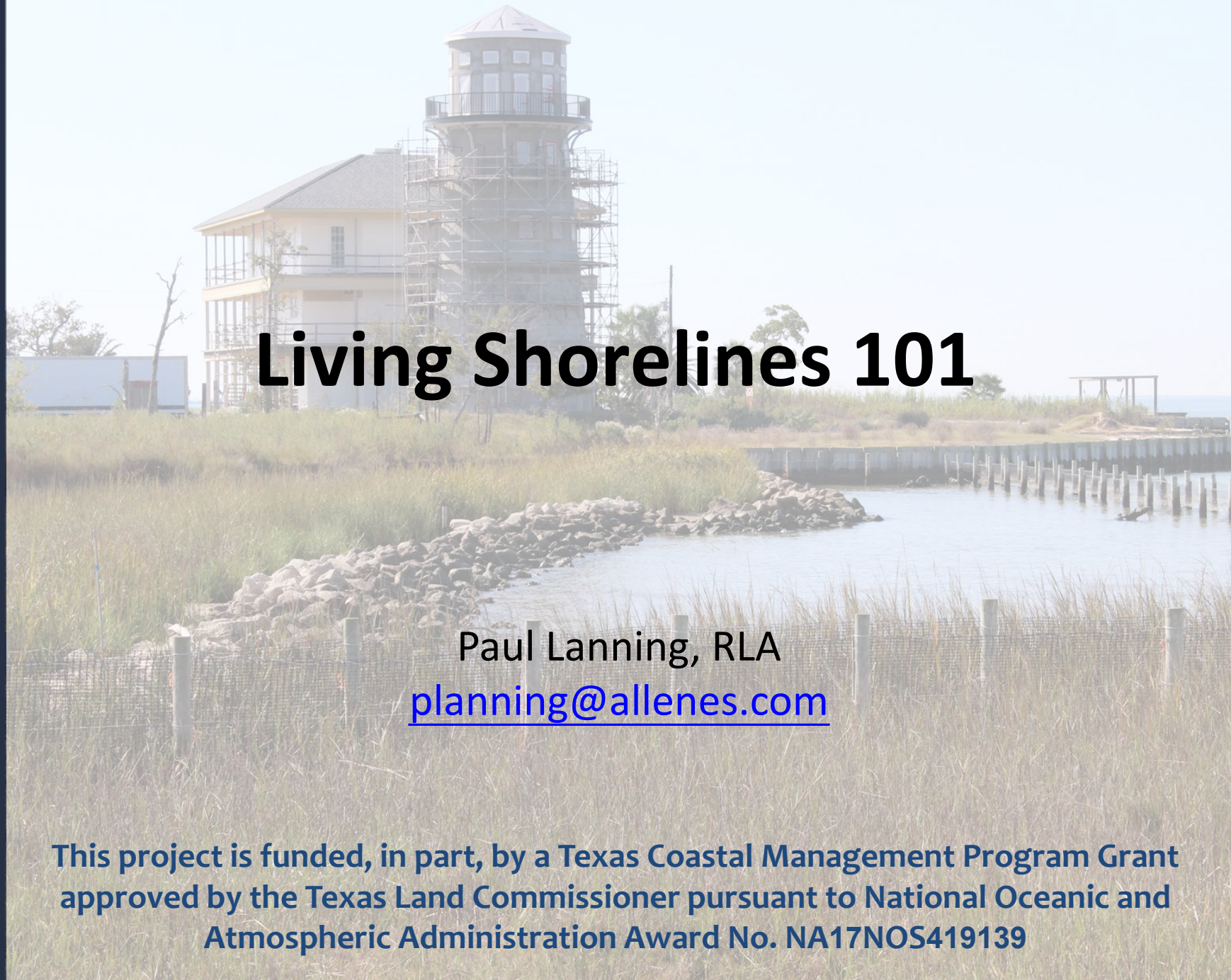
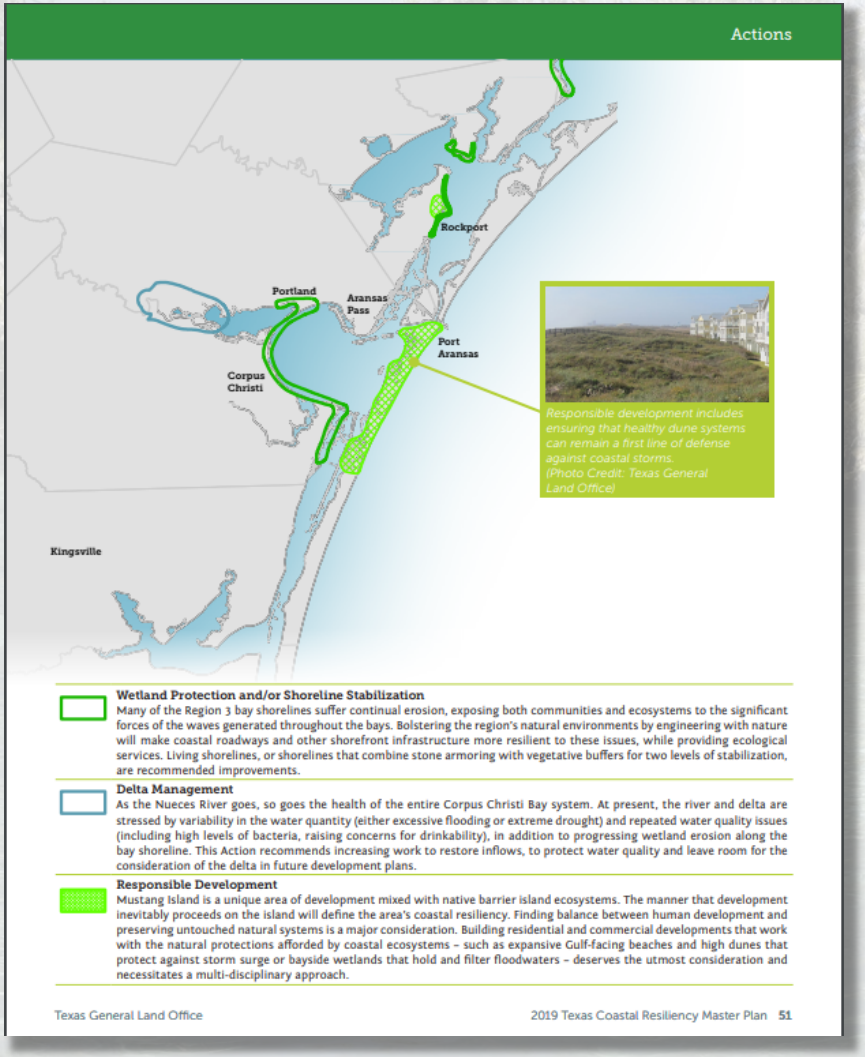


Living Shorelines 101

Paul Lanning, RLA
planning@allenes.com

This project is funded, in part, by a Texas Coastal Management Program Grant approved by the Texas Land Commissioner pursuant to National Oceanic and Atmospheric Administration Award No. NA17NOS419139

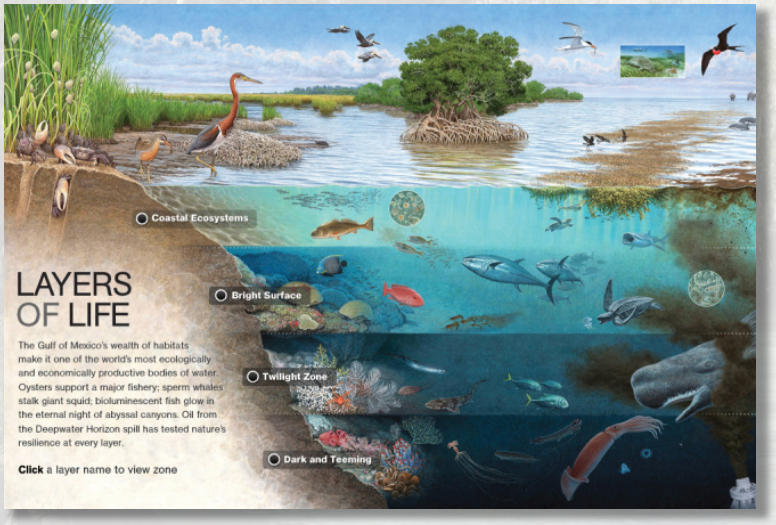
WETLAND PROTECTION AND/OR SHORELINE STABILIZATION



[2019 Texas Coastal Resiliency Master Plan p. 51]

COASTAL ECOSYSTEM BENEFITS

Habitat



Shoreline Stabilization

Tourism, Recreation, Aesthetics

Sediment, Nutrient & Carbon Storage

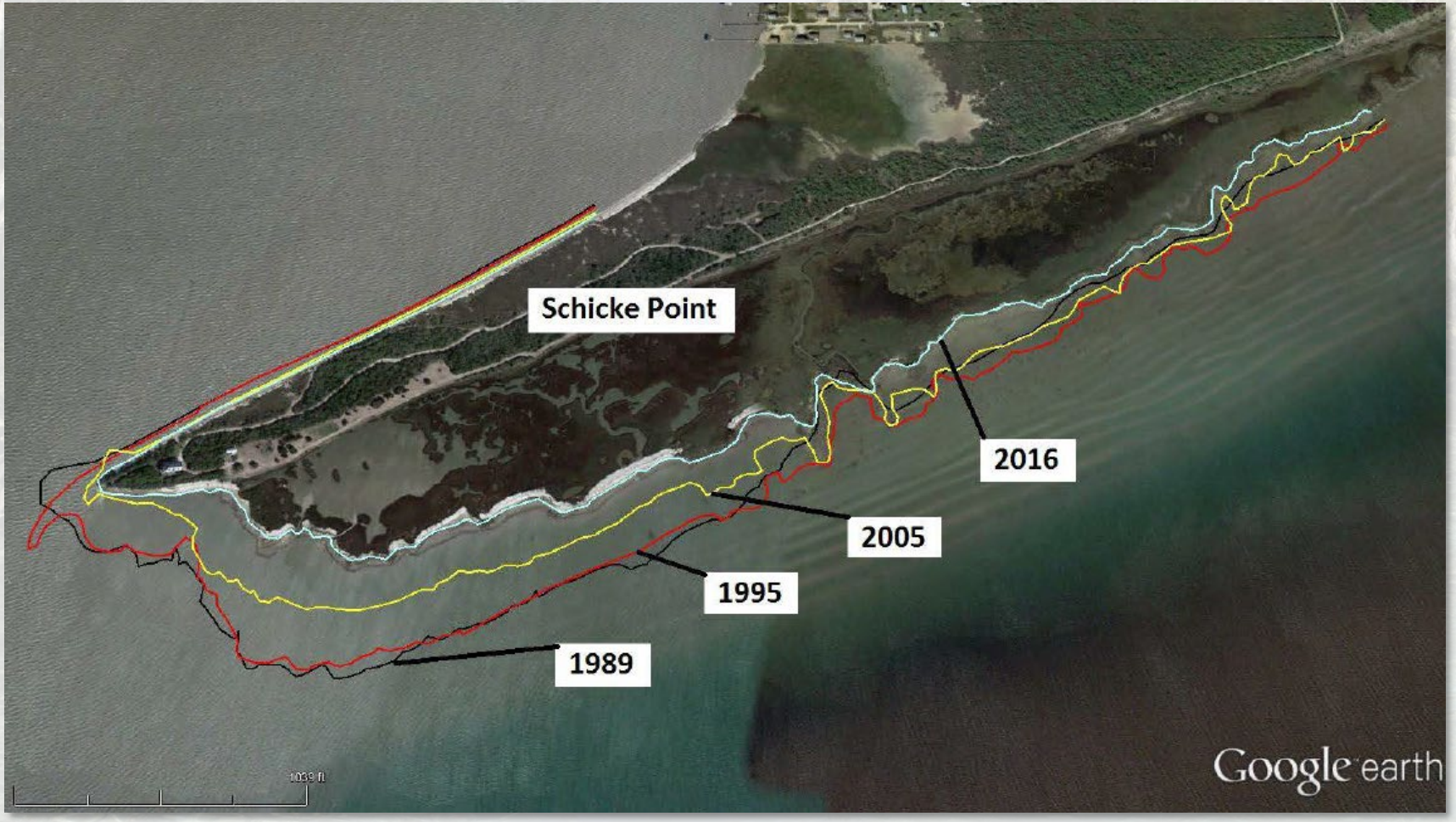
WE NEED TO WORK TOGETHER TO MAINTAIN A SUSTAINABLE COASTAL ENVIRONMENT DUE TO:

- 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

Texas Coastline [Google Earth]

COASTAL EROSION



Schicke Point, Matagorda Bay, Texas [Freese and Nichols]

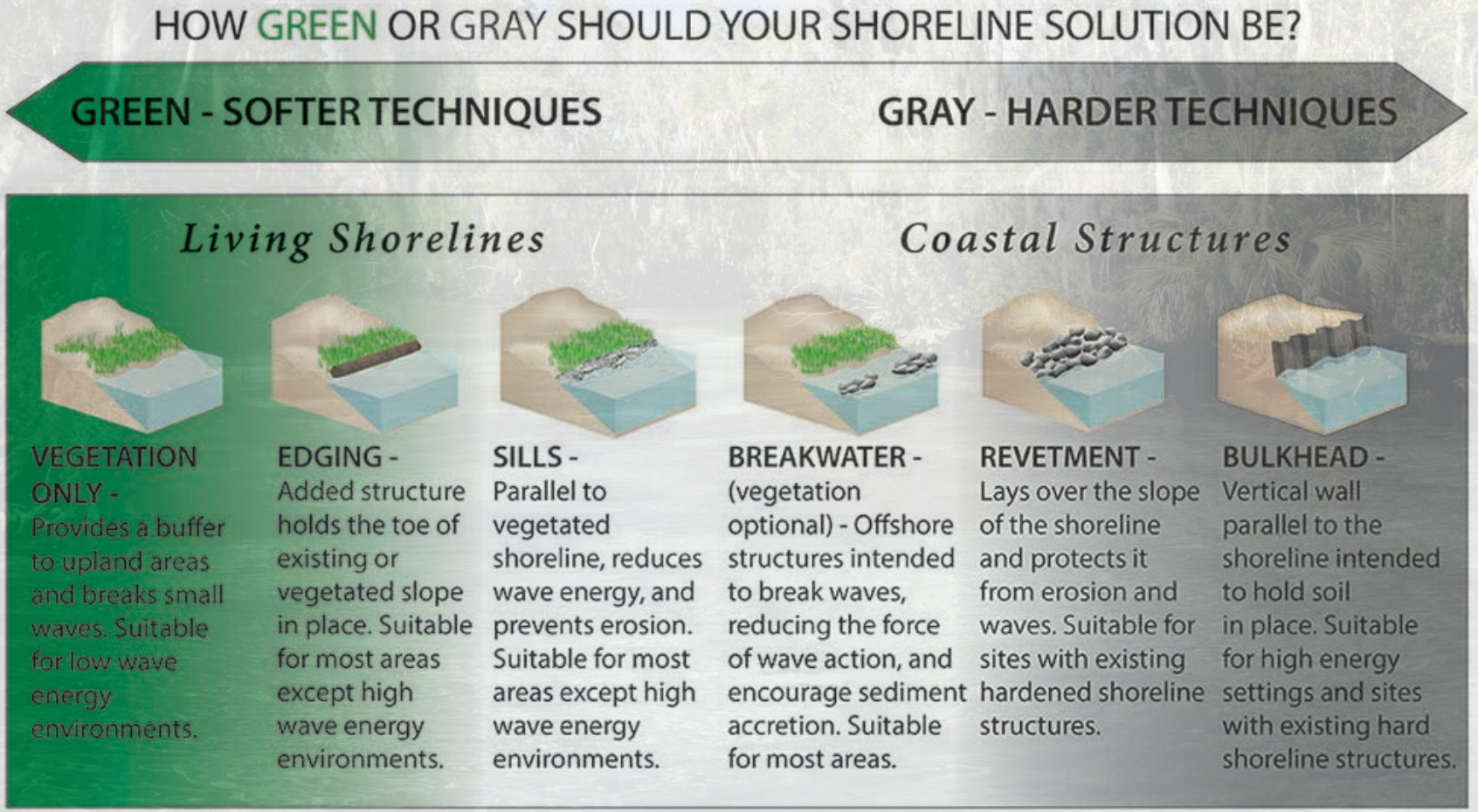
WHAT FACTORS CREATE EROSION?

- 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



[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

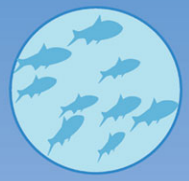
- Reduce wave energy and associated shoreline erosion
- Buffer the effects of storms, especially tropical storms and hurricanes
- Build-up shoreline areas by trapping sediments and stabilizing coastal land.
- Ensure natural sediment movement along shorelines
- Improve water quality in bays and estuaries 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 SUPPORT RESILIENT COMMUNITIES

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.

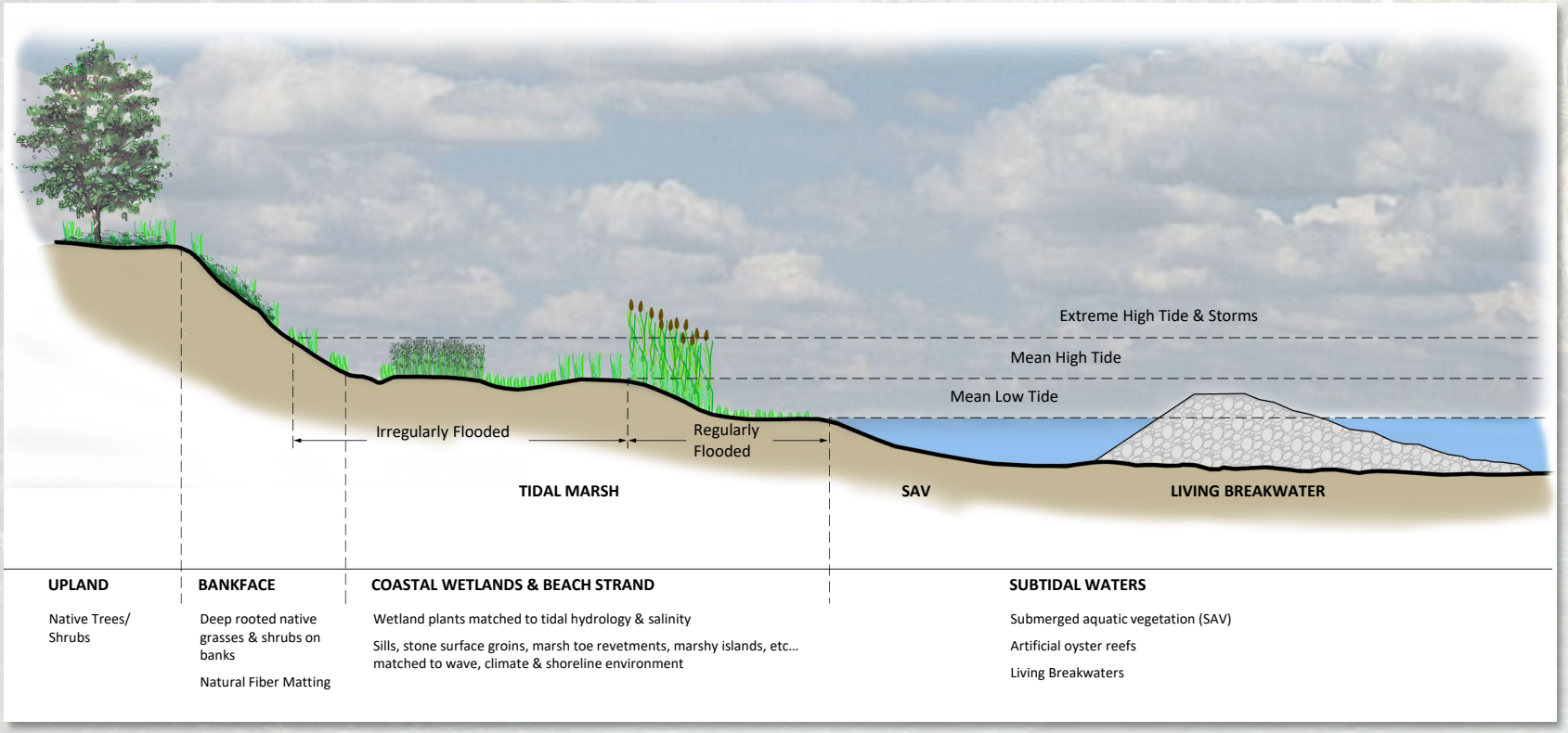
33% of shorelines in the U.S. will be **hardened** by **2100**, decreasing fisheries habitat and biodiversity.

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 [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

Texas Coast 2018 [Google Earth]

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 (*Juncus roemerianus*)

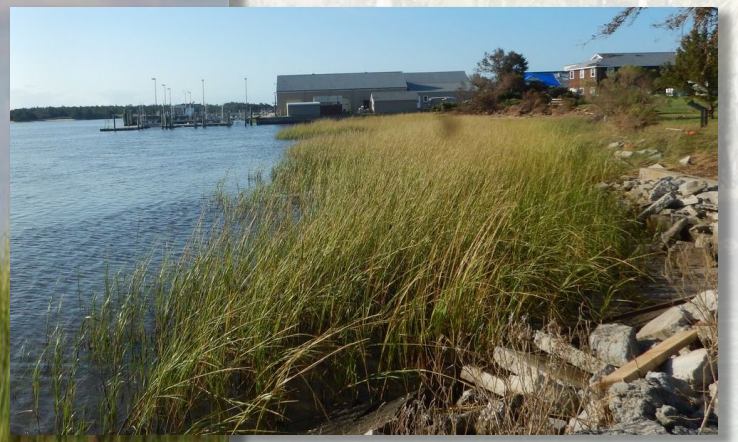
- Smooth Cordgrass (*Spartina alterniflora*)

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

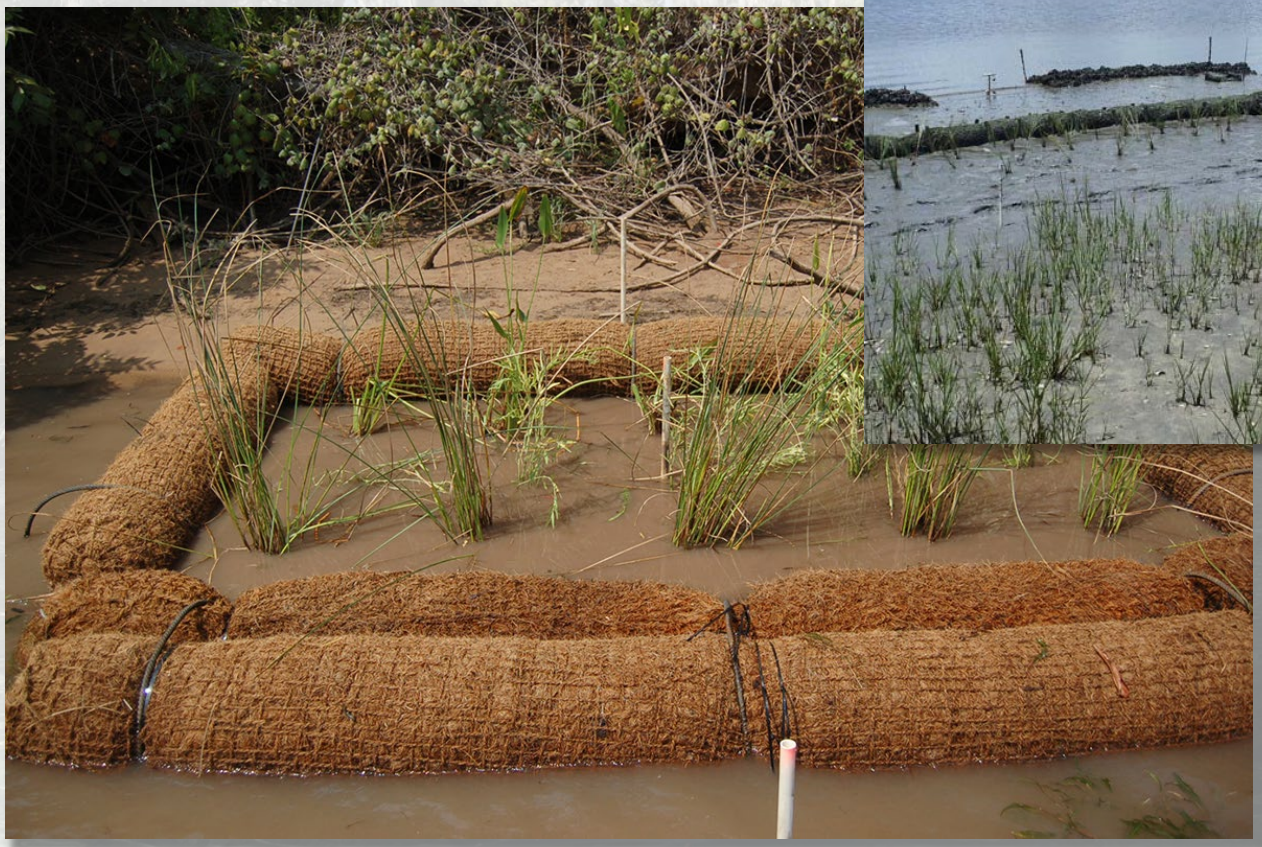
Dune Restoration South Padre Island, Texas [Galveston Bay Foundation]

TYPES OF SHORELINE MANAGEMENT

Coir Logs – Anchored natural fiber log with marsh grass planting

Wrights Landing

St. Johns County, Florida



Lake Austin, Austin, Texas

TYPES OF SHORELINE MANAGEMENT

<u>Natural Fiber Matting</u> – Stabilize slope and allow for regrowth of vegetation

Delaware Living Shorelines

TYPES OF SHORELINE MANAGEMENT

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

Reef Balls Test Site, Living Shoreline Project, Louisiana [Tetra Tech]

Indian Riverside Park, Martin County, Florida

"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

Reef Innovations

Stratford Point, All Habitat Services

TYPES OF SHORELINE MANAGEMENT

<u>Oyster shell/Oyster shell breakwater</u> – 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

Saw Grass Point Marsh

Saw Grass Point Marsh

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

Reefmaker

TYPES OF SHORELINE MANAGEMENT

Ecodisk Trays [Reefmaker]

Ecodisk Trays [Reefmaker]

TYPES OF SHORELINE MANAGEMENT

Reef Balls [Reef Ball Foundation, Inc.]

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

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.

VIMS, [K. Duhring]

Hybrid Living Shoreline, Delaware

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

TYPES OF SHORELINE MANAGEMENT

Sill with Planted Marsh - Protect eroding shoreline, restore shoreline wildlife habitat

Hull Springs Farm, Montross, Virginia [Photo: Longwood University]

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

Pine Knoll Shores, North Carolina Coastal Federation

Marsh Toe Revetment [Center for Coastal Resources Management]

TYPES OF SHORELINE MANAGEMENT

<u>Breakwater with Transitional Wetland</u> – Similar to Sill, but used in the event of greater water depth, slope of shoreline, higher wave action

North Carolina [North Carolina Coastal Federation]

TYPES OF SHORELINE MANAGEMENT

Great Marsh Island, Jacksonville, Florida [Infrastructure Alternatives, Inc. / Manson Construction Company]

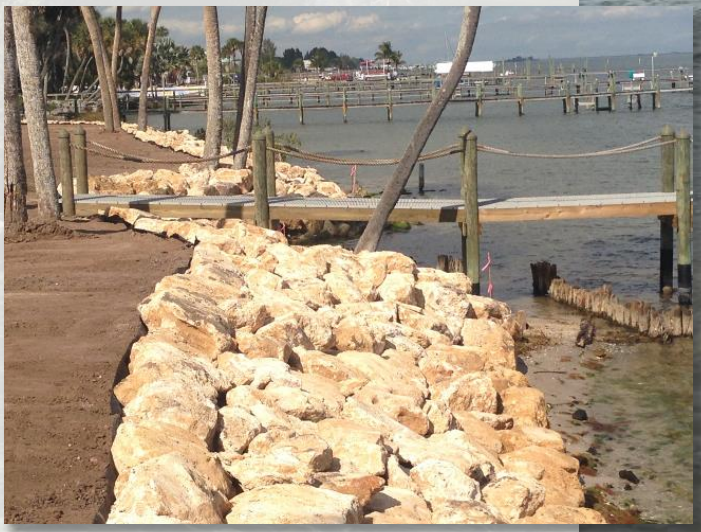
TYPES OF SHORELINE MANAGEMENT

Triton Marine Mattress [JLS Contracting]

Great Marsh Island, Jacksonville, Florida [Google Earth]

TYPES OF SHORELINE MANAGEMENT

Shoreline Revetment – a protective covering on an embankment of earth designed to maintain the slope or to protect it from erosion.



Land and Sea Marine

Land and Sea Marine

TYPES OF SHORELINE MANAGEMENT

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.

L.S.I. Marine Construction

WHICH SHORELINE WOULD YOU WANT?

or

WHERE ARE LIVING SHORELINE PROJECTS APPROPRIATE?

It depends on several factors:

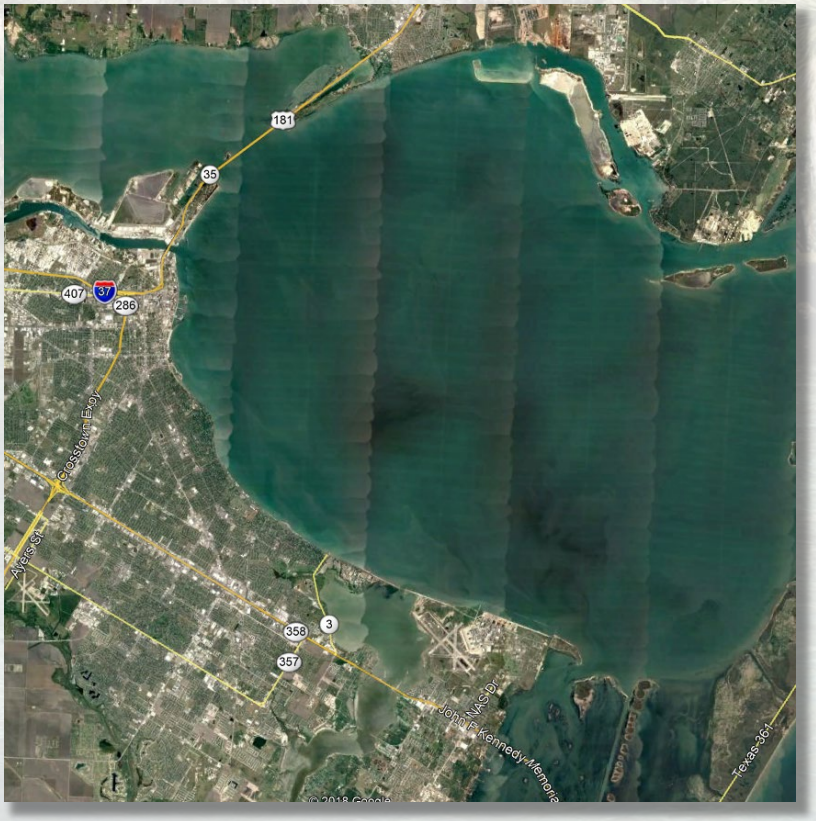
- Landscape setting
- Erosion condition
- Wave climate
- Gradual slope
- Existing erosion buffers
- Willing property owner

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?

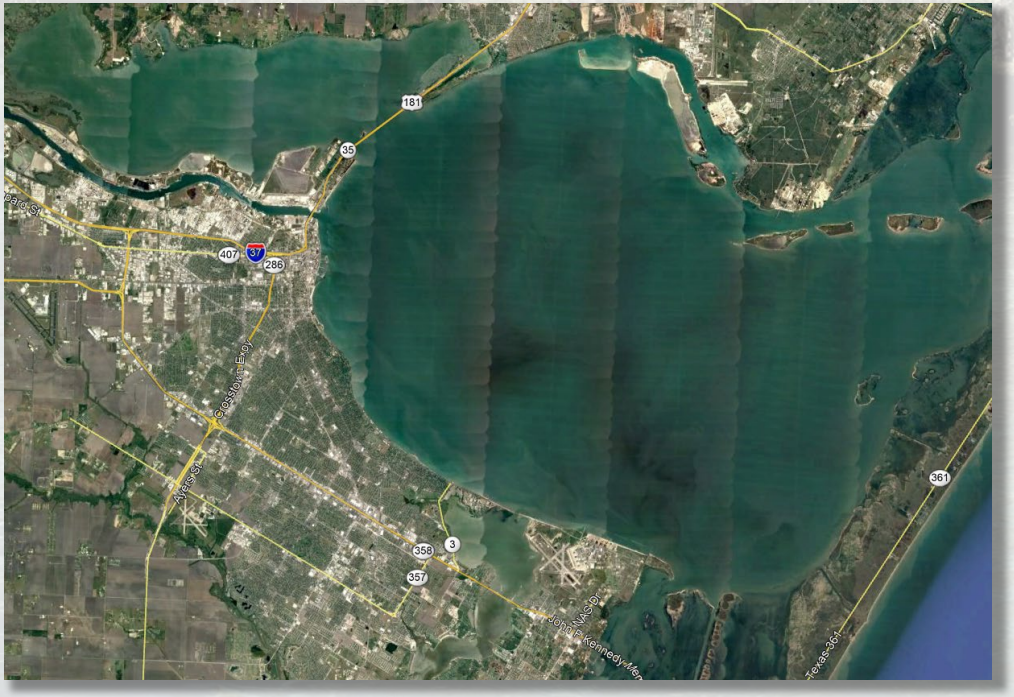
Erosion Condition

- 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

Living Shorelines 101

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?

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

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

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

GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT

6. Match your Shoreline to Best Management Practice

Upland Vegetation - Trees, Shrubs, Grasses and Grass Roots	• Soil stabilization in upland zone • Stormwater runoff filtration
Wetland Vegetation - Marsh Grasses	• Improves finfish and shellfish habitat • Stabilizes soil • Traps sediment • Improves water quality by filtering runoff
Natural Fiber Logs with Vegetation	• Low impact • Biodegradable • Traps and retains sediment • Promotes plant growth • Inexpensive and easy to install • Flexible and easy to mold to shape of shoreline
Natural Fiber Matting with Vegetation	• Can be used for moderate slopes • Low cost • Biodegradable • Traps and retains sediment
Living Breakwaters	• Wave attenuation • Improved water quality • Increased oyster habitat • Creates a calm area near shoreline that can be planted with vegetation for improved marsh habitat

GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE PROJECT

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

GENERAL STEPS TO IMPLEMENT A LIVING SHORELINE 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

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

LIVING SHORELINE EXAMPLE

Living Shoreline, Edgewater, Maryland [Arundel Rivers Federation]

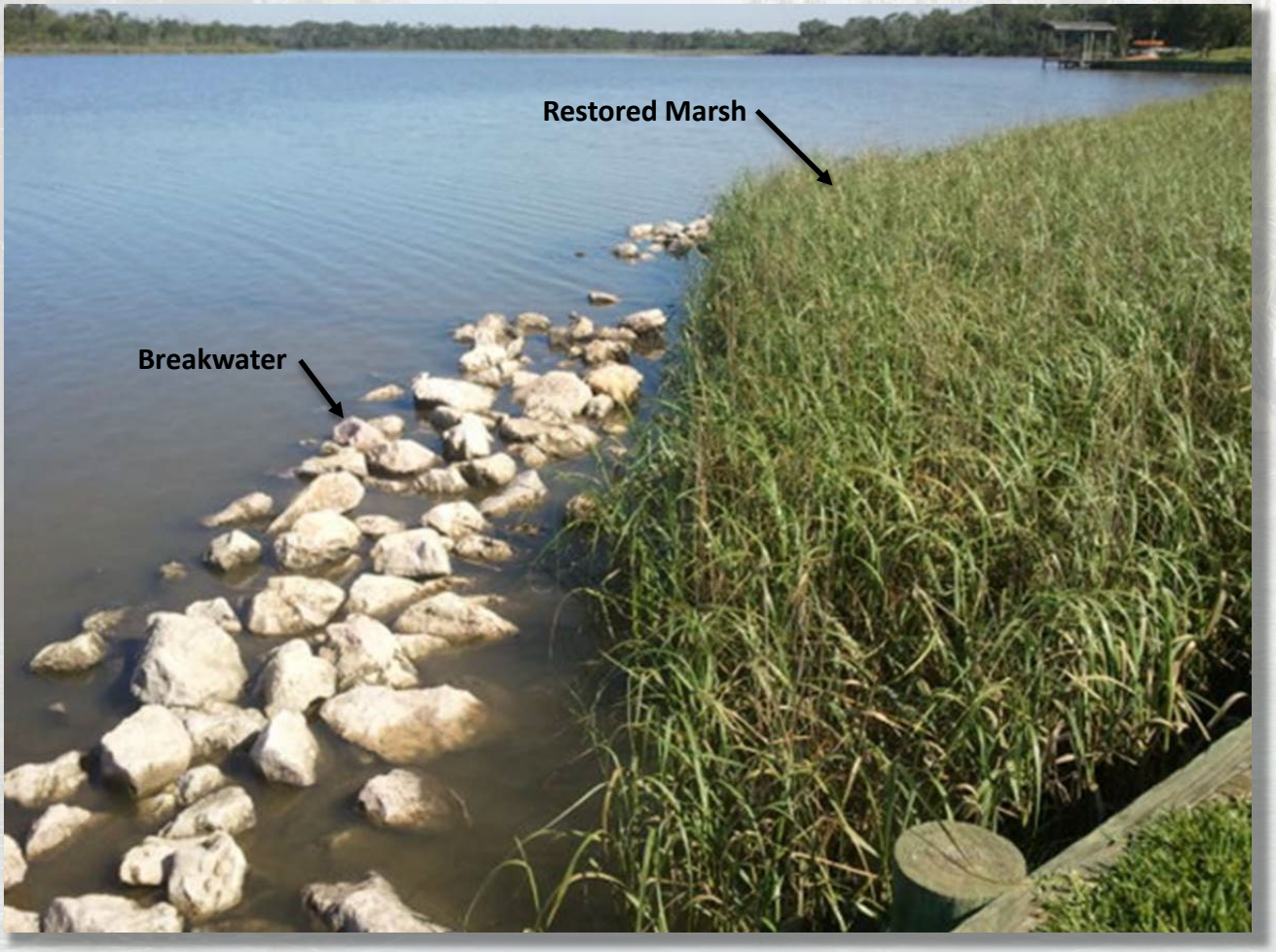
LIVING SHORELINE EXAMPLE

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

Shipe Woods Living Shoreline, Trinity Bay (East Shore), Texas [Google Earth]

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

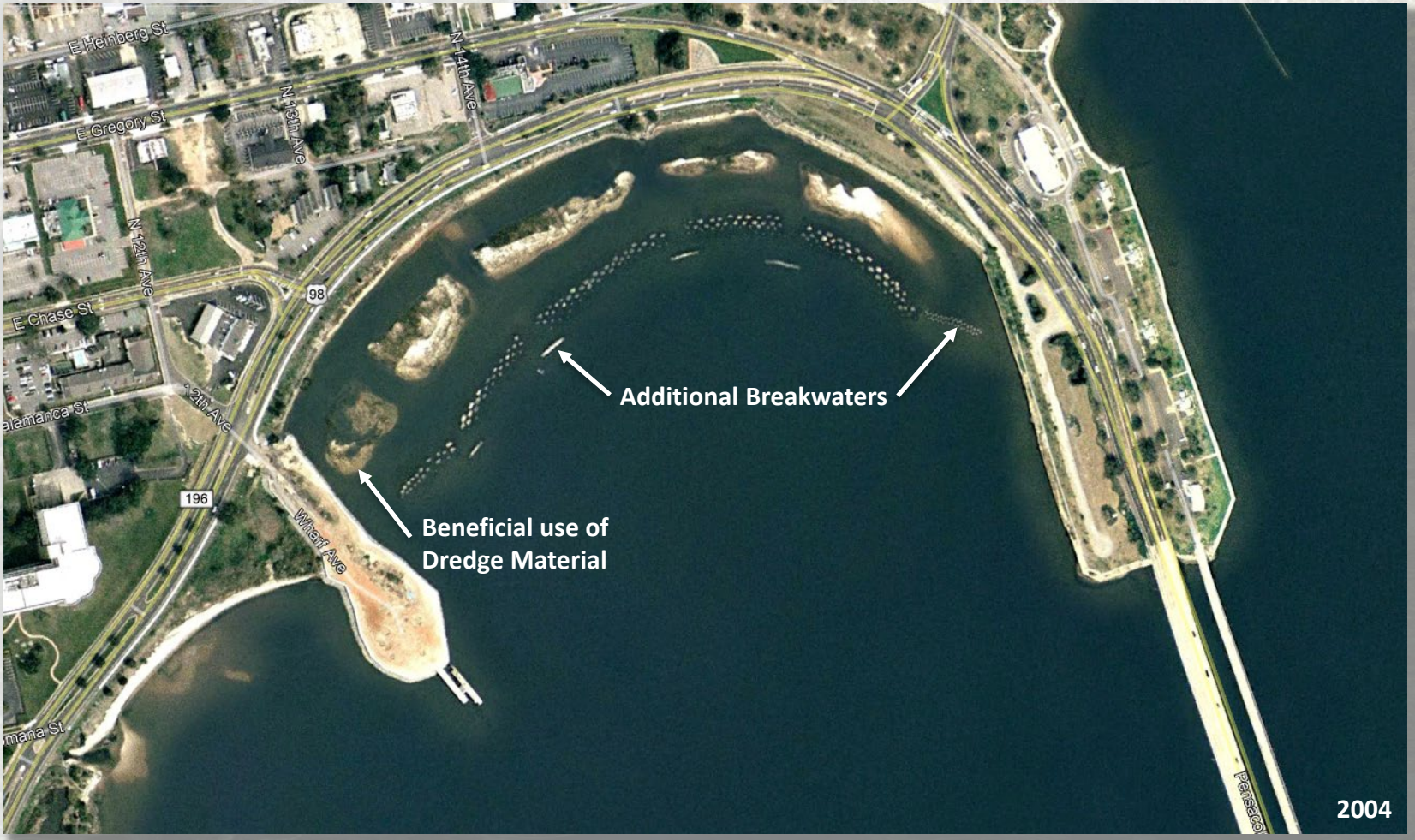
LIVING SHORELINE EXAMPLE
LOCATION, LOCATION, LOCATION

Project GreenShores, Pensacola Bay, Florida [Google Earth]

LIVING SHORELINE EXAMPLE
PHASED APPROACH

Project GreenShores, Pensacola Bay, Florida [Google Earth]

LIVING SHORELINE EXAMPLE
PHASED APPROACH



Project GreenShores, Pensacola Bay, Florida [Google Earth]

LIVING SHORELINE EXAMPLE

Project GreenShores, Pensacola Bay, Florida [Google Earth]

LIVING SHORELINE EXAMPLE

Project GreenShores, Pensacola Bay, Florida [Google Earth]

LIVING SHORELINE EXAMPLE

Project GreenShores, Pensacola Bay, Florida [Google Earth Street View]

LIVING SHORELINE EXAMPLE
LOCATION, LOCATION, LOCATION

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?

Paul Lanning, RLA
planning@allenes.com

This project is funded, in part, by a Texas Coastal Management Program Grant approved by the Texas Land Commissioner pursuant to National Oceanic and Atmospheric Administration Award No. NA17NOS419139

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
  - https://www.arcgis.com/apps/MapJournal/index.html?appid=95bfc110379844d5809bce8d09487538#