Archaeo-Tech: The Barrier Island

Cultural Resources Education

Created by Jacob Hamill, SCDNR Heritage Trust Public Information Coordinator (2019). Adapted from "Coastal Erosion Activity Poster" by USGS and "Shoreline Science: Exploring the Erosive Energy of Waves" from Scientific American (originally from Science Buddies).

Grade Levels
3rd – 8th, High School Earth Science

Estimated Time
1 – 1 ½ hours

Goal
After watching the *Archaeo-Tech: The Barrier Island* short film, students will model coastal erosion and observe the problems coastal erosion poses to archaeological sites with an in-class activity. Afterwards, students will learn how coastal erosion impacts South Carolina, specifically how coastal erosion impacts South Carolina's cultural resources.

Objectives
After viewing the *Archaeo-Tech: The Barrier Island* short film and completing the activity, students will be able to:

1. *Locate* and *name* South Carolina's barrier islands on a map.
2. *Give examples* of the barrier islands' unique geological and ecological features.
3. *Identify* different groups of people and cultures that have occupied South Carolina's barrier islands over the course of human history and *recognize* the importance of these groups in the history of South Carolina.
4. *Observe* the effects of coastal erosion on a shoreline.
5. *Identify* changes in a shoreline from continuous wave activity.
6. *Discuss* the impact of coastal erosion on South Carolina's cultural resources.
7. *Model* the erosion of a shoreline and *observe* how erosion damages archaeological sites.
8. *Explain* why rising sea levels and coastal storms accelerate coastal erosion.
9. *Construct* and *test* different engineering solutions to coastal erosion and *discuss* the effectiveness of such solutions.
10. *Relate* the erosion of the model shoreline and model archaeological site to the erosion and loss of real beaches and archaeological sites in South Carolina, like Pockoy Island and Edingsville Beach.

South Carolina Academic Standards
Science
5.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

5.E.3 The student will demonstrate an understanding of how natural processes and human activities affect the features of Earth's landforms and oceans.

- **5.E.3B.1** Analyze and interpret data to describe and predict how natural processes (such as weathering, erosion, deposition, earthquakes, tsunamis, hurricanes, or storms) affect Earth's surface.
- **5.E.3B.2** Develop and use models to explain the effect of the movement of ocean water (including waves, currents, and tides) on the ocean shore zone (including beaches, barrier islands, estuaries, and inlets).
- **5.E.3B.3** Construct scientific arguments to support claims that human activities (such as conservation efforts or pollution) affect the land and oceans of Earth.
- **5.E.3B.4** Define problems caused by natural processes or human activities and test possible solutions to reduce the impact on landforms and the ocean shore zone.

8.S.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

8.E.5 The student will demonstrate an understanding of the processes that alter the structure of Earth and provide resources for life on the planet.

- **8.E.5A.1** Develop and use models to explain how the processes of weathering, erosion, and deposition change surface features in the environment.

H.E.1 The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

H.E.3 The student will demonstrate an understanding of the internal and external dynamics of Earth's geosphere.

- **H.E.3B.3** Analyze and interpret data to explain how natural hazards and other geologic events have shaped the course of human history.
- **H.E.3B.4** Obtain and evaluate available data on a current controversy regarding human activities which may affect frequency, intensity, or consequences of natural hazards.
- **H.E.3B.5** Define problems caused by the impacts of locally significant natural hazards and design possible devices or solutions to reduce the impacts of such natural hazards on human activities.

H.E.6 The student will demonstrate an understanding of Earth's freshwater and ocean systems.

- **H.E.6A.8** Develop and use models to describe how waves and currents interact with the ocean shore.
- **H.E.6A.9** Ask questions about the designs of devices used to control and prevent coastal erosion and flooding and evaluate the designs in terms of the advantages and disadvantages required for solving the problems.

Social Studies

3-1.1 Categorize the six landform regions of South Carolina – the Blue Ridge, the Piedmont, the Sand Hills, the Inner Coastal Plain, the Outer Coastal Plain, and the Coastal Zone – according to their climate, physical features, and natural resources.

3-1.2 Describe the location and characteristics of significant features of South Carolina, including landforms; river systems such as the Pee Dee River Basin, the Santee River Basin, the Edisto River Basin, and the Savannah River Basin; major cities; and climate regions.

3-2.1 Compare the culture, governance, and physical environment of the major Native American tribal groups of South Carolina, including the Cherokee, Catawba, and Yemassee.

3-2.2 Summarize the motives, activities, and accomplishments of the exploration of South Carolina by the Spanish, French, and English.

8-1.1 Summarize the collective and individual aspects of the Native American culture of the Eastern Woodlands tribal group, including the Catawba, Cherokee, and Yemassee.

8-1.2 Compare the motives, activities, and accomplishments of the exploration of South Carolina and North America by the Spanish, French, and English.

Activity Type: In-Class / Out-of-Class

This is intended as an in-class activity. The teacher will provide the required materials.

Materials

- Heritage at Risk Activity Handout (one per student)
- Lab Equipment:
    - Paint-Roller Trays, Clear Plastic Tubs can also work (one for each group)
    - Dry measuring cup (to measure sand)
    - Liquid measuring cup (to measure water)
    - Sand (approximately five cups of sand for every group)
    - Water (approximately six cups of water for every group)
    - Stopwatch / Timer (one for each group)
    - Paint Sir Stick for creating waves (one for each group)
    - Ruler (one for each group)
    - Small Rocks, about 1 -2 cm in diameter (two to four for each group)
    - Wooden dowel rod, approximately 1 cm in diameter and 10 cm in length (one for each group)
    - LEGO® pieces, small blocks, or other props to mimic an archaeological site.
    - Model trees, bushes, etc. can be used to delineate between the beach and maritime forest (optional)
    - Goggles and aprons (optional)

Pockoy Background Information

- **Pockoy Island** is a remote South Carolina barrier island, part of the Department of Natural Resource's Botany Bay Heritage Preserve / Wildlife Management Area. The property is located on the northeast corner of Edisto Island in Charleston County.
- Botany Bay is one of the largest relatively undeveloped wetland ecosystems on the Atlantic Coast, providing a critical habitat for a number of wildlife species.
- The **cultural resources** of Botany Bay are equally important, with **sites** dating from approximately 4,000 years ago to the nineteenth century. Several sites are listed on the National Register of Historic Places, including the outbuildings from Bleak Hall Plantation, granite markers from the 1850 Alexander Bache U.S. Coast Survey, and the Fig Island Shell Rings.
- The shell ring on Pockoy Island was first identified in early 2017 by analysts studying Hurricane Matthew's effect on South Carolina's coastline. When studying maps produced by aerial light detection and ranging, or **LiDAR**, the analysts noticed strange circular features on the coast of Pockoy Island, indicating the presence of a shell ring. **Shovel testing** began in the summer of 2017, which confirmed the ring's existence. **Radiocarbon dating** conducted on recovered animal bone revealed that the site was approximately 4,300 years old, making it the oldest known shell ring in South Carolina.
- Testing continued in late 2017, with large scale **excavations** taking place in May and December of 2018.
- **Shell rings** are mysterious structures found along the coasts of South Carolina, Georgia, Florida, and Mississippi. These sites date to the **Late Archaic** period (roughly 5,000 – to 3,000 years ago) and are the earliest significant examples of people living on the southeastern U.S. coast. Dates suggests that the shell ring on Pockoy Island was built over a relatively short period of time, around 20 – 30 years.
- As the name indicates, shell rings are large circular or semi-circular structures made from piled shell. Some are C-shaped and U-shaped, while others are irregularly shaped or made up of multiple shapes. Pockoy is doughnut-shaped. Shell rings are primarily composed of oyster shell, but cockles, periwinkles, clams, and whelk shells are also commonly found. They range in size from 30 to 250 meters and are between 1 and 6 meters high. Pockoy's shell ring is approximately 60 meters in diameter.
- Another key feature of a shell ring is a central area called a **plaza**, which is devoid of shell. **Archaeologists** speculate that this area was maintained for ceremonial purposes or contained some sort of structure.
- Archaeologists have been studying shell rings for decades but there is still a lot we do not know.
- Archaeologists are unsure if shell rings were intentionally built or not. Some argue that shell rings were inadvertently created from piles of discarded shell following meals over a long period of time. Others believe shell rings were planned structures built from leftover shells of feasts and other quarried shell.

- Archaeologists are also unsure what shell rings were used for. Some believe shell rings were sites of general human occupation, while others theorize shell rings were ceremonial structures only used for specific purposes at specific times.
- Archaeologists have recovered thousands of **artifacts** from Pockoy and other shell rings. The most common artifacts are pottery, shell, and animal bone.
    - The pottery found at Pockoy belongs to the earliest types of ceramics found in South Carolina. Many of the **potsherds** found at Pockoy are decorated with punctations, incised lines, or stamped designs. The people who created this pottery used shells, reeds, and other natural materials to produce these effects.
    - Shells were not only used to build the ring, they were also used as tools and for decoration. The ancient inhabitants of Pockoy modified **whelks** and other shells to create hammers, awls, **adzes**, hoes, and other tools necessary for everyday life. They also turned shells into jewelry by shaping them into beads.
    - Animal bone is normally not well preserved because of the acidity of South Carolina’s soil. However, bone is plentiful at Pockoy because the calcium from the shell raises the soil’s pH level, preserving the bone. Worked bone is frequently found and at Pockoy archaeologists have recovered numerous finely decorated bone pins.
- What archaeologists do not find at a site can also tell them a lot about the people that lived there. Very little stone has been found at Pockoy, telling archaeologists that the people that once lived there did not rely on stone tools. Some archaeologists interpret this as evidence that the shell ring was not a site of human occupation, but others propose that this is reflective on the environment – good stone is hard to find on the coast so the people living there adapted by making their tools out of shell and bone.
- Due to Pockoy’s location along the coast, the site is vulnerable to coastal erosion and rising sea levels. With a rate of 9.5 meters of coastline lost per year, Pockoy is expected to be completely engulfed by the ocean by 2024.
- Climate change, or “heritage at risk”, poses a serious challenge to archaeologists, and Pockoy is not the only site facing destruction. According to a report by DINAA (The Digital Index of North American Archaeology), a one-meter rise in sea level would result in the loss of 13,583 archaeological sites across the Southeastern United States. It is imperative to salvage, protect, and study these vulnerable sites before they are gone.

Coastal Erosion Background Information

- **Coastal erosion** happens when storms, rising sea levels, flooding, and human activities wear away beaches and bluffs along the coastline.
- Coastal erosion is a natural process and not always a bad thing. Beach sand is frequently moved onshore and offshore by waves, tides, and currents. However,

human activities, such as dredging, river modification, removal of vegetation, and construction can significantly impact the coastline.

- Scientists and engineers have several solutions to protect beaches from excessive erosion:
    - **Groins**, usually made of timber, rock or concrete, are built perpendicular to a beach and jut into the water to trap sand. However, by trapping sand from incoming waves, groins will starve beaches further down the coast of sand.
    - **Seawalls** are another solution to fighting coastal erosion. Seawalls, typically constructed of timber, rock, steel, or concrete, are placed at the back of the beach. While seawalls protect the land behind them, they can accelerate the erosion of the land in front of them. Waves hitting a seawall spread sand from the beach back into the water, over time making the beach lower and flatter until it eventually disappears.
    - **Breakwaters** are barriers built offshore to protect a part of the shoreline. Breakwaters act as a barrier to waves by dissipating energy carried by longshore currents. The material carried by the currents is deposited behind the breakwater, building the shore in the process. However, like groins, the part of the beach protected by the breakwater grows at the expense of the shoreline not protected by the breakwater.
- Artificial beach nourishment is another method used to slow beach erosion. Sand is deposited from other sources to replenish the sand lost by an eroding beach. Experts must consider the coarseness of beach sand when replenishing a beach. If the new sand is finer than the original beach sand, the new sand will be quickly picked up and lost by the waves.

Vocabulary

- **Archaeological Site:** A place where human activity occurred and material remains were deposited.
- **Archaeologist:** An Anthropologist (social scientist) who studies the material remains of past human activity.
- **Archaeology:** The scientific study of past human cultures by analyzing the material remains (sites and artifacts) that people left behind.
- **Artifact:** Any object made, modified, or used by people.
- **Barrier Island:** An island off the coast that protects the mainland.
- **Breakwaters:** Barriers built offshore to protect a section of the coastline from waves by dissipating energy carried by longshore currents.
- **Coastal Erosion:** The degradation of beaches and bluffs from storms, rising sea levels, flooding, and human activity.
- **Cultural Resources:** Evidence of past human activity. They include archaeological sites, historic homes, battlefields, burial grounds, shipwrecks, historic and prehistoric artifacts.
- **Excavations:** The systematic digging and recording of an archaeological site.

- **Groins:** Structures made of timber, rock, or concrete built perpendicular to the shoreline and designed to trap sand from incoming waves.
- **Late Archaic:** A period of North American prehistory ranging from 5,000 to 3,000 years ago.
- **Seawall:** A barrier constructed of timber, rock, steel, or concrete designed to protect the land behind it from coastal erosion.
- **Shell Ring:** Large circular or semi-circular structures made from piled shell. In the southeastern United States, these structures date to the Late Archaic period (5,000 – 3,000 years ago) and are found along the coasts of South Carolina, Georgia, Florida, and Mississippi.

Lesson

1. Prepare the required materials for the activity before beginning the lesson.
    - o Construct the model beaches by adding sand and water to the paint trays.
        - Thoroughly wet the sand before adding to the tray.
        - Cover the shallow end of the paint tray with sand (about five cups).
        - Fill the deep end of the paint tray with water (about six cups).
        - Give the sand and water time to settle before starting the activity (at least five minutes).
    - o Give each group a paint stir stick (to make waves with), a stopwatch, a dowel rod about 1 cm in diameter, a few small rocks, and small props to decorate the beach with (like wooden blocks, LEGO® pieces, etc.).
2. Begin the lesson by showing the class a map of South Carolina. Ask your students to identify barrier islands on South Carolina's coast. Discuss the geography of barrier islands.
    - o Take this moment to ask your students to think about the people that once lived on South Carolina's barrier islands. Encourage them to consider how these past people lived. What did they build and what did they leave behind? You can talk about the Native Americans that lived on the barrier islands before European colonization, early European settlements, antebellum rice and cotton plantations, etc.
    - o For a lesson on the ecology of salt marshes, see the Fort Lamar: Salt Marsh Ecosystem lesson plan at http://heritagetrust.dnr.sc.gov/education.html
3. Show your class the *Archaeo-Tech: The Barrier Island* short film.
4. Discuss coastal erosion as a threat to cultural resources. Ask your students if they have observed coastal erosion in action. If you live near the coast, have your students think of examples of coastal erosion in their area.
5. Tell your students that they will be modelling coastal erosion and its effect on cultural resources in a lab activity.
6. Distribute the handout for the activity and divide your class into small groups. Each group should have a minimum of three students.
7. Give an overview of the lab activity. Students can follow along in their worksheets.

- Have the students decorate their beaches with LEGO® pieces, blocks, etc. Tell them that these props represent an archaeological site. Students can interpret their sites any way they want. It could represent an ancient Native American shell ring, a European colonial fort, or a 19th century African American fishing community. Students can place the props directly on top of the sand or they can bury them partially or completely in the sand.
- Have your students draw a picture of their beach, including the archaeological site, on their worksheet from a top-down perspective. Students should take note of the shape of the beach and shoreline.
- Have students measure the distance from the edge of the paint tray to the shoreline. Students will use these measurements to study the rate of erosion.
- Using a paint stir stick (or a plastic ruler), have the students create a steady series of gentle waves for two minutes. To make waves, have your students hold the stick horizontally and use a short, sharp hand motion to push the wave at an angle towards the beach.
- After two minutes, have your students note and discuss the changes in their shorelines. Was the archaeological site disturbed? Did any pieces wash into the ocean? Have your students draw another picture of their beach from the same perspective for comparison.
- Using the paint stick, have the students simulate the effect of heavy storms on the coast by making stronger waves for 30 seconds. Afterwards, have the students make the same observations as before. What does the shoreline look like now? Was the archaeological site disturbed? How much of the original site remains intact? Have students draw a third picture of their beach for comparison.
- Explore different engineering solutions to coastal erosion. Using the wooden dowel rod and rocks, students can either make a groin, a seawall, or a breakwater to protect their shoreline from erosion. Have students test their solution by creating gentle waves for two minutes. Then stronger waves for 30 seconds. How did these structures effect the shoreline? Were they effective in reducing erosion? What are some of the drawbacks to these engineering solutions? Why might it be difficult to implement these engineering solutions in a real-world scenario?
- Ask students to consider how raising the water level would impact coastal erosion. Discuss that while coastal erosion is a natural process, rising sea-levels and increased coastal storms have accelerated the rate of erosion.
- Finish the activity by asking your students to consider coastal erosion’s impact on archaeology. What do we lose when cultural resources are washed away by the ocean?

8. Read and / or discuss the articles on Pockoy and Edingsville. Edingsville was a community on Edisto Island that was lost due to coastal erosion and powerful hurricanes in the 1890s.
    - Pockoy Article: http://www.scseagrant.org/Content/?cid=1044

- Edingsville Article: http://www.artsandsciences.sc.edu/sciaa/mrd/node/539

References

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⚠ Heritage at Risk ⚠
Activity Worksheet


Pockoy Island King Tide May 2018. Photo coutesy of Jamie Koelker, Koelker & Associates.

Introduction
South Carolina has around 35 **barrier islands**, which are the state's most seaward landforms. These islands are important for several reasons. Barrier islands shield inland sea islands and the mainland from damage caused by **coastal storms** and **erosion**. These are dynamic and fragile environments, yet despite their vulnerability, barrier islands provide a critical habitat for many plants and animals. Barrier islands also have an extensive human history and have been occupied by humans for thousands of years. From ancient Native Americans, to the earliest European settlements, to the modern-day Gullah culture, South Carolina's barrier islands are home to a staggering amount of **cultural resources**.

But, rising sea levels, increased coastal storms, and accelerating coastal erosion is threatening these cultural resources. **Pockoy Island** (pronounced Pock-ee) is a small barrier island off the coast of Edisto Island and is the site of the oldest known **shell ring** in South Carolina. This structure was built by Native Americans during the Late Archaic period 4,300 years ago, making it as old as the pyramids in Egypt.

Instructions
In this activity, you will be creating a beach and an archaeological site to model coastal erosion and monitor how erosion can threaten and destroy cultural resources. Then, you will test different engineering solutions to reduce the damage done by coastal erosion.

For this activity, your group will need a timer / stopwatch, a paint stir stick, a dowel rode, a few small rocks, a ruler, and props (like blocks or LEGO® pieces) to create your archaeological site.

Step One

Create your archaeological site. Decorate the beach with the props your teacher provided. You can place the objects on top of the sand, or you can partially or completely bury them in the sand. Create an interpretation for your site. Is it a Native American shell ring like Pockoy? Or a Spanish colonial fort like Santa Elena? Is it a fishing village from the 19th century? Draw a map of your beach and archaeological site in the space below using a top-down view. Measure the distance from the edge of the paint tray to the shoreline. Take multiple measurements to find the average distance.

Step Two

Using your paint stir stick, create a steady series of waves for two minutes. To make waves, hold the stick horizontally and use a short, sharp hand motion to push the wave at an angle towards the beach.

After two minutes, observe the changes in the shoreline. Was the archaeological site damaged in any way? Did any structures or parts of the site wash into the ocean? Draw a second map of the beach using the same perspective from Step One in the space below. Measure the distance from the edge of the paint tray to the shoreline again. Take multiple measurements to find the average distance. Compare this result to the measurement taken in Step One. How much beach was lost from Step One to Step Two?

Step Three

This time you will model the effect of heavy storms on the coast by making stronger waves for 30 seconds. Make the same observations you did in Step Two. Draw a third map of the beach and archaeological site using the same perspective from Step One and Two. Take measurements of the beach again and find the average. Compare the result to the results from Step One and Two. Did the stronger storm waves erode more coastline than the gentle waves from Step Two?

Step Four

Using the dowel rod and small rocks, brainstorm ways to protect the beach and archaeological site from erosion. You can create a groin, a seawall, a breakwater, or any other solution you can think of. Create steady waves for two minutes, like the waves you created in Step Two. Observe any changes in the shoreline and any effects on the archaeological site. Then, create strong waves for 30 seconds, like the waves you created in Step Three. Observe any changes in the shoreline and the state of the archaeological site. Answer the following questions.

How did the structure effect the shoreline?

Was it effective in reducing the rate of erosion?

What are some of the drawbacks to the engineering solution you came up with?

Did your solution impact the archaeological site?

Why might it be difficult to implement these engineering solutions in a real-world situation?