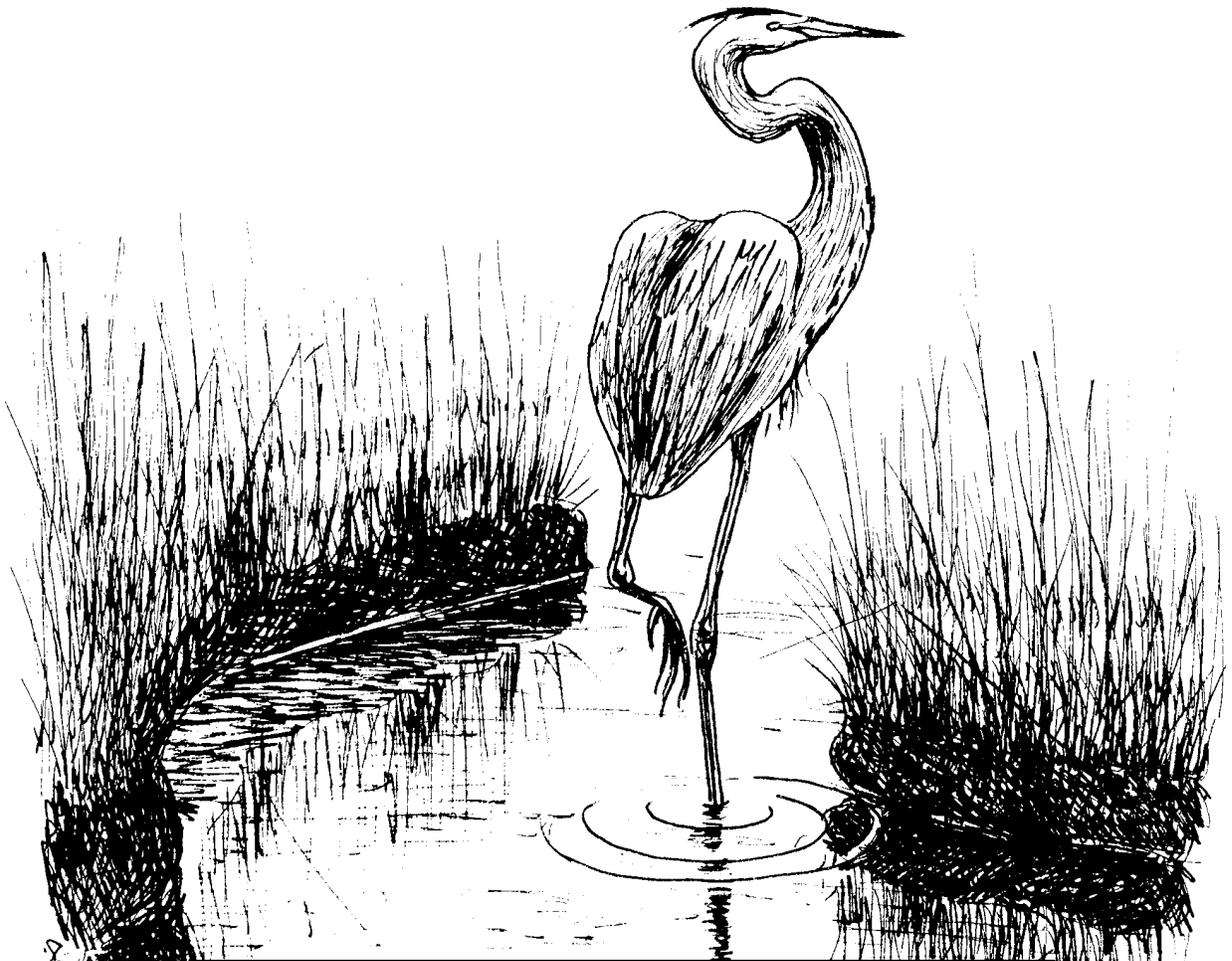
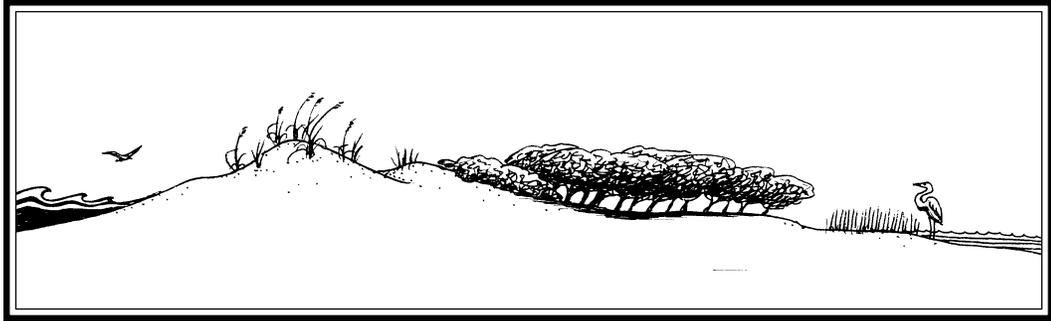
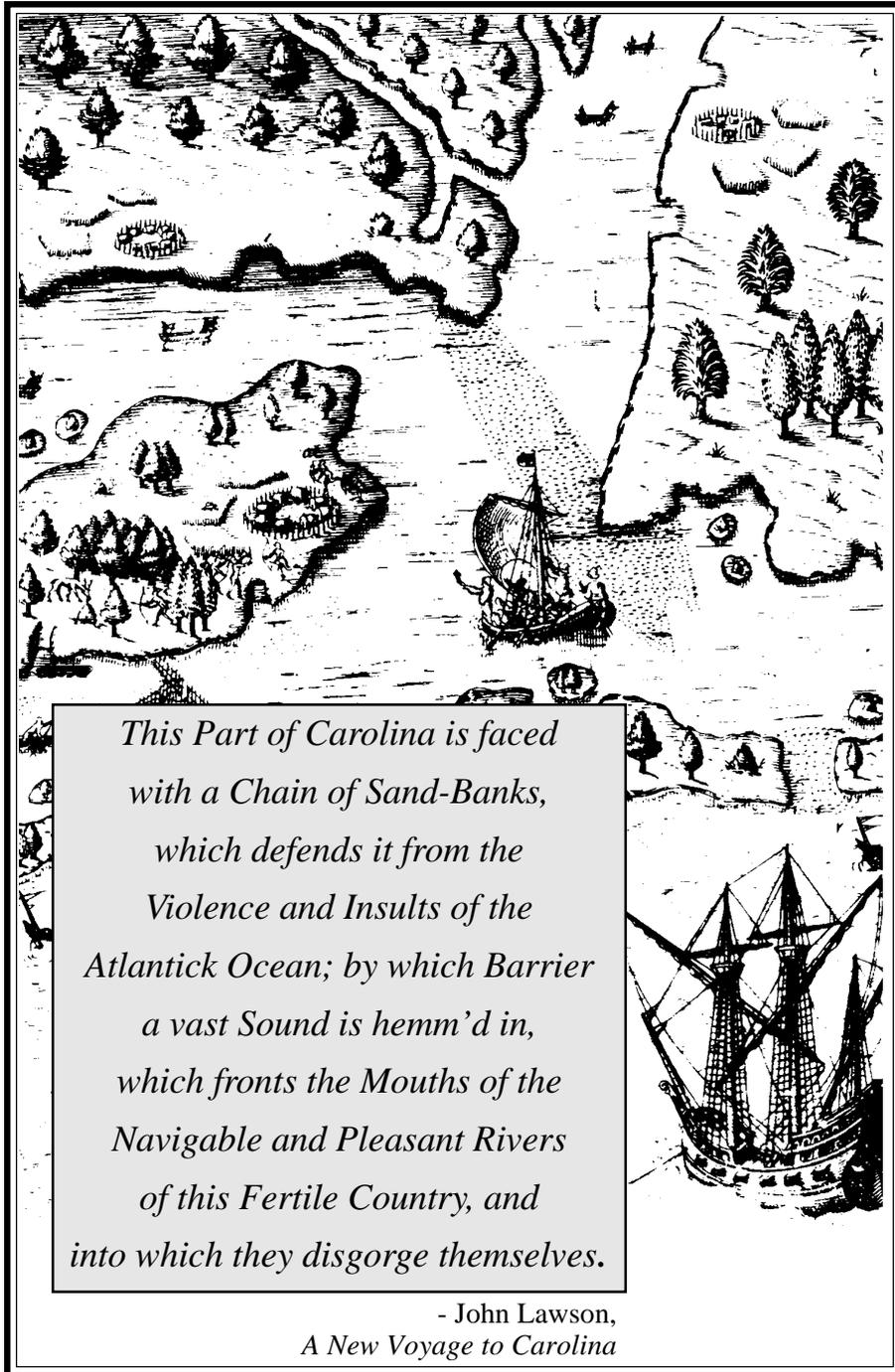


# BARRIER BEGINNINGS



**Fort Macon State Park**  
**An Environmental Education Learning Experience**  
Designed for Grades 7-9



*This Part of Carolina is faced  
with a Chain of Sand-Banks,  
which defends it from the  
Violence and Insults of the  
Atlantick Ocean; by which Barrier  
a vast Sound is hemm'd in,  
which fronts the Mouths of the  
Navigable and Pleasant Rivers  
of this Fertile Country, and  
into which they disgorge themselves.*

- John Lawson,  
*A New Voyage to Carolina*

Funding for this publication was generously provided by

**CP&L**

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was developed by

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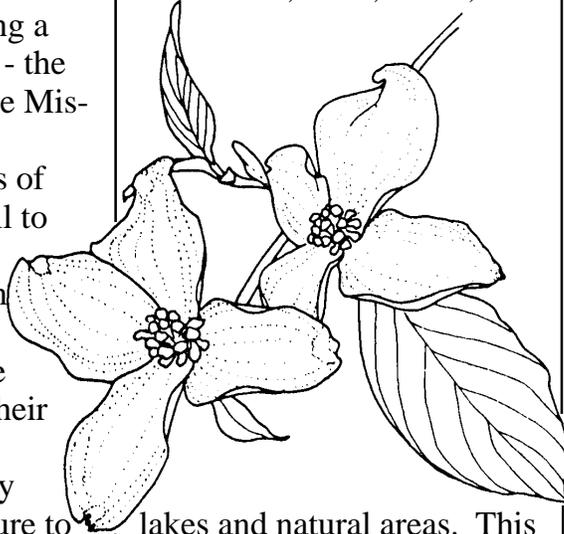
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# Introduction to the North Carolina State Parks System

Preserving and protecting North Carolina's natural resources is actually a relatively new idea. The seeds of the conservation movement were planted early in the 20th century when citizens were alerted to the devastation of Mount Mitchell. Logging was destroying a well-known landmark - the highest peak east of the Mississippi. As the magnificent forests of this mile-high peak fell to the lumbermen's axe, alarmed citizens began to voice their objections. Governor Locke Craig joined them in their efforts to save Mount Mitchell. Together they convinced the legislature to pass a bill establishing Mount Mitchell as the first state park of North Carolina. That was in 1915.

The North Carolina State Parks System has now been established for more than three quarters of a century. What started out as one small plot of public land has grown into 61 properties across the state, including parks, recreation areas, trails, rivers,



lakes and natural areas. This vast network of land boasts some of the most beautiful scenery in the world and offers endless recreation opportunities. But our state parks system offers much more than scenery and recreation. Our lands and waters contain unique and valuable archaeological, geological and biological resources that are important parts of our natural heritage.

As one of North Carolina's principal conservation agencies, the Division of Parks and Recreation is responsible for the more than 168,000 acres that make up our state parks system. The Division manages these resources for the safe enjoyment of the public and protects and preserves them as a part of the heritage we will pass on to generations to come.

An important component of our stewardship of these lands is education. Through our interpretation and environmental education services, the Division of Parks and Recreation strives to offer enlightening programs which lead to an understanding and appreciation of our natural resources. The goal of our environmental education program is to generate an awareness in all individuals which cultivates responsible stewardship of the earth.

**For more information contact:**

**N.C. Division of Parks  
and Recreation  
1615 Mail Service Center  
Raleigh, NC 27699-1615  
919/ 733-4181  
[www.ncsparks.net](http://www.ncsparks.net)**

# Introduction to Fort Macon State Park

Fort Macon State Park is located on the eastern end of Bogue Banks—a barrier island on the coast of North Carolina. Just minutes away from Beaufort and Atlantic Beach, the park offers a close look at barrier island ecology as well as a glimpse into the area's historic past.

North Carolina's barrier islands have long provided ships safe haven from rough seas, offering easy access to the calmer waters of the sound. In the mid-1700's, Beaufort was one of the first harbors designated as a port of entry, a designation bringing it both notoriety and danger. The threat of attack by nations hostile to the colonies was

ever present. In 1747, the threat became a reality when Spanish raiders held the town for several days.

Plans were soon drawn up to build several forts along the eastern seaboard to guard against attacks. Ships entering Beaufort Inlet had to bypass the east end of Bogue Banks, and several forts were constructed there over time.

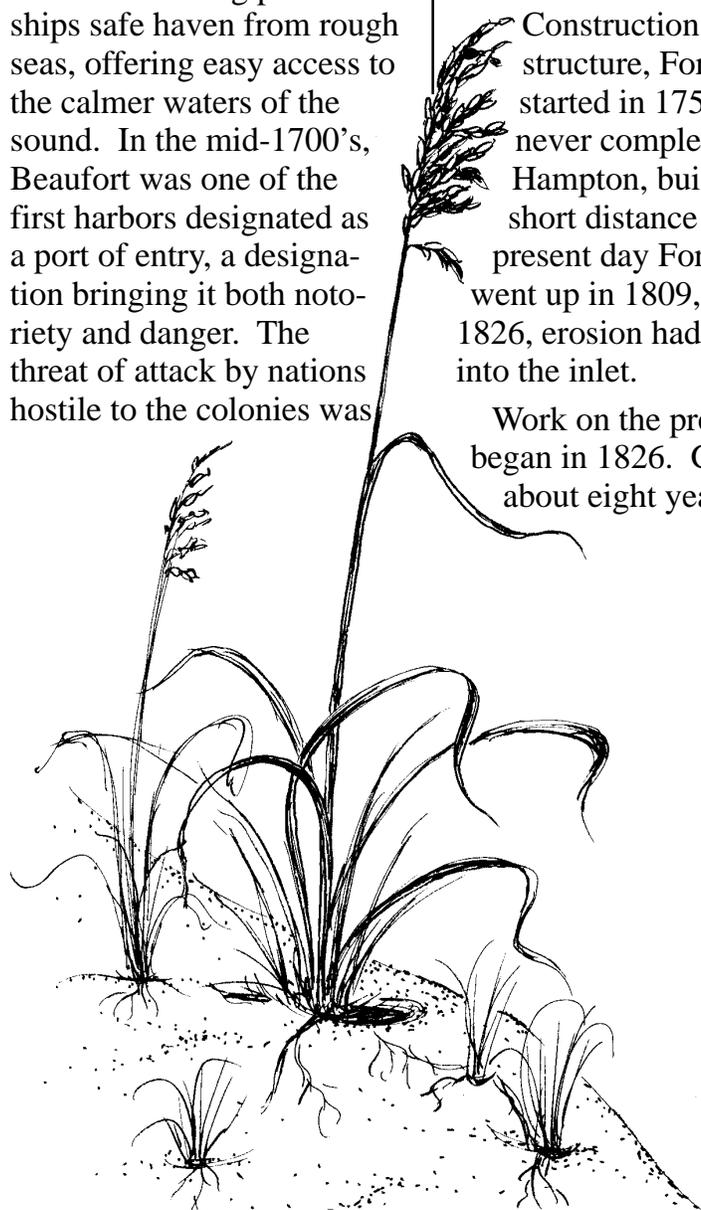
Construction of the first structure, Fort Dobbs, started in 1756 but was never completed. Fort Hampton, built just a short distance from the present day Fort Macon, went up in 1809, but by 1826, erosion had washed it into the inlet.

Work on the present fort began in 1826. Garrisoned about eight years later, the

fort was named for North Carolina Senator Nathaniel Macon, who procured the funds to construct the fort. When the Civil War broke out, the fort was seized by Confederate forces. In 1862, it was attacked and once again occupied by Union forces. Fort Macon served as a federal prison from 1866-1876, and was occupied by soldiers in 1898, during the Spanish-American War. The Fort was closed in 1903, and in 1924 became North Carolina's second state park. It was again occupied during World War II by the United States Army as a lookout for enemy submarines.

The barrier island environment of Fort Macon State Park offers a variety of natural resources for recreational and educational opportunities. Sandy beaches and sand dunes, shrub thickets and salt marsh each contain a variety of plant life. From sea oats found along the dunes to live oak and yaupon in the thickets, the diversity of plant communities creates a variety of habitats for animal life.

Whether touring Fort Macon or exploring the barrier island environment, the visitor may enjoy a varied experience at Fort Macon State Park.



## Program Options:

Environmental and historical education programs are available by reservation. Programs are designed for various age groups and include a variety of topics such as barrier island ecology, birds, sea life and history of Fort Macon. Interpretive programs on these and other topics may be adapted to meet special requests. Self-guided walks are also encouraged for groups visiting the park.

## Scheduling a Trip:

1. To make a reservation call the park office Monday-Friday, at least two weeks in advance.
2. Please complete the scheduling worksheet provided on page 8.1.

## Before the Trip:

1. Complete the pre-visit activity in the Environmental Education Learning Experience packet.
2. Visit the park, without the group, prior to your trip. This will give you a chance to familiarize yourself with the facilities and identify potential problems.
3. Discuss behavior expectations with leaders and participants. All park regulations apply and safety should be emphasized.
4. Insect repellent may be needed for mosquitoes. Poison ivy is abundant in certain areas of the park and should be avoided.

5. Cactus and sandspurs are abundant. Shoes which cover the foot should be worn while on hikes in the dunes or marsh.

6. *The group leader is responsible for obtaining a consent form for each participant; health considerations and medical needs should be noted.* A parental consent form is available on page 8.2.

7. Collection of plants, animals or minerals requires a Research Activity Permit. Contact the park office to obtain a permit application.

8. *If you are going to be late or have to cancel your trip, please notify the park as far ahead as possible.*

## While at the Park:

### Please obey the following rules:

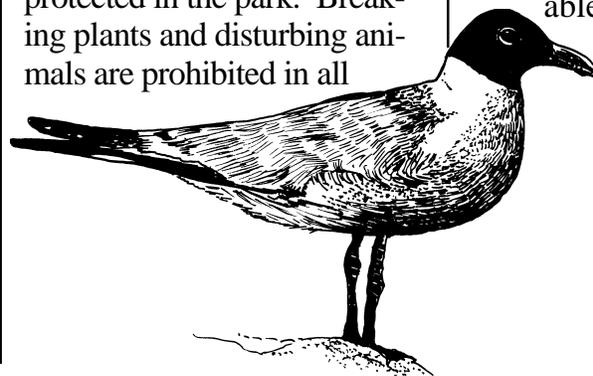
1. To get the most from your experience and increase the chance of seeing wildlife, be as quiet as possible.
2. When on hikes or touring the fort, stay behind the leader. Running is not permitted. Other groups may be in the fort, so please respect them by being as quiet as possible. No playing is permitted in the fort.
3. All plants and animals are protected in the park. Breaking plants and disturbing animals are prohibited in all

state parks. This allows others in the future to enjoy our natural resources.

4. Picnic only in designated areas. Please help keep the park clean by not littering.
5. Absolutely no swimming or wading is allowed in Beaufort Inlet.
6. In case of accident or emergency, contact park staff immediately.

## Following the Trip:

1. Complete the post-visit activity in the Environmental Education Learning Experience packet.
2. Build upon the field experiences and encourage participants to seek answers to questions and problems encountered in the park.
3. Relate the experience to classroom activities and curriculum through reports, projects, demonstrations, displays and presentations.
4. Give tests or evaluations, if appropriate, to determine if students have gained the desired information from the experience.
5. File a written evaluation of the experience with the park. Evaluation forms are available on page 8.3.



**Park Information:**

Fort Macon State Park  
P.O. Box 127  
Atlantic Beach, NC 28512  
Tel: (252) 726-3775  
Fax: (252) 726-2497

**Office Hours:**

8:00am - 1:00pm  
2:00pm - 5:00pm  
Monday - Friday

**Hours of Operation:**

**Bathhouse Gate**

Nov-Feb 8:00am - 5:30pm  
Mar,Oct 8:00am - 6:00pm  
Apr,May,Sep 8:00am - 8:00pm  
Jun,Jul,Aug 8:00am - 9:00pm

**Fort Gate**

Oct-Mar 8:00am - 6:00pm  
Apr,May,Sep 8:00am - 7:00pm  
Jun-Aug 8:00am - 8:00pm

**Fort Macon**

Year round 9am - 5:30pm

**Other Educational Opportunities in the Area:**

North Carolina Aquarium at  
Pine Knoll Shores  
P.O. Box 580  
Atlantic Beach, NC 28512  
Tel: (252) 247-4003

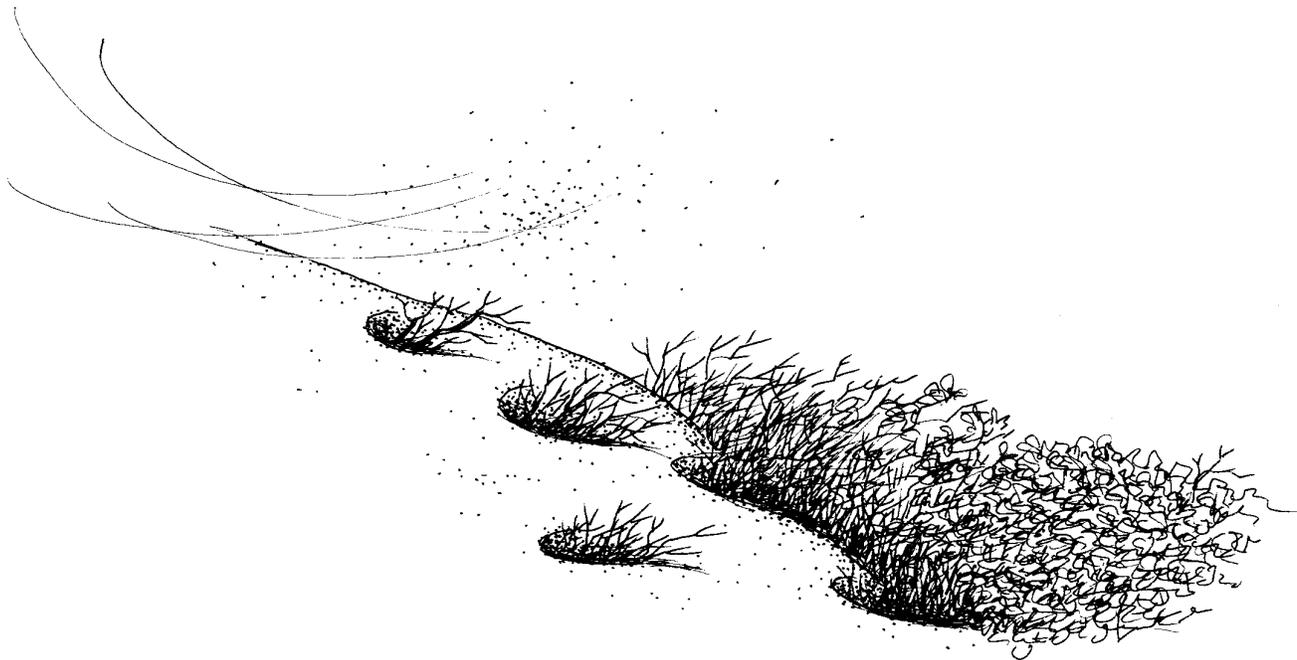
(Note: You should call in advance to have the admission fee waived.)

**North Carolina Maritime Museum**

315 Front Street  
Beaufort, NC 28516  
Tel: (252) 728-7317

**North Carolina Estuarine Research Reserve**

135 Duke Marine Lab Road  
Beaufort, NC 28516  
Tel: (252) 728-2170



# Introduction to the Activity Packet for Fort Macon State Park

The Environmental Education Learning Experience, *Barrier Beginnings*, was developed to provide hands-on environmental education activities for the classroom and the outdoor setting of Fort Macon State Park, instructing students about barrier islands. This activity packet, developed for grades 7 through 9, meets established curriculum objectives of the North Carolina Department of Public Instruction. Three types of activities are included:

- 1) Pre-visit activity
- 2) On-site activity
- 3) Post-visit activity

The on-site activity will be conducted at the park, while pre-visit and post-visit activi-

ties are designed for the classroom. The pre-visit activity should be introduced prior to the park visit so the students will have the necessary background and vocabulary for the on-site activity. We encourage you to use the post-visit activity to reinforce concepts, skills and vocabulary learned in the pre-visit and on-site activities. These activities may be performed independently or in a series to build upon the students' newly gained knowledge and experiences.

Fort Macon State Park provides an excellent area to study barrier islands because the beach, inlet and natural areas are easily reached.

The Environmental Education Learning Experience, *Barrier Beginnings*, will expose the student to the following major concepts:

- **Coastal geology**
- **Human impacts on the environment**
- **Geography**

The first occurrence of a vocabulary word used in these activities is indicated in **bold type**. Their definitions are listed in the back of the activity packet. A list of the reference materials used in developing the activities follows the vocabulary list.

This document was designed to be reproduced, in part or entirety, for use in North Carolina classrooms. If you wish to photocopy or adapt it for other uses, please credit the N.C. Division of Parks and Recreation.

**Note:** On-site activities may expose the students to hot, humid conditions, poison ivy, ticks, mosquitoes, cactus and sandspurs. Accessibility to some of the on-site activity areas may be difficult for persons with disabilities.



# Introduction to Barrier Island Geology

**Barrier islands** are coastal islands, separated from the mainland, that stretch for 2,700 miles in 18 states along the Atlantic Ocean to the Gulf of Mexico. These islands form on shorelines where the earth's crust is slowly sinking or the **sea level** is rising.

Sea level fluctuation has created and destroyed a number of different barrier island systems during the past 100,000 years. The Atlantic **coastal plain** is composed mainly of **sediments**. When the sea level was low, erosional forces deposited these sediments further east than the present coastline, forming the hills of the early coastal plain.

Around 19,000 years ago sea level was almost 330 feet below the present level. There were no barrier islands and the shoreline was located very near the edge of today's continental shelf, which is currently located 45 to 50 miles off-

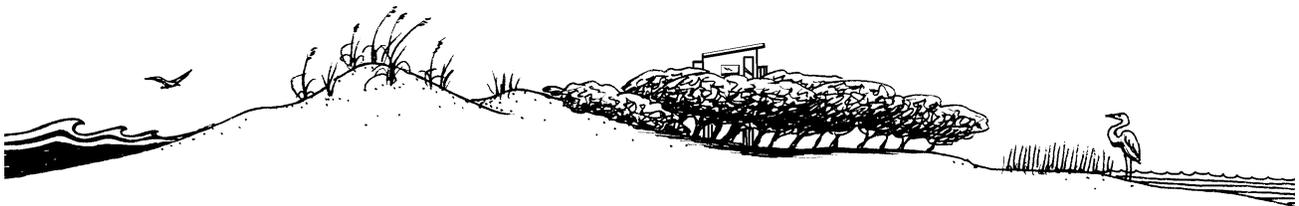
shore.

About 15,000 years ago the sea level began to slowly rise, flooding the coastal plain. Higher points of land were surrounded by the sea, resulting in today's barrier islands. Water surging around these islands, and **currents** sweeping along their lengths, formed the **beaches** and extended the islands in the direction of the currents. The resulting barrier islands were usually long and broken by **inlets**, which allowed water to move between the **sound** and the sea. Geologists believe this is how Bogue Banks was formed.

Other barrier islands, especially some of the small islands along the Gulf of Mexico, are believed to have formed differently. One theory maintains that **wave** action built up offshore sand into shoals which eventually became higher than the surrounding water. Another

theory suggests the islands built up from **sand** carried by currents, forming spits, narrow points of land that extend out into the water. Inlets then eventually cut the islands off from the forming spits.

**Winds**, currents and waves—especially from storms—move sand and sediment, causing the islands to **migrate** landward. When the sea level was changing rapidly, the rising water assisted in moving these islands. Where the mainland shoreline did not retreat as the islands moved, some of these islands collided with, and joined, the mainland. The landward movement of these islands slowed as the rise in sea level slowed. However, the sea level is again rising, which means these islands are beginning to move towards the mainland and will cause many changes in the appearance of



our coastal area.

Storms may cause waves to break through low spots in the dunes and move large quantities of sediments across to the sound side of the island. This **overwash** may be particularly great during **hurricanes** when large waves, accompanying the storm surge, may flatten tall dunes and even carve a new inlet through the island. When overwash happens repeatedly, over a long period of time, the island rolls over, causing its migration landward.

The beach, the most unstable area of the island, is constantly changing due to wind, waves and currents.

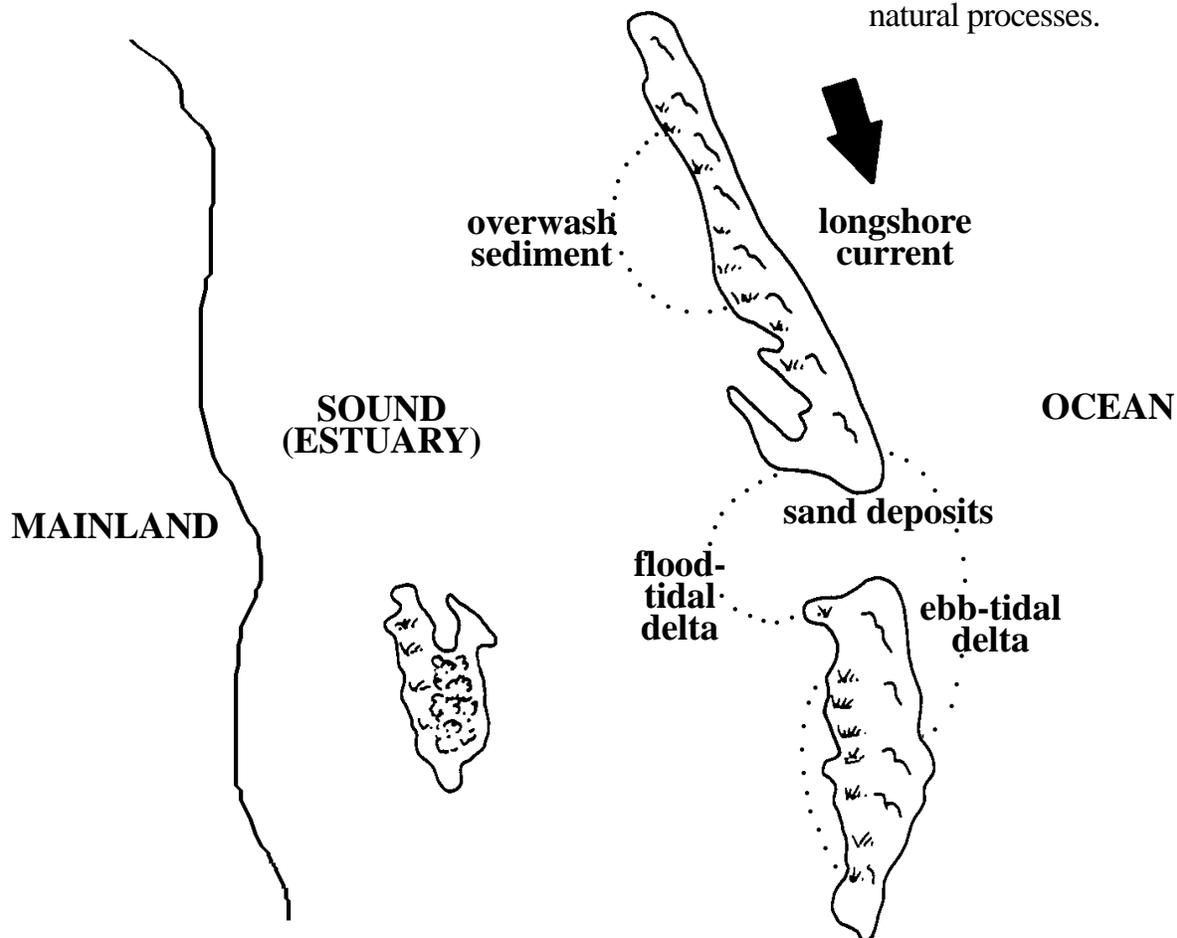
Waves, breaking on the beach **surf zone**, deposit sand and sediments or remove them, depending on their size and force. **Storm waves**, for example, tend to remove sediments and erode the beach. **Fair weather waves** tend to deposit sand and sediments and build up the beach.

Currents play an important role in the deposition and removal of sediments. Currents moving parallel to the shoreline, or **longshore currents**, may remove sediments from one area of the beach and deposit it farther down the beach or on another island. This **longshore transport** of sediment results in a sediment sharing system where sediment

lost from one beach or island will be deposited on another.

Winds also move sediments from one area of the beach to another. **Dunes** are formed when blowing sediments are trapped by the leaves and roots of salt tolerant plants. The dunes eventually build and the plants which cover them help to stabilize them from the winds.

Constant changes associated with barrier islands, due to their geology and location, make it difficult for plants and animals to survive. Natural processes also make it difficult for people to develop the islands and, ultimately, barrier islands cannot be developed without interfering with the natural processes.



# Activity Summary

The following outline provides a brief summary of each activity, the major concepts introduced and the objectives met by completion of the activity.

## I. Pre-Visit Activity

### #1 Our Restless Beaches (page 3.1.1)

Students will watch the video, “The Beaches Are Moving.” Afterwards, the class will discuss barrier islands, the forces creating them and dynamics affecting them. A crossword puzzle is included to emphasize vocabulary words.

#### Major Concepts:

- Coastal geology
- Currents
- Geography

#### Objectives:

- Explain one theory on how the barrier islands in North Carolina formed.
- List three ways barrier islands move.
- Describe three currents affecting barrier islands.
- Define 10 vocabulary words concerning coastal geology.

## II. On-Site Activity

### #1 Shifting Sands (page 4.1.1)

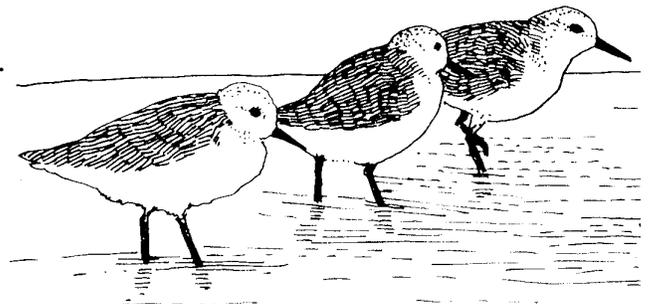
Students, working in groups, will complete various experiments on the beach to learn about sand movement, wind, currents and the various materials making up the beach. The groups will then answer questions and explain to the class what they discovered.

#### Major Concepts:

- Barrier island geology
- Tides
- Currents
- Winds

#### Objectives:

- Describe how tidal changes affect the movement of sand.
- Describe the differences in sand near the dunes and near the beach.
- List three materials that form islands.
- Name two currents that carry sand.
- Describe the sand grains moved by wind.



### III. Post-Visit Activity

#### #1 Let's Make An Island (page 5.1.1)

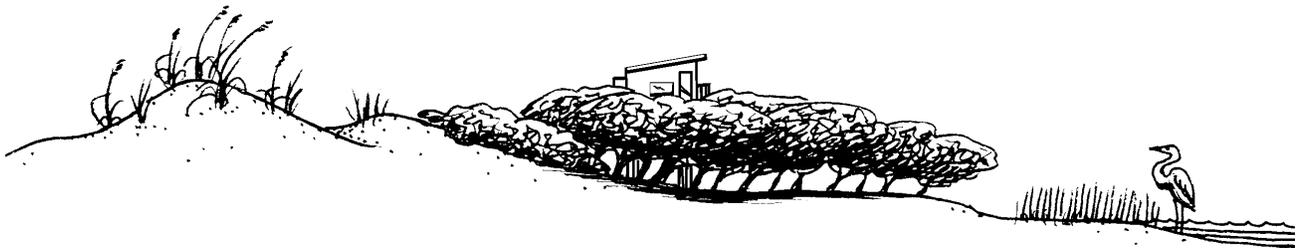
Students, working in groups, will draw a barrier island. They will then choose a scenario card affecting their island, analyze the information and draw the results on their island. The groups will then write a brief description of what happens to their island.

#### Major Concepts:

- The effect of natural forces on the environment
- Human impacts on the environment

#### Objectives:

- Explain how barrier islands can cope with drastic changes caused by natural forces.
- Describe how the activities of humans can manipulate barrier island environments.
- List three natural forces that help maintain barrier island environments.



## Curriculum Objectives:

### Grade 7

- Communication Skills: listening, vocabulary and viewing comprehension, study skills using environmental sources, speaking techniques
- Guidance: develop an awareness of alternative points of view
- Science: interaction of people and the environment, earth science, natural phenomena, meteorology and climatology
- Social Studies: know the importance of natural resources, gather, organize and analyze information, draw conclusions

### Grade 8

- Communication Skills: listening, vocabulary and visual comprehension, study skills using environmental sources, speaking techniques
- Guidance: understand the consequences of personal actions, distinguish between fact and opinion
- Science: earth science, geomorphology, landform processes
- Social Studies: gather, organize and analyze information, draw conclusions, North Carolina geography

### Grade 9

- Communication Skills: listening, vocabulary and visual comprehension, study skills using environmental sources, speaking techniques
- Guidance: draw reasonable conclusions
- Science: physical science, earth science, waves, shoreline modification/erosion, tides
- Social Studies: gather, organize and analyze information, draw conclusions

**Location:** Classroom

### Group Size:

30 students, class size

### Estimated Time:

45 - 60 minutes

**Appropriate Season:** Any

### Materials:

Provided by the educator:  
television set, VCR, the "Beaches are Moving" video tape, discussion questions with answers

Per student: crossword puzzle

## Major Concepts:

- Coastal geology
- Currents
- Geography

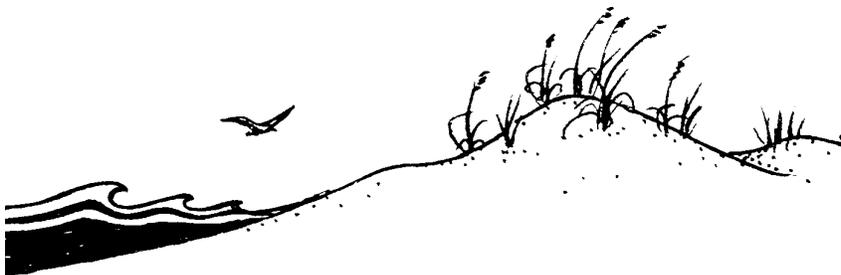
## Objectives:

- Explain one theory of how the barrier islands in North Carolina formed.
- List three ways barrier islands move.
- Describe three currents affecting barrier islands.
- Define 10 vocabulary words concerning coastal geology.

## Educator's Information:

This activity is designed to introduce students to an accepted theory on the formation of eastern North America's **barrier islands**. Students will view a video, "The Beaches Are Moving" and, as a class, answer discussion questions after viewing the tape. Vocabulary is then reinforced by completing a crossword puzzle. NOTE: The video may be checked out from Fort Macon State Park or acquired through the inter-library loan system.

The video is organized in three parts. The first part discusses barrier islands and an accepted theory on their formation. The movement and storage of **sand** on barrier islands is studied along with the **migration** of these islands. Students will also learn about the types of **inlets** found on our coast and how they form.



## Instructions:

After viewing the video, discuss the following questions as a class.

1. Name three ways water moves sand on a barrier island. (Onshore, offshore and longshore transport.)
2. What happens to sand removed from the beach during storms? (It is generally stored offshore in sandbars and later returned to beach.)
3. What kind of waves build up the beach? (Fair weather waves.)
4. What kind of waves erode the beach? (Storm waves.)
5. When storm waves overwash the island, what is the short term result? (Sand is transported over the island and deposited on the back side of the island as the wave's energy fades.)

6. When overwash happens repeatedly over a long period of time, what are the results? (The island slowly rolls over, causing its migration towards the mainland.)
7. On a typical North Carolina beach, how much sand is moved by longshore currents in a year? (100,000 cubic yards.)
8. Why is the surf often brown? (The water is full of sand and sediments from the breaking waves and the longshore current.)
9. What is an inlet? (A break between islands where water flows between the sound and the sea.)
10. How do the longshore currents and tides affect inlets? (Longshore currents try to close inlets while the tides work to keep them open. This results in fan-shaped deltas being deposited on either side of the inlet, known as ebb-tidal deltas on the ocean side, and flood-tidal deltas on the sound side.)

11. What are the three ways inlets move? (Breathing—expanding and contracting; migration; migration and return.)

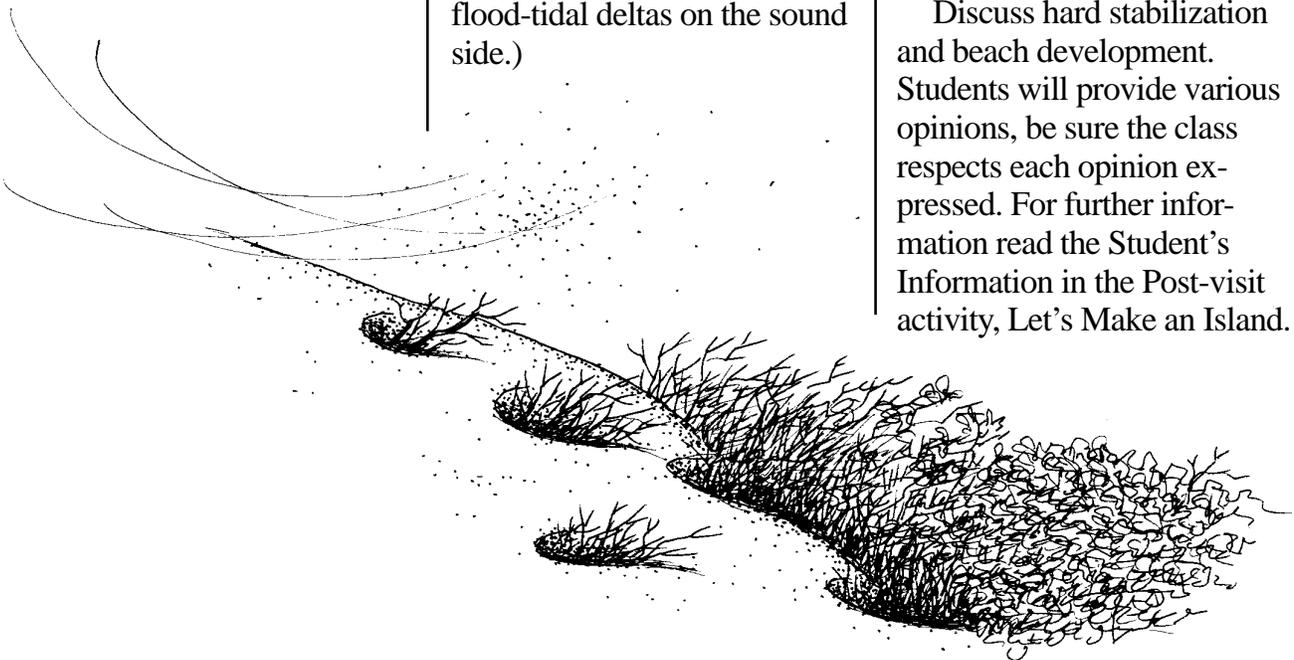
12. Where is the greatest amount of sand usually stored in the barrier island system? (Within the deltas of inlets.)

To reinforce the vocabulary have the students complete the crossword puzzle.

## Suggested Extension:

Watch the second and third parts of "The Beaches Are Moving" video. The second part, from tape counter 1560 - 3477, discusses the colonization of barrier islands and the change in people's perspective about these land masses. The various methods people have developed attempting to control coastal **erosion**, such as **hard stabilization**, are also addressed. The third part is an actual debate over the development and hard stabilization of North Carolina's barrier islands.

Discuss hard stabilization and beach development. Students will provide various opinions, be sure the class respects each opinion expressed. For further information read the Student's Information in the Post-visit activity, Let's Make an Island.



# Crossword Puzzle Clues

Use the following vocabulary words to complete the crossword puzzle clues.

|                 |                     |                          |             |
|-----------------|---------------------|--------------------------|-------------|
| accrete         | erosion             | migration & return inlet | scarp       |
| barrier island  | fair weather waves  | offshore (current)       | sea level   |
| beach scarp     | flood-tidal delta   | onshore current          | sound       |
| beach           | hurricane           | outer banks              | storm waves |
| berm            | inlet               | overwash                 | tidal delta |
| breathing inlet | longshore current   | oystershell              | tides       |
| Coastal Plain   | longshore transport | receding                 | wave        |
| dunes           | migrate             | sand                     | wind        |
| ebb-tidal delta | migrating inlet     | sandbar                  |             |

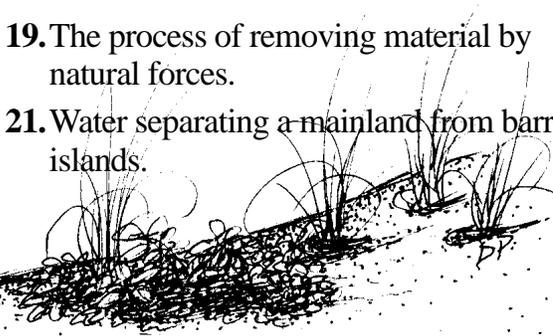
## ACROSS

3. Fossils found on the beach indicating migration.
6. An offshore deposit of sand built by wave action or currents.
7. Waves which build up a beach.
8. An opening between barrier islands.
11. A sound-side deposit of sand in an inlet is called a flood \_\_\_\_\_.
12. Smaller than gravel, coarser than silt.
13. A terrace of sand.
15. A current, traveling parallel to the beach, carrying vast quantities of sand.
20. One way barrier islands \_\_\_\_\_ is by overwash, causing the island to roll over.
22. A long, narrow coastal piece of land separated from the mainland.
23. One of the three physiographic regions in North Carolina.

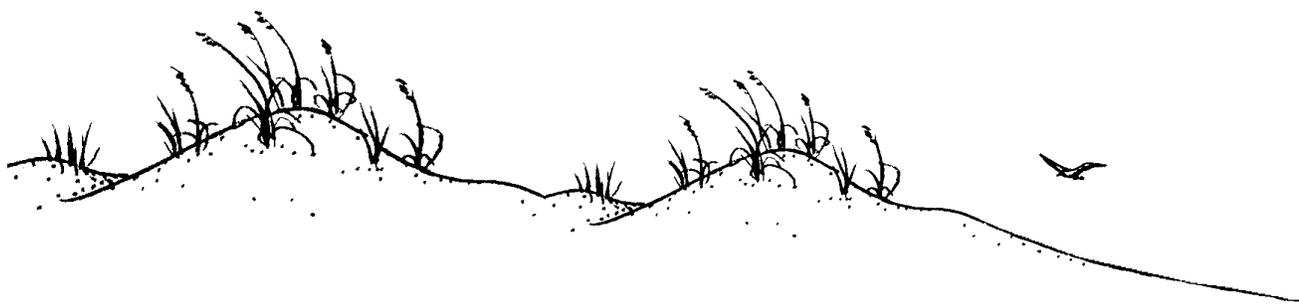
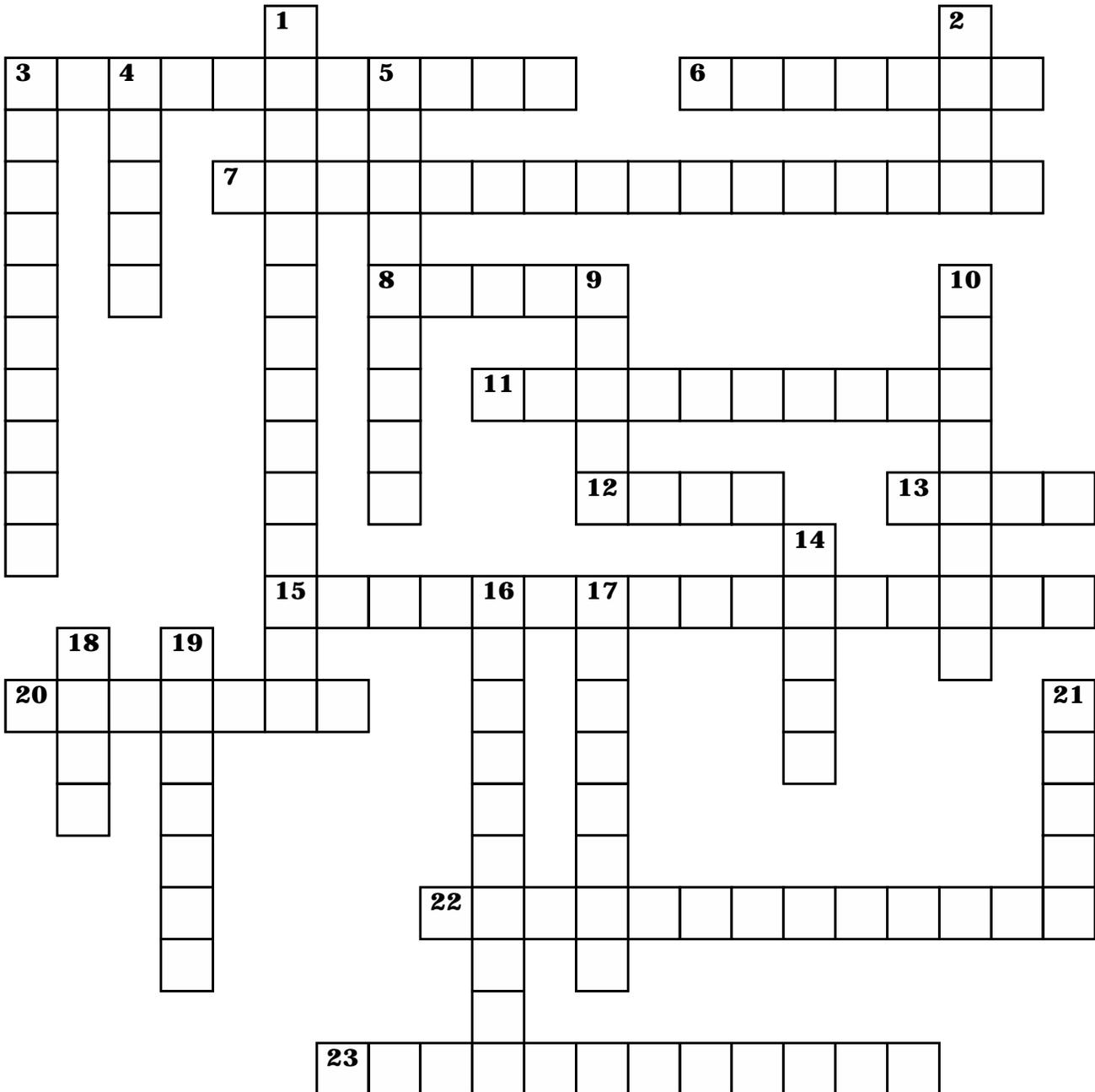
## DOWN

1. An inlet which expands and contracts as it moves.
2. Energy passing through a medium such as water.

3. North Carolina's barrier islands.
4. The vertical face in a dune, caused by severe erosion.
5. A severe tropical cyclone originating over water, with sustained winds of 74 mph or more.
9. Caused by the gravitational pull of the moon and sun.
10. 19,000 years ago \_\_\_\_\_ was over 300 feet lower.
14. Mounds of wind-blown sand.
16. \_\_\_\_\_ tend to erode the beach during inclement weather.
17. A current moving sand away from an island.
18. A current of air which causes waves on water.
19. The process of removing material by natural forces.
21. Water separating a mainland from barrier islands.

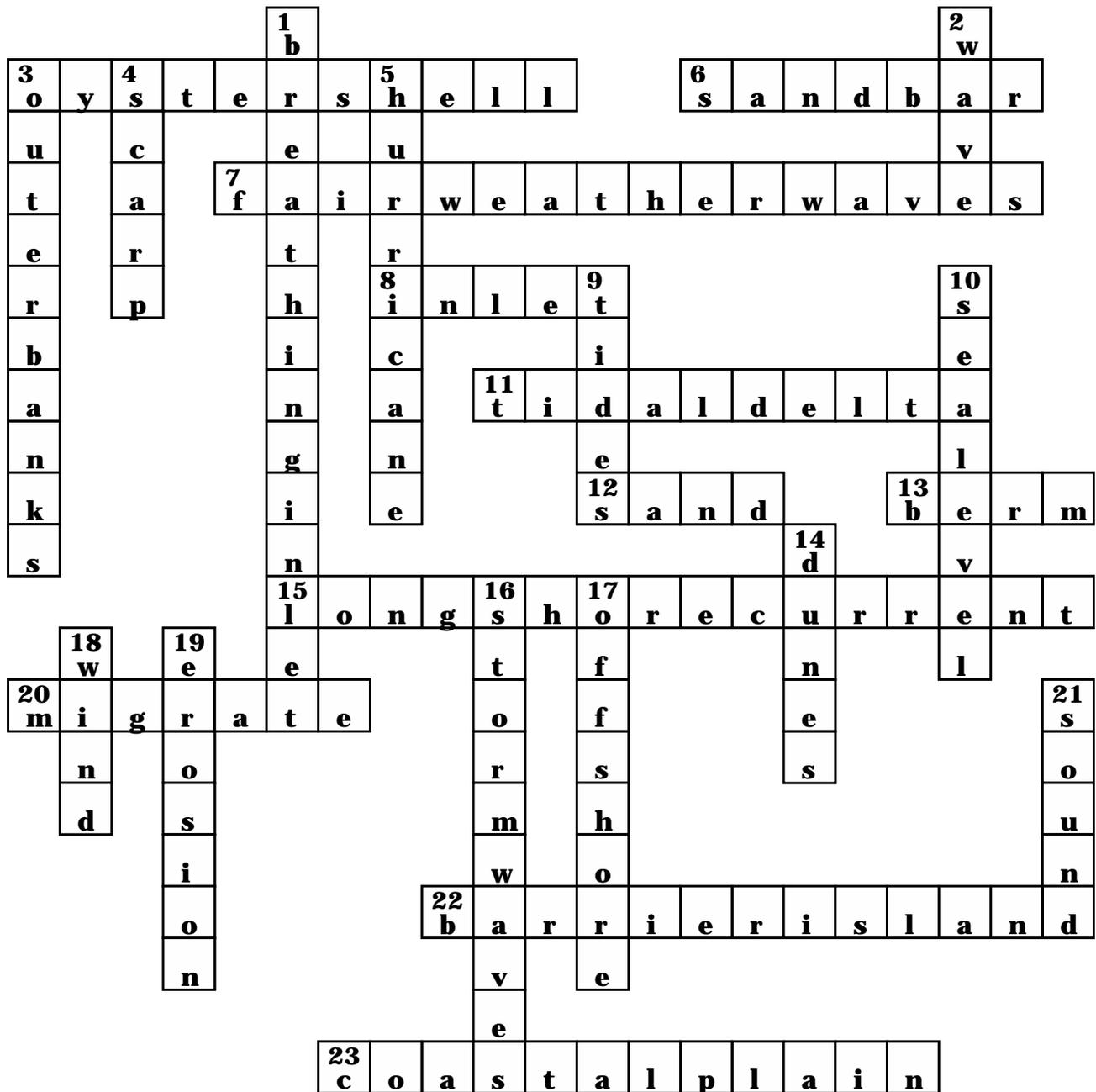


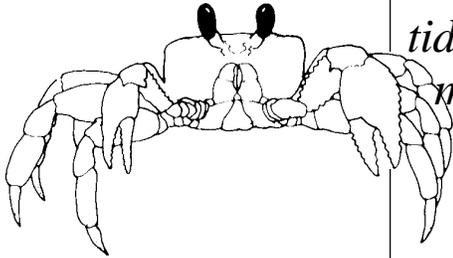
# Our Restless Beaches Crossword Puzzle



# Our Restless Beaches Crossword Puzzle

# Answers





*“The combination of sand, wind, currents, and tides, punctuated by hurricanes and northeasters, make the North Carolina coast one of the most dynamic geological environments on earth.”*

O. H. Pilkey, Jr., W. J. Neal and O.H. Pilkey, Sr.,  
From Currituck To Calabash:  
Living with North Carolina's Barrier Islands

## Curriculum Objectives:

### Grade 7

- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills using environmental sources, speaking techniques
- Guidance: being responsible in a group, develop an awareness of alternative points of view
- Mathematics: solve problems in time and measurement
- Science: interaction of people and the environment, earth science, natural phenomena, meteorology
- Social Studies: know the importance of natural resources, gather, organize and analyze information, draw conclusions

### Grade 8

- Communication Skills: listening, vocabulary and visual comprehension, study skills using environmental sources, reading, speaking techniques
- Mathematics: solve problems in time and measurement
- Science: earth science, geomorphology, landform processes
- Social Studies: gather, organize and analyze information, draw conclusions, North Carolina geography

## Grade 9

- Communication Skills: listening, speaking, reading, writing and visual comprehension
- Health: recreational safety
- Mathematics: solve problems in time, measurements and averages
- Science: physical science, mechanics of fluids, earth science, oceanography
- Social Studies: gather, organize and analyze information, draw conclusions, North Carolina geography

### Location:

Beach at bathhouse area of Fort Macon State Park

### Group Size:

30 students, class size

### Estimated Time:

1 hour to 1 hour 15 minutes

### Appropriate Season: Any

### Materials:

Provided by the park: 2 flat shovels, 2 metric measuring sticks, 1 metric tape measure, 5 stakes, bucket, petroleum jelly, 4 clipboards

Provided by the educator: 2 - 3 oranges or apples; 1 clear plastic 2-liter bottle; 2 watches with second hands

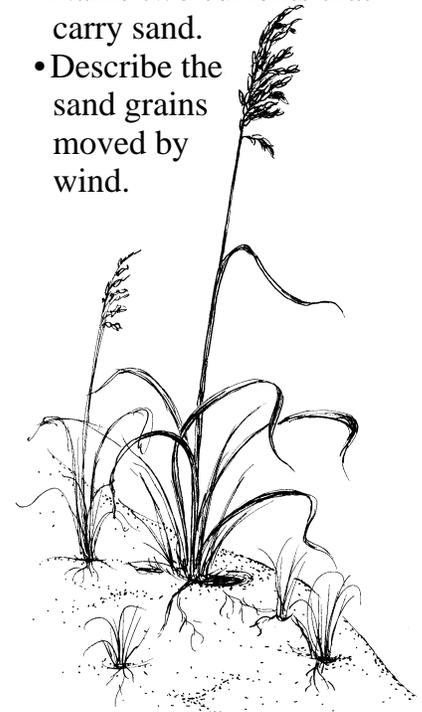
Per group: calculator, “Shifting Sands” worksheet, pencil

## Major Concepts:

- Barrier island geology
- Tides
- Currents
- Winds

## Objectives:

- Describe how tidal changes affect the movement of sand.
- Describe the differences in sand near the dunes and near the beach.
- List three materials that form islands.
- Name two currents that carry sand.
- Describe the sand grains moved by wind.



## Educator's Information:

In this four-part activity, students will learn how **sand** and **sediments** are moved by **wind**, **waves** and **currents**, and deposited in layers.

Parts I and II should be completed as a class. Part I can only be completed if the **tide** is falling. Consult a current tide table or contact park staff for tide information.

For parts III and IV, the class should be divided into four equal groups and each group assigned a number. Each group should have a worksheet, calculator and pencils. The groups will complete the activities corresponding with their assigned numbers. Each group should complete its activity at the same time as the others. The groups should then gather as a class and discuss each experiment, recording the information on the worksheets.

## Instructions:

Have the students read the Student's Information prior to the park visit.

### Part I

1. To study tides as a class, place stake 1 at the highest point where the water flows after a wave breaks on the beach. Record the time on each group's worksheet under Part I.

### Part II

2. To study wind as a class, place a stake with a light coat of petroleum jelly on the upper beach. The results will be observed as a class later.

### Parts III & IV

3. Break into four groups and complete Parts III and IV. Approximate time is 10 to 15 minutes.

4. After parts III and IV are completed, gather as a class and visit each group's experiment. The group should:

- A) explain what they did;
- B) describe the results;

and

C) answer any questions.

Be sure to refill all holes dug on the beach.

After all four groups have completed their presentations, complete Parts I and II.

5. To complete Part I, place stake 2 at the highest point now reached by waves on the beach. Record the time.

Measure and record the distance between the two stakes, using the metric system. Calculate the difference in time the stakes were placed. Discuss and record any observations in Part I.

6. To complete Part II, observe the petroleum jelly coated stake from Part II for any particles of sand. Discuss the following questions:

Which side of the stake has the most sand on it?

Would more sand be on the stake if the wind were blowing harder?

Does the wind appear to be blowing in the same direction as the longshore current?

Record any observations on Part II.



# Student's Information

The main building materials of **barrier islands** are **sand** and **sediment**. Fine, small particles of sediment and sand are moved by **wind** and may be trapped by the leaves and roots of plants, forming **dunes**. The larger grains of sand and sediment are more easily moved by water. **Peat**, organic material formed in the salt marsh, is another type of material found on a barrier island.

In the chain of barrier islands, located along the eastern and gulf coasts of the United States, the islands depend on one another for survival. These islands participate in a sand sharing system where sand from one island is removed by **waves** and **currents** and deposited on the next island. The currents moving sand from one island to another are called **longshore currents**. The

movement of sand from one area of the **beach** to another or from one island to another island is called **long-shore transport**.

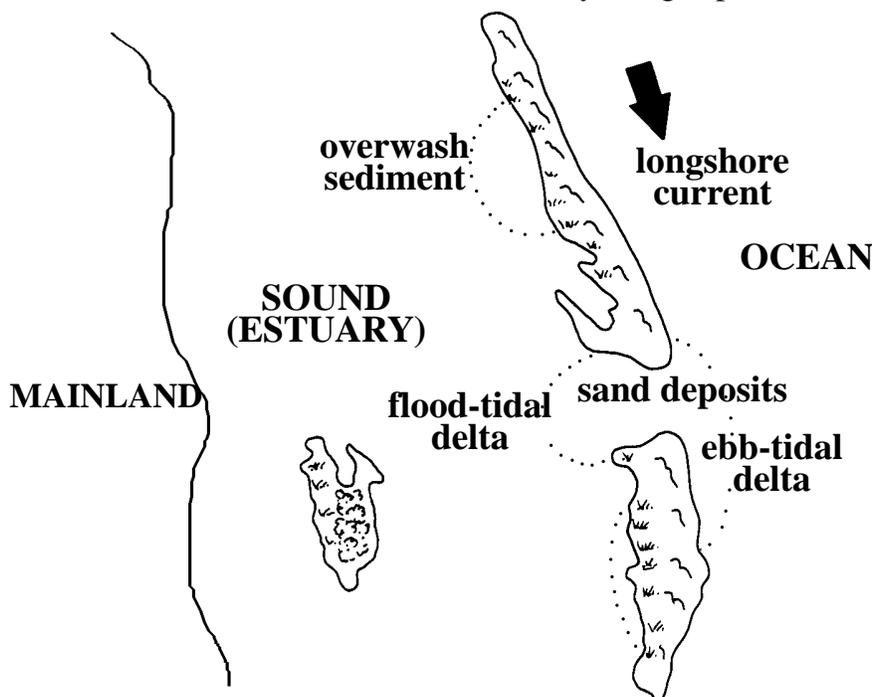
Wind also moves finer particles of sand on these islands. These blowing sediments may be trapped by the salt-tolerant dune plants, such as sea oats, which eventually results in building a dune system.

These islands are moving constantly, as can be seen through natural processes such as storms, currents, waves and wind. These forces all originate from changes in temperature and pressure in the earth's atmosphere. Tidal action in the **intertidal zone** moves quite a bit of sand up the beach or removes it from the beach where currents then carry it to another part of the beach or a different island. Sand is continuously being deposited and

removed by **onshore** and **offshore currents**. **Fair weather waves** permit these currents to gradually build up a beach by depositing sand.

Storms, however, are capable of moving huge amounts of sand. **Hurricanes**, severe tropical storms originating over water with sustained winds 74 miles-per-hour or more, produce large waves and increased **tides**. These waves and tides are capable of carrying sand over low spots on the land. As the waves lose their strength, the sand is deposited on the other side of the island. This occurrence, called **overwash**, may result in the flattening of dunes and the burial of salt marshes and thickets. Following an overwash the island begins to stabilize when dunes reform and new plant growth on the island traps the blowing sand. This overwash process also aids in the landward **migration** of barrier lands.

Signs of barrier island migration may be seen on the beach. Tree stumps are the remains of a thicket area. Dark areas of sand on the beach, actually an organic material called **peat**, and fossil oyster shells reveal that what is now a beach was once a salt marsh. Since salt marshes can only form on the protected sound side of an island, these signs show that the island has rolled over itself in a landward migration.



# Shifting Sands Worksheet

Group members:

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## Part I. Tides

Time stake 1 was placed \_\_\_\_\_

Time stake 2 was placed \_\_\_\_\_

Distance between stakes \_\_\_\_\_

Difference in the time the stakes were placed \_\_\_\_\_

What is the area of the beach found between high tide and low tide called?

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Observations: \_\_\_\_\_

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## Part II. Wind

Place a stake coated with petroleum jelly on the upper beach. What do you expect to happen?

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Final observations: \_\_\_\_\_

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## Part III.

Complete the following observations:

A. Using complete sentences, describe the sand found on the lower beach. (Is it wet, dry, fine, coarse, etc.?) \_\_\_\_\_

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B. Using complete sentences, describe the sand near the dunes.

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C. In each part, circle the correct description of today's weather.

Temp: hot      mild      cold

Winds: heavy winds      windy  
         steady breeze      calm  
         occasional breeze

Forecast: rain      overcast      clear

D. In each part, circle the correct description of how the sand is moving.

Sand blowing on beach: yes      no

If yes, blowing on the :  
upper beach      lower beach      both

If yes, blowing in the following direction:  
(facing the dunes from the beach is north)

N    S    E    W    NE    NW    SE    SW



## Part IV.

### GROUP 1

Fill a two liter plastic bottle one-third full of sand collected from the lower beach. Use the sand from the hole Group 3 is digging. Fill the bottle with sea water. Replace the lid and shake the bottle. Record the time it takes for all the sand to settle to the bottom. **DO NOT SHAKE AGAIN OR EMPTY** - Allow the other groups to observe the results.

Answer the following questions:

How long did it take for all the sand to settle to the bottom? \_\_\_\_\_

Which sand grains settle first?

fine                      coarse

Which sand grains do you think are deposited and tend to remain on the lower beach?

fine                      coarse

Which sand grains tend to be suspended in the water?

fine                      coarse

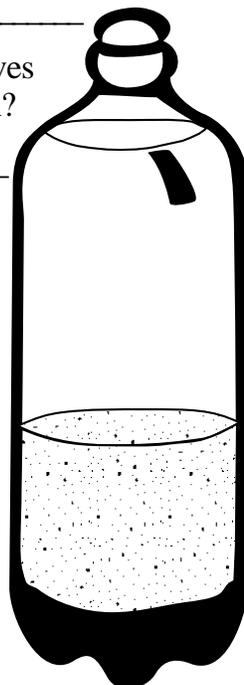
Which current(s) and waves deposit sand on the beach? \_\_\_\_\_

\_\_\_\_\_

Which current(s) and waves remove sand from the beach?

\_\_\_\_\_

\_\_\_\_\_



### GROUP 2

To measure the velocity of the current, you will use an orange. One group member will throw the orange out about 15 meters into the water. Be sure it is close enough to shore for you to be able to observe it. Watch the orange to determine the direction it is traveling. When you have determined the direction of the current, two group members will walk along the shore a few meters ahead of the orange and place two stakes, ten meters apart. Have a group member time (in seconds) how long it takes the orange to travel the distance between the stakes. Record that time. Using the formula below, determine the velocity of the current. If time permits, repeat the activity and average the results.

**velocity (v) = distance (meters) / time (sec)**

Distance (m) \_\_\_\_\_

Time in seconds: 1) \_\_\_\_\_ sec.

+ 2) \_\_\_\_\_ sec.

= \_\_\_\_\_ sec. ÷ 2

Avg. \_\_\_\_\_ sec.

Current velocity (v) = \_\_\_\_\_ meters / \_\_\_\_\_ sec.

v = \_\_\_\_\_ meters/sec.

What direction is the current?

east                      west

What is this current called? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



## GROUP 4

Dig a hole 50 centimeters deep at the base of the dunes. Do not disturb plants or their roots. In the space below, sketch any layers you find and label them by their thickness, color and the materials within the layers. Measure and record the thicknesses.

Can you find any fossil oyster shells?

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What are these evidence of?

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What do these layers represent?

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Compare the layers found in your area to those found at the lower beach (Group 3). Are there any differences? Why, or why not?

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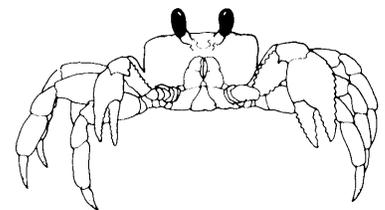
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# Shifting Sands Worksheet - Sample Answers

Group members:

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## Part I. Tides

Time stake 1 was placed 10:20 am

Time stake 2 was placed 10:50 am

Distance between stakes 2 meters

Difference in the time the stakes were placed 30 minutes

What is the area of the beach found between high tide and low tide called? Intertidal zone

Observations: \_\_\_\_\_

## Part II. Wind

Place a stake coated with petroleum jelly on the upper beach. What do you expect to happen? Sand that is blown by the wind will stick to the stake.

Final observations: Sand stuck to the west side of the stake because the wind was blowing from that direction.

## Part III.

Complete the following observations:

A. Using complete sentences, describe the sand found on the lower beach. (Is it wet, dry, fine, coarse, etc.?) Sand found on the lower beach is wet, very coarse and contains many shells.

B. Using complete sentences, describe the sand near the dunes.

Sand found near the dunes is dry and very fine. It has a very consistent texture.

C. In each part, circle the correct description of today's weather.

Temp: hot mild cold

Winds: heavy winds windy  
steady breeze calm  
occasional breeze

Forecast: rain overcast clear

D. In each part, circle the correct description of how the sand is moving.

Sand blowing on beach: yes no

If yes, blowing on the :  
upper beach lower beach both

If yes, blowing in the following direction:  
(facing the dunes from the beach is north)

N S E W NE NW SE SW



## Part IV.

### GROUP 1

Fill a two liter plastic bottle one-third full of sand collected from the lower beach. Use the sand from the hole Group 3 is digging. Fill the bottle with sea water. Replace the lid and shake the bottle. Record the time it takes for all the sand to settle to the bottom. **DO NOT SHAKE AGAIN OR EMPTY** - Allow the other groups to observe the results.

Answer the following questions:

How long did it take for all the sand to settle to the bottom? 45 seconds

Which sand grains settle first?

fine      coarse

Which sand grains do you think are deposited and tend to remain on the lower beach?

fine      coarse

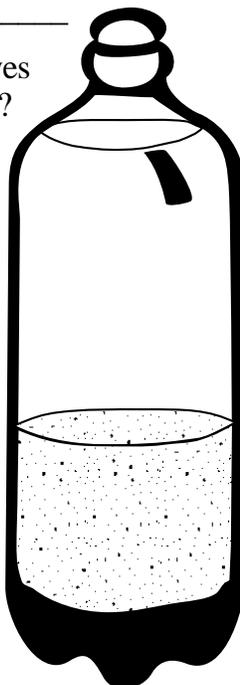
Which sand grains tend to be suspended in the water?

fine      coarse

Which current(s) and waves deposit sand on the beach? onshore currents and fair weather waves

Which current(s) and waves remove sand from the beach?

offshore currents and storm waves



### GROUP 2

To measure the velocity of the current, you will use an orange. One group member will throw the orange out about 15 meters into the water. Be sure it is close enough to shore for you to be able to observe it. Watch the orange to determine the direction it is traveling. When you have determined the direction of the current, two group members will walk along the shore a few meters ahead of the orange and place two stakes, ten meters apart. Have a group member time (in seconds) how long it takes the orange to travel the distance between the stakes. Record that time. Using the formula below, determine the velocity of the current. If time permits, repeat the activity and average the results.

**velocity (v) = distance (meters) / time (sec)**

Distance (m) 10 meters

Time in seconds: 1) 15.1 sec.

+ 2) 17.5 sec.

= 32.6 sec. ÷ 2

Avg. 16.3 sec.

Current velocity (v) = 10 m meters / 16.3 sec.

v = 0.61 meters/sec.

What direction is the current?

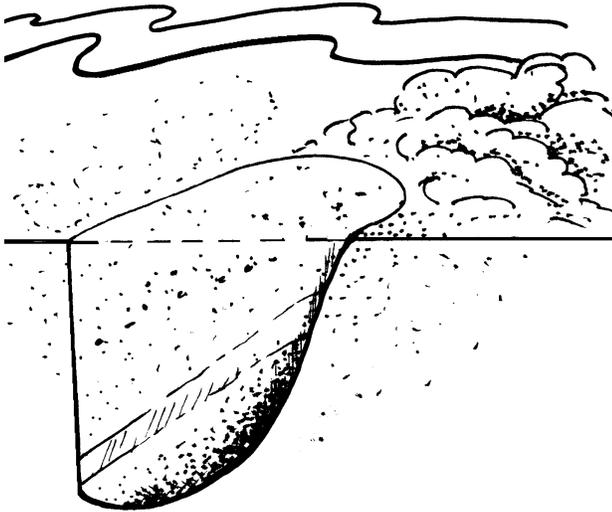
east      west

What is this current called? \_\_\_\_\_

longshore current

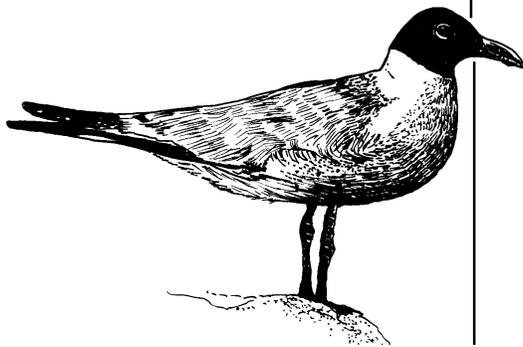
### GROUP 3

Dig a hole 50 centimeters deep, just above the surf. (If you are too close to the surf and water seeps into the hole, move higher on the beach until the hole can be dug 50 cm deep and remain dry.) In the space below, sketch any layers you find and label them by their thickness, color and the materials within the layers. Measure and record the thicknesses.



What do these layers represent?

Depositing of sediments at different times  
in the intertidal zone. Coarsest sediments are  
found here as water and wind carry the lighter  
sand away.



Write in complete sentences how you suppose these layers formed in this manner (ideas: blown by wind, deposited by waves, overwash, dredging).

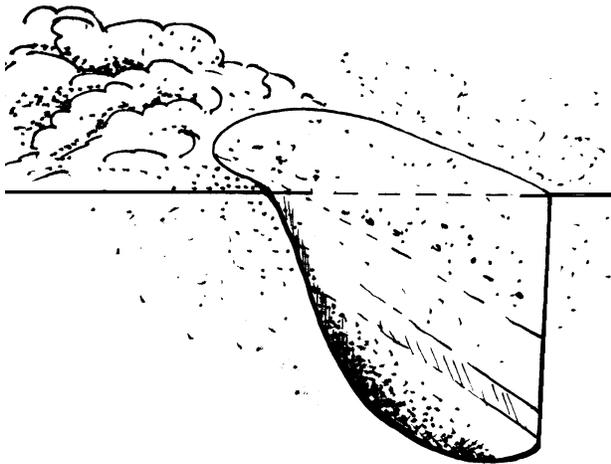
As breaking waves loose their energy,  
they deposit the heavier sediments of  
coarse sand and shells on the beach one layer  
after another.

Compare the layers found in your area to those found at the dune base (Group 4). Are there any differences? Why, or why not?

Generally the coarser sediments stay in the  
lower beach area as they are deposited by  
waves. Fine sand is easily dried out and  
picked up by the wind and carried up to the  
dune, leaving the coarse sand and shells  
behind.

## GROUP 4

Dig a hole 50 centimeters deep at the base of the dunes. Do not disturb plants or their roots. In the space below, sketch any layers you find and label them by their thickness, color and the materials within the layers. Measure and record the thicknesses.



Can you find any fossil oyster shells?

What are these evidence of?

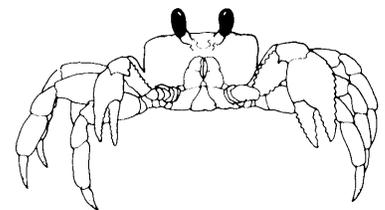
Fossil oyster shells are evidence of barrier island rollover. The presence of these shells indicates there was once a marsh in this location.

What do these layers represent?

These layers represent different times that sand was deposited in the upper beach by wind. A dark, thick, coarse layer indicates that a high tide deposited coarse sand higher on the beach.

Compare the layers found in your area to those found at the lower beach (Group 3). Are there any differences? Why, or why not?

Generally the coarser sediments stay in the lower beach area as they are deposited by waves. Fine sand is easily dried out and picked up by the wind and caught by a dune plant's leaves. The dune is slowly built up with fine sand, and occasionally with coarse sand deposited by storm waves.



## Curriculum Objectives:

### Grade 7

- Arts Education: develop positive attitudes
- Communication Skills: listening, reading, and viewing comprehension, study skills using environmental sources, speaking techniques
- Guidance: being responsible in a group, develop an awareness of alternative points of view
- Science: science and its relationship to human endeavor, interaction of people and the environment, earth science, natural phenomena, meteorology and climatology
- Social Studies: know the importance of natural resources, gather, organize and analyze information, draw conclusions

### Grade 8

- Arts Education: develop positive attitudes, understand the role creativity plays in art and producing art
- Communications Skill: listening and visual comprehension, study skills using environmental sources, speaking techniques
- Guidance: understand the consequences of personal actions, distinguish between fact and opinion
- Science: science and its relationship to human endeavors, earth science, geomorphology, landform processes
- Social Studies: gather, organize and analyze information, draw conclusions, North Carolina geography

### Grade 9

- Arts Education: accept work of others, do art, demonstrate personal perception in art, evaluate art, communicate about art
- Communication Skills: listening and viewing comprehension, study skills using environmental sources, speaking techniques
- Guidance: demonstrate life planning skills, discuss responsibility for individual actions, examine personal attitudes, beliefs and values; draw reasonable conclusions
- Science: humans and the environment, oceanography, resources and environment, meteorology
- Social Studies: participate effectively in groups, evaluate information, identify problems and suggest ways of solving them, draw conclusions

**Location:** Classroom

**Group Size:** 30 - 40 students

**Estimated Time:** 45 minutes

**Appropriate Season:** Any

### Materials:

Provided by the educator:

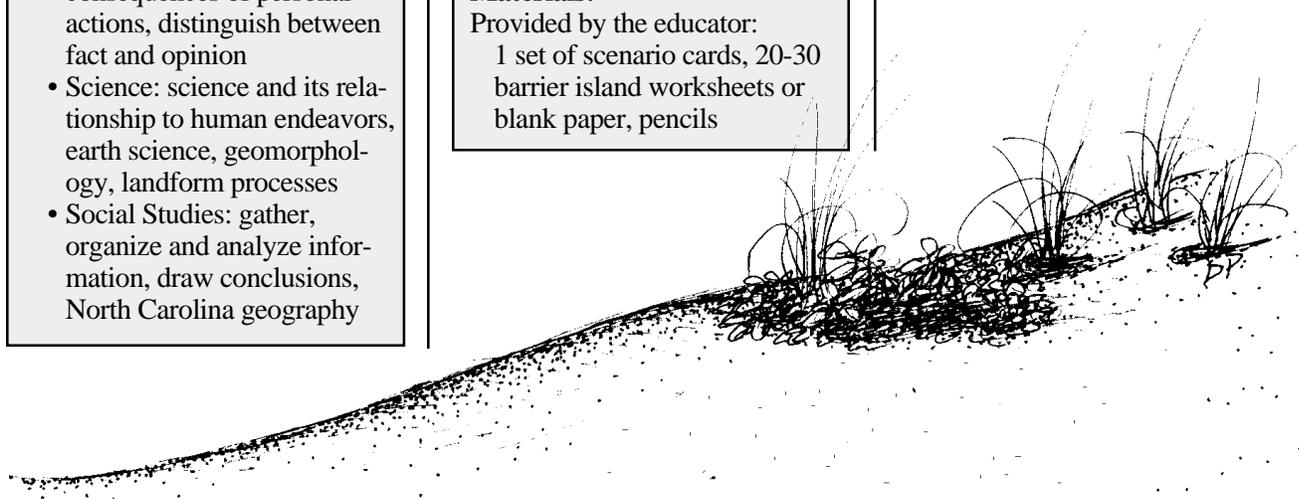
- 1 set of scenario cards, 20-30
- barrier island worksheets or blank paper, pencils

## Major Concepts:

- The effect of natural forces on the environment
- Human impacts on the environment

## Objectives:

- Explain how barrier islands can cope with drastic changes caused by natural forces.
- Describe how the activities of humans can manipulate barrier island environments.
- List three natural forces that help maintain barrier island environments.



## Educator's Information:

**B**arrier islands absorb the ocean's energy, providing protection for salt marshes and the mainland. These islands are constantly changing due to forces or natural processes, ranging from **tides** to occasional **hurricanes**. One such process, the rise in **sea level**, actually increases the movement of barrier islands. These islands seem to move more rapidly with an extreme rise in sea level.

**Erosion** on the **beaches** is a healthy natural process. However, many beachfront developers see erosion as a problem. By attempting to reduce erosion through the construction of **groins**, **jetties** and sea-

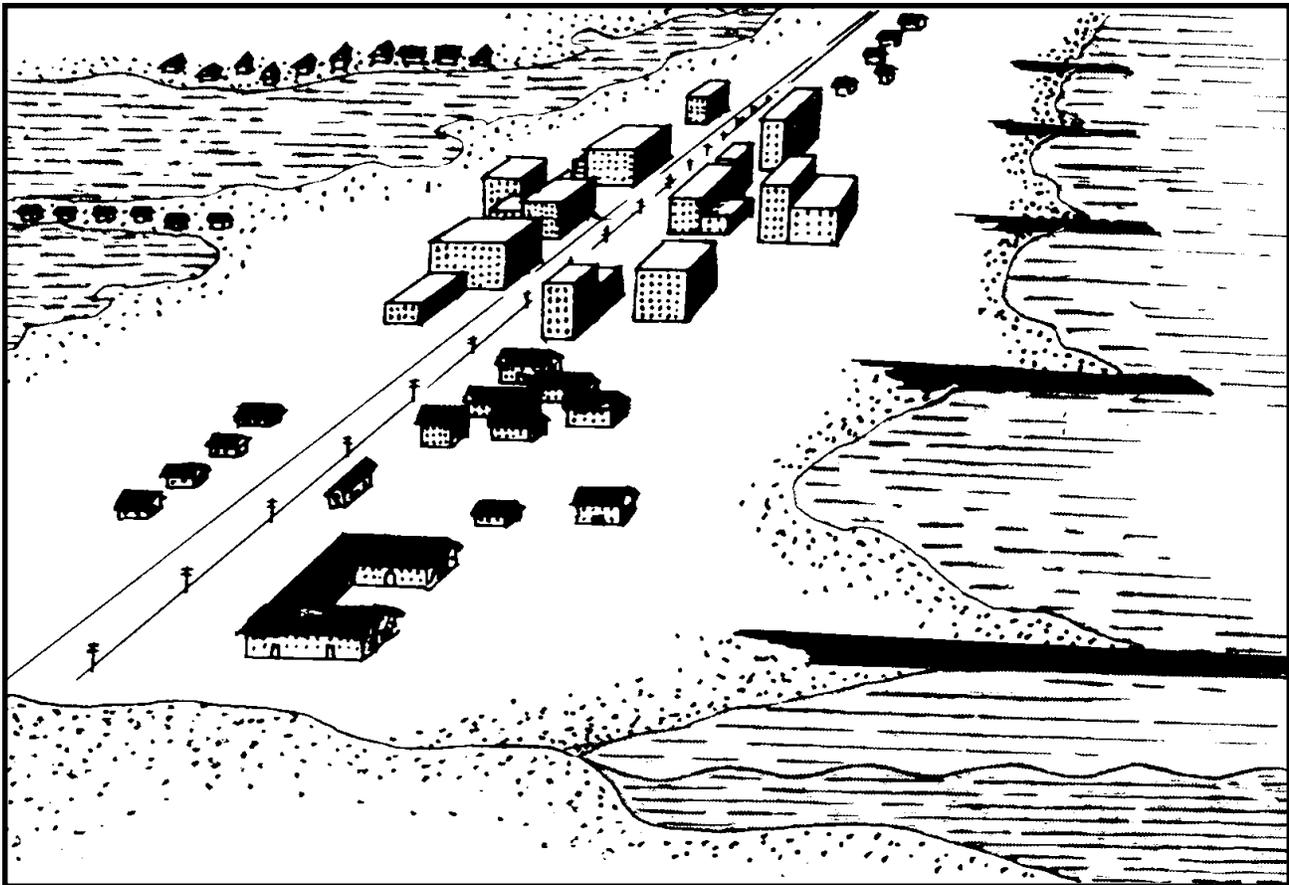
walls, people have interfered with the natural processes important to maintaining barrier islands. This activity allows students to form conclusions, using reasoning and interaction, on how the events described on their scenario card affect their barrier island.

### Instructions:

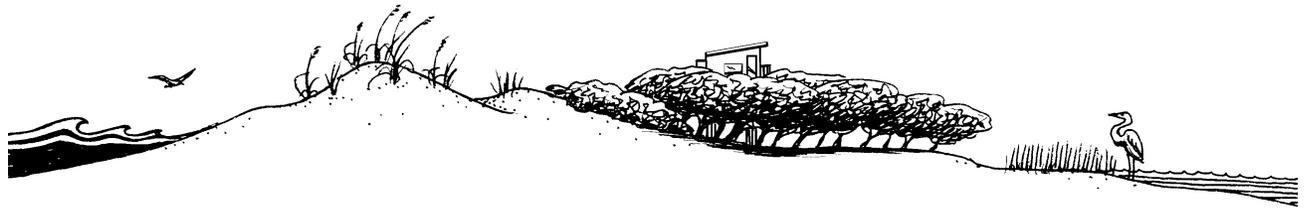
1. Discuss the Student's Information with the class. Divide students into ten groups and provide each group several barrier island worksheets.
2. Each group will pick a scenario card and discuss the information within the group until a conclusion is formed on the effects caused by the event or phenomenon on the scenario card. On the work-

sheets provided, or on a blank sheet of paper on which they create their own island, the students are to draw the effects the group agrees upon. Students may decide to draw before and after pictures of their island. Include how the scenario affects the environment, wildlife, development, the island and the future outlook of each. Each group's conclusions should be evident in its drawings.

3. Write a few brief sentences describing the effects the events have on the island, the environment, wildlife and development.
4. All drawings and conclusions should then be discussed with the class.



# Student's Information



The first people to use barrier islands were the Native Americans. The tribes found on the coast of North Carolina, the Secotan, Croatan and Roanoke, spoke the Algonquian language. These hunters and gatherers did not live on these islands but built temporary settlements on them. The Native Americans caught fish, collected shellfish and hunted waterfowl in the saltmarshes. During the winter they returned to the mainland to their permanent settlements.

The first European explorers preferred the more stable mainland environment to that of the **outer banks**. In 1524, Giovanni Da Verrazzano, an Italian explorer, visited the outer banks of North Carolina. He found them an unforgiving environment. It was not until the early 1700's that people began to live on the barrier islands year-round. A few years later, permanent towns of 500 people or more were found on the islands of Ocracoke, Portsmouth and Shackleford.

These first islanders knew the dangers of living on the water and respected the natural forces of storms such as **nor'easters**. Towns were built on the back side of the

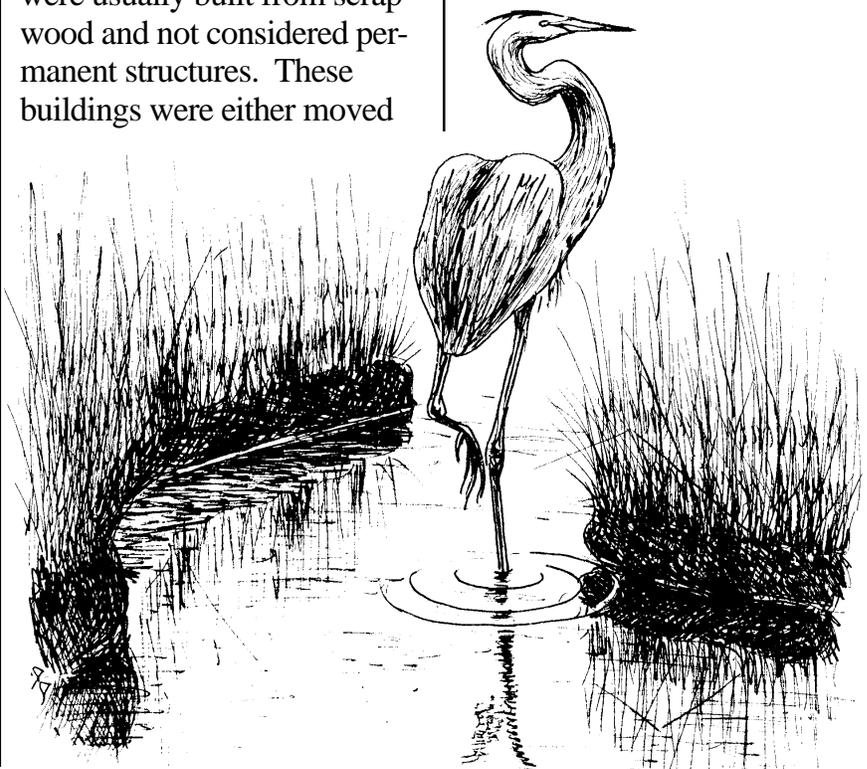
island where the maritime forests protected buildings from the **winds** and flooding waters. These buildings usually had trap doors, cut into the bottom of the houses, which allowed flood waters to flow through—thus keeping the buildings from floating off their foundations.

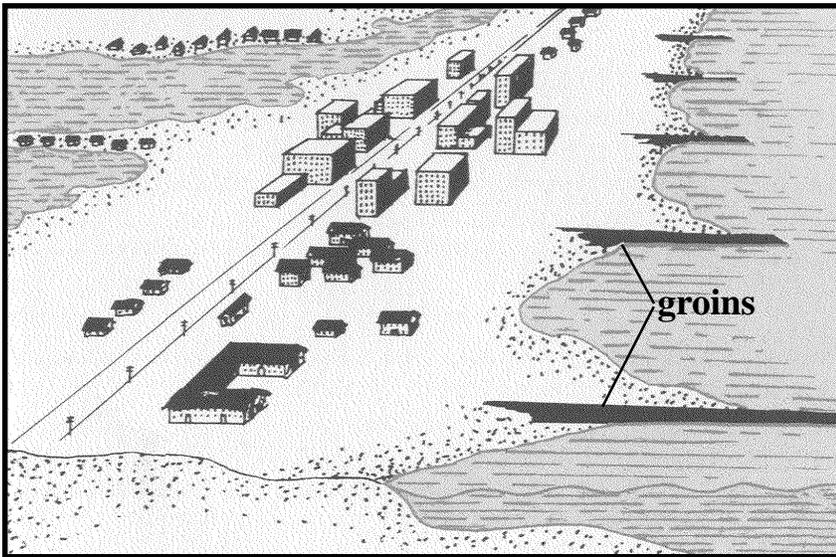
In the 1800's, when people found recreation at the ocean enjoyable, many resorts were built on the mainland or on the backside of the island and daily excursions were made to the **beach**. Later that century, the first buildings were constructed on the beach. They were usually built from scrap wood and not considered permanent structures. These buildings were either moved

further from encroaching **waves** or rebuilt if destroyed.

Human habitation on these islands took its toll on the natural resources. People cut down trees for timber, and livestock overgrazed the island's vegetation.

After World War II, with the use of heavy machinery, sand was moved to build homes. **Dunes** were often bulldozed down to make level building lots for a better ocean view, thus eliminating natural protection from flooding tides. Maritime forests were cleared to make room for houses.





Salt marshes suffered from intrusion by people. These wetlands were often buried to provide land for further development. Development of these fragile areas has destroyed essential habitat for numerous plants and animals. It is now known that salt marshes are the most productive lands on earth. They are important buffers for **sound** side erosion of the island and they absorb water, helping to keep the mainland from flooding during storms.

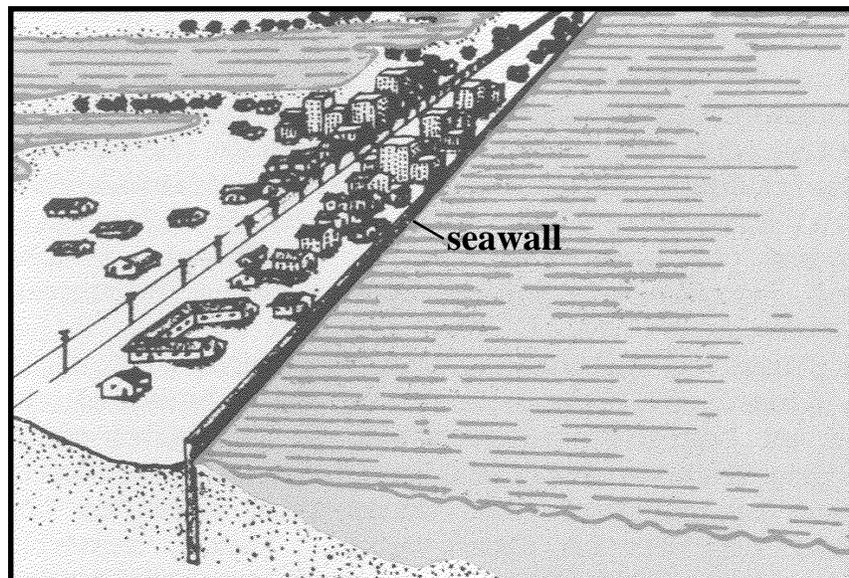
Today, beachfront property development is common. Structures considered permanent are regularly built facing the ocean. To protect these investments, there is a need to replace “lost” **sand** on the beach. While the sand isn’t actually lost, it is removed naturally from one beach to another by the **longshore current**. Even though dunes are no longer bull-dozed, but encouraged to grow, beachfront development continues.

Methods for replacing or reducing the amount of removed sand by holding the shoreline in place with immovable hard objects is called **hard stabilization**. **Groins** and **jetties** are examples of hard stabilization. Groins are rocks, concrete or other materials which extend perpendicularly from the beach into the surf. Jetties, similar to a groin in design, are usually constructed next to an **inlet**. Both groins and jetties trap sand moving along the beach in the

longshore current. The result is an **accreting** beach on one side, while the amount of sand on the opposite side decreases or **recedes**. Groins tend to multiply as individual owners try to ensure their sand remains on the beach. A series of groins and jetties were constructed to protect Fort Macon from severe beach erosion.

Seawalls and **breakwaters** are two other types of hard stabilization. These are built parallel to the shoreline and are designed to hold the existing beach. As the beach slope in front of the seawall begins to steepen, wave action eventually undermines the seawall and a larger one has to be built. The long term effect is eventual loss of the recreational beach and the potential hazard of scattered debris on the beach.

**Non-rigid stabilization** techniques are also used to stabilize our beaches. These methods, such as beach renourishment and dune build-



ing, focus on sand replenishment rather than construction.

Beach renourishment is accomplished by pumping sand, usually **dredge spoil** material from the bottom of the sound or ocean, or bringing in sand with dump trucks. This steepens the natural beach profile by placing more sand than there ordinarily would be on the beach. The resulting beach actually erodes more quickly. Beach renourishment is an expensive alternative and usually lasts only 2-4 years before it has to be done again. Three-hundred million dollars is spent every five years in North Carolina for beach replenishment.

Dune building is the encouragement of dune growth by erecting sand fence or planting beach grasses, such as sea oats, to promote the natural build up of sand. Both beach renourishment and artificial building of dunes have been used at Fort Macon.

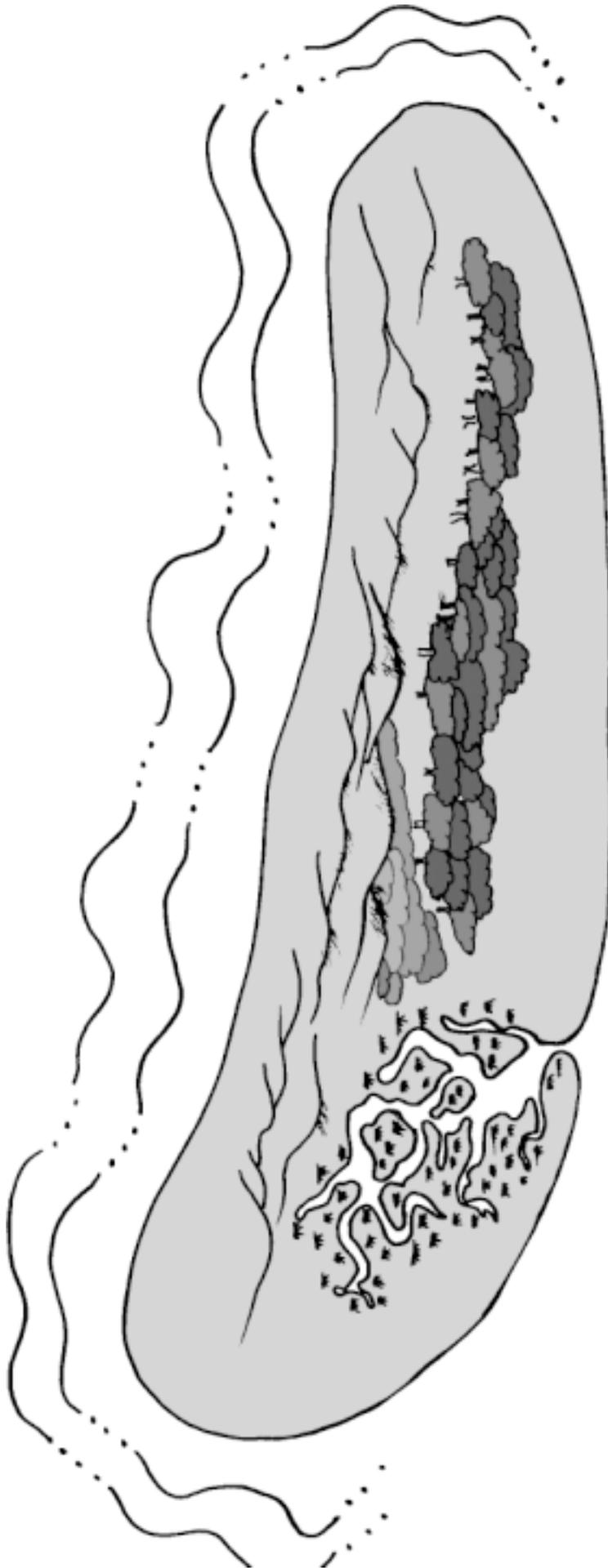
Barrier islands provide critical habitat for several species of threatened and endangered wildlife. These islands protect our invaluable salt marshes, areas where 90% of all commercial seafood species depend on for all or part of their life cycles. Barrier islands provide us with recreation and are important in the tourism industry. These benefits are tangible and affect all of us. But how about the intangible benefits? The sound of the

surf, the smell of the salty air, sunsets and sunrises over dancing blue waters, peace and solitude. How do we put a price on their worth?

Other questions which must be answered are—When is it appropriate for people to interfere with the natural processes of beach **migration** and erosion? Should we permit hardening or hard stabilization of our beaches to satisfy short term goals of landowners and communities, and at whose expense? Or should landowners and communities learn to adjust to the natural processes constantly affecting barrier islands?



# Imaginary Barrier Island Worksheet



# Scenario Cards

SCENARIO



C A R D

SCENARIO



C A R D

SCENARIO



C A R D

SCENARIO



C A R D

SCENARIO



C A R D

SCENARIO



C A R D

# Scenario Cards

**Category 3 Hurricane**  
(you decide the name)  
Winds 111-130 mph

Storm surges of 9 to 12 feet, break through low areas in the dunes. Extensive damage to the island, which is commercially developed with businesses, motels and resorts. Roof, window and tree damage, mobile homes destroyed, and boats ripped from docks. Flooding on the island; four feet of water in homes.

**Inlet Shift** due to a  
Category 3 Hurricane  
(you decide the name).

The storm has 111-130 mph winds. A new inlet is formed in the middle of the island where a canal had been cut on the sound side for waterfront homes. One island has now become two. Minor flood damage and several homes destroyed when the inlet formed. Now, several homes are in danger and others separated on the new island.

**Category 4 Hurricane**  
(you decide the name).  
Winds over 130 mph.

Washover to sound side of island. Extensive damage to island. High dunes flattened and sand pushed into salt marsh. Fortunately, the wash-over occurred in an area where there was no development; however, sand covers the area between two towns. The resulting washover will provide good nesting habitat for the endangered piping plover.

**Four-wheel drive vehicles**  
allowed on beach and dunes.

Their activity is not regulated. This area is in the city limits, with development and beachfront homes. Beach is used mainly for recreation, but some sea turtles nest on these beaches in the summer.

**Increased beach development**

Property is sold for residential and commercial development. No public beach access is provided, yet the beach is heavily used by tourists. With increased beach erosion, property owners choose to use hard stabilization to protect their property so buildings will not have to be moved.

**Northeaster storm**  
with 50 mph winds.

Beach erosion due to large waves. Beachfront homes are in danger of being destroyed; however, no hard stabilization is permitted by law. Property owners are forced to move their homes or lose them.

# Scenario Cards

SCENARIO



C A R D

SCENARIO



C A R D

SCENARIO



C A R D

SCENARIO



C A R D

# Scenario Cards

**Laws protecting wetlands are relaxed** to allow for easier development.

Most of the property on the island is already developed. There is a large tourist industry for recreation.

**Laws protecting wetlands become more strict** towards development.

Draining of the salt marsh is no longer permitted. Development of wetland areas is allowed only with minimal impact.

The year is 2050.  
Since 1993, **all laws regulating development have been repealed**, permitting unrestricted development.

(Consider the fact that the human population in North Carolina continues to grow.)

The year is 2050. Since 1993, **laws regulating development in coastal environments have been strengthened.**

(Think of what some of these laws might be and list them.) Pollution has been reduced in the salt marsh.

# VOCABULARY

**Accrete** - To build up in amount, to increase. Some beaches are accreting while others are receding or eroding.

**Barrier island** - A long, narrow, dynamic island parallel to the coast. North Carolina's coast has some of the most prominent barrier islands, called the outer banks.

**Beach** - Portion of the shoreline from the dunes to the nearshore sandbar. In North Carolina, the beach is composed of between 5 and 25% shell fragments, with the rest being sand and sediments.

**Beach scarp** - A vertical face on a dune resulting from severe erosion.

**Berm** - A terrace of sand found at the highest tide point where waves have either deposited sand or eroded a beach.

**Breakwater** - A seawall of rock, concrete, etc., built to absorb the impact of waves and protect the shore behind it.

**Breathing inlet** - An inlet that tends to expand and then contract as it moves between two islands.

**Coast** - The land next to an ocean or sea; the seashore.

**Coastal plain** - Flat land composed of deposited sediments between the ocean and hills of the North Carolina Piedmont.

**Currents** - Flowing water in the ocean that has continuous onward movement. Currents are caused by energy from natural processes such as wind, temperature and pressure changes and gravity.

**Deposition** - The deposit of sediments.

**Dredge** - To remove sand from the bottom of a body of water using a scoop or shovel-like device or a pump.

**Dredge spoil** - The sand and sediment removed by a dredge. This dredge spoil is usually pumped onto beaches to replenish or build up the beach.

**Dunes** - Mounds of sand usually built by the deposition of material by wind and water. The primary dunes are the first line of dunes found on a beach. Secondary dunes are found behind the primary dunes. Dunes are important because they help absorb large amounts of energy from storms.

**Ebb tide** - The movement of the tidal current away from shore.

**Ebb-tidal delta** - The fan shaped deposit of sand and sediments left by the out-going tide on the ocean side of an inlet.

**Erosion** - The process where by sand and other materials are removed by natural forces such as waves.

**Fair weather waves** - Waves during calm weather that tend to carry sand toward shore, slowly building up the beach.

**Flood-tidal delta** - The fan shaped deposit of sand and sediments left by the in-coming tide on the sound side of an inlet.

**Groin** - A low, narrow jetty made of timber, stone, concrete or steel, usually extending perpendicular to the shoreline, which is designed to protect the shore from erosion by trapping deposition from currents, tides or waves.

**Hard stabilization** - The use of immovable hard objects to reduce erosion of a shoreline. Examples are groins, jetties and breakwaters.

**Hurricane** - A severe tropical cyclone originating over water with sustained winds of 74 miles per hour or more. The Atlantic hurricane season starts June 1 and ends November 30. On average, there are six Atlantic hurricanes each year.

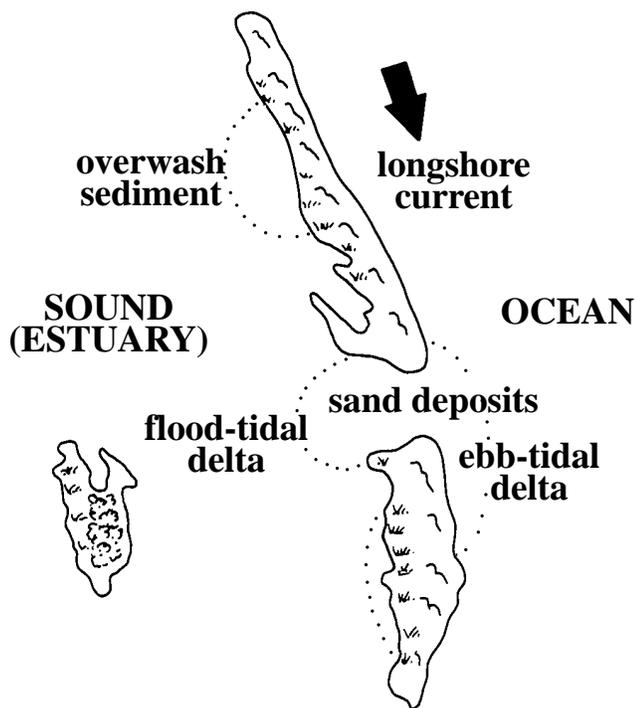
**Inlet** - A narrow channel between barrier islands through which water flows between the sound and ocean. Examples are migrating inlet, migration and return inlet, tidal inlet and breathing inlet.

**Intertidal zone** - The zone between high and low tide marks where the surf breaks. The subtidal zone is found below the low tide line.

**Jetty** - A structure extending from the shore into a body of water, designed to direct or confine the current to prevent sand from building up into a channel or inlet.

**Longshore current** (also called **littoral current**) - A current that runs parallel to the beach. It is caused by waves approaching at an oblique angle, with energy deflected by the sloping sea bottom, causing the current to veer off parallel to the shore. Most of the long-distance moving of sand from one beach to another is the work of longshore currents.

**Longshore transport** - The movement of sand and sediments from one area to another by longshore currents.



**Migrate** - The landward movement of barrier islands by wind, ocean waves and currents. The more gentle the slope of the coastal plain, the faster the islands and their shorelines migrate or retreat.

**Migrating inlet** - An inlet that tends to move, as erosion occurs from one island while sand is being deposited to the island on the opposite side of the inlet.

**Migration and return inlet** - Similar to a migrating inlet, but the inlet quickly returns to its original location to start the process over.

**Non-Rigid stabilization** - Methods other than hard stabilization to prevent beach erosion, such as beach renourishment.

**Northeaster** (also **Nor'easter**) - A gale or storm from the northeast, known to cause considerable erosion and damage to developed property on North Carolina's beaches.

**Offshore current** - Currents which tend to take sand away from a beach, usually to be deposited on a submerged mound of sand called an offshore bar. The process of these currents carrying sand is called onshore/offshore transport.

**Onshore current** - Currents which tend to carry sand toward shore, therefore, building up the beach. Onshore currents redistribute the sands on the beach.

**Outer banks** - Term describing North Carolina's barrier islands. The term "banks" is the only topographic term unique to North Carolina. Nowhere else do barrier islands occur so far from the mainland.

**Overwash** - A process where waves wash over an island, depositing sand from the seaside to the soundside of the island.

**Peat** - Organic material composed of partially decomposed vegetation, often found in salt marshes.

**Recede** - To reduce or erode. Some beaches are receding while others are accreting or building up.

**Sand** - Loose particles of worn rock that are finer than gravel and coarser than silt and clay. Most of the sediments making up the beaches of North Carolina are sand.

**Sandbar** - An offshore deposit of sand formed by wave action or currents.

**Sea level** - The level of the ocean's surface. The sea level on North Carolina's coast is thought to be on the rise.

**Sediments** - Fragments of material such as sand, gravel, silt, mud and clay.

**Sounds** - Areas of water which, on the North Carolina coast, separate the mainland from the barrier islands.

**Storm waves** - Foul weather waves which tend to quickly erode a beach.

**Surf zone** - The area where the waves break.

**Tides** - The cycle of low and high water levels that occurs two times each day due to the gravitational pull of the sun and moon.

**Waves** - Energy passing through a medium such as water. Storm waves tend to erode a beach. Fair weather waves tend to build up a beach.

**Wind** - A current of air, caused by differences in temperature and pressure, which creates waves on water.



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## SCHEDULING WORKSHEET

For office use only:

Date request received \_\_\_\_\_ Request received by \_\_\_\_\_

1) Name of group (school) \_\_\_\_\_

2) Contact person \_\_\_\_\_  
name phone (work) (home)

\_\_\_\_\_ address  
3) Day/date/time of requested program \_\_\_\_\_

4) Program desired and program length \_\_\_\_\_

5) Meeting place \_\_\_\_\_

6) Time of arrival at park \_\_\_\_\_ Time of departure from park \_\_\_\_\_

7) Number of students \_\_\_\_\_ Age range (grade) \_\_\_\_\_  
(Note: A maximum of 30 participants is recommended.)

8) Number of chaperones \_\_\_\_\_  
(Note: One adult for every 10 students is recommended.)

9) Areas of special emphasis  
\_\_\_\_\_

10) Special considerations of group (e.g. allergies, health concerns, physical limitations)  
\_\_\_\_\_

11) Have you or your group participated in park programs before? If yes, please indicate previous programs attended: \_\_\_\_\_  
\_\_\_\_\_

12) Are parental permission forms required? \_\_\_\_\_ If yes, please use the Parental Permission form on page 8.2.

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I, \_\_\_\_\_, have read the entire Environmental Education Learning Experience and understand and agree to all the conditions within it.

Return to: Fort Macon State Park  
P.O. Box 127  
Atlantic Beach, NC 28512

Fax: (252) 726-2497

## PARENTAL PERMISSION FORM

Dear Parent:

Your child will soon be involved in an exciting learning adventure - an environmental education experience at **Fort Macon State Park**. Studies have shown that such “hands-on” learning programs improve children’s attitudes and performance in a broad range of school subjects.

In order to make your child’s visit to “nature’s classroom” as safe as possible we ask that you provide the following information and sign at the bottom. Please note that insects, poison ivy and other potential risks are a natural part of any outdoor setting. We advise that children bring appropriate clothing (long pants, rain gear, sturdy shoes) for their planned activities.

Child’s name \_\_\_\_\_

Does your child:

- Have an allergy to bee stings or insect bites? \_\_\_\_\_  
If so, please have them bring their medication and stress that they, or the group leader, be able to administer it.

- Have other allergies? \_\_\_\_\_

- Have any other health problems we should be aware of? \_\_\_\_\_

\_\_\_\_\_

- In case of an emergency, I give permission for my child to be treated by the attending physician. I understand that I would be notified as soon as possible.

\_\_\_\_\_ date \_\_\_\_\_

Parent’s signature

date

Parent’s name \_\_\_\_\_ Home phone \_\_\_\_\_  
(please print) Work phone \_\_\_\_\_

Family Physician’s name \_\_\_\_\_ phone \_\_\_\_\_

Alternate Emergency Contact

Name \_\_\_\_\_ phone \_\_\_\_\_

**NORTH CAROLINA PARKS & RECREATION  
PROGRAM EVALUATION**

Please take a few moments to evaluate the program(s) you received. This will help us improve our service to you in the future.

1. Program title(s) \_\_\_\_\_ Date \_\_\_\_\_  
Program leader(s) \_\_\_\_\_

2. What part of the program(s) did you find the most interesting and useful? \_\_\_\_\_  
\_\_\_\_\_

3. What part(s) did you find the least interesting and useful? \_\_\_\_\_  
\_\_\_\_\_

4. What can we do to improve the program(s)? \_\_\_\_\_  
\_\_\_\_\_

5. General comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**LEADERS OF SCHOOL GROUPS AND OTHER ORGANIZED YOUTH GROUPS  
PLEASE ANSWER THESE ADDITIONAL QUESTIONS:**

6. Group (school) name \_\_\_\_\_

7. Did the program(s) meet the stated objectives or curriculum needs? \_\_\_\_\_  
If not, why? \_\_\_\_\_

**Please return the completed form to park staff. Thank you.**

Fort Macon State Park  
P.O. Box 127  
Atlantic Beach, NC 28512