2.2 Living with Living Shorelines

AGE RANGE

9th—12th grade

TIME REQUIRED

90 minutes

ACTIVITY OVERVIEW

Engage: Shoreline Images
Explore: Water Pan Demos
Explain: Discussion
Elaborate: Reading
Evaluate: Discussion

MATERIALS

Clear plastic containers (4 per group)
Sand (1 bag per ~8 containers)
Playdoh Dough (1 tub per group)
Water
Plastic aquarium grass
2 small vinyl siding samples
Small mesh bags
Small pebbles/rocks inside
Rubber bands
Small paint scrapers
Towels
Saran /Plastic Wrap
Rulers
Masking Tape
Wet/Dry Erase Markers

BASED ON:

"Shifting Shorelines" from North Carolina Coastal Federation

LESSON TOPIC: Living shorelines

ACTIVITY SUMMARY: Students compare erosion from waves and storms on four different beach types.

OBJECTIVES:

Students will be able to:

- Identify components of a living shoreline and built stabilization structures.
- Understand coastal erosion and erosion control methods.
- Describe benefits of living shorelines to animal habitat and economic benefit.

LESSON BACKGROUND: Shorelines are the first line of defense against storms in the Gulf of Mexico. A healthy coast helps to protect our communities. Coastal erosion results in loss of land and can be caused by wind, waves, storms, boat wakes, and rising water levels. Some techniques to protect the coast from erosion are human built structures like bulkheads and seawalls. These structures provide a barrier to water stressors, but they require expensive maintenance and during strong storms they can fail. Additionally, hardened structures can often lead to loss of natural intertidal habitat and all of the benefits they provide. Natural shoreline protection can come in the form of oyster reefs and wetlands. These act as speed bumps to storms, slowing them down and reducing erosion. Living shorelines is a broad term that covers a variety of shoreline construction & protection techniques that harnesses the ability of natural habitats to provide shoreline protection, through using natural elements like native marsh grasses and oyster shells to stabilize the shore. Another benefit of living shorelines is that they offer habitat for animals like fish, crabs, and oysters. Oysters are filter feeders and help clean the water they are in, so using oyster shells in living shorelines promotes oyster reef growth to clean the water while also preventing erosion. Marsh grasses provide habitat for fish to hide while they are young. Adult fish will venture into the Gulf of Mexico. The Gulf of Mexico is the second largest area of fish landings in the United States, second only to Alaska. Commercial fisheries in the Gulf of Mexico have an economic impact through job creation, including processors, dealers, retailers, restaurateurs that transport seafood from the ocean to our plate. Utilizing living shorelines helps to affordably and sustainably protect our coasts while also supporting fisheries and clean water.

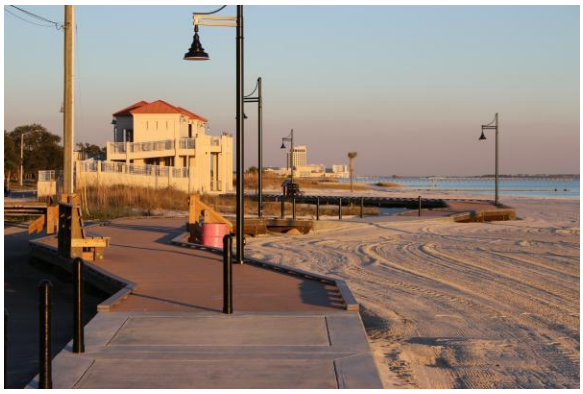
Mississippi State University Coastal Conservation and Restoration Program has developed larger scale living shoreline education tanks. At several locations along the MS and AL, coast there are living shoreline education tanks – also called SWASH tanks – Gulf Coast Research Laboratory Marine Education Center, Pascagoula River Audubon Center, Grand Bay National Estuarine Research Reserve, Mississippi Aquarium, and Dauphin Island Sea Lab Estuarium. Each tank is actually a set of three tanks that each have a different type of shoreline on one side. Those shoreline types are bulkhead, natural shoreline, and living shoreline (with breakwater). On the other end of the tank is a paddle connected to a lever. When the lever is pushed it creates an equal-sized wave in each tank that then crashes into the different shoreline types. You will notice that the wave dissipates quickest (i.e., the water gets calmer – faster) in the natural shoreline and living shoreline tanks than the one with the bulkhead. The bulkhead is essentially a flat wall that reflects waves instead of dissipating them, which can cause erosion on neighboring shorelines. The natural or living shoreline tanks have several characteristics that help dissipate wave energy and reduce potential erosion – those are a gentler slope, vegetation, and a breakwater. This demonstration shows that the more natural shorelines you have, the more waves will be dissipated.

VOCABULARY:

Coastal Processes	Physical, biological, and geological processes and affecting coastlines and coastal habitats.
Ecosystem Service Valuation	Quantifying the benefits that humans receive from natural systems; often utilizes economic value.
Erosion	Process wherein sediments are broken down and worn away by waves, currents, wind, and/or precipitation.
Habitat Management	Manipulating an ecosystem in order to suit a purpose, especially to balance environmental and human activities.
Living Shoreline	A living shoreline is a protected and stabilized shoreline that is made of natural materials such as plants, sand, or rock.
Restoration	Manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning previous function(s). Includes ecological, ecosystem, and habitat restoration.
Rhizome	A rhizome is a modified subterranean plant stem that sends out roots and shoots from its nodes.

ENGAGE:

Display the images of the sand beach, wetland salt marsh, living shoreline planted with marsh grass and oyster reef, hardened shoreline near city, and bulkhead. Have students discuss the benefits of each type of shoreline. Then ask students to rank the images according to how well they think the type of shoreline will protect upland habitat.



West Biloxi Beach Boardwalk. Source: GulfCoast.org

A natural shoreline at Guana Tolomato Matanzas National Estuarine Research Reserve. Source: Melody Ray-Culp, US Fish and Wildlife Service

A living shoreline in Panama City, Florida. Source: Florida Living Shorelines

Hardened shorelines in South Florida. Source: Florida Living Shorelines

Hardened bulkhead shoreline in Scarborough, ME. Source: Maritime Construction and Engineering, LLC

EXPLORE:

Activity Overview: water pan demos - Students will explore how various shoreline stabilization methods influence coastal erosion and the surrounding habitat. They will rotate through four stations: a bare sand shoreline, a hard structure protection method, a living shoreline with planted marsh grasses, and a living shoreline with both planted marsh grasses and a constructed oyster reef. While rotating through the stations in small groups, students will simulate wave energy and observe which method works best to protect estuarine shores.

Materials:

- Clear plastic containers (11 in X 16 in, 15 Qt.), enough for students to work in groups of 3
- Playdoh or Crayola Dough (1 tub per group)
- Saran /Plastic Wrap

- Sand (1 bag per ~8 containers)
- Plastic aquarium grass used in fish tanks
- 2 small vinyl siding samples from Lowes Hardware (for bulkhead/seawall)
- Small mesh bags with small pebbles/rocks inside (for oyster reef)
- Rubber bands
- Small paint scrapers or dust pans (as many as plastic containers)
- Water (enough to fill each contained ½ way)
- Rulers (one for each station)
- Wet/Dry Erase Markers or Masking Tape (one for each station)
- Towels

Procedure:

1. Divide students into groups of 2-3. Each group will build a shoreline. Depending on your class size there may be duplicate shorelines.
    - All: Make a one-inch layer of playdoh along the bottom of the plastic container from the edge to 1/3 of the way. Place a sheet of plastic wrap over the playdoh, to help with cleanup. Add sand on top of the playdoh and form a gentle slope to create a beachfront/shoreline. Add water to the opposite end of the container so it reaches roughly ¼ of the sandy shore. The only sand shoreline is complete, all other shorelines continue with the following directions.
    - Bulkhead/seawall: Add the small vinyl siding samples and place them side by side. Stick them down into the playdoh.
    - Living shoreline with plants: Add aquarium plants and bury down in the sand/playdoh a bit to represent plant roots. You may need to cut the aquarium plants so they fit in your container correctly.
    - Living shoreline with plants and oyster reef: Add plants and then place pebble bags slightly in front of plants. You may need to use rubber bands around the pebble bags to make the reef more streamline.

Image: From left to right, sand only, bulkhead, living shoreline with plants, living shoreline with plants and oyster reef. Image showing the complete shoreline setups.

2. Rotate student groups through the shoreline stations to observe wave action and erosion. At each station have students record the following:
    - Their prediction/hypothesis for amount of erosion they expect from the type of shoreline.
    - The number of millimeters of erosion they measure after making waves.
3. When a group arrives at a shoreline have them mark the end of the shoreline (the coast) with tape on the outside of the container.
   Alternative: students trace the edge of the shoreline with a dry or wet erase marker. If you want to prevent the students from writing directly on the bin, each group can tape a transparent paper (sheet protector or laminated page) to the bin to draw the “before” shoreline in one color permanent marker and the “after” shoreline in another color permanent marker. These transparent pages can be kept to compare all bins at the end of the lesson.
   One student per group will make 20 waves in the water using the paint scraper.
4. Using the ruler, the group will measure the distance from the coast to their piece of tape.
   Alternative: students measure the distance to their traced line. This will show the amount of erosion. Before the group rotates to the next station have them repair the shoreline back to the original condition and remove the tape/erase the line.
5. Groups continue rotating until each group has been to each type of shoreline at least once.

Image: Marker on the outside of the container showing original shoreline shape compared to new shoreline share.

Tips for resetting the activity between classes:

- Have extra sand on hand to replace
- Use fresh playdoh if it has dried out
- Have dump buckets for used water and sand

EXPLAIN:

With groups all together discuss with students what they saw and how it might translate to what we experience on the Gulf Coast.

- Which shoreline eroded the most during the wave experiment?
- Which shoreline offered the most protection from erosion?
- What happened to the sand? Where did it go? Why did this happen?
- What do you think would happen if a hurricane came to the shorelines? At this point the teacher or a student can simulate a hurricane on each shoreline with strong waves.
- What do you think the different shorelines would look like a year after the hurricane? (Plants and living shorelines are able to recover naturally).
- How do you think the plants and oyster reefs can help keep the surrounding water clean? (plants can help filter any pollutants coming from the mainland, and the oyster reefs will attract new oysters, which naturally help clean and filter water)
- What other benefits do they provide?

ELABORATE:

Students read "Living with Living Shorelines" and then look over living shoreline resources available to homeowners.

Protection your property and the environment: A homeowner's guide to living shorelines in Alabama. Martin SE, Sparks EL, Temple NA, Firth DC. 2017.
http://extension.msstate.edu/sites/default/files/publications/publications/P3063.pdf

Protection your property and the environment: A homeowner's guide to living shorelines in Mississippi. Martin SE, Sparks EL, Temple NA, Firth DC. 2017.
http://extension.msstate.edu/sites/default/files/publications/publications/P3062.pdf

Living shorelines can be implemented as a buffer in many areas: homes, bridges, roads, and more.

Discussion questions for students:

- How do we rely on wetlands?
    - They offer protection from erosion. They buffer the coastline during storms, thus protecting our structures. They are a nursery habitat for fish and crabs and help contribute to the large seafood industry in the Gulf of Mexico.
- What plant grows in a salt marsh?
    - Common salt marsh plants along the northern Gulf of Mexico inclide: smooth cordgrass *Spartina alterniflora*, Black needlerush *Juncus roemerianus,* Saltmeadow cordgrass *Spartina patens*, Bulrush *Schoenoplectus americanus*, and Salt grass *Distichlis spicata*
- Where are salt marshes located?
    - Salt marshes are wetlands located along the coast and influenced by tides.
- What organisms rely on salt marsh habitat?
    - Blue crab, shrimp, red drum, osprey, blue heron, periwinkle snails, and many more.
- What is a rhizome and what is the function?
    - A rhizome is a horizontal underground root. It spreads to produce new clones of the plant.
- Why are salt marshes threatened?
    - Salt marshes are threatened from upland sources like human development and runoff, and from sea-level rise.
- Why are sea walls not as good as natural shorelines?
    - Sea walls and hardened structures are not able to adapt and change over time. Also, due to their impermeability they redirect wave energy and can increase erosion in adjacent locations.

- Name 3 benefits of restoring natural shorelines on private properties.
    - Restoring natural shorelines on private property can help reduce erosion, support healthy coastal ecosystems, and boost local economies.
- Which was more efficient at protecting the shoreline, the 50 percent coverage area or the 100 percent coverage area?
    - The area planted at 50 percent coverage was the most efficient as it performed just as well as the area plated at 100 percent but cost less to install.
- Which would be cheaper and less labor intensive (less hard work)?
    - The 50 percent coverage.
- What is a breakwater?
    - A nearshore breakwater is a structure used to help reduce wave energy before it hits the marsh. Depending on the site, these breakwaters can be made of temporary materials, such as biodegradable coir logs or short, board fences, or longer-term materials, such as loose stone, concrete structures, or oyster shell cages.

Connect the outcomes of the water pan demonstration to coastal building ordinances in Module 3 (Lesson 3.3) and Module 4 (Lesson 4.1).

EVALUATE:

Return to the images from the start of the lesson. Ask students if their thoughts changed on the erosion protection.

Ask students: What causes erosion? What are examples of different shorelines? Which shoreline offered the most protection from erosion? Which shoreline offered the most habitat to animals?

STUDENT PAGE | Reading – Living with Living Shorelines

Salt marshes are coastal wetlands common throughout the globe and visible just about any time you drive over a bridge along the coast. Found in estuaries, where rivers meet the ocean, these wetlands stabilize the shoreline, act like kidneys to filter nutrient pollution, and offer food and shelter for birds and fish. Black needlerush is one of the dominant species of grass-like perennial foliage native to the Gulf and Atlantic coasts. It grows moderately fast, forming a deep, fibrous root system and dense above-ground canopy that provide habitat for waterfowl, muskrats, nongame birds, and organisms that are the base of the food chain for fish, shrimp, crabs and other commercially important seafood. The hardy root system essentially grabs and holds sediment in place, which, in turn, slows down shoreline erosion.

Salt marshes are rapidly disappearing as people build hard structures, such as seawalls and bulkheads, to help lessen erosion. Human development in these wetlands all over the world is causing large losses of marshland, but the most dramatic losses in the United States are happening in the northern Gulf of Mexico, which includes Mississippi, Texas, Louisiana, Alabama, and Florida. Natural shorelines are much better at providing a long-term solution for lessening coastal erosion. Sea walls and other hard structures deteriorate from exposure to saltwater, and many must be replaced every 10 to 30 years.

Restoring natural shorelines on private property can help reduce erosion, support healthy coastal ecosystems, and boost local economies. In fact, scientists have conservatively estimated that coastal marshes provide more than $20 billion worth of shoreline stabilization and storm protection services in the United States alone. The majority of our shoreline is small, privately owned tracts of property.

Resent research explored the most economical and effective method of salt marsh restoration for small-scale projects. Restoring natural shorelines on private property can help reduce erosion, support healthy coastal ecosystems, and boost local economies.

In the study, scientists from Mississippi State University, the University of South Alabama, Dauphin Island Sea Lab, the University of Connecticut, The Nature Conservancy, and the Grand Bay National Estuarine Research Reserve planted black needlerush in two different designs at the Grand Bay National Estuarine

Black needlerush lines many Mississippi and Alabama coastal areas and protects them from erosion. Extensive root systems protect bayou and bay shorelines from low to moderate wave energy. (Photo by MSU Extension Service/Eric Sparks)

Research Reserve in Moss Point, Mississippi. They harvested the marsh plants from a nearby marsh and used this donor area as a control site for comparison. Transplants were planted in one design area at 100 percent coverage. The second design area was planted at 50 percent coverage, which was less costly and labor-intensive. After two years, both design areas performed similarly. The area planted at 50 percent coverage was the most efficient as it performed just as well as the area planted at 100 percent but cost less to install.

The techniques used in living shorelines are extremely site specific, but an essential aspect of the construction is a nearshore breakwater to help reduce wave energy before it hits the marsh. Depending on the site, these breakwaters can be made of temporary materials, such as biodegradable coir logs or short, board fences, or longer-term materials, such as loose stone, concrete structures, or oyster shell cages. Temporary breakwaters are intended to persist long enough for plants to get established or rerooted. In higher wave energy environments, the more permanent breakwaters may be needed for sustained shoreline protection in conjunction with the shoreward salt marsh.

Reading adapted from publications by Dr. Eric Sparks: Salt marsh plants offer valuable shoreline service, Sparks EL. 2018. Research helps landowners reduce erosion and support ecosystems. Sparks EL, Cebrian J. 2016. Salt marsh plants offer valuable shoreline service, Sparks EL. 2018.

Shoreline #1: _____

Draw a picture of what the shoreline looks like before any wave action:

Write your hypothesis for what you think will happen when waves come up to this shoreline?

Place a piece of tape on the outside of the container where the sand stops.

One student per group will make 20 waves in the water using the paint scraper.

Marks where the sand stops with another piece of tape.

Use a ruler to measure how far the sand traveled from the first piece of tape to the last piece of tape. How many millimeters did the shoreline move back from the start of the experiment to the end? _____

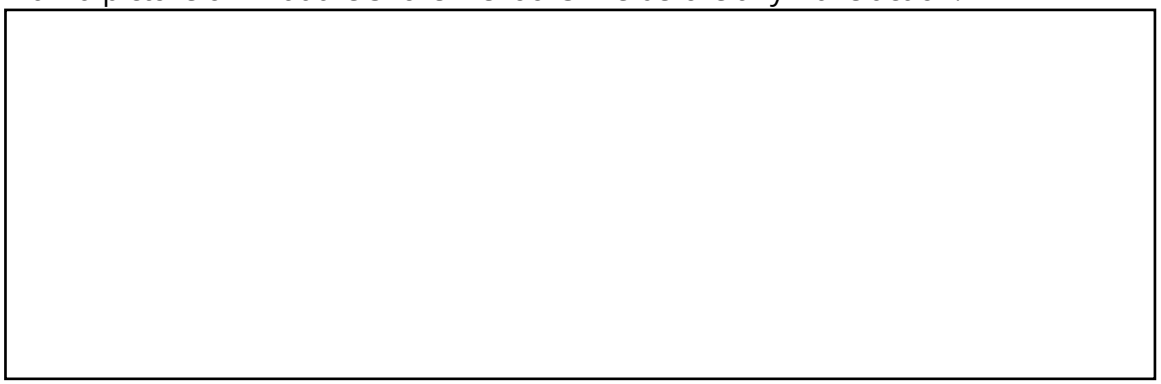
Draw a picture of what the shoreline looks like after all 20 waves:

Before you rotate to the next station, repair the shoreline back to the original condition and remove the tape.

Was your hypothesis supported by the data? Explain.

Shoreline #2: _____

Draw a picture of what the shoreline looks like before any wave action:



Write your hypothesis for what you think will happen when waves come up to this shoreline?

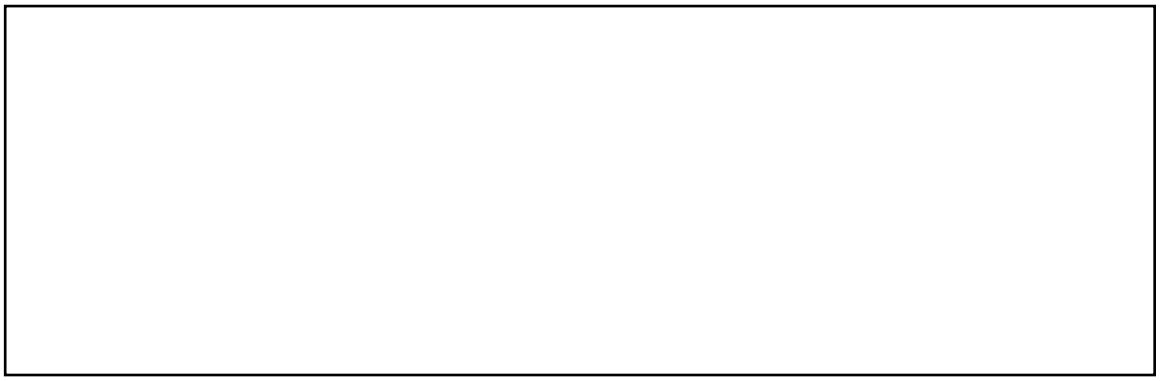
Place a piece of tape on the outside of the container where the sand stops.

One student per group will make 20 waves in the water using the paint scraper.

Marks where the sand stops with another piece of tape.

Use a ruler to measure how far the sand traveled from the first piece of tape to the last piece of tape. How many millimeters did the shoreline move back from the start of the experiment to the end? _____

Draw a picture of what the shoreline looks like after all 20 waves:



Before you rotate to the next station, repair the shoreline back to the original condition and remove the tape.

Was your hypothesis supported by the data? Explain.

Shoreline #3: _____

Draw a picture of what the shoreline looks like before any wave action:

Write your hypothesis for what you think will happen when waves come up to this shoreline?

Place a piece of tape on the outside of the container where the sand stops.

One student per group will make 20 waves in the water using the paint scraper.

Marks where the sand stops with another piece of tape.

Use a ruler to measure how far the sand traveled from the first piece of tape to the last piece of tape. How many millimeters did the shoreline move back from the start of the experiment to the end? _____

Draw a picture of what the shoreline looks like after all 20 waves:

Before you rotate to the next station, repair the shoreline back to the original condition and remove the tape.

Was your hypothesis supported by the data? Explain.

Shoreline #4: _____

Draw a picture of what the shoreline looks like before any wave action:

Write your hypothesis for what you think will happen when waves come up to this shoreline?

Place a piece of tape on the outside of the container where the sand stops.

One student per group will make 20 waves in the water using the paint scraper.

Marks where the sand stops with another piece of tape.

Use a ruler to measure how far the sand traveled from the first piece of tape to the last piece of tape. How many millimeters did the shoreline move back from the start of the experiment to the end? _____

Draw a picture of what the shoreline looks like after all 20 waves:

Before you rotate to the next station, repair the shoreline back to the original condition and remove the tape.

Was your hypothesis supported by the data? Explain.

STUDENT PAGE | Living with Living Shorelines

DO NOW:

Describe the following terms:

Landward Migration

Vertical Accretion

EXIT TICKET:

What characteristics make a shoreline more resilient to wave action?