaa.gov]
GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT

2. Set project goals
   – Erosion Prevention
   – Water Quality Improvement
   – Fish Production
   – Habitat Diversity
   – Recreational Benefits
GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT

3. Work/Consult with professionals
   – Coastal Engineers, Landscape Architects, Coastal Biologists, University and Agency Staff, other experts

4. Identify project location and existing shoreline type
   – Natural or Hardened Shoreline
   – Slope
   – Erosion Rates
   – Wave Energy
   – Water Depth
   – Salinity
   – Fetch
   – Longshore Sediment Transport
GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT

5. Determine which Best Management Practices meets your goals

<table>
<thead>
<tr>
<th>General Practices</th>
<th>Erosion Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marsh Plantings</td>
<td>Reduces wave energy, holds soil and traps sediments in grasses.</td>
</tr>
<tr>
<td>Coir Logs</td>
<td>Reduces wave energy, holds soil and traps sediments more effectively than plantings alone.</td>
</tr>
<tr>
<td>Beach Renourishment</td>
<td>Replenishes eroded shorelines and minimizes loss of private property. Reduces wave energy and inland damage from coastal storms.</td>
</tr>
</tbody>
</table>

- **Practice and Ecosystem Benefits**
  - Water Quality Improvement
  - Fish Production
  - Habitat Diversity
  - Recreational Benefits

- Marsh Plantings
  - Provides food and protection for forage fish, shellfish, marine mammals, and shorebirds.
  - Not for public use; piles must be elevated.

- Coir Logs
  - Reduces habitat diversity by covering existing plants and other organisms with sand. Also increases sediment in breeding grounds which can smother plants and fish eggs.
  - Not for public use.

- Beach Renourishment
  - Provides opportunity for public access to swimmers and boaters.

- Oyster Reefs/Balls
  - Provides habitat for shrimp, crabs, clams, snails, worms, and fish.
  - In-stream season, oysters, fish, and crab can be harvested from the reef located in approved waters.

- Sills with Plantings/Hybrids
  - New marsh may attract a greater diversity of aquatic species, plants, and migrant birds. Rocks or recycled material are good habitat for aquatic species, especially oysters. Sills can encourage growth of subaqueous vegetation.

- Breakwaters
  - Depending on wave energy, can create shellfish and finish habitat. Can also create conditions for subaqueous vegetation if wave depth (amount of light) and sediment content is appropriate. Placement of extra sand on some beaches can impact habitat of protected turtle species.

- Bulkhead
  - Minimizes or eliminates the marsh/wetlands, reducing habitat and food for fish.
  - Easy access to deeper water.
GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT

6. Match your Shoreline to Best Management Practice
7. Develop timeline
   - Plan for Permitting
   - Plan for Agency/Municipal/USACE Review
   - Plan for Optimal Planting Times

8. Identify project partner(s), (if applicable)
   - Federal
   - State
   - Local
   - Non-Profit Organizations
   - Homeowner’s Association

9. Determine permitting requirements

10. Funding for the Project
11. Project design and monitoring plan
   - Site Inventory and Analysis
     • Focused on coastal erosion factors
   - Acquire a survey (if needed)
   - Conceptual drawings
   - Engineering drawings/cross-sections
   - Develop monitoring plan (if needed)

12. Permitting
   - Create and submit permit drawings
   - Get all approvals/permits

13. Construction
GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT

14. Post construction monitoring (Not required in most cases)
   – Monitoring Methodology
     • What is the success criteria?
   – Sampling methods
     • Number, size, location, analytical tools, mapping using GIS
   – Monitoring Schedule
     • Growing seasons for vegetation, Tidal or hydrology cycle to assess performance at different times and intervals
   – Photos
     • Ground and/or aerial photos taken from the same place (reference)
GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT

15. Adaptive management

– Procedures in place to modify the project design in the event the project does not meet the success criteria

– Potential problems include
  • Loss of physical structures from storms
  • Invasive vegetation
  • Hydrological conditions (too wet/too dry)
Living Shorelines 101

CASE EXAMPLES
LIVING SHORELINE EXAMPLE

Planted Marsh

Perdido Key, FL [Dr. Eric Sparks, MASGC.org]
LIVING SHORELINE EXAMPLE
LIVING SHORELINE EXAMPLE

Breakwater

Restored Marsh

Clear Lake Forest Park Living Shoreline, Clear Lake Forest, Texas [Google Earth]
LIVING SHORELINE EXAMPLE

Clear Lake Forest Park Living Shoreline, Clear Lake Forest, Texas [Galveston Bay Foundation]
LIVING SHORELINE EXAMPLE

Clear Lake Forest Park Living Shoreline, Clear Lake Forest, Texas [Galveston Bay Foundation]
LIVING SHORELINE EXAMPLE

Clear Lake Forest Park Living Shoreline, Clear Lake Forest, Texas [Galveston Bay Foundation]
LIVING SHORELINE EXAMPLE—PROJECT
GREENSHORES, PENSACOLA, FL

• Multimillion-dollar habitat restoration
• Restored oyster reef, salt marsh and seagrass habitat
• Partners included:
  – Florida’s Department of Environmental Protection Northwest Aquatic Preserves, City of Pensacola, Escambia County, Ecosystem Restoration Support Organization, EPA Gulf of Mexico Program, National Fish and Wildlife Service, NOAA, Gulf Power, local agencies, and volunteers (Boy Scout, Cub Scout and Girl Scouts).
• Seven acres of constructed oyster reef
  – 14,000 tons of Kentucky limestone / 6,000 tons of recycled concrete / 40 wave attenuators
• Eight acres of salt marsh
  – 35,000 cubic yards of sand / 40,000 smooth cordgrass plants
• Submerged breakwaters
  – 25,000 cubic yards of recycled concrete
LIVING SHORELINE EXAMPLE
LOCATION, LOCATION, LOCATION

Protection

Fetch = 7.5+/- miles

1999
LIVING SHORELINE EXAMPLE
PHASED APPROACH

Breakwater

Project GreenShores, Pensacola Bay, Florida [Google Earth]
LIVING SHORELINE EXAMPLE
PHASED APPROACH

Additional Breakwaters
Beneficial use of Dredge Material

2004
Project GreenShores, Pensacola Bay, Florida [Google Earth]
LIVING SHORELINE EXAMPLE
LIVING SHORELINE EXAMPLE
LIVING SHORELINE EXAMPLE
LOCATION, LOCATION, LOCATION

- Storm water Drainage
- 600’ x 150’ x 0.5’ Wavebreak
- No Western Protection
- Fetch = 7.5+/- miles

Project GreenShores, Pensacola Bay, Florida [Google Earth]
KEY POINTS

- Living Shorelines are an integral piece of the Texas Coastal Resiliency Plan
- Living Shorelines have many ecosystem service benefits from habitat creation to shoreline protection
- Living Shorelines are better suited for Sea Level Rise
- Living Shorelines can be more cost effective than traditional hardening methods
Thank you for your time! Questions?

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ADDITIONAL RESOURCES

• Arundel Rivers Federation
  – http://www.arundelrivers.org/restoration/living-shorelines/
  – https://southriverdata.net/

• Florida Living Shorelines
  – http://floridalivingshorelines.com/florida-sampler/

• NOAA
  – https://www.habitatblueprint.noaa.gov/storymap/ls/

• Virginia