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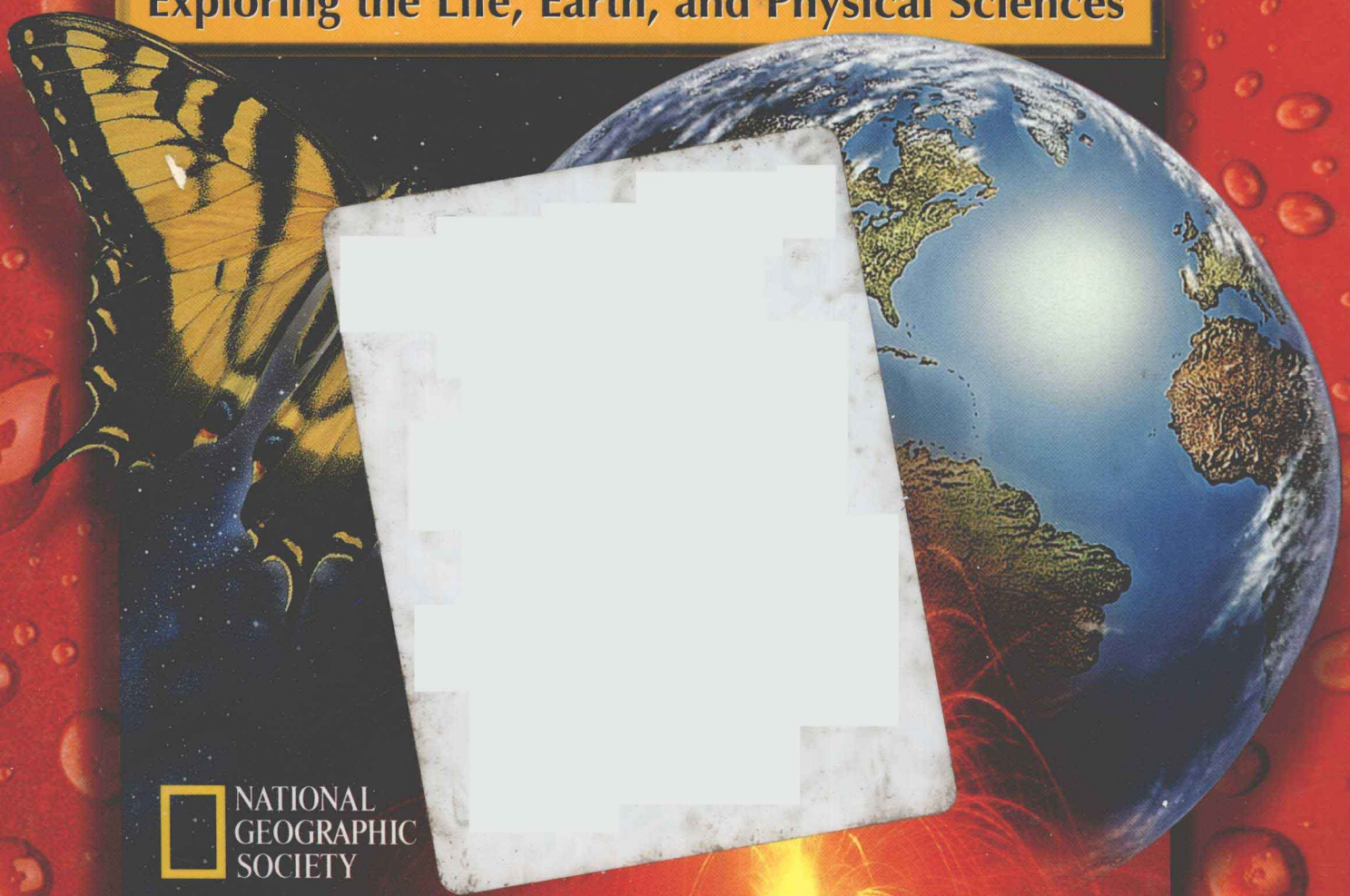
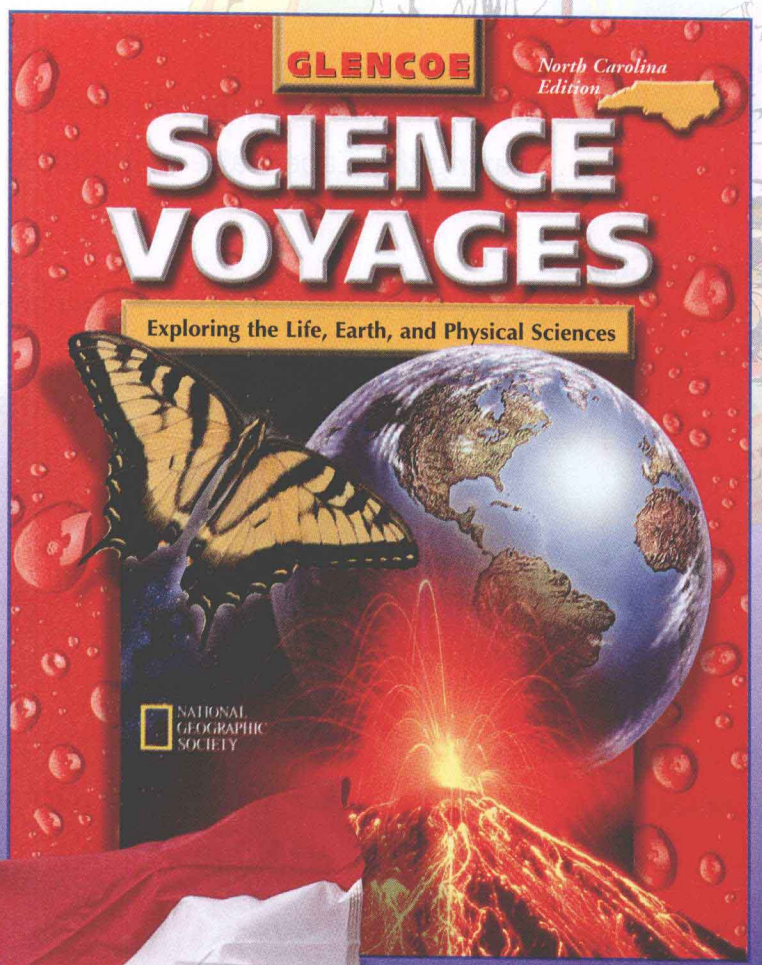


NATIONAL GEOGRAPHIC SOCIETY

North Carolina Case Studies



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North Carolina Edition

Glencoe Science Voyages

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What are the North Carolina Case Studies?

Welcome to Science Voyages for North Carolina. Do you like to find out what makes things work? Perhaps you just like to spend time fishing or watching birds. Whatever your interest, you will come to know that science is an exciting subject that has something for everyone. The case studies on the following pages will help you learn about science in your home state. They also will help you achieve the understanding of the standards for science that are listed in the North Carolina Standard Course of Study for Grade 6.

Science—what it is, how science is done, and the effects that scientific developments have on your life—is discussed in the articles and illustrations on the following pages. The Case Studies, and Inquiry Activities that go with them, have been selected to reinforce the Competency Goals and objectives of science for your grade level.

How to Use the North Carolina Case Studies

As you read each Case Study, notice that it is a topic about North Carolina. Notice too, at the beginning of each article, that it is correlated to the North Carolina Standard Course of Study for science. Each Case Study has one or more Inquiry Activities. These activities will help you understand each Science Competency Goal better and help you remember its importance.

At the end of each Case Study, there are references to chapters in your textbook where you will study similar concepts.

The North Carolina Advisory Board

North Carolina CASE STUDY

Saving the Cape Hatteras Lighthouse

COMPETENCY GOAL 1
The learner will build an understanding of the lithosphere.

Saving the Cape Hatteras Lighthouse

The lithosphere is the more rigid outer layer of Earth that includes the crust and upper mantle. The outermost layer of Earth, where soil-forming processes occur, is sometimes called the pedosphere. Serious problems can occur when beaches, soil layers, and other areas erode. In the following discussion, this problem will be explored.

A popular summer place is the Cape Hatteras National Seashore on the coast of North Carolina. This was the first national seashore park in the United States. The park is part of the Outer Banks, which is a long, narrow, curved sandbar that includes three islands. One of the islands is Hatteras Island.

At the southern tip of Hatteras Island is the most well-known lighthouse in North America—the Cape Hatteras Lighthouse. Its distinctive black-and-white, candy-cane design has made the lighthouse a popular landmark of the Carolina coastline. For many years, the tallest brick lighthouse in North America has been photographed, painted, and visited by thousands of people. Because of its historical importance to the region and the nation, the lighthouse and its buildings have been placed on the National Register of Historic Places.

A View from the Top

If you want to get a good view of the islands, visit the lighthouse and climb the 269 steps to the top. High above the beach, you can see a panoramic view of long stretches of beaches, sand dunes, marshes, and woodlands that go on for many kilometers. When you peer out over the ocean, you will see a helicopter platform rising out of the water. The platform was built on a shoal about 36 km

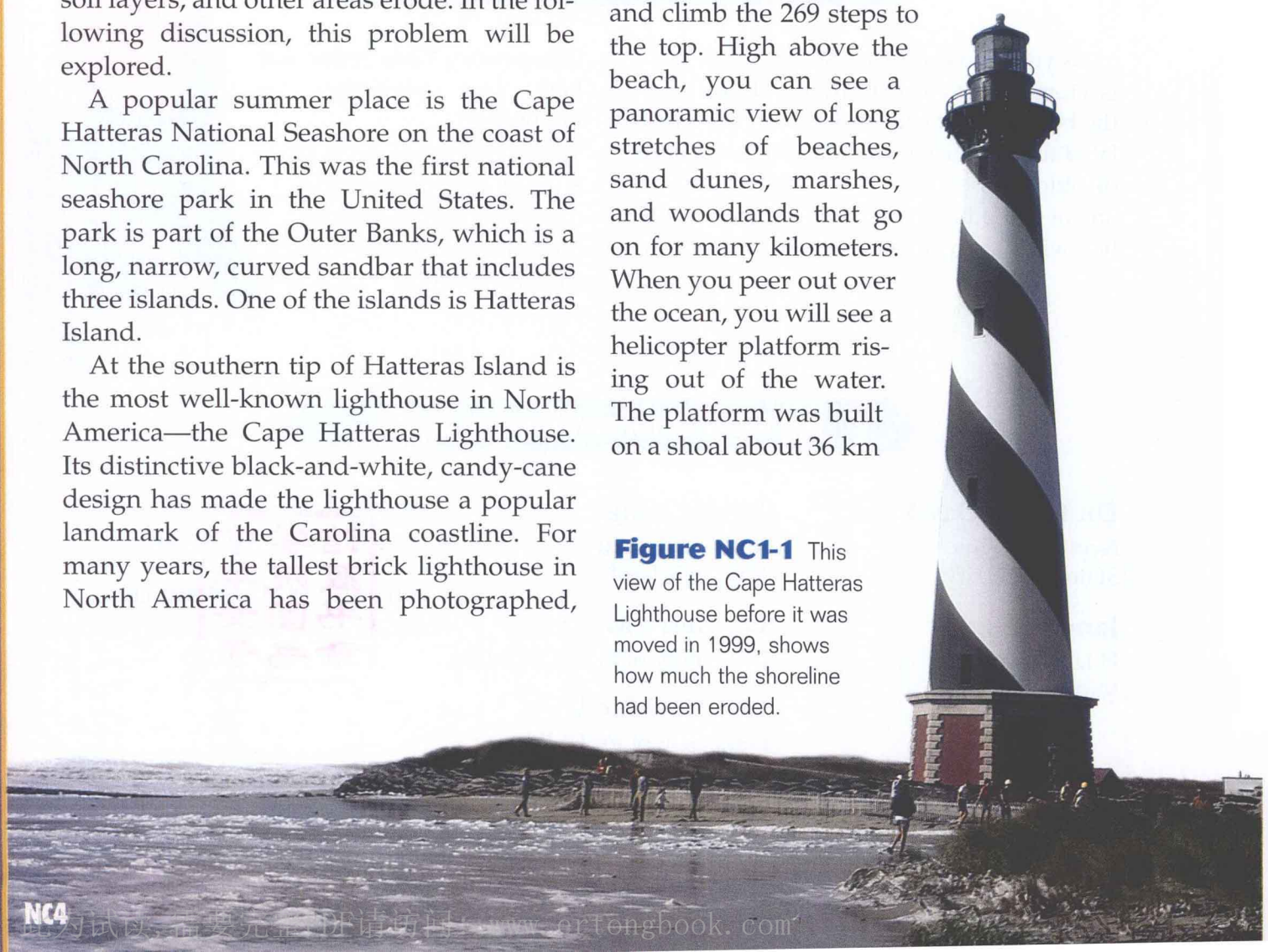


Figure NC1-1 This view of the Cape Hatteras Lighthouse before it was moved in 1999, shows how much the shoreline had been eroded.

Figure NC1-2 An aerial view of the Cape Hatteras Lighthouse shows the low-lying barrier island on which the lighthouse is built.

offshore. The shoal is an accumulation of shifting sand on the bottom of the ocean floor. In some places, the shoal is less than 10 m below water level at low tide. This shoal, called the Diamond Shoals, is potentially dangerous to ships. For hundreds of years, hundreds of shipwrecks have taken place at or near this location.

To protect shipping vessels, the present Cape Hatteras Lighthouse was built in 1870 and is more than 60 m high and weighs about 4700 tons. The lighthouse served as a navigational aid for sailing ships rounding the treacherous Diamond Shoals. The beacon light warned sea captains and their crews of the dangerous waters and prevented many ships from being grounded or sunk on the shoals.

Soil Erosion

The Cape Hatteras National Seashore is comprised of a series of barrier islands that are sandwiched between the Atlantic Ocean on one side and Pamlico Sound on the other side. The barrier islands, stretching for about 100 km, help protect the lowlands of eastern North Carolina from violent storms and massive waves.

However, for hundreds of years mechanical weathering and erosion have taken their toll on the islands. Fierce winds and heavy waves driven by violent storms and hurricanes have caused major erosion problems. As a result of these forces, the barrier islands have migrated westward toward Pamlico Sound. This migration occurs as storm-driven ocean waves wash completely over the islands. The water carries and deposits the sand sediments on the

Figure NC1-3 The new location (cleared area in the upper right) can be seen from the keeper's walk at the top of the lighthouse.

Pamlico side of the island. Because of this migration, barrier islands are among the most unstable landforms on Earth. Therefore, stationary buildings, such as the Cape Hatteras Lighthouse, are threatened by these conditions.

Inquiry Activity

Objective 1.03

Explain how humans can reduce the impact of erosion on Earth's pedosphere. Include the human impact on soils and sediments in coastal environments, and other developed areas.

Soil Erosion Threatens Lighthouse

When the lighthouse was built, it was situated 460 m from the shoreline. By 1919, the ocean had advanced to within 100 m of the tower. In 1997, the lighthouse was about 49 m from the eroding coastline. Erosion-control projects have been used at the lighthouse site to protect the structure. As an example, in 1969, the U.S. Navy built a series of groins (seawalls) that were placed perpendicular to the shore. The groins helped slow down the erosion. After a violent storm in the early 1980s, volunteers and citizens used sandbags, sand fences, and even synthetic seaweed to protect the lighthouse. All of these activities helped, but they did not stop the shoreline from moving closer to the lighthouse. Something more had to be done to save the lighthouse.

Inquiry Activity

Objective 1.01

Why is soil erosion a serious problem? Research in the library and with other resources the physical and biological processes that form soil. Include why soil is important to humans and how long it takes soil profiles to form. What other factors besides time affect soil formation?

What can be done?

The National Park Service makes decisions on how to preserve lighthouses. So, in 1987, the National Park Service asked the National Academy of Sciences to study and provide advice on how to save the Cape Hatteras Lighthouse. Meetings were held to evaluate and develop several options for preserving the lighthouse from the invading Atlantic Ocean. Everyone agreed that the major objective was to preserve the Cape Hatteras Lighthouse so that future generations would understand and appreciate the nation's maritime heritage. However, the debate was about how to do that.

Figure NC1-4 These sea oats growing on the coastal dunes in North Carolina stabilize the dunes and reduce erosion.

Keep It Where It Is...

One local group favored keeping the lighthouse in its present location. They reported that it would cost too much to move the lighthouse and it could be damaged during the move to another site. Their recommendations included adding more sand to the beach and constructing another groin. The groin would trap a portion of the sand that is moved by the offshore current. The buildup of sand would provide a wider and more protected beach in front of the lighthouse.

Another suggestion was to use underwater groins made of elongated bags filled with concrete and positioned on heavy mats. Functioning like speed bumps, the underground groins would slow the movement of water currents, creating deposits of sand that would build up the beach and eventually cover the groins completely. Since the water passes over the groins rather than around the ends, there is no erosion to the adjacent shoreline. However, this method was never used on the barrier islands.

...Or Move It

The National Park Service and others agreed that relocation was the best option to save the lighthouse. Their plan called for moving the lighthouse about 900 m to a

Figure NC1-5 The Block Island Lighthouse in Rhode Island was successfully moved in 1993.

new site. They reported that other lighthouses have been moved successfully. As an example, moving it saved the Highland Lighthouse on Massachusetts's Cape Cod. This lighthouse was only 30 m from the edge of a cliff when it was moved about 140 m to a more secure place. If the Highland Lighthouse was not moved, experts agree that the landmark would have toppled into the ocean within three or four years. The lighthouse on Block Island, Rhode Island, shown in **Figure NC1-5,** was also moved to a new location. Structural engineers experienced in moving similar buildings indicate that the Cape Hatteras Island Lighthouse could be moved without significant risk to the structure.

Because the lighthouse would be placed further back from the beach, the structure could be preserved for a long period of time from the advancing soil and beach erosion. The group also believed that there would be a minimum of ecological damage during the move and at the new site. Relocating the lighthouse would also reinforce state and government policies of allowing the natural processes of beach erosion to continue.

After much debate, a decision was made by the National Park Service to move the lighthouse. In 1998, the National Park Service received government funding to move the Cape Hatteras Lighthouse. The lighthouse was relocated 2900 feet over a period of 23 days in the summer of 1999.

Inquiry Activity

Objective 1.02

What is a soil profile? Find an area where a hole or cut has been made into the soil, at least 1 m to 1.5 m in depth. As a class, describe the features of the soil profile and make a labeled drawing of the profile in your Science Journal. Include a description of the layers, or horizons, in the soil, the color, the texture, the amount and type of organic material; the pH, the temperature; and any soil structures.

Going Further

To learn more about the lithosphere, see:

1.01 Chapter 3, Section 1, Landforms
Chapter 4, Section 2, Igneous and Sedimentary Rock
Chapter 4, Section 3, Metamorphic Rock and the Rock Cycle
Chapter 5, Section 1, Weathering
Chapter 5, Section 2, Soil
Chapter 6, Section 1, Gravity
Chapter 6, Section 2, Glaciers
Chapter 6, Section 3, Wind
Chapter 7, Section 2, Using Land
Chapter 7, Section 3, Recycling
Chapter 8, Section 2, Seedless Plants
Chapter 9, Section 2, Plant Processes

1.02 Chapter 5, Section 2, Soil
Chapter 6, Section 3, Wind
Chapter 7, Section 2, Using Land

1.03 Chapter 1, Section 1, How Science Works
Chapter 3, Section 1, Landforms
Chapter 5, Section 2, Soil
Chapter 6, Section 1, Gravity
Chapter 6, Section 2, Glaciers
Chapter 7, Section 1, Population Impact on the Environment
Chapter 7, Section 2, Using Land
Chapter 7, Section 3, Recycling
Chapter 8, Section 1, Characteristics of Plants

North Carolina CASE STUDY

North Carolina's Carnivorous Plants

COMPETENCY GOAL 2
The learner will investigate the characteristics of matter and energy flow through an ecosystem.

Most plants obtain the nutrients and the energy needed for their life processes from the soil and the sun. In the following discussion, plants that obtain some of their energy and matter in other ways will be explored.

West of Raleigh and close to Chapel Hill is the North Carolina Botanical Garden. The garden contains a collection of plants that reflect the vegetation of the various regions of North Carolina. Near the visitor's center is a notable collection of the carnivorous plants found within the state.

A Pattern for Survival

Several carnivorous plants grow in North Carolina. Venus's-flytraps, pitcher plants, sundews, butterworts, and bladderworts can be found in the sandy, boggy soil in coastal areas. This soil is low in nitrogen and the carnivorous nature of these plants is an adaptation to the nutrient-poor soils in which they grow. To obtain enough nutrients, especially nitrogen, these plants

Figure NC2-1 Shown here is the extensive pitcher plant display at the North Carolina Botanical Garden in Chapel Hill.

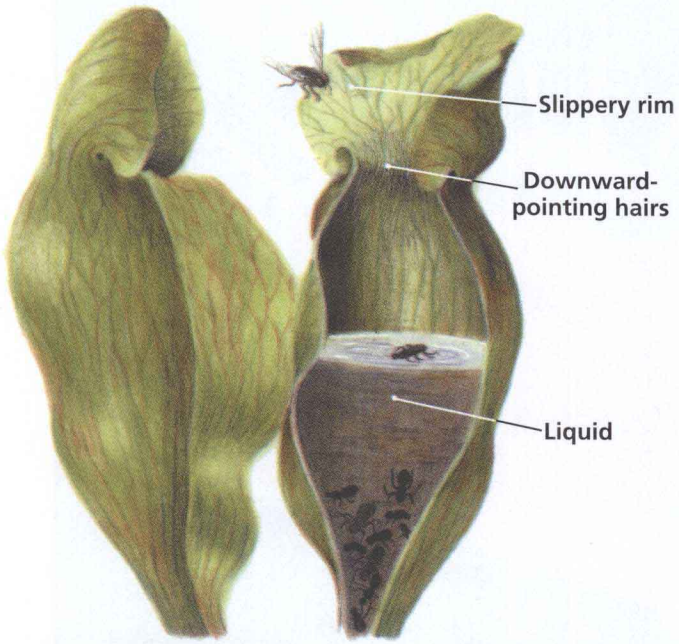
have evolved the ability to extract nutrients from the flesh of other organisms. The adaptations for this ability include sticky, flypaper-like surfaces, spring-like trap-doors, and pitfalls leading to vats filled with digestive enzymes. The trapping mechanisms of these plants are either passive or active. Passive traps involve no movement to trap their prey; active traps move.

Pitcher Plants

Pitcher plants get their name from the shape of their leaves. Like a pitcher, the leaves are bowl-shaped at the bottom and narrow at the top. Glands on the outside of the green leaf secrete nectar, a sweet-tasting liquid that attracts many kinds of insects. The end of the leaf forms a hood that curves over the plant's mouth providing shade and keeping rainwater from filling the leaf.

Figure NC2-3 There are six different varieties of pitcher plants that live in North Carolina. This example is the *Sarracenia leucophylla* variety.

Figure NC2-2 The slippery outer rim and the downward-pointing hairs trap the insects in the pitcher plant. The liquid contains digestive enzymes that break down the insects.



The underside of the hood is covered with hairs that point downward. An insect clings to these hairs as it moves down the leaf to get more nectar. At the mouth, the hairs stop and a waxy substance makes the walls of the leaf slippery. The insect slides down into the bowl-shaped bottom where digestive enzymes have collected. In some species, the digestive enzymes are strong and in others, they consist mostly of water. Bacteria that live on the insects help break them down.

Of the nine known, native, North American species of pitcher plants, six are found in North Carolina. The odor of decaying insects in pitcher plants is foul to humans but attracts other insects that feed on dead organisms.

Inquiry Activity

Objective 2.03

Explain how the activity of the pitcher plant and an insect is an example of a predator-prey relationship.

Venus's-flytraps

The Venus's-flytrap lives within a 200-kilometer radius of Wilmington, North Carolina. It is found in bogs, or savannas and traps ants, beetles, spiders, and flies. It has sticky leaves at the end of its broad, flat, green stalk. The active trap is a specialized leaf blade with oval halves that are hinged along the middle. Trigger hairs on the inside of each leaf half cause the trap to close. The edge of the trap has a row of long stiff spines. Its upper surface is bright-red to pale-green in color and has glands that produce digestive enzymes.

When an insect gets between the two halves of the trap and touches any two of six trigger hairs, the halves silently snap shut in less than one second. The insect

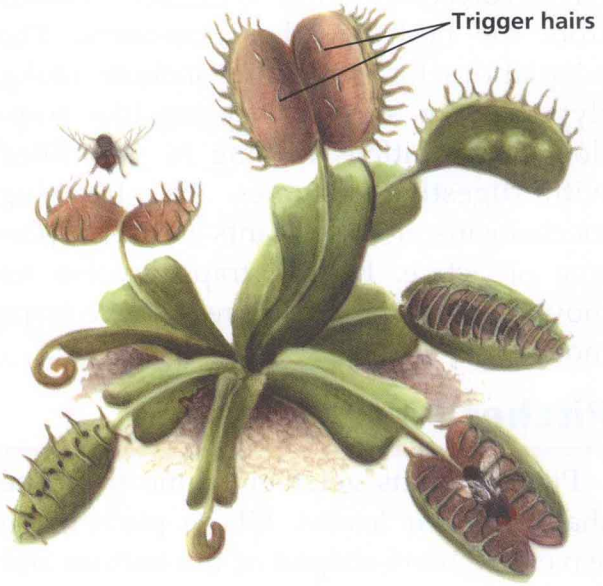


Figure NC2-4 The Venus's-flytrap has sticky leaves. When an insect lands on the leaves, trigger hairs cause the hinged leaves to close. This traps the insect.

Figure NC2-5 This Venus's-flytrap is the variety *Dionaea muscipula.*

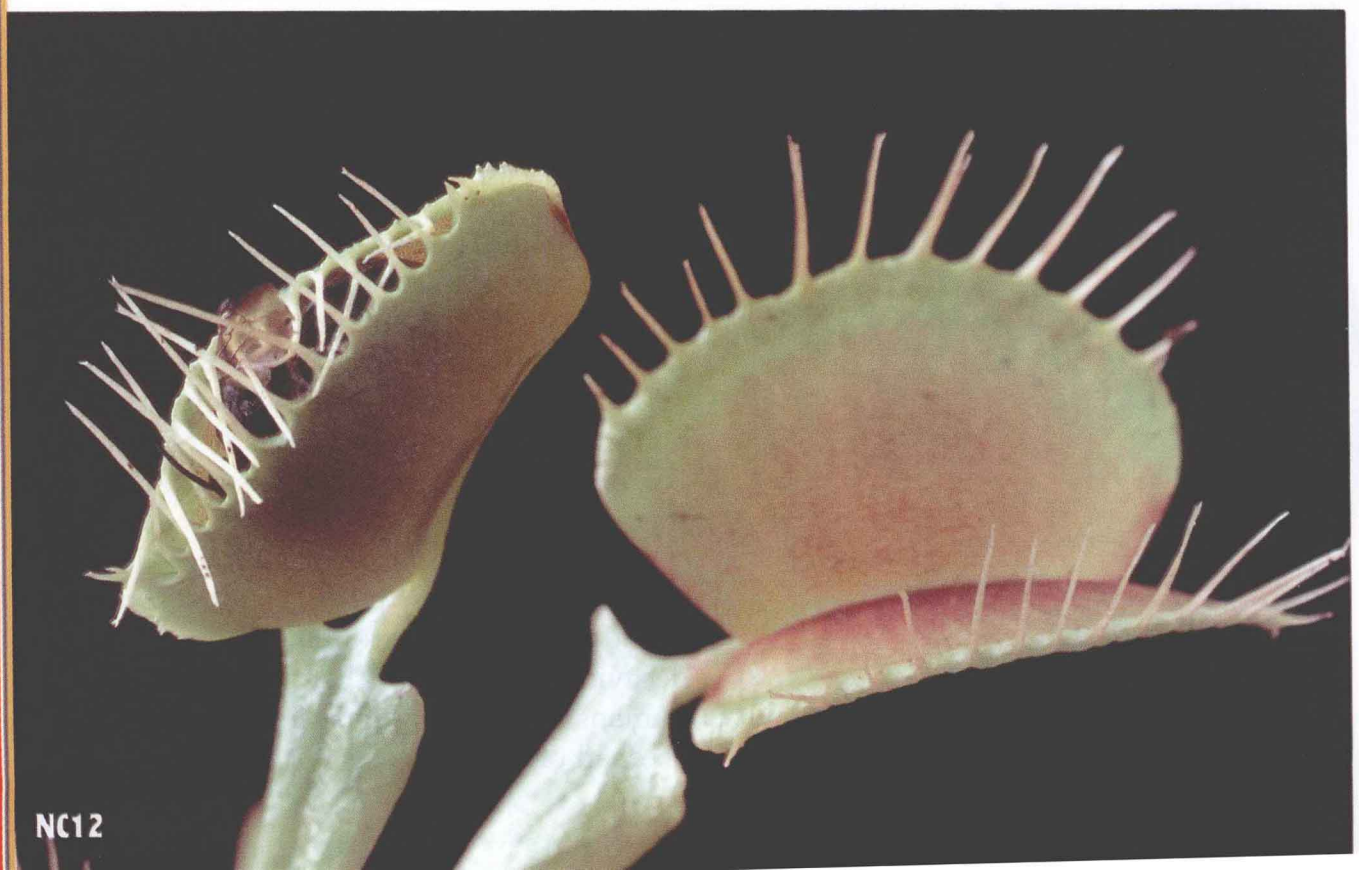


Figure NC2-6 The sundew attracts insects with a scent and then traps them with a sticky substance on the leaves.

struggles for an hour or so as the tiny area fills with enzymes that digest the insect. The trap absorbs the liquid food and reopens in three days to two weeks. A trap wears out after one to four insects are consumed, and then the whole leaf turns black and dies. The plant continues to grow new leaves with fresh traps.

Sundews

Sundews are beautiful, carnivorous plants that are often difficult to see because larger plants obscure them. At least five species grow in North Carolina. The roundleaf sundew covers about 9 centimeters and has a pink or white flower. Tiny, red tentacles cover each of its green leaves. A gland at the end of each tentacle produces a sticky substance that glistens in the sun and looks like dew. This is how the plant gets its name.

The sundew's deceptive appearance and attractive smell draw flies and other insects to its leaves. When an insect lands on a leaf, it becomes trapped in the sticky liquid. The more the insect struggles, the more liquid is given off by the gland at the tip of each tentacle. When the prey is trapped, the plant curls over its entire leaf in order to produce digestive enzymes. The leaf stays curled over for four or five days as the plant digests the insect. The leaf then unfolds to catch another insect.

Inquiry Activity

Objective 2.04

What might be the consequences for carnivorous plants if they were deprived of their insect-food supply? Give reasons for your answer.

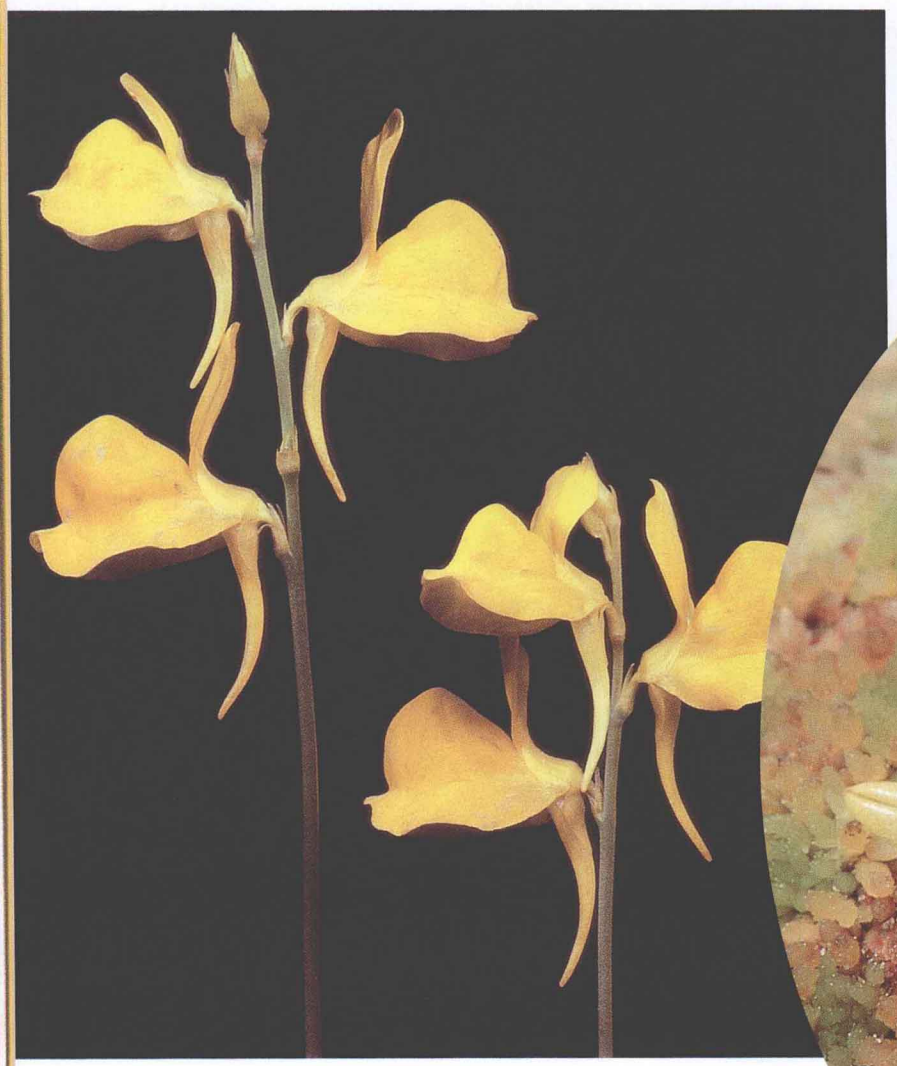


Figure NC2-7 The horned bladderwort, *Utricularia cornuta*, is one of the many carnivorous plants that live in North Carolina.

Figure NC2-8 This butterwort, *Pinguicula sp.*, is found in the Croation National Forest in North Carolina.

Bladderworts

Bladderworts are tiny plants that usually live in water. Part of the plant is a long, thin stalk with a small flower on top that grows above the surface of the water. Underneath the water surface, the plant looks like tree roots with tiny sacs or bladders. The sacs trap insects that provide nourishment for the whole plant.

While waiting to catch an insect, the sac is flat. When a water insect brushes the hairs around the opening of the sac, the sides of the sac quickly expand. Water rushing into the sac carries the insect with it. Most bladderworts digest small insects within 30 minutes and large insects within two hours.

Butterworts

Butterworts, also called bog violets, live in warm, marshy areas and produce flowers that look like violets. Their leaves are

small and fleshy with edges that curl toward the center. The leaves are covered with a musty-smelling substance that feels greasy, or buttery, and attracts insects.

Butterworts, as shown in **Figure NC2-8,** trap tiny insects such as gnats and small ants. When the insect becomes trapped on the greasy surface of the leaves, digestive juices come out of specialized leaf cells and the leaves start to curl. It takes a butterwort about one day to close completely and another day to digest the insect.

Protecting Carnivorous Plants

Sundews and butterworts are plentiful in North Carolina but Venus's-flytraps, pitcher plants, and some bladderworts are either endangered or threatened species. Poaching is one reason for the scarcity of Venus's-flytraps. Another reason is the control of fires. Without periodic fires, shrubs and hardwoods take over the savanna regions. When the dominant plants are woody, fires seldom occur. As a result, the savanna disappears along with nonwoody plants. Caterpillars and moths damage the flowers and leaves of some carnivorous plants such as pitcher plants.

Development is the worst enemy of carnivorous plants. By draining swamplands, development has caused the loss of habitats of many carnivorous plants. This, along with poaching, may cause all carnivorous plants to become endangered.

Inquiry Activity

Objective 2.04

Find out what laws in North Carolina protect the carnivorous plants described here. What are the consequences for poaching these plants? Put together an informative brochure on a particular carnivorous plant in North Carolina. Include information about laws that protect plants in North Carolina.

Going Further

To learn more about matter and energy flow through an ecosystem, see:

2.01 Chapter 7, Section 2, Using Land
Chapter 8, Section 1, Characteristics of Plants
Chapter 8, Section 2, Seedless Plants
Chapter 8, Section 3, Seed Plants
Chapter 9, Section 1, Photosynthesis and Respiration

2.02 Chapter 7, Section 2, Using Land
Chapter 8, Section 1, Characteristics of Plants
Chapter 10, Section 3, Matter and Energy
Chapter 11, Section 2, Unity of Life

2.03 Chapter 7, Section 1, Population Impact on the Environment
Chapter 7, Section 2, Using Land
Chapter 9, Section 1, Photosynthesis and Respiration
Chapter 9, Section 2, Plant Processes
Chapter 10, Section 1, The Living and Nonliving Environment
Chapter 10, Section 2, Interactions Among Living Organisms
Chapter 10, Section 3, Matter and Energy
Chapter 11, Section 1, Diversity of Life
Chapter 11, Section 2, Unity of Life
Chapter 16, Section 2, Why do things fall?

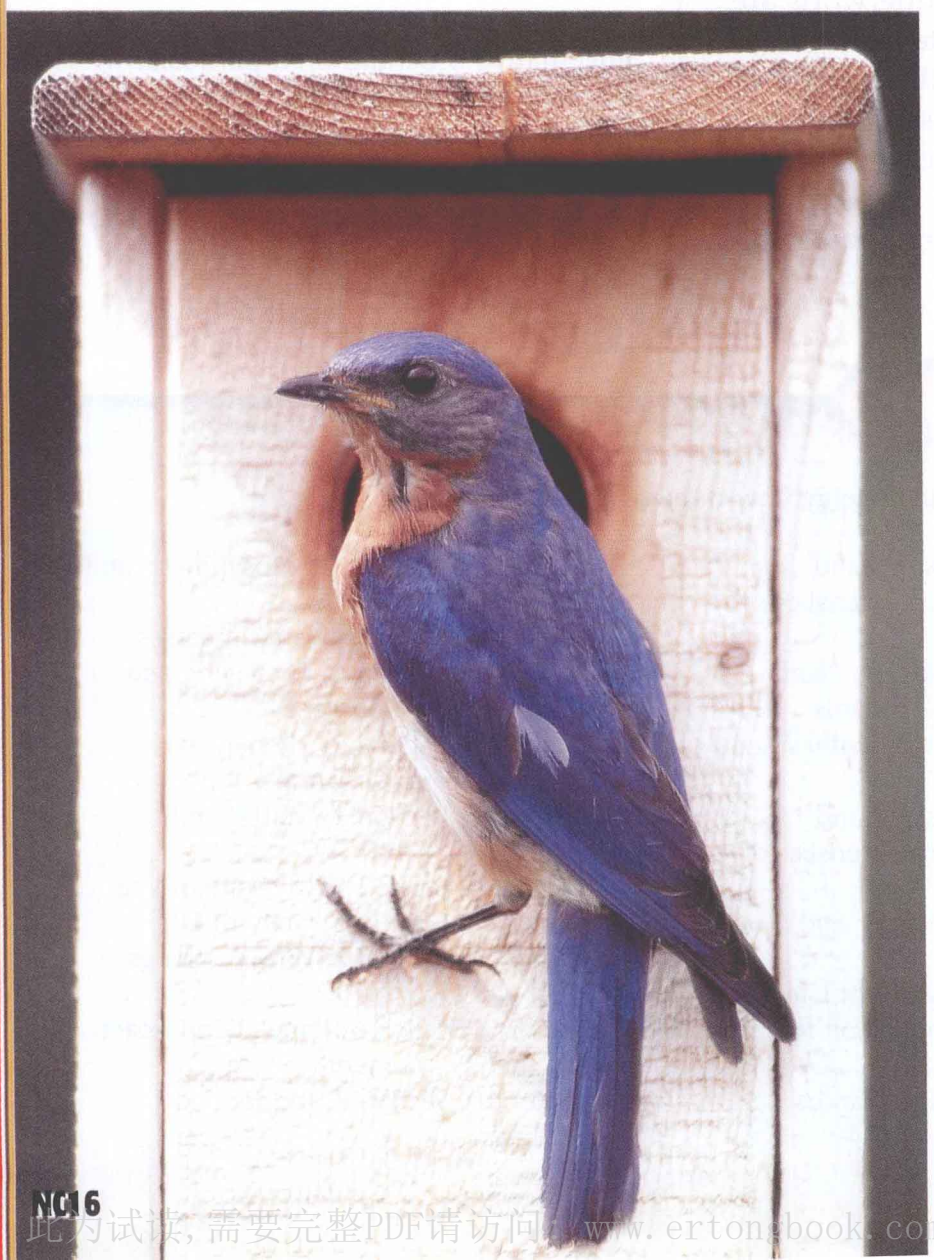
2.04 Chapter 7, Section 1, Population Impact on the Environment
Chapter 10, Section 3, Matter and Energy

North Carolina CASE STUDY

Introduced Species

COMPETENCY GOAL 2
The learner will investigate the characteristics of matter and energy flow through an ecosystem.

When settlers flocked to North Carolina in the 1600s, they were greeted by the songs of bluebirds. These tiny songbirds were once common throughout the eastern United States, heralding the approach of spring with cheerful warbles. By the 1960s, however, bird watchers began to notice a drop in bluebird numbers. Why? Other bird species, such as the European starlings and house sparrows, were competing with bluebirds for nesting sites. Bluebirds, starlings, and sparrows all nest in cavities—old woodpecker holes, fence posts, and bird boxes. When a sparrow comes across a bluebird nest, it will toss out the pale blue eggs and claim the nest for its own.



A Long Way from Home

Unlike bluebirds, starlings and sparrows are not native to North Carolina. They are introduced species that were brought to America from Europe. Introduced species are plants and animals that have been transported from their native ecosystems to new ecosystems.

The introduction of a new species can occur in several ways. Animals, for instance, sometimes migrate to new areas. Plant seeds may be carried by wind or water to new habitats. People, however,

Figure NC2-9 Building bluebird boxes provides nesting sites for the Eastern bluebird.