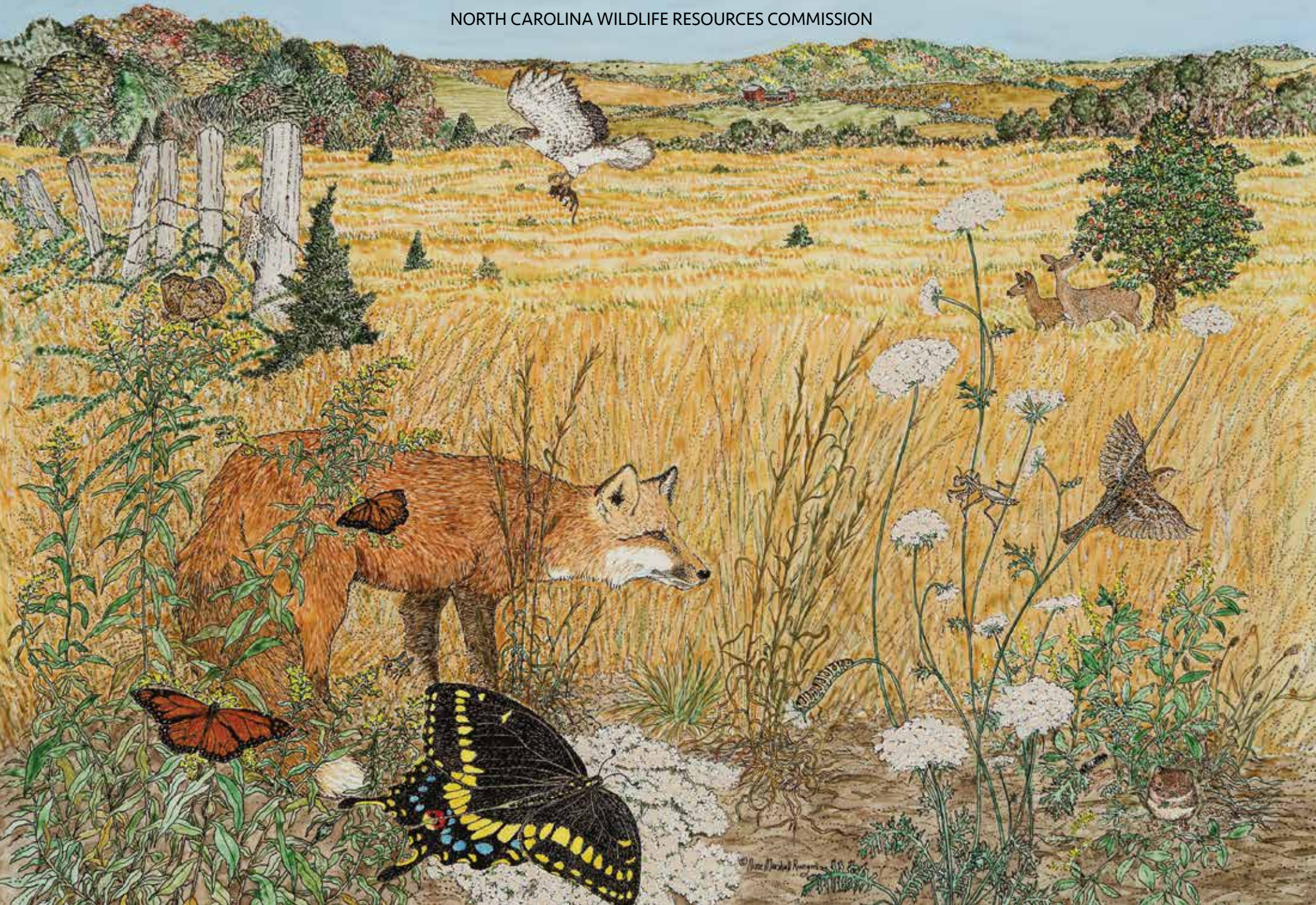


NORTH CAROLINA WILD PLACES: A CLOSER LOOK

NORTH CAROLINA WILDLIFE RESOURCES COMMISSION



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THE NORTH CAROLINA WILDLIFE RESOURCES COMMISSION

The N.C. Wildlife Resources Commission is the state agency that is responsible for regulating the hunting, fishing and trapping activities that go on in North Carolina. But our duties and responsibilities encompass much more than that.

We are biologists who conduct research on wildlife, both game and nongame, common and endangered. We are officers who enforce the state's wildlife laws. We are writers, editors, photographers and graphic designers who produce publications about wildlife, notably *Wildlife in North Carolina* magazine. We are educators who teach environmental education to teachers and students. We are an agency that cares about the wildlife that is our charge and the natural resources on which wildlife depend.

EDITED BY LAWRENCE S. EARLEY • ILLUSTRATED BY ANNE MARSHALL RUNYON

NORTH CAROLINA WILDLIFE RESOURCES COMMISSION • DIVISION OF CONSERVATION EDUCATION, RALEIGH, NORTH CAROLINA

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ACKNOWLEDGMENTS

It has been over 24 years since North Carolina Wild Places: A Closer Look was first printed and even longer since it was first conceived.

The project arose in the Wildlife Education Division, which facilitates educator trainings, such as Project WILD and Growing Up WILD, which are just a few of the formal and non-formal educator workshops offered by NCWRC. The Wildlife Education Division also manages the Hunter Education program, the Becoming an Outdoors Woman program, three education centers, the shooting sports program, *Wildlife in North Carolina* magazine and much more.

The original writing, graphic design and artwork for the book took the efforts of a talented group of naturalists, educators, biologists, graphic designers and artists. We want to acknowledge the hard work these folks put into this book, without which you wouldn't have this version today. Those people are: John Alderman, A. Sidney Baynes, Carl Betsill, Alvin Braswell, Jim Brown, John Connors, Phil Doerr, Mike Dunn, Lawrence S. Earley, Steve Hall, Merrill Lynch, Laura Mansburg, David Penrose, Sarah Friday Peters, Donnan Robbins, Anne Marshall Runyon, Michael Schafale, Kimberly KC Schott, Ernest Seneca, Terry Sharpe, Lundie Spence, Dennis Stewart, Perry Sumner, Mark Taylor, Vic Venters, Alan Weakley, Tom Wentworth and Randy Wilson.

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INTRODUCTION

What is a habitat and why is it important to wildlife? What are some of North Carolina's most important wildlife habitats? How are animals adapted to their habitats? What is the importance of particular habitats in our state and how are they threatened today?

These are basic questions that people ask about wildlife habitats in North Carolina, yet before the publication of this book you might not have been able to find answers to them on the shelves of your bookstore or library.

That's the reason why the N.C. Wildlife Resources Commission published *North Carolina WILD Places: A Closer Look*. Between the covers of this book are found short, accurate descriptions of 13 of North Carolina's major habitats, including their plants and animals. Some of these habitats are widespread through North Carolina, while others are limited to relatively small areas of the state. Carolina bays exist nowhere but in the southeastern portion of the state, and trout streams are found in the upper elevations of our mountains.

The state contains dozens of habitats, some quite large and others tiny, but in this book we've focused on 13 of the most important.

HOW TO USE THIS BOOK

After the introductory chapters on habitat, four chapters discuss specific habitats found in each of the physiographic sections of the state. Each habitat discussion begins with a sensory introduction. You are there, walking through the habitat at a particular time of year, aware of colors, sounds and smells characteristic of the habitat. Anne Marshall Runyon's illustrations show you what the habitat looks like and where key plants and animals are located. An illustration key identifies each of the plants and animals depicted.

Next, is a full discussion of the dynamics of the habitat and short natural histories of the plants and animals. The species in bold print are depicted in the illustration. The importance of each habitat is noted, as well as the forces that threaten it. We've also provided a list of public areas where examples of each habitat can be visited.

WHO WILL USE THIS BOOK?

North Carolina WILD Places: A Closer Look has been written with many audiences in mind. One of our primary audiences will be educators, formal and non-formal. We hope the book will give educators and their students a handy guide to the diversity of the state's natural communities.

THE PURPOSE OF NORTH CAROLINA WILD PLACES: A CLOSER LOOK

This book is intended to help the reader understand some of North Carolina's most important natural communities and the ways that humans affect them. The concentration of our population in the Piedmont section of the state has meant that few natural communities there have survived intact. But in the Coastal Plain and the Mountains, the remnant natural communities are daily affected by various human activities, most of them intended to accommodate a growing population. What are we losing as we grow? Do the gains outweigh the losses? We should not be surprised to learn that a naturally functioning ecosystem is as important to the health of humans as to that of wildlife. Informed citizens make good decisions about what is important. This is the educational goal behind *North Carolina WILD Places: A Closer Look*.

"A child's world is fresh and new and beautiful, full of wonder and excitement. It is our misfortune that for most of us that clear-eyed vision, that true instinct for what is beautiful and awe-inspiring, is dimmed and even lost before we reach adulthood. If I had influence with the good fairy who is supposed to preside over the christening of all children, I should ask that her gift to each child in the world be a sense of wonder so indestructible that it would last throughout life..."

—Rachel Carson, *The Sense of Wonder*

MORE BIRD LORE

Woodcocks like to probe moist soil with their long bills, looking for insects and worms. Their bills have “prehensile” tips, meaning they can open and close even when they’re underground. So sensitive are the bills to movement that woodcocks can actually seize and swallow an insect without removing its bill from the ground.

HABITAT IS HOME

All of these species may differ greatly, yet they are linked by at least one thing; each of them has a home it fits into as snugly as a hand in a glove. You won’t find a fish walking about in a forest, for example, or a deer nibbling plants at the bottom of the ocean. Each animal has a proper home that we call a *habitat*. Habitat is where an animal lives, where it finds its food and water, where it goes to escape from its enemies, and where it finds enough space to carry on its life. Habitat is home.

Wildlife habitats can be found just about anywhere—on land, in water and even in areas in-between. There are *aquatic habitats* on the bottom of a pond or even on the surface of a pond, behind a rock in a rushing stream or deep in the ocean. *Terrestrial habitats* may occur at the top of a frozen mountain, in a cave where light never enters or in a dead log lying on the forest floor. And some of the richest wildlife habitats are *wetland habitats*, where the soil is saturated with water much of the year.

Habitats are different because each has a unique combination of soil, temperature and rainfall. Among terrestrial habitats, for example, are quite different forest types: bottomland hardwood forests, longleaf pine forests, spruce–fir forests and others. A longleaf pine tree and a Fraser fir tree are both coniferous (cone-bearing), yet only the longleaf pine is adapted to the sandy soils and frequent natural fires of the Coastal Plain. Only firs and spruces are suited to the frigid climate of our mountain peaks.

Each of these habitats has a community of sometimes unique animal inhabitants. The Southern fox squirrel and the Northern flying squirrel are both squirrels, but the fox squirrel is found primarily in longleaf pine forests in the Coastal Plain, while the Northern flying squirrel is found in spruce–fir forests in mountains above 5,000 feet. Only in these habitats is each animal able to satisfy its needs for food, water, cover and space.

A habitat can be large or small, depending on the animal. A pine vole may never get farther than a hundred yards from where it was born. A black bear, on

the other hand, may roam across several square miles of Coastal Plain habitats from spring to fall to satisfy its needs. River otters may need as much as 50 miles of stream habitat, while wood ducks with ducklings may travel a mile a day or more during the spring.

An animal’s habitat may change during the day and during the year. At twilight and dawn, white-tailed deer browse on tender leaves along open field edges, but when they bed down they seek cover in dense woodland nearby. As the weather gets colder, they look for thickets of evergreen vegetation for shelter. In spring, a black bear in eastern North Carolina might forage in swamps for greenbrier. In summer, when blueberries ripen in Carolina bays, the bear will move there, and in fall, it will eat acorns and fruit growing in swamps and on sand ridges. A newt hatches in a pond then often spends the next several years as a “red eft” crawling about the forest floor and hiding in rotting logs and wet, mossy places. After this juvenile adventure, the newt spends the last years of its life as a mature adult back in the pond again.

This is to say that most animals may not be able to find everything they need in a single habitat. Wildlife need a diversity of habitats in which to survive. Indeed, the edge between two habitats, often called the “ecotone,” is often the place where you will find the most wildlife. Where a field and a forest come together, for example, you may see birds and other animals that are unique to each habitat plus other animals that can exploit the transitional zone in-between.

SURVIVING IN A CROWDED WORLD

Many people, especially in the United States, choose whether to live in a house or an apartment, in a warm climate or cold, beside the ocean or on a mountain slope. The choice is based on such things as the availability of work, the size of the family, the safety of the neighborhood, the quality of the schools and the cost of living. And if a parent gets a new job, the family can move to the other side of the state or even to a new state.

But fish and wildlife don’t have much choice over the habitats in which they live. That’s because over

many thousands of years, animals have been shaped by their environments, developing “tools” that help them exploit the habitat to its fullest. These tools are called adaptations.

Some of these adaptations are physical ones—differences in color, shape, size, etc. For example, bird bills exhibit a tremendous variety of shapes, each one enabling a bird to access certain foods in its habitat. The pelican’s pouch allows it to hunt for fish in aquatic habitats. Opening underwater, the pouch scoops up a mouthful of water and fish and the water rushes out. The woodcock’s long, slender bill enables it to probe for earthworms several inches below the surface of the ground. The hawk’s curved bill enables it to hunt animals and tear their flesh. Each bill fits the particular needs of a particular animal in a particular habitat.

But nature doesn’t play favorites. Predators’ adaptations enable them to hunt effectively, but prey creatures’ adaptations give them a chance to escape. Among the superlative physical adaptations of a great horned owl, for example, are wing feathers that muffle the noise of its flight; extraordinarily sensitive ears that can pinpoint the sounds of prey even in the dark; strong talons for gripping prey; a hooked bill for ripping fur and flesh; and binocular vision. All of these adaptations make the owl a formidable hunter.

On the other hand, a prey creature such as a rabbit isn’t helpless. It can hear quite well with its extra-large ears; it has strong hind legs that launch it quickly on its way once it senses danger; and with eyes on the sides of its head it can detect movements on all sides.

Rabbits also jump quickly from side to side when they run, and they double back on their tracks. These behavioral adaptations may help the rabbit live another day when it’s being pursued by a predator.

Other behavioral adaptations include a fawn’s instinct to freeze when alerted by danger, an instinct that gives the young deer a chance to survive. In the Coastal Plain, the tiger salamander and other amphibians mate in ponds that are wet only in winter and early spring and dry when the weather turns hot. Thus by mating in December and January, salamanders produce young that can develop and leave

the pond before the water evaporates. It may have taken the salamanders thousands of years to evolve this behavioral adaptation that has enabled them to exploit this habitat.

Adaptations enable wildlife to coexist in a crowded habitat without competing for the same food. Take the examples of the pickerel, the bluegill and the sucker, three fish that are adapted to lake habitats but not exactly in the same way. A pickerel ambushes small fish in the weed beds near the water’s surface, while the bluegill feeds on crustaceans, aquatic insects and tiny fish in the shallow portions of the lake. The sucker sifts its vegetable and animal diet from the lake’s mud bottom.

You might say that these fish all work in the same building, but on different floors doing different jobs. What enables them to avoid tripping over each other is a variety of different physical and behavioral adaptations. The pickerel’s mouth is long and narrow, for example, and studded with teeth that can hold a swiftly moving fish. Its body is streamlined, a good adaptation for a predator that ambushes fish by lunging from concealment. It has an elongated stomach that enables it to swallow fish almost its own size.

The bluegill, on the other hand, has a small, flexible mouth that can suck in small insects from submerged vegetation. Its body shape is more compressed, enabling it to maneuver both to feed on insects and to escape lunging predators like the pickerel. Its stomach is smaller but capable of being expanded while digestive juices help break down the food it eats.

Wildlife biologists say that each of these animals occupies a different niche. Habitat is where an animal lives and gets its food, water and shelter; the niche is how the animal makes a living in a habitat that is filled with many other animals. It includes the kind of food it eats, its activities, its daily and seasonal behavior, and how it relates to other animals in the habitat.

Although all wildlife species are adapted to certain habitats, some are more adaptable than others. Animals that can survive in many different habitats are called *generalists*, while those with more specific requirements are called *specialists*. A white-tailed deer,

POPULATION FLUCTUATIONS

When do you think wildlife populations are generally highest—spring or fall? The answer is summer. Most wildlife species breed in the spring and feed their growing young with summer’s food bounty. Wildlife populations generally begin to decline in the fall and continue falling until the following spring. That’s because they outstrip their habitat’s ability to feed them. In biological terms, they exceed the “carrying capacity” of the habitat.

PYRAMID OF NUMBERS

At the bottom of a food chain are hosts of insects and other creatures that are both numerous and small. As you go up the food chain, the animals get larger but there are fewer of them. At the top are the largest predators of all—alligators and eagles—that are naturally less abundant in nature. Thus, a food chain forms a pyramid. The wide base consists of abundant insects and other small animals; the narrow top consists of a top predator whose populations are generally scarce.

for example, is a generalist because it can adapt to many different habitats across the state. It doesn't rely on a single kind of food, nor is it choosy about where it finds cover. Raccoons are generalists, too, and so are opossums, bullfrogs, robins, largemouth bass and lots of other creatures. Certainly humans must be considered the ultimate generalists. We're able to live in a variety of environmental conditions using tools and technology to adapt to our surroundings.

In contrast, red-cockaded woodpeckers are nothing if not choosy. This wildlife specialist not only requires open longleaf pine forests for its habitat, but mature longleaf pine trees—trees that are at least 75 to 100 years old. Most woodpeckers build their cavities in dead trees, but not the red-cockaded woodpecker. Because longleaf pine forests burn frequently, standing dead trees are uncommon. The red-cockaded woodpecker has adapted to these conditions by digging its cavities in living trees, especially older ones infected with a disease called “red heart” that softens the tree's interior, making it easier to dig out the wood. This woodpecker has been more successful than other woodpeckers in exploiting this once vast forest (see “Sandhills Longleaf Pine Forest”).

This success has also been its undoing. As the longleaf pine forests were cut down or grew up in oak thickets, this woodpecker lost its primary habitat. Today the red-cockaded woodpecker is an endangered species.

When environments tend to be constant, specialists have an edge. A species that is able to exploit a hard-to-get food or a narrow habitat will have fewer competitors than the generalist. But specialists are more vulnerable to changing conditions, a problem that the more adaptable generalist doesn't face.

POPULATION CONTROL

Although habitats are filled with innumerable niches holding many different kinds of animals, only a limited number of individuals belonging to a particular species can fit into that habitat at a particular time. This is called the habitat's “carrying capacity” for that species. Some habitats have a higher carrying capacity than others. Carrying capacity also varies

from season to season and it changes over time as the habitat changes.

Carrying capacity is not an exact number. A given population always seems to fluctuate between highs and lows. The rabbit population in a field may increase periodically, for example, but eventually it will decline. The food supply may decrease as the rabbit population soars, causing increased competition among rabbits for the remaining food. Some rabbits will starve, but starvation is only one of nature's brakes on population. Predators will also whittle down the rabbit population. And as more rabbits occupy the field, diseases from viruses or parasites are more easily spread from animal to animal. These diseases may not necessarily kill the rabbits outright, but they may weaken them so that they fall prey to predators or even to severe weather.

Thus a number of factors are always working to keep wildlife populations in check, and predators as well as prey are affected. With fewer rabbits to hunt, predators may turn to more fertile hunting grounds, or their populations may begin to decline. At this point, the rabbit population may increase once again.

In some cases, “limiting factors” determine the carrying capacity of a habitat. Limiting factors are deficiencies in a habitat that prevent populations from increasing. Woodpecker populations, for example, may be limited by a small number of dead trees available for nesting cavities. Or perhaps a high number of predatory Cooper's hawks may be a limiting factor.

THE WEB OF LIFE

As we discuss how animals adapt to their habitats, it may be growing clearer that plants and animals are not independent of each other, but are connected within each habitat by complex relationships. For example, grasses provide food for rabbits, and rabbits provide food for hawks, owls and bobcats. It might be easy to understand that bobcats depend on rabbits for food, but rabbits also depend on bobcats and other predators, too. Without predators, rabbits might soon overpopulate their habitat, causing starvation and disease among other rabbits. So by helping to control the rabbit populations, predators are actually helping

the rabbits and the community as well. Each performs an important service to the community.

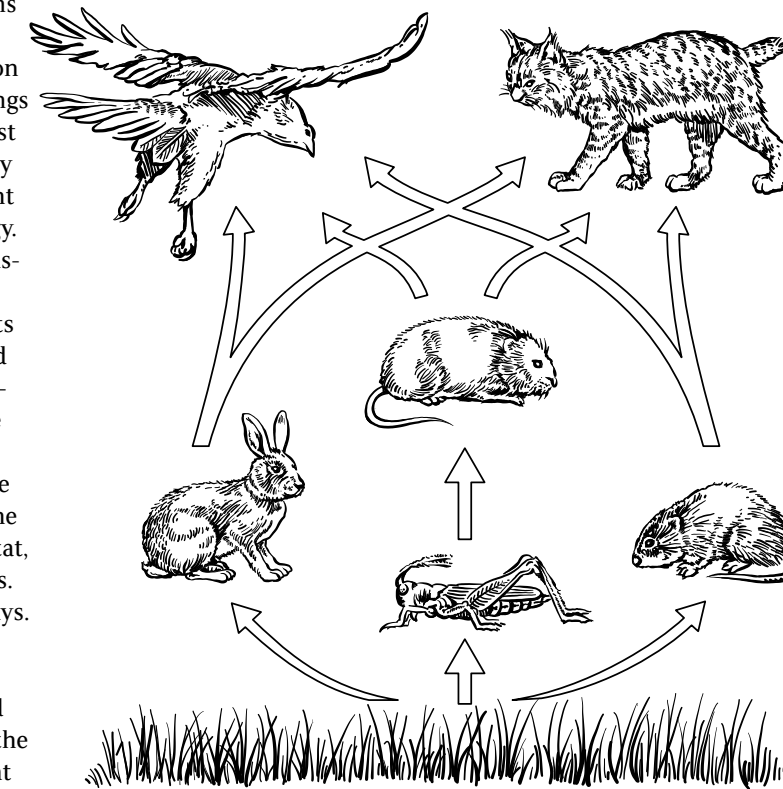
Indeed, each animal is dependent in some way on other animals, on plants, and even on non-living things such as air, water and minerals. And ultimately most living things are dependent on the sun for their very energy. Grass, rabbit, bobcat—all life can be thought of as a series of links in an unbroken chain of energy. By photosynthesis, the light energy of the sun is transformed into the food energy of grass. Rabbits eat grass and bobcats eat rabbits; when grasses, rabbits and bobcats die, decomposers—both animals and microorganisms—help turn their bodies into substances that can be used by grasses again. And the whole cycle begins anew.

How species fit together in a habitat is what the study of ecology is all about. When we talk about the various roles that plants and animals play in a habitat, we are really talking about how an ecosystem works. Ecosystems are communities linked in complex ways. One link is the food web.

Food webs are made up of many different food chains. Grass, rabbit and bobcat form a simple food chain, as we've seen. At the bottom of this chain is the plant, but the plant actually has the most important role. Ecologists think of plants as producers because they make food out of the sun's radiant light through the miracle of photosynthesis. All life on Earth depends on plants. Animals are consumers—primary consumers, or herbivores, eat plants while secondary consumers, or carnivores, eat plant-eaters. Many food chains even have a top carnivore. But eventually all carnivores die, and decomposers—both plants and animals—feed on them.

Every ecosystem, therefore, is made up of producers, consumers and decomposers. An oak tree and marsh grass don't look at all alike, but both are producers in their respective ecosystems. Rabbits and snails don't have much in common, either, but they are both consumers.

A simple food chain like grass, rabbit and bobcat only hints at the complex feeding relationships in an ecosystem. Like a spider web with strands that radiate



Simple food chains combine to make complex food webs.

in all directions, food chains grow into food webs. In a salt marsh, for example, a grasshopper is one of the few species that eats the living spartina grass. Wrens eat grasshoppers and marsh hawks eat wrens. But spiders and clapper rails eat grasshoppers, too, and the hawk will also eat red-winged blackbirds, bitterns and mice. Each food chain connects with other food chains until we're looking at a web that encompasses an astonishing number of plants and animals.

What happens when an animal or a plant is removed from this web of life? How will animals that depend on a habitat survive if it is changed? These questions are the subjects of the next chapter.

2 | OUR CHANGING HABITATS

Today, North Carolinians enjoy a temperate climate in which the winters are generally mild, the summers are hot and rainfall is moderate. As a result, our habitats consist of plants and animals that are adapted to these conditions.

Yet 18,000 years ago, North Carolina had a very different climate that hosted quite different animals and plants. At that time, the climate was much colder than it is today. During the most recent ice age, glaciers flowed down from Canada as far south as Pennsylvania on the East Coast. The area today called New York City was encased in a mile-high block of ice. North Carolina was spared the glaciers, but temperatures more like Canada's today were normal here. Icy winds blew and snow was more common than it is now. Only plant species adapted to cold climates could live here. The dominant trees were conifers—spruces, firs, jack pines and hemlocks. Mountain tops were bare.

And the animals? You might have seen strange-looking herbivores such as elephant-sized woolly mammoths and three-ton ground sloths. The predators would have included such scary creatures as the saber-toothed tiger and the dire wolf. All of these animals are extinct today.

Other animals that roamed North Carolina would have been more familiar—horses, caribou, moose, musk-oxen and bison may have wandered across the frozen landscape. Though not extinct, they are long gone from North Carolina. As the climate warmed and the plant communities changed, the animals followed their accustomed habitats north. Gradually, forests of Southern pines and hardwood trees adapted to warmer climates became dominant here, along with animals adapted to them.

But habitats change in other ways. Consider what happens to the site of a Piedmont farm after it's been abandoned. Without human aid, the field will gradually grow back into a forest that once grew there, but not all at once. During the first couple of years, it will flourish with grasses, and then shrubs will grow up along with young loblolly pines. In 25 to 50 years, the pines will gradually fill the field and all the grasses and shrubs will die back, starved for light. During the next 50 to 150 years, oak or hickory saplings will slowly grow and finally overtake the pines.

Called natural succession, this process takes place not only

when humans disturb a habitat, but after major natural disruptions such as wildfires and hurricanes. For thousands of years, storms often knocked over trees in small areas throughout the virgin forests. The empty spaces allowed sunlight to penetrate to the forest floor where wildflowers flourished and trees slowly reached for the canopy above. Thus the forests would have contained trees of many different ages, some young and some old, creating a diversity of habitat for many wildlife creatures.

Sometimes succession is stalled and the full progression of stages doesn't take place. For example, the longleaf pine forest is one of several community types in North Carolina that are adapted to wildfire. Historically, lightning-ignited fires frequently swept through these forests, killing the shrubs and the young oak trees that competed with the pines. The pines are adapted to fire, but the shrubs and oaks are not. Without fire, the oaks might have grown up and replaced the pines.

THE CRISIS IN HABITAT

Unfortunately, habitats don't always change naturally. Humans have altered or eliminated many of our habitats and ecosystems, with complex effects on plants and animals. Here are some examples:

Wetland destruction: About half of North Carolina's wetland habitats have been destroyed since European settlement, according to one estimate. Over the years, thousands of acres of salt marshes have been drained for coastal development. Vast acreages of bottomland hardwood forests have been cleared for agricultural crops or pine plantations. Hundreds of Carolina bays have been ditched and drained, and hundreds of thousands of acres of pocosins have been converted into mega-farms.

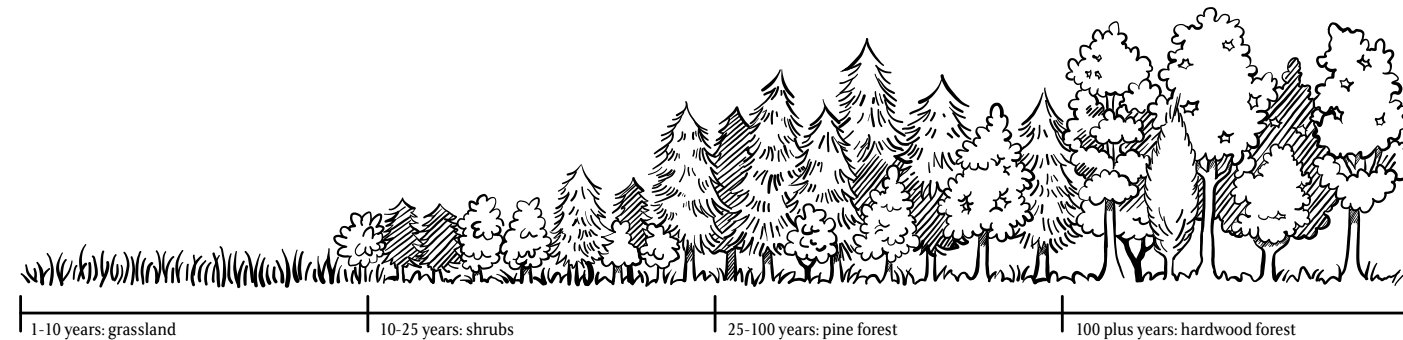
For centuries since European settlement here, marshy lands were considered wastelands and were drained so that crops could be grown or forests planted. Today we know that many wetland types perform important functions that are useful to us—they help reduce floods, improve water quality, stabilize shorelines, recharge groundwater and provide recreation for hunters, fishermen and other outdoor enthusiasts. Some are also among the richest plant and wildlife habitats in the state.

Salt marshes fringing our estuaries are so fertile that most of the saltwater fish we eat spend a portion of their life cycle there,

“Our grandfathers saw wildlife spectacles that we shall never see, and we have viewed natural spectacles that perchance none of our children or their children's children will ever see. Some, who can remember the great buffalo herds, are still among us. Many yet live who saw great waterfowl flights...Many more, who saw the wildlife wither and disappear like autumn leaves before the careless storm of an advancing civilization, can only bemoan the tragedy of the wastage.”

—Ira N. Gabrielson, *Wildlife Refuges*

Over time, some landscapes change naturally from bare field to oak forest



eating and growing in a secure and food-rich environment. Salt marshes also provide wintering habitat for migrating waterfowl. The deep woodland and swamp habitats of bottomland hardwood forests feed and shelter multitudes of deer, turkey, cavity nesters, fish and waterfowl. Fully 70 percent of the rare and endangered plant species in North Carolina's Coastal Plain belong to wetlands of one type or another, including the unique insect-eating plants that are among the most remarkable plants in the world.

Wetlands and other natural habitats are vanishing in the face of a growing shift in the human population toward the coast. Ninety-five percent of our wetlands are located in the Coastal Plain, but as coastal areas grow, these natural areas are being replaced by homes, shopping malls and highways.

Habitat Fragmentation: Draining a swamp and converting it into cropland or a shopping mall is obviously bad for the creatures that live there. As the habitat is destroyed, the animals that live there will be eliminated. But fragmenting a habitat is almost as bad as destroying it.

The effects of fragmentation are subtle. When a forest is cut in two by a highway or a power line, the result is two smaller pieces of forested habitat. Neither may be big enough to feed and shelter

species like the black bear that require large blocks of habitat. Facing a similar problem are many of our migratory songbirds that are adapted to deep forest cover. Within these deep forests the birds have few predators. But as forests are fragmented and more edge habitat is created, warblers, flycatchers, vireos and other forest-interior birds are increasingly falling prey to edge species such as brown-headed cowbirds, raccoons, blue jays and even house cats. These edge species find it easy to prey on interior forest birds because many of the birds build their nest on the ground. Forest fragmentation is one reason why the populations of more than 70 percent of migratory songbirds have declined in recent years.

Fragmentation often results in islands of habitat surrounded by a sea of human development. By cutting animals off from others of their species, forest fragmentation also endangers the genetic diversity that wildlife species need to guarantee their survival.

Pollution: Humans have been extremely resourceful in developing chemicals that make our daily lives easier. Unfortunately, we have not always been able to minimize the effects of these chemicals either on us or on animals and their habitats. When released into nature, many have had cruel consequences.

The story of the terrible effects of DDT poison-

ing shows us how difficult it is to predict the effects of the chemicals we use. DDT is a poison that was widely used in sprays after World War II to control mosquito populations, beetles and other crop pests. But the chemicals also ended up in insects, fish and many other kinds of animals that were eaten by still other animals. These chemicals tended to concentrate in the bodies of the predatory birds at the top of the food chain, birds such as peregrine falcons and brown pelicans.

These birds weren't immediately killed, but the accumulated poisons in their bodies altered the calcium content of their eggs. The eggshell-thinning that resulted meant that eggs could not be incubated successfully. Populations of the peregrine falcon, brown pelican, golden eagle and bald eagle plummeted. In 1972, DDT was banned and these birds were able to slowly rebuild their populations.

While chemicals like DDT are now illegal, other chemicals are still being emitted into the air and into our water, sometimes with equally lethal results. Aquatic habitats (river, streams, ponds and lakes) can be destroyed or altered by pollution. Sometimes pollutants enter rivers and streams directly, through pipes or culverts that carry wastes or chemicals from industries or city wastewater treatment plants directly into the water. Such sources are called *point sources* of pollution and they are many. *Nonpoint source* pollution comes from hard-to-detect runoff from farms and cities and from construction and mining activities. This is a much more difficult kind of pollution to control since it doesn't enter a river from a particular point like a pipe, but from many different sources along the river's length.

Who pollutes aquatic habitats? All of us qualify as polluters whether we know it or not. People who live in cities, towns and even rural subdivisions contribute their share of pollutants to rivers. Our paved streets, driveways, shopping malls and parking lots convey water swiftly into drainage pipes that empty into rivers. But what finally enters the waterway is not just rainwater. By the time it has made its journey across all of these paved surfaces, rainwater has

picked up oil, grease, heavy metals and other toxic chemicals that we use in our daily lives. Once in the water, these substances may be harmful to fish and the aquatic animals that fish eat.

Coastal marinas are by rule closed to the harvest of shellfish due to the potential of overboard discharge of sewage from boats and the possibility of pollution when motorboats leak oil and gasoline. Coastal housing developments and other changes in land use may pollute, too, if proper controls are not put into place. Issues may include stormwater runoff, and in some cases septic tanks leaking into inshore waters. In order to protect public health, shellfishing waters are required to be closed when standards for bacterial contamination are exceeded. Over 15 percent of our 2 million acres of coastal waters were closed to shellfish in 1990, a figure that increased with coastal development. As of the start of 2015, 19 percent of shellfishing waters were closed due to either not meeting the bacterial standard, or as a result of potential pollution sources.

When roads and houses are built on steep mountain slopes, soils erode from the land and run into streams. This sediment fills in reservoirs, reducing their capacities, and it widens the area of flooding by filling in streambeds. It can also reduce the food supply for fish, cover spawning beds and suffocate fish. Sediment is a major cause of degraded water in the state.

Farmers can pollute, too. As a result of improper farming methods, rainfall carries tons of eroded soils from field to river and stream, with devastating results. Fertilizers and pesticides also end up in our waters. The nutrients in fertilizers make crops grow on the land, but when rainfall carries them off agricultural fields and into rivers they can encourage unsightly mats of algae to erupt. These aquatic plants decay and rob oxygen from fish, crowd out beneficial algae species and eliminate important parts of the river's food web.

Farms are not the only source of nutrient pollution—urban runoff, wastewater treatment plants and industries contribute their share. Nutrient pollution can cause thousands of fish to die and has been

WHAT'S HAPPENING TO OUR SONGBIRDS?

"The most alarming of all man's assaults upon the environment is the contamination of air, earth, rivers and sea with dangerous and even lethal materials," wrote Rachel Carson in 1964 in her book, *Silent Spring*.

But a quarter century after Rachel Carson described a world without bird song, songbirds are again in trouble. This time the problem is due to habitat destruction here and in Central and South America. The destruction of tropical rainforests south of the border deprives our forest songbirds—warblers, vireos, and flycatchers—of their winter habitat. The fragmentation of forests in the United States exposes these birds to increased predation.

WHERE DOES YOUR WATER COME FROM?

Water comes out of a tap, but before that, where does it flow? Knowing your watershed, or the area drained by a major river, may be just as important as knowing where you live.

North Carolina has 17 watersheds. Starting in the mountains, they are: Hiwassee, Little Tennessee, Savannah, French Broad, Watauga, Broad, Catawba, New, Yadkin-Pee Dee, Roanoke, Cape Fear, Lumber, Neuse, Tar-Pamlico, Chowan, White Oak and Pasquotank.

blamed for the increase in fish and crab diseases in the Pamlico River.

Acid Precipitation: Carried aloft in the smoke from Midwestern and Northeastern factories and steel mills are chemical compounds that are carried to our mountains. When it rains or snows or when heavy fogs coat the trees, these deadly pollutants enter mountain soils and streams, causing an increase in acidity. This acidity has been blamed at least in part for the massive die-off of spruce trees growing on Mount Mitchell and other high-elevation forests in the southern Appalachians.

Exotic Invasives: Wildlife habitats are also degraded when humans introduce harmful exotic and invasive species to an area either accidentally or deliberately. Sixty European starlings released in New York City's Central Park in 1890 have proliferated to 200 million starlings today. They inhabit the entire continent and have displaced many North American bird species. A fungus, introduced from Asia earlier this century, killed the native chestnut trees in the Appalachians, eliminating a major component of the forest and depriving wildlife of a rich food source. A zebra mussel from the Caspian Sea between Europe and Asia threatens native freshwater mussels in our rivers and streams. White-nose syndrome in bats is caused by a European cold-loving fungus that biologists conservatively estimate has killed between 6 and 7 million bats as of 2016.

EXTINCTION IS FOREVER

What happens to wildlife once its habitat is destroyed, polluted or fragmented into smaller parcels? The options are few. When an old-growth forest is cut, for example, owls, woodpeckers and other cavity nesters won't find the dead trees they need in the cutover field. Can't they just go somewhere else? They can look for suitable habitat in adjacent forests, if there is any, but in most cases the carrying capacity of that forest may already have been reached. In these cases, the displaced wildlife are out of options.

But while changes in habitat threaten many species, they create opportunities for others. The

red-tailed hawk and the red-shouldered hawk provide a case in point. The red-tailed hawk is generally considered an upland bird, favoring open spaces such as fields and even highway borders where it searches for rodents, rabbits, small birds, snakes and insects. The red-shouldered hawk's habitat is the deep, wet, bottomland hardwood forests where its preferred prey—rodents, snakes, frogs and crayfish—abound. When we eliminate bottomland hardwoods to create lakes or farmland or houses, we deprive red-shouldered hawks of habitat, but we create habitat for the red-tailed hawk. It's little wonder that populations of red-shouldered hawks have declined while red-tailed hawks are abundant.

Similar examples can be found. As habitat generalists, white-tailed deer adapt well to human-altered landscapes; it's no wonder that deer populations, despite a long hunting season, remain healthy and even continue to rise in many areas. Snakes and many amphibians, on the other hand, do not fare well around humans and their populations generally decline as humans eliminate or alter their habitat for roads, manicured lawns, subdivisions and shopping malls. Brown-headed cowbirds, space-loving birds once confined to the open prairies of the Midwest, have thrived as humans have cut down the Eastern forests. But cowbirds are parasites that lay their eggs in the nests of many of our forest songbirds such as warblers and vireos. As we have seen, these birds are already suffering predation as a result of forest fragmentation.

This may tempt some to say "It's an even trade—though we lose some wildlife, we gain others." But the problem is that our activities generally create habitats that favor species we already have in great numbers.

Wildlife managers seek to preserve a diversity of habitats—oak and hickory forests as well as pine plantations; old-growth forests as well as young forests. Diverse habitats mean a diversity of wildlife species.

The ultimate danger that any plant or wildlife species can face is extinction. Millions if not billions of passenger pigeons once darkened the Eastern skies, but market hunting and habitat destruction reduced

the population to a single bird by the early 20th century. Its death alerted the nation to the effects we were having on wildlife in general.

Extinction has engulfed other living things in North Carolina and the United States since European settlement—the ivory-billed woodpecker and the Carolina parakeet just to mention two. It threatens many more. Partly as a result of habitat losses and pollution, hundreds of plant and animal species in North Carolina are in trouble today.

Why should we care about species that seem to be slowly fading into the oblivion of extinction?

For one thing, we never know how important a species may be. Some species are so important that ecologists call them "keystone species." This means that their existence is so essential to a community that once they are removed, the community changes in a major way. Remove a beaver from the beaver pond, for example, and in time the pond will fill in. Fish, frogs, dragonflies, ducks, mink, wading birds and many other species adapted to this wetland habitat will be evicted. Eliminate longleaf pine trees and you may eliminate red-cockaded woodpeckers, fox squirrels and many plants that need the frequently burned forests to survive. We don't know how many keystone species there are, nor do we know what happens once they disappear.

Another reason to care about the disappearance of a species is that it tells us that there's something amiss with the environment. If poor water quality is killing off nearly half of our freshwater mollusks and endangering nearly a fifth of our fish, perhaps we should worry, too. By conserving habitats so that fish and animals can survive, we are also attending to our own survival.

We may also care about endangered plants and animals because they are useful to us. Aside from their obvious importance as food, plants and animals may perform little-seen but essential services such as making soil, controlling erosion and even maintaining our climate.

Finally, there is so much to learn from these species. Countless cures and antidotes to human diseases

have come from often obscure plants, yet according to one estimate, nearly 25 percent of the world's 250,000 species of plants may face extinction in the next 25 years. Which among them may hold a cure for cancer? For heart disease?

As wildlife conservationists and as responsible citizens, we should be intensely concerned about the preservation of species. Yet as this book suggests, our concern should also encompass the wild places where our native plants and animals are found. As we have seen, habitat is precious and fragile; the entire web of life linking plants and animals rests on the health of habitats. Indeed, the only sure way to protect our native species is to protect the habitats they call home.

Turkeys, bears, and countless other species have made a comeback because of focused efforts to improve habitat, among other things. With careful management, closure of fall hunting seasons and habitat restoration work, Eastern wild turkey populations have rebounded from only 2,000 birds across North Carolina, to 265,000 birds in 2015! The future also looked bleak for our black bears numbering only around 1,500 in 1980. Deforestation, chestnut blight, and unregulated killing nearly extirpated bears in North Carolina. But thanks to improved management and bear sanctuaries, black bears have rebounded. In 2018, the bear population was estimated to be around 15,500 to 17,200 bears! Their range has also expanded to over 60 percent of the state. Public education is key to minimizing conflicts with humans.

GONE WITH THE WIND

It's hard to believe that the teeming populations of passenger pigeons are gone today. Who could have believed they would become extinct? Certainly not John Lawson, an early traveler and explorer in North Carolina, who described them in this way in 1709:

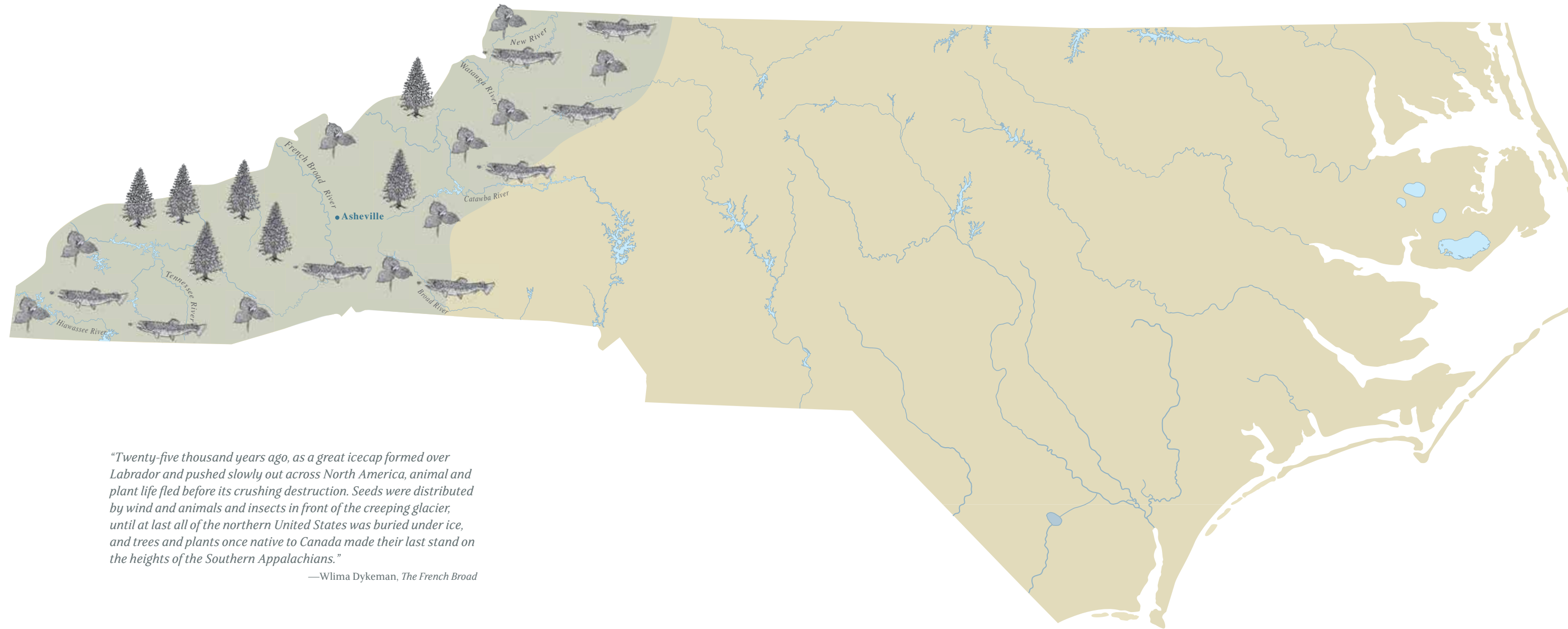
"These [passenger] pigeons...would fly by us in such vast flocks, that they would be near a quarter of an hour before they were all passed by; and as soon as that flock was gone, another would come; and so successively, one after another, for a great part of the morning."

3 | MOUNTAIN HABITATS

The mountain region extends west from the Blue Ridge Mountains to the Tennessee border. It's a region of lofty mountains—43 peaks rise above 6,000 feet and 82 are between 5,000 and 6,000 feet. This area boasts the highest mountains east of the Mississippi River and the greatest mass of high elevation peaks in all the Southern Appalachians.

This is where Mount Mitchell rises 6,684 feet high, the tallest mountain in eastern North America. You can find thousands of acres of public game lands, including lands owned and managed by the N.C. Wildlife Resources Commission, as well as those on two vast national forests, Pisgah and Nantahala. This region also contains several state parks and two popular national parks—the Blue Ridge Parkway and Great Smoky Mountains National Park. It's a region of spectacular gorges and waterfalls, where about 80 inches of rain and snow fall each year. It's a place where mist clings to the valleys, and innumerable cold streams trickle down from the mountain heights, sheltering trout and other aquatic life.

These mountains contain a rich diversity of habitats, from rare bogs to rich cove forests, to spruce-fir forests on often icy mountain tops. There are more than 1,600 species of flowering plants in the region, including more than 100 native tree species—that's more tree species than the entire nation of Great Britain!



“Twenty-five thousand years ago, as a great icecap formed over Labrador and pushed slowly out across North America, animal and plant life fled before its crushing destruction. Seeds were distributed by wind and animals and insects in front of the creeping glacier, until at last all of the northern United States was buried under ice, and trees and plants once native to Canada made their last stand on the heights of the Southern Appalachians.”

—Wlima Dykeman, *The French Broad*

MAP KEY



Mountain cove forest



Spruce-fir forest



Trout stream

Mountain Cove Forest

For coastal residents, the word “cove” conjures up images of skiffs gently bobbing in a sleepy little inlet on the edge of a bay. But for a mountain native, a cove is another thing altogether.

“Cove” is the name given to the upper portions of mountain valleys and to mountain slopes that have been carved by small creeks and streams. Scattered throughout our mountains, some of these remote and rugged sites have never been logged. The result is some of the oldest mature deciduous forest known in the Southern Appalachians—indeed, in eastern North America. These cove areas contain enormous specimens of tulip poplar, yellow buckeye, hemlock and sugar maple trees.

You’ll climb steep slopes when you explore a cove forest, and you’ll find boulders, fallen logs and stumps in your path. Then there are creeks, branches, seeps, and springs flowing from the mountainside and tumbling downslope. In a mountain cove, it’s

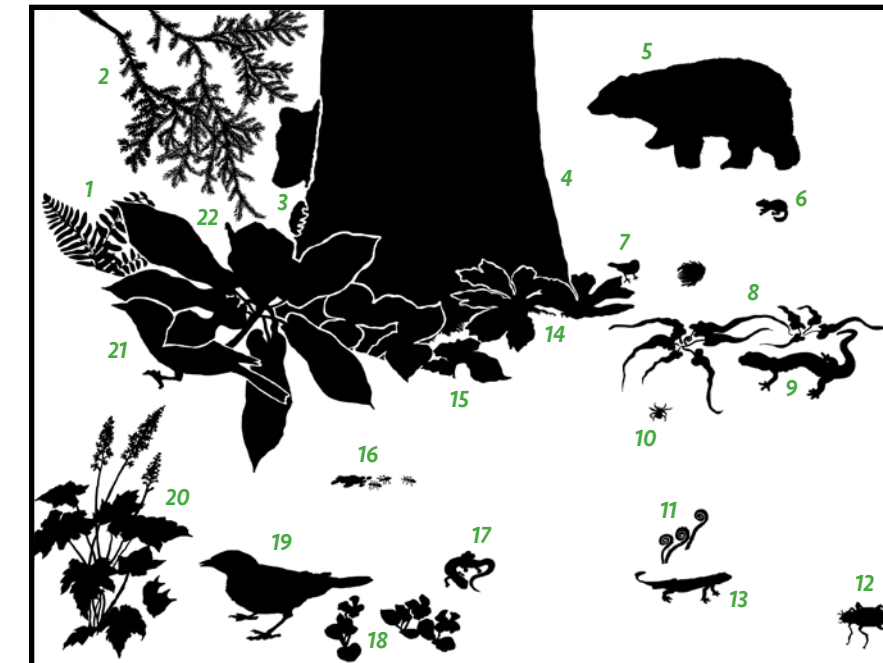
hard to see the sun. The steep slopes and a dense canopy of tall, deciduous trees make sunshine rare.

Most challenging of all are the “laurel hells”. These dense thickets of rhododendrons grow mostly in the deeper and steeper-sloped ravines, and can be quite a challenge to navigate over, under, and around.

Don’t be scared off. A visit to a mountain cove is well worth the effort. Nowhere else will you find so many different kinds of trees, and so tall and wide. Nowhere else will you find such a lush carpet of flowering plants and ferns.

LIFE IN A MOUNTAIN COVE FOREST

Visiting a mountain cove for the first time in winter, you might think it a drab and boring place. Bird song and the musical trickle of water are silenced by icy temperatures. The thick carpet of herbaceous plants is missing, but with the arrival of spring, all of this changes.



1. Christmas fern
2. Hemlock tree
3. Black bear cub
4. Tulip poplar tree
5. Female Black bear
6. Chipmunk
7. Junco and nest
8. Walking fern
9. Yonahlossee salamander
10. Camouflaged spider
11. Fiddleheads
12. Ground beetle
13. Red eft (red-spotted newt)
14. May apple
15. Yellow trillium
16. Ants with larvae
17. Red-backed salamander with eggs
18. Yellow violets
19. Ovenbird
20. Foam flower
21. Black-throated blue warbler (male)
22. Fraser's magnolia

Colors, smells, bird song and nesting activity greet your senses. You see masses of yellow and white-flowered **trilliums**; swatches of shiny, umbrella-like leaves of **May apple**; tiny **yellow-flowered violets**; delicate white spikes of **foam flower**; and the pale, pouch-like flowers of Dutchman's britches and squirrel corn. From late April onward, a display of flowering plants decorates the cove floor. A great variety of ferns are here as well, many starting out as "**fiddleheads**" in spring, as in the **Christmas fern** in the illustration.

Giant trees of this forest include **tulip poplar**, **hemlock**, basswood, sugar maple, buckeye, birch, beech, ash, cherry and silverbell. Their flowers contribute to the spring bloom. Nearly overpowering are the sweet and pungent scents emanating from the large creamy-white flowers of **Fraser's magnolia** and the inconspicuous red blossoms of sweetshrub.

Of particular concern to mountain cove forest is

Examples of MOUNTAIN COVE FORESTS



Pond Mountain Game Land (located in the northeast corner of Ashe County, adjacent to both Virginia and Tennessee Ashe County). Several mountain cove forests exist within the game land, most notably along the headwaters of Ripshin branch and portions of the property next to the Virginia state line. Visit the "Game Lands Hunting Opportunities" link at <http://www.ncwildlife.org/Hunting/Where-to-Hunt> for directions and game land access information.

Green River Game Land (located in Polk and Henderson Counties). Contains numerous patches of mountain cove forests, throughout the entire game land. Many of these are near game land roads and parking areas. Visit the "Game Lands Hunting Opportunities" link at <http://www.ncwildlife.org/Hunting/Where-to-Hunt> for directions and game land access information.

South Mountains Game Land (located in Burke, Cleveland, and Rutherford Counties). Contains numerous patches of mountain cove forests, throughout the entire game land. Many of these are near game land roads and parking areas. Visit the "Game Lands Hunting Opportunities" link at <http://www.ncwildlife.org/Hunting/Where-to-Hunt> for directions and game land access information.

the rapid decline of the hemlock. This "redwood of the east" can reach over 150 feet tall, measure six feet in diameter, and live longer than 500 years. The decline in hemlocks is a result of non-native insect called the hemlock woolly adelgid. Since its arrival in the U.S. in the 1920s the hemlock woolly adelgid has rapidly colonized parts of New England and the Mid-Atlantic States, where it feeds on hemlock. The hemlock woolly adelgid is dispersed by birds, wind and as a hitchhiker on infested horticultural material.

Forests in areas like Shenandoah National Park and the Blue Ridge Parkway have recorded over 80 percent loss of hemlock trees. Luckily, there are three types of treatments that are being used to combat the rapid loss of hemlock trees. Hemlocks in developed areas and along roads are often treated with insecticidal soap or horticultural oils. However, this method kills only the insects that are present on the tree at the time of application and requires retreatment every six months to one year. Systemic treatments of insecticides by soil drenching or by injecting directly into the trunk have proven to be very successful, plus, these treatments may remain effective for up to five years. In addition, predator beetles, which feed exclusively on adelgids, were introduced to the area as a biocontrol in 2002. It will take years before populations of beetles increase enough to naturally control adelgid infestations, but preliminary monitoring in the Great Smoky Mountains National Park have been encouraging.

WHILE THE HEMLOCK TREE CONTINUES to hang on in our forests, one giant tree you won't find here is the American chestnut, once one of the most important trees in the mountain cove forest. Its nuts fed many forest animals, but the only thing that remains of this tree are stumps and stump sprouts. A fungal disease accidentally introduced to the United States from Asia around 1900 killed all of the chestnuts by the 1930s. Today, only an occasional sprout grows tall enough to produce a few nuts, before succumbing to the fungus. However, efforts are underway to develop a blight-resistant American chestnut tree, so there is still hope for restoring this native giant

to forests along the eastern United States.

Plants of the cove forest attach to their own special habitats. And each plant, in turn, creates habitat for wildlife species, particularly birds, amphibians and invertebrates. Large mammals like the black bear tend to roam widely and thus use a variety of habitats, both in and out of cove forests.

In spring, many animals in the cove forest are busy caring for their young. Many birds nest in mountain cove forests, although each species builds its nest in a particular way and in a particular place.



For example, the ovenbird tucks its dome-roofed nest of grass and leaves at the base of a shrub or plant clump, or in a slight depression near a path or other opening in the forest. Juncos, too, are ground nesters. They usually conceal their nests made of moss, rootlets and plant stems in crevices or beneath over-hanging ferns and grasses growing on embankments.

Warblers and many other songbirds, on the other hand, have adapted to the complex, many-layered environment of the canopy. The Northern parula (our only blue-backed warbler with a yellow throat) suspends its nest high on a tree branch, perhaps 25 or 30 feet above the ground. The **black-throated blue warbler**, on the other hand, builds its nest at a height of 3 inches to 10 feet, often in the fork of a shrub.

Almost all of these songsters migrate here in the spring from Central and South America (or at least the very southeastern United States). That is why you can see and hear so many of them on a warm day in spring. In autumn, there's a good chance of spying the red-eyed vireo with bright red berries in its beak.

The same fallen logs, stumps and rocks that make a hike through a mountain cove so strenuous create

a multitude of animal and plant habitats. Pads of moss-covered stumps and logs, and the rotting wood itself, are home to a variety of insects, amphibians, mushrooms and other organisms. These decomposers reduce rotting wood to nutrients that can be used again by trees and other plants. A bit of probing at a rotten log with a stick often reveal a nest of ants complete with eggs, larvae and adults.

Even the ferns are producing young! **Walking fern** gets its name from the fact that immature "fernlets" spring up where its arching, pointed fronds touch the moss on which it grows. The color pattern of lichens growing on the surface of a stump or tree trunk are mimicked by some invertebrates in an attempt to hide from their predators (birds and salamanders). Can you find the **camouflaged spider** in the illustration?

The forest floor is busy with animal life, too. A **ground beetle** scurrying across the dry leaves is a common sight. Indeed, the noise made by a startled beetle on a lazy summer afternoon can make you imagine something larger is running toward you.

THE MOUNTAIN REGION OF OUR STATE is famous for its great diversity of salamanders. Sometimes people confuse salamanders with lizards. Lizards are reptiles, salamanders are amphibians. Salamander skin is smooth or slightly rough and moist, but never scaly. In a mountain cove, you may have to look under the bark of a rotting log, or peer into a crevice in a wet rock face, to find one of these reclusive creatures.

Biologists often separate the salamanders found in mountain coves into two groups: woodland species and stream species. Woodland salamanders, such as the **red-backed salamander**, spend most of the time in the leaf litter and rotten logs of the forest floor. They forage for food mostly at night, or on rainy days. Woodland salamanders lay their eggs, encased in a gelatin-like substance, beneath the bark of a rotting log and in other damp places. The Yonahlossee salamander is one of the largest of the woodland salamanders: adults may grow as much as 7 inches long.

The stream species of salamanders stay closer to water—if not directly by a stream, then at least along

wet rock faces and seepages on the mountain slope. It's hard to know whether to classify another red-skinned salamander as a stream species or a woodland species. The red-spotted (or Eastern) newt spends the first months of its life as an aquatic larva in ponds or slow moving streams. Then, in the late spring or summer, many will decide to crawl out of the water with feet, a finless tale and lungs. From 2 to 8 years, the so-called **red eft** will make the mossy mats and thick, damp leaf litter of the forest floor its home. One winter's day, the red eft returns to its watery birthplace where it undergoes another transformation into an adult. The adult keeps its spots but turns a dull green color; its tail thickens into an aquatic fin. Adult newts can live for 10 or 15 years. While still not understood, some red-spotted newts skip the red eft stage and never leave the water, transforming from larva to adult.

Some inhabitants of this forest are quite visible. What would you see on a warm day in May? On a warm day in May, the **chipmunk** might be running back and forth between its burrow and the sources of its favorite foods: nuts, seeds, snails and other small invertebrates. A mama **black bear** and her cub would be a rare sight! She'd probably sense you first and avoid you, but, the fruits and berries of late summer will draw bears to this place.

Not to be forgotten is a predator at the top of the food chain: the bobcat. The only wild cat known today in our mountains, the bobcat will lie up during the day in a rock cleft, thicket or other hiding place, and emerge at night to prey on rabbits and small rodents.

IMPORTANCE OF MOUNTAIN COVE FORESTS

To the early settlers of our mountains, coves were important places. Most farming took place near streams and on the lower slopes of mountains—the only places that might even remotely be called flat. The diverse vegetation also provided a number of useful and medicinal herbs, like goldenseal and ginseng. The healing properties of the orange-yellow root of goldenseal, which were used to produce an eyewash and a tea used to ease throat disorders, was probably learned from Native Americans. Ginseng

Features of MOUNTAIN COVE FORESTS



- "Cove" is a term that describes a certain kind of mountain topography: sheltered valley slopes and gentle ravines.
- In terms of life, the cove forest is one of the most diverse natural communities in our mountains. In fact, outside of tropical zones, Appalachian cove forests represent some of the most diverse ecosystems in the world!
- Many useful (medicinal and food) plants are found in the cove forests. Examples include ginseng, goldenseal, black cohosh, May apple, jewelweed and wild ginger.
- Many long-distance migratory birds nests in cove forests.
- Some of North America's last old-growth deciduous forests are found in mountain coves in North Carolina.

root is often collected and exported to China, where its ability to preserve youthfulness is revered. On any given year, thousands of pounds of ginseng root will be collected in a single year in North Carolina.

The cove forests also produce valuable wood, like black cherry and black walnut trees, which have long been valued for the beautiful dark grain of their wood. Prior to the chestnut blight, chestnut wood was used for furniture and paneling.

Some of North Carolina's mountain coves harbor the last remnants of old-growth deciduous forests in eastern North America. Old, relatively undisturbed forests provide habitat for numerous species not found in younger forests.

THREATS TO MOUNTAIN COVE FORESTS

According to the 2015 North Carolina Wildlife Action Plan, the most pressing problem affecting mountain cove forests are several exotic pest species. Species like the hemlock woolly adelgid has devastated most of the eastern hemlock stands in the state. Other threats to mountain cove forests include residential development, logging and conversion to other forest types, like white pine.

Spruce-Fir Forest

Let's take a mountain hike. Starting at the sunny banks of a roaring stream, you enter the shady deciduous forest of a mountain cove. During the long upward climb you pass through a grove of birch and beech trees on a slight ridge, stumble over boulders, crawl through rhododendron thickets and leap over soggy seeps.

The air is cool and full of the smell of fall—rotting leaves and mushrooms. Red, yellow and orange leaves settle on the ground at your feet. The roar and tumble of the stream will have faded away by the time you reach the uppermost slopes of the mountain. Now the flute-like notes of the veery, or the loud, wandering song of the tiny winter wren keep you company.

With hardly a warning, you find yourself in a mist-shrouded grove of tall evergreen trees. The tree trunks are shaggy with mosses and lichens. The air is cool and strongly flavored with the pungent smells of spruce and fir needles and rotting wood. You're

in a spruce-fir forest. Now the voices you hear are of the wind.

The spruce-fir forest is a forest type composed of needle-leaved evergreen trees, mostly spruce and fir trees, that grow where temperatures are cool, moisture is abundant and mosses cover just about every surface. Plants and animals living here are the same as (or are close relatives of) those found in the spruce-fir forests of New England.

In the Southern Appalachians, you might call these forests “islands in the sky,” since spruce-fir forests only occur above 5,500 feet, limiting them to the highest peaks of the Blue Ridge Mountains of southern Virginia and North Carolina, and the Great Smoky Mountains of Tennessee and North Carolina.

LIFE IN A SPRUCE-FIR FOREST

The climate of a spruce-fir forest can be harsh. Wind and ice storms are facts of life here: trees with their tops missing are common sights. And, as with any high-elevation ecosystem,



1. Red spruce tree
2. Fraser fir tree
3. Raven
4. Migrating hawk
5. Red-breasted nuthatch
6. Dead fir tree
7. Sand myrtle
8. Saw-whet owl
9. Red spruce cones
10. Catawba rhododendron
11. Coal skink
12. Red squirrels
13. Mushrooms
14. Mountain wood fern

rain, fog, sleet or snow can occur unpredictably—in any month, at any time of day. Nevertheless, you will find there a lush growth of plants and a variety of animals adapted to life in a cool, wet habitat.

You won't find too many deciduous trees growing in a spruce-fir forest, although yellow birch grow in some areas. Nowhere else in our mountains do needle-leaved, evergreen trees grow so extensively. Though spruce-fir forests are found in a broad region of northern North America, they occur south of New England only in a thin zone along the Appalachian Mountain chain.

The fir tree that grows here is **Fraser fir**—not the balsam fir found in the northern Appalachian forests. Fraser fir grows only in the southern Appalachians, from Mount Rogers in southwestern Virginia to our own Balsam Mountains in Haywood County. The

Examples of SPRUCE-FIR FORESTS

Pisgah Game Lands near Roan Mountain (located in Mitchell and Avery Counties, adjacent to Tennessee). Isolated patches of spruce-fir forest exist along this area, including along HWY 261 and NC-1348. Visit the “Game Lands Hunting Opportunities” link at www.ncwildlife.org/Hunting/Where-to-Hunt for directions and game land access information.

Pisgah Game Lands near Mount Mitchell State Park (located in the portions of Buncombe, McDowell and Yancey counties near Mount Mitchell). Isolated patches of spruce-fir forest exist along this area, including along the Blue Ridge Parkway and HWY 128. Visit the “Game Lands Hunting Opportunities” link at www.ncwildlife.org/Hunting/Where-to-Hunt for directions and game land access information.

Pisgah and Nantahala Game Lands near Middle Prong and Shining Rock Wilderness Areas (located in Haywood and Jackson counties). Isolated patches of spruce-fir forest exist along this area, including along the Blue Ridge Parkway and Black Balsam Knob Road. Visit the “Game Lands Hunting Opportunities” link at www.ncwildlife.org/Hunting/Where-to-Hunt for directions and game land access information.

Fraser fir shares the canopy with **red spruce**, which grows in the North as well.

Though fir and spruce trees look similar, they are quite different. Fraser fir leaves are flat, although they are definitely of the conifer type—narrow and straight. The leaves of red spruce, on the other hand, are needle-like, pointy and slightly curved. Generally, the cones of the fir stand upright, while those of the spruce dangle from the branches.

IN A SPRUCE-FIR FOREST you will also notice the abundance of dead and dying trees. While historical logging and associated slash fires, as well as land development activities associated with the Blue Ridge Parkway, have altered our spruce-fir forests, additional declines continue to occur from acid deposition and an exotic pest called the balsam woolly adelgid. Furthermore, threats from climate change are on the horizon, making this ecosystem one of the most endangered in the United States.

Unlike the cove forest, where warblers are abundant in spring, spruce-fir is not visited by many birds that winter in the Tropics. Instead, species that migrate short distances (sometimes just up the mountain from the foothills) breed here. Dark-eyed juncos, black-capped chickadees, golden-crowned kinglets, winter wrens, red-breasted nuthatches and brown creepers make up about 80 percent of birds seen in the breeding season.

Two birds that do breed in the spruce-fir forest, the red-breasted nuthatch and the brown creeper, glean their food from the trunks of trees. Nuthatches scurry headfirst down the trunks of trees, plucking insects from crevices in the bark. Brown creepers tend to work their way up the trunk of a tree in a spiral fashion. Black and white warblers also feed on insects in tree bark, and though they breed at lower elevations, they frequently wander into the higher-elevation forests after the nesting season is over.

A diminutive predatory bird, the **saw-whet owl** (no more than 8 inches tall) is a rare breeder and perhaps a winter resident of the spruce-fir forest. This bird is hard to find in North Carolina, for it is at the southernmost limit of its range here.

Though it is heavily shaded, the ground layer of the spruce-fir forest can be dense with plants. The delicate, clover-like leaves of wood sorrel are most prominent, but ferns, asters and a pretty plant with a pretty name—bluehead lily—also grow here. The **mountain wood fern** grows in spruce-fir forests in the Appalachians from North Carolina to Canada. Mosses are especially lush, on fallen logs, old stumps and rocks as well as the trunks of firs.

Underneath is a sponge-like, moist soil in which leaves, branches and other organic matter decompose slowly, because of the cold temperatures and soggy conditions. When a tree falls (a common event, given the frequency of wind and ice storms in winter and the shallow root systems of these trees), the newly created gap brings sunlight to the forest floor. Seedlings of spruce and fir, which cannot grow in the shade of a solid canopy, then can grow to mature sizes. Thus, the forest becomes a patchwork of groups of trees of different ages, and the ground layer is littered with slowly decomposing logs, which in turn are the nurseries for moss, mushrooms and tree seedlings.



Of the two kinds of squirrels that live in the spruce-fir forest, you would most likely meet the **red squirrel**, also known as a “boomer” or chickaree. Though it is the smallest squirrel of this part of the world, it seems to be the loudest. Its drawn-out, almost scolding trill can be heard from quite a distance. The red squirrel finds many of its favorite foods in the spruce-fir forest: nuts and seeds, birds' eggs, **mushrooms**—even mushrooms that

are deadly to humans. In the fall, these squirrels store huge quantities of food in the damp earth: as much as a bushel of green pine cones has been observed in a red squirrel's underground cache.

The squirrel that is much harder to see is a subspecies of the Northern flying squirrel, the Carolina Northern flying squirrel, which is restricted to western North Carolina, east Tennessee and southwest Virginia. It prefers the “ecotone” or edge between the high-elevation cove forest and the spruce-fir forest, but it frequently wanders into the spruce-fir forest.

The Northern flying squirrel is so rare that it has been listed by the U.S. Fish and Wildlife service as an endangered species. This squirrel, like the more common Southern flying squirrel, is nocturnal. Flying squirrels spend the daytime in nests in hollow trees, so tapping on an old snag will sometimes bring a small furry face to the opening of an old woodpecker hole.

THE COLD UPPER ELEVATIONS of our mountains do not offer a lot of habitat for reptiles and amphibians. Still, you could find a coal skink under the rotting bark of a fallen tree, its body curled around a dozen or so tiny eggs. Even snakes are seen on occasion—garters or ring necks.

The treacherous ledges of rocky crags are home to a few unusual and hardy plants. These are uniquely adapted for clinging to windswept ledges in extremely shallow, acidic, sandy soil. A native plant of our coastal Sandhills region, **sand myrtle** grows here far from its typical home under longleaf pine. The dense shrubbery of **Catawba rhododendron** and other heath shrubs is patched with open rock face. Mats of spike-moss, grasses and small herbs grow here and there in depressions in the rock surface.

From the rocky ledges in the fall of the year, you may also see scores of migrating hawks that seem to hang in the air. These hawks are migrating to Central and South America following the Appalachians south. They soar on thermals, or rising currents of warm air. Ravens are also residents of these rock ledges, emitting a low, hoarse croak.

IMPORTANCE OF SPRUCE-FIR FORESTS

The spruce-fir forest is a unique mountain community. The climate is different, the vegetation is different, and many of the species are unique or unusual. Scientists have demonstrated that during the last great ice age, some 18,000 years ago, temperatures were much colder and forests like these were more widespread in the Southeast. As the climate grew warmer, these forests “retreated” up the mountains, finally occupying only the highest and coldest peaks. These areas became refuges for species that could not live in warmer, drier habitats. In fact, many of them, once isolated from other populations of the same species to the north, evolved into new species. Thus, spruce-fir forests are living laboratories for studying the process by which new species develop.

The Carolina Northern flying squirrel is not the only rare or endangered species here. Weller's salamander and the long-tail shrew are both listed by the state as species of special concern. Several plants are also confined to a few locations in spruce-fir forests in North Carolina and Tennessee: Rugele's ragwort (listed by the state as threatened), spreading avens (federally listed as endangered) and Heller's blazing star (federally listed as threatened).

THREATS TO SPRUCE-FIR FORESTS

In the 1980s, North Carolina's spruce-fir forest made the news. Fir trees and some spruce were dying at alarming rates on Mount Mitchell. Since then, scientists have tried to sort out the complicated story behind the decline of the spruce-fir.

It's known that high elevation ecosystems are especially vulnerable to air pollution. Ozone, nitrogen oxides and other chemicals from factories, power plants and automobiles of the eastern United States are carried into the spruce-fir forests by means of wind, clouds, fog, rain and snow that frequent these high elevations.

Though spruce is believed to be more susceptible to pollutants, Fraser fir has its own problems: an introduced insect. The balsam woolly adelgid (a kind of aphid) has been spreading through our region since about 1960. Massive diebacks of fir can be observed

Features of SPRUCE-FIR FORESTS



- The Fraser fir is endemic (restricted) to the southern Appalachians. It occurs only above about 5,500 feet on mountain peaks from Mount Rogers in southwestern Virginia to the Balsam Mountains in North Carolina (Haywood County).
- Red spruce, the other dominant tree, can live to ages of 300 to 400 years.
- As many as 235 species of moss may occur in spruce-fir forests.
- Spruce-fir forests are a rare and endangered natural community, particularly the pure fir variety (highest elevations), because it is limited in geographic area and because of infestation by balsam woolly adelgids.
- Red spruce and Fraser fir trees are dying in part because of chemical pollution introduced by acid deposition.

on Richland Balsam Mountain along the Blue Ridge Parkway as well as on Mount Mitchell. It is possible that air pollution in the form of acid deposition weakens the firs, making them more susceptible to the insect.

It will be a long time before all the effects on mammals, birds, insects, mosses and lichens, as well as tree seedlings, of this forest are known. But it is certain that the few remnants of undistributed spruce-fir forest we have will look very different in future years.



Mountain Trout Stream

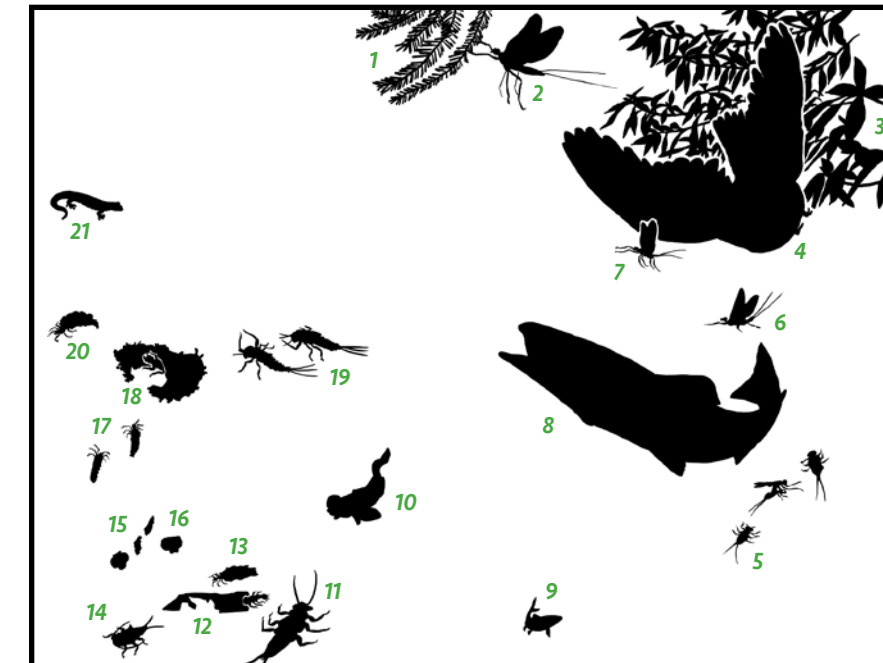
You take a few steps out into a mountain stream. Even in the summer the water feels cold against your legs and it's also crystal-clear. The water feels cool because it comes from cold springs and is always shaded along its course.

It's clear because there's no pollution in the watershed. The ecology of a trout stream completely depends on its temperature and clarity. If the water temperature warms because shading trees are cut down, or if dirt from construction activities enters a stream, the inhabitants of a trout stream could be in danger.

An early evening in summer is a magical time! You see aquatic insects hatching from immature larvae into winged adults. Trout are feeding on the insects that are hatching. Through the tree, shafts of sunlight appear and downstream you may see a doe with her new fawn drinking water. A fisherman once wrote that the environments in which trout are found are always beautiful and an endless source of delight.

In North Carolina, trout streams are mostly mountain habitats, although some are also found in the foothills. Wherever trout streams are found, they are cool places to visit, especially in late spring or early summer. Shaded by trees and dense bushes, the cold water rushes past boulders and smaller rocks, making a merry sound that is part of its appeal.

Unlike most streams in the Piedmont or Coastal Plain regions of North Carolina, mountain trout streams flow quite rapidly. Because most flow down steep mountain slopes, they may fall several hundred feet within a mile. This high gradient creates a series of waterfalls, splash pools and boulder-filled riffles that host different kinds of aquatic life forms. The splash pools, found directly below the waterfalls, are often the best places to see trout swimming. The riffles are the swift, shallow-stream sections between the pools and waterfalls. Most aquatic insects are found in riffle areas.



1. Hemlock tree
2. Mayfly adult
3. Rhododendron
4. Phoebe
5. Epeorus mayfly nymph
6. Epeorus mayfly dun
7. Epeorus mayfly adult
8. Brook trout
9. Rosyside dace
10. Sculpin
11. Acroneuria stonefly larva
12. Heteroplectron caddisfly larva
13. Pycnopsyche caddisfly larva
14. Tallaperla stonefly larvae
15. Neophylax caddisfly larva
16. Goera caddisfly larva
17. Apatania caddisfly larva
18. Hydropsyche caddisfly larva
19. Isonychia mayfly nymph
20. Glossosoma caddisfly larva
21. Seal salamander

LIFE IN A MOUNTAIN TROUT STREAM

Mother Nature has put on a new green coat for her admirers in early summer. Notice the lush rhododendron and mountain laurel thickets along the stream banks. Both of these shrubs have heavy leaves that reflect less light than most other leaves. Hemlock trees are also visible. They can grow at elevations near the valley floor to the ridge tops at 5,000 feet. Unlike those of other conifers, hemlock's flat-looking needles grow in a row along the stream.

If you are patient; you are likely to see small silhouettes of fish darting between the boulders. In clean, unstressed mountain streams, the most



Visit a
MOUNTAIN TROUT STREAM

North Carolina has approximately 4,000 miles of streams capable of supporting trout and providing angling opportunities. However, these streams are located at the southern range of coldwater fishery habitat in the eastern United States, which restricts trout populations to higher elevations.

Of the estimated 4,000 miles of trout waters in North Carolina, approximately 2,000 miles are designated as Public Mountain Trout Waters (PMTW) and managed by the North Carolina Wildlife Resources Commission (Commission). Nearly 1,000 miles of these streams are managed to protect self-sustaining, wild trout populations. The Commission annually stocks approximately 900,000 hatchery-raised trout to maintain fisheries within the remaining 1,000 miles of PMTW.

There are several good ways to find a mountain trout stream, but one of the best methods is to visit the Commission's website: www.ncwildlife.org. There you will find the NC Interactive Fishing Access Map and a Public Mountain Trout Waters Search function.

These tools allow you to locate a great new place to fish for trout in the mountains of North Carolina or learn more about the rules and regulations of trout fishing. This search can help you locate Public Mountain Trout Waters and show you which regulatory classifications apply. You can open a map and zoom to the selected water once you have made a list of locations or save your list as a PDF document to read when you are on the go.

abundant fish species are trout. **Brook trout**, or "speckled trout," are the only trout native to North Carolina. In most large trout streams, these beautiful little trout have been replaced by rainbow and brown trout. Both of these species are exotics—they were first introduced to our streams in about 1900; the rainbow trout from the West Coast of the United States and the brown trout from Europe.

Relative few other fish species occur in trout streams. A few of the more common non-trout fish species in streams include the **sculpin**, Western black-nose dace, and the **rosyside dace**, all of which are quite small at about 3½ inches long. Yet trout streams are alive with other kinds of aquatic life. A single portion of a trout stream might contain only a few fish species, but over 300 aquatic insect species. Trout feed on these insects.

Most of the insects are small, but a simple hand lens will reveal an amazing new world for even an amateur naturalist. Pick up a rock in a stream and you will notice aquatic insects scurrying to get away from the light. You'll also find insects hiding in small stone or stick shelters. These animals have evolved and adapted to life in the stream in many ways. One thing they all have in common is that they breathe dissolved oxygen with gills rather than atmospheric oxygen with lungs like we do. Many of them have developed amazing forms of camouflage to avoid being eaten by fish and other types of predators in the stream.

One of these aquatic insects is the mayfly. Mayfly eggs are usually produced in the spring. The eggs and the immature mayflies quickly develop during the summer and fall months, but their growth slows in winter. The following spring, a year after they hatched, most mayfly nymphs (immature mayflies) swim to the surface and molt—they shed their outer skin (exoskeleton). Now called subimagos or **duns**, some dry their wings while floating and then fly to the shore-side vegetation where they will molt again, most often overnight. Others float or crawl to the vegetation where they molt. This time they achieve the **adult mayfly** stage (called the imago or spinner) and

all take to the air, this time as winged insects. That same evening, or within a few days at the most, both males and females gather over the stream where they mate, lay eggs in the water and then die.

It can sometimes be a spectacular sight when mayfly duns hatch and when the spinners mate and fall into the water to die. They often provide a feast for trout and streamside birds such as the **phoebe**.



LIFE IN RAPIDLY FLOWING WATER can be difficult. Without special adaptations, insects would be swept away by the current. For example, one of the first mayfly nymphs you are likely to see each spring in a trout stream is called **Epeorus**, which has a very flat body. A flattened body offers less resistance to currents. Thus, Epeorus can live effectively in a thin layer of water on the tops of rocks where the current is insignificant. (Common names of mayflies vary from region to region and so Latin names are used to be precise.)

Another interesting adaptation to life in swift water is a streamlined shape. Fish have streamlined body shapes. Their bodies are widest about one third from the front and they gradually taper toward the rear. A lot of insect larvae have similar shapes. A common insect in trout streams is the mayfly nymph called **Isonychia**. This mayfly has a streamline body enabling it to position itself in the current without getting swept away. *Isonychia* obtains its food by filtering microscopic plants and animals out of water that pass through hairs attached to the insect's front legs.

Another group of aquatic insects are the stoneflies. Stoneflies are perhaps the most sensitive of the

aquatic insects and are usually the first to disappear when streams become polluted. There are about 170 species found in North Carolina. Their presence in trout streams indicates that the water quality is good.

Perhaps the most common stonefly larva in trout streams is **Tallaperla**. This stonefly looks like a cockroach and is very effective at shredding leaf matter for its food. Another common stonefly larva is **Acroneuria**. This aquatic insect is a predator and spends much of its time roaming around the streambed hunting other aquatic insects.

The most diverse group of insects found in trout streams are the caddisfly larvae that make up a portion of a trout's diet at certain times of the year. Over 7,000 species are known worldwide and over 300 species are found in North Carolina. This group of insects feeds in many different ways. Some caddisflies are predators and feed on other aquatic insects. Others are filter feeders and still others are grazers, obtaining their food by scraping algae off rocks and logs.

Many species of caddisfly larvae build portable shelters that protect them from predators and help them obtain food. For example, **Hydropsyche** weaves complex nets. These insects make tubes of silk that project out into the water with strings of saliva between the tubes that act like a net to catch passing food items.

Caddisfly larvae are most interesting for the portable cases they build. Most cases are built with small rocks or sand grains and sticks and vegetable matter. A common resident of trout streams is the caddisfly **Glossosoma**. This caddisfly builds a saddle-shaped case of small stones and slowly grazes the surfaces of rocks for attached algal food material. One advantage of building a case of sand and small stones is that it makes the insect heavier and therefore less likely to be washed away.

Each case-making caddisfly shapes its case differently, which can tip off a biologist about which insect species is hiding within. For example, cases of **Apatania**, **Neophylax** and **Goera** are all made of small rocks or sand grains, but each case is quite different.

Besides mayflies, caddisflies and stoneflies, other aquatic insects inhabit the cold waters of trout streams.

Some of these are dragonflies, damselflies, crane flies, hellgrammites and midges. Trout also eat ants and other terrestrial insects that fall into the water.

The silty edges of trout streams, where the current is reduced, often are good places to look for aquatic insects. Animals here don't have to worry as much about being swept away as do animals that live in the current. As an example, the caddisfly **Pycnopsyche** constructs an awkward-looking case of twigs that would be washed away if it were in the current. But here at the edge of the stream, this caddisfly is content to graze on submerged logs for food. An unusual caddisfly, **Heteroplectron**, actually excavates the center of twigs to build a case. The twigs cases of these two caddisflies camouflage them from their most active predator, trout, although sometimes the fish will eat them twigs and all. Also along stream edges, **seal salamanders** are abundant. The female lays her eggs on the undersides of rocks in streams or in cavities in rotten logs.

**IMPORTANCE OF MOUNTAIN TROUT STREAMS**

With their generally superb water quality, mountain trout streams represent one of the few pristine habitats left in North Carolina. With the continuing pressure to find and use clean, unpolluted water for drinking, mountain trout streams will serve as a primary source of drinking water for towns and communities in the western part of the state.

In several watersheds in the Great Smoky Mountains National Park and other areas, reintroduced river otters are thriving today. Trout stream watersheds also serve as habitats for other animals, including the black bear, peregrine falcon, Carolina Northern Flying Squirrel and wild turkey.



Features of
MOUNTAIN TROUT STREAMS

- Recent surveys have indicated that there are numerous rare and endangered plant species found only in well protected trout stream watersheds.
- Mountain stream systems, which include the riparian zones next to streams, are protected habitat for many species, including salamanders, black bears, flying squirrels, wild turkeys and river otters.
- The range of the brook trout, the only trout species that occurs naturally in North Carolina streams, is being reduced to small, clean headwater streams.
- If you look closely at the rocks and boulders in a trout stream you will find an astonishing variety of aquatic insects. These insects have evolved to live in a swiftly flowing stream system. Many insects construct portable cases for protection from predators and for ballast.

THREATS TO MOUNTAIN TROUT STREAMS

The gravest threat to the ecology of mountain trout streams comes from uncontrolled development. Mountain soils are very thin and are easily eroded when disturbed, especially on steep slopes. Any logging or construction project (road or housing construction are examples) will release sediment into the stream system if it's not properly managed. Sediment fills the pools and the spaces between the rocks and boulders on the stream bottom. It will smother the gravel beds where trout spawn and the eggs that trout lay there.

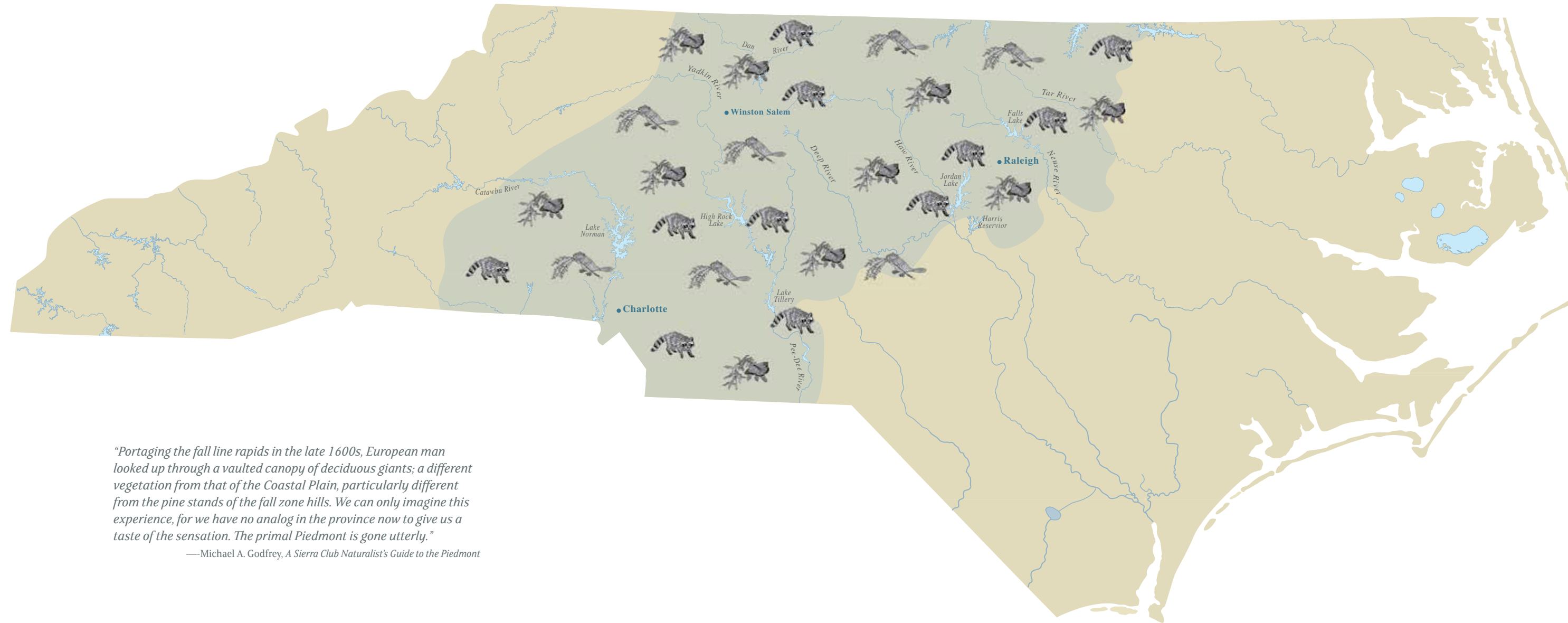
Other threats to the ecology of mountain streams include acid deposition, primarily from coal fired power plants and automobiles, and an increase in stream temperatures. The latter can be caused by the loss of stream shading from riparian vegetation removal, climate change, water withdrawals, storm water runoff over heated impervious surfaces, and impoundments. Finally, the introduction of invasive species can also have impacts to mountain trout streams, through direct competition and predation, by providing a vector for diseases and parasites, and by limiting habitats within and along streams.

4 | PIEDMONT HABITATS

Because it's softly rolling hills reminded them of their foothills homes in Europe, early settlers use the term "Piedmont" (literally, "foot of the mountain") to refer to the region between the Blue Ridge Mountains in the west and the fall line in the east. The fall line is where the harder rock of the Piedmont comes into contact with the younger and softer rock sediments of the Coastal Plain. Rivers and streams entering the Coastal Plain erode the soft sedimentary layers more easily, creating a series of rapids and small waterfalls.

Of all the provinces in the state, the Piedmont has been settled the most densely. While the clay soils disappointed early settlers, the fast-flowing rivers provided power for grist mills and textile mills. Industry developed first in the Piedmont. Most of our major cities are located here, as are most of our people. Economically, it's the most important region in the state.

Because the original mixed pine and hardwood forests were cut and the land was farmed not only by Europeans but by Native Americans before them, much less is left of the Piedmont natural communities than those of any other region in the state. In many places, decades of poor farming practices have denuded the land of its topsoil. As farms wore out and were abandoned, they were often replaced by forestland.



"Portaging the fall line rapids in the late 1600s, European man looked up through a vaulted canopy of deciduous giants; a different vegetation from that of the Coastal Plain, particularly different from the pine stands of the fall zone hills. We can only imagine this experience, for we have no analog in the province now to give us a taste of the sensation. The primal Piedmont is gone utterly."

—Michael A. Godfrey, *A Sierra Club Naturalist's Guide to the Piedmont*

MAP KEY



Old field



Beaver pond



Piedmont stream forest

Piedmont Old Field

Last summer, the old field was a patchwork of greens and browns with a smattering of colors from wildflowers such as Queen Anne's lace. But now, in early fall, the glow of goldenrods reflecting the Autumn sun is the dominant color.

As the days grow shorter with the onset of winter, the fields are covered with the brown and rust of broomsedge and the dried seed heads of various wildflowers.

When early settlers arrived in North Carolina's Piedmont, they saw a different landscape than we see today. Originally, hardwood forests of chestnuts, oaks, hickories and tulip poplars towered over much of this area. But the settlers cut the forests to build houses and they farmed the land. A typical Piedmont farm was moderate in size and consisted of a patchwork of many different land uses. Tilled fields of row crops and a cluster of tobacco barns adjoined pastures for grazing livestock. A small orchard, woodlots and the farmers' small pond provided a diversity of habitat types for wildlife.

Old Fields are a habitat type that develops after a farmer abandons the corn or tobacco field permanently or doesn't plant anything for a few years. When a farmer abandons a piece of cropland, a succession of different plant communities invades the bare soil, following each other in a predictable order. At first, herbs such as crabgrass and horseweed appear. In two to three years, asters and **broomsedge** begin to dominate. Gradually, shrubs, vines and small **pine seedlings** and **cedar trees** begin to appear and if left undisturbed for 10 or 15 years, the pines will quickly grow into a young pine forest. The grasses and other early plants will die in the shade of the pines. After another 50 to 100 years, a forest of deciduous **oak** and **hickory trees** will replace the pine forest and again dominate the landscape. Scientists call this process plant succession. An old field represents the early years of this ecological process.

Where did all these plants come from? In some cases, seeds were already present in the soil, waiting for the proper light



1. Oak/hickory forest
2. Red-tailed hawk
3. Cotton rat
4. Pine seedlings
5. Apple tree
6. White-tailed deer
7. Field sparrow
8. Yellow sweet clover
9. Meadow vole
10. Queen Anne's lace
11. Praying mantis
12. Eastern black swallowtail caterpillar
13. Broomsedge
14. Eastern black swallowtail butterfly
15. Red fox
16. Viceroy butterfly
17. Insect galls
18. Monarch butterfly
19. Goldenrod
20. Buckeye butterfly
21. Red cedar tree
22. Common flicker

conditions in which to grow. Seeds of other plants were brought there by wind, by birds and by other animals. Some seeds appear earlier than others because they are lighter and can be dispersed by the wind. Larger seeds may need animals to carry them and so they appear later. Some plants can only tolerate certain light conditions. Pine seeds, for example, cannot develop in the shade created by pine trees, but the seeds of hardwood trees such as oaks and hickories are tolerant of shade.

On almost any drive through the Piedmont, you can see evidence of former old fields scattered throughout the landscape. Unless planted to provide timber for the landowner, the stand of young pines you see today was the old field of not so many years ago.

Examples of PIEDMONT OLD FIELDS



Eno River State Park (Orange and Durham counties). Managed old fields near picnic area at Fews Ford Access. Contact Eno River State Park, Route 2, Box 436-C, Durham, NC 27705. (919) 383-1686.

Falls Lake State Recreation Area (Wake and Durham counties). Variety of successional habitat types. Write Falls Lake State Recreation Area, 13304 Creedmoor Road, Wake Forest, NC 27587. (919) 676-1027.

Piedmont Environmental Center (Guilford County). Mowed open pastures maintain early successional habitat for wildlife as part of providing a natural exhibit of all stages of Piedmont vegetation succession. Located on the north shore of High Point Lake, 1220 Penny Road, High Point. (336) 883-8531.

Mason Fann Biological Reserve (Orange County). Outstanding examples of successional old fields rich in wildflowers and butterflies. Public access restricted. Permits must be obtained from the administrative office, N.C. Botanical Garden, University of North Carolina at Chapel Hill, CB#3375, Totten Center, Chapel Hill, NC 27599-3375. (919) 962-0522.

Stone Mountain State Park (Wilkes and Allegheny counties). Piedmont and mountain vegetation communities merge here. Numerous old fields scattered throughout park. Stone Mountain State Park, Star Route 1, Box 17, Roaring Gap, NC 28668. (919) 957-8185.

LIFE IN AN OLD FIELD

As you walk through the field you may notice tiny runways through the grass. These are the root systems of small mammals such as **meadow voles** and **hispid cotton rats**. One cotton rat wandered too far from the safety of thick vegetation and provides a meal for the **red-tailed hawk** seen flying overhead. With its incredible eyesight, the hawk noticed the rodent's movements from high atop its favorite hunting perch along the edge of the field. At twilight the hawk's place is taken over by another large predator, the great horned owl. This raptor is adapted to hunt in the dark.

Nearby, the keen ears of a **red fox** have detected the sounds of a meadow vole. The red fox is easily distinguished from its woodland cousin, the gray fox, by having much more red in its fur and by its distinctive white-tipped tail. In addition to rodents, foxes consume a wide variety of other foods, both plant and animal. In summer, their diet is largely made up of vegetation such as berries and other fruits. They also eat a lot of grasshoppers, beetles and other insects.

Smaller than the cotton rat, the meadow vole (also commonly called a "field mouse") is capable of eating its own weight in vegetation daily. Look closely and you may see the small piles of grass clippings left behind by these tiny mammals as they feed. Meadow voles have one of the highest reproductive rates of any mammal. Fortunately, predators such as hawks, owls, snakes and foxes help keep populations of these rodents in balance.

As evening approaches, a female **white-tailed deer** and her fawn journey from the forest edge into the open field. As they wander, they nibble on the tender leaves of various plants and eventually wind up under an old **apple tree** that stands as a reminder of a past farmer's modest orchard. In the first few months after a fawn's birth, its coat is speckled with white markings against a brown background. This pattern serves as a protective coloration. When danger is near, a young fawn will drop on the ground and remain motionless until the danger passes. The fawn's coat looks like the pattern of light and shadow created

when sunlight passes through vegetation.

Perhaps the most noticeable wildlife on any summertime visit to an old field are the birds and insects. Across the field a **common flicker** hunts insects hidden in the cracks of a locust post in the old fence row. Sit quietly along the edge of any field and you'll soon see the rusty cap and distinctive pink bill of a **field sparrow**. If you are lucky, you may find a nest from earlier in the season. Any prominent perching spot in the field (such as a snag or a fence post) is sure to attract a number of other common birds such as bluebirds, indigo buntings and mockingbirds.

The flying jewels we call butterflies are common in summer and fall as they flit from flower to flower gathering sweet nectar. It's easy to see male **Eastern black swallowtail butterflies** with their large size, bold black and yellow markings and "tails." Females of this species prefer to lay their eggs on plants in the parsley family known as Queen Anne's lace.

These eggs will develop into butterflies, but not before they undergo several changes. First they hatch into tiny caterpillars. These tiny eating machines shed their skin several times and continue to grow into the familiar **Eastern black swallowtail caterpillar** with bright green, yellow and black stripes. Eventually that caterpillar will enter its pupal stage. Crawling away from its host plant, it hangs from a twig or a blade of grass by means of a safety line, much like one worn by a repairman climbing a utility pole. It spins a chrysalis or pupal case, a green one or a brown one depending on the background color of the attachment site. In about two weeks, the chrysalis will split open and a new butterfly will emerge.



Also known as wild carrot, Queen Anne's Lace is the ancestor of the garden carrot. As with many of our common field and roadside "weeds," **Queen Anne's lace** is not a native plant but was brought to this country from Europe because it served a useful purpose to early settlers. In addition to having an edible taproot, its seeds and finely divided leaves were dried and used as a seasoning or made into a tea. The **yellow sweet clover** is also an introduced species prized for its ability to enrich the soil with nitrogen.

ON ANY STROLL THROUGH A FALL FIELD, you will pick up a variety of hitchhiking seeds clinging to your clothes. This represents one of nature's best strategies for getting a plant from one place to another. Because their seeds are generally able to travel great distances, most old field plants are able to take advantage of any cleared land by having their seeds in the right place at the right time. Enclosed in sticky seed covers, these hitchhiking seeds attach themselves to the fur or feathers of animals which can travel long distances before the seed falls off. Other seeds are packaged in sweet fruits that are eaten by animals in one place and then excreted somewhere else.

When in bloom, **goldenrod** produces lots of nectar and pollen, attracting wasps bees and a variety of flies, beetles and butterflies. Shown in the illustration are

the colorful **buckeye**, **viceroy**, and familiar **monarch butterflies**. Each fall, millions of monarchs born along the East Coast migrate to cool mountain valleys in Mexico to spend the winter before heading back north to start a new monarch generation. Monarch butterflies lay their eggs on various species of milkweed that contain powerful chemicals toxic to most animals. The monarch caterpillars are immune to the milkweeds' poisons and are able to eat the leaves and absorb the toxins into their bodies. These chemicals protect both the caterpillars and later the adult monarchs from most bird predators by making them taste bad.

Take a closer look at a goldenrod plant. You may see a swelling along the stem. The swelling on goldenrod stems come in two shapes—elliptical or round—and are called **insect galls**. The ball-shaped goldenrod gall is formed by a small fly; the elliptical gall by a moth. These galls are formed when an insect lays its eggs in the stem. As a result of chemicals inserted with the egg or released by the feeding larvae, a characteristic swelling develops. The larva continues to live and feed inside the gall until it matures.

Field crickets and grasshoppers make up another large group of insects of old fields. Various spiders, from the web-building argiopes to the big-eyed jumping spiders, can be found feeding on the abundant insect life. Other invertebrate predators such as the praying mantis are also commonly seen.

IMPORTANCE OF OLD FIELDS

In addition to being pleasing to the eye, Piedmont old fields have been of great importance to two groups of scientists: wildlife biologists and ecologists. Wildlife biologists value the habitat because many different animals feed and raise their young there. These biologists have encouraged landowners to mow and burn their old fields to help sustain populations of rabbits, quail and other species. Old fields have also been important to the work of ecologists. By studying old fields in the Southeastern United States, these scientists learned a great deal about how plant and animal communities function.

Features of PIEDMONT OLD FIELDS



- The vast majority of the land in the Piedmont has at one time or another been cleared and farmed. Over time, abandoned fields are colonized by a rather predictable series of grasses and wildflowers (crabgrass, horseweed, broomsedge, asters, goldenrods). This process of change in the plant communities on abandoned fields is known as succession.
- Early successional plant species are able to grow in a wide range of soil, nutrient and moisture conditions. They also have the ability to spread their seeds quickly over a wide area to take advantage of abandoned fields.
- Left undisturbed, the herbaceous phase of vegetation lasts an average of about five years before being heavily invaded by pines and other tree species.
- Typical wildlife of old fields includes a variety of insects, birds and small mammals. The abundant supply of potential prey provides food for predators such as hawks, owls and foxes.

THREATS TO PIEDMONT OLD FIELDS

Unlike most habitats in this book, old fields are not natural. They come about because of human-caused disturbances. They occur when farmland is abandoned or when current fields are disturbed in some way. And old fields will disappear if they are left alone.

Thus the major threats to Piedmont old fields are changes in the way the land is used. In the past, old fields were constantly being created as scattered farmlands were temporarily abandoned for various reasons. But because of changing farming methods, it's less likely that small landowners will periodically rotate tracts of land out of production. With increased urbanization, more and more of our farmlands are converted to shopping centers, housing developments and other non-wildlife uses. And if not properly managed, even fields acquired for parks or other public open spaces are lost through the process of natural succession. Old fields need to be periodically burned, mowed or tilled in order to be maintained for any length of time.

Piedmont Stream Forest

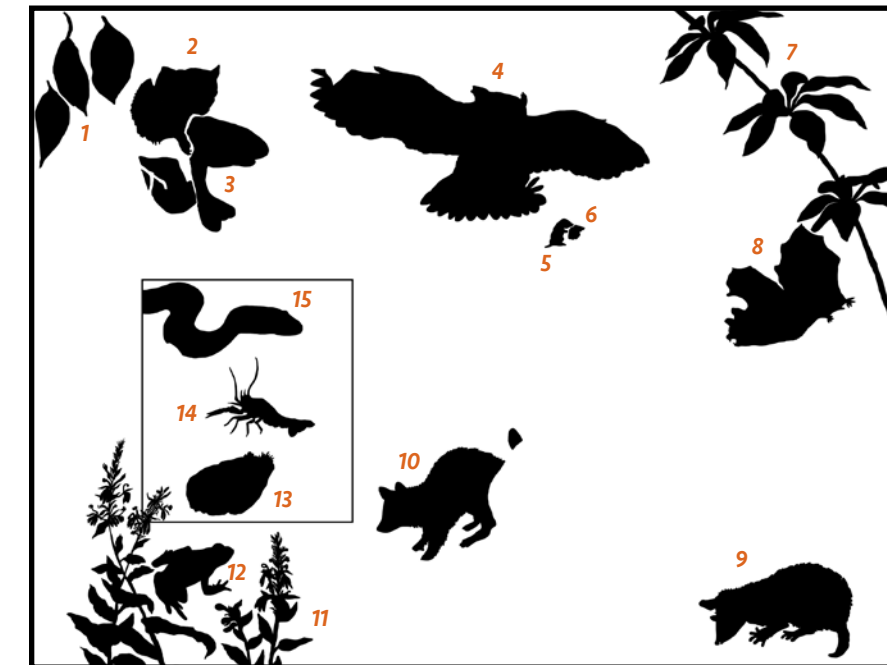
Most of us pass them every day on our way to and from work, school or home. You may even have one in your backyard—a small stream surrounded by woods.

By day, the summer stream forest is an exciting place to explore. Taking one of the many paths through this woodland, you'll see numerous insects, frogs, toads and maybe a snake or two. You may even flush a rabbit from a brier tangle. Under streamside rocks are crayfish, salamanders and other amphibians. In the stream, minnows and larger fish flash by. In the trees above are common year-round resident birds like cardinals, mockingbirds and blue jays, while bright flashes of color announce summer residents like Kentucky warblers, black-and-white warblers and yellow-throats. The shade from the overhead trees helps hold in the moisture from the stream, and vegetation will be lush, the air humid and ripe with the smells of plants, mud and water.

But after the sun sets, another world emerges. You may not see much wildlife now, but you can hear it. The summer streamside forest hums with life—crickets chirping, insects buzzing, frogs peeping, owls hooting, and opossums and raccoons scurrying through the leaves. Moist leaves and vines slap at your legs as you walk through.

Unlike people, many animals are adapted to feeding, hunting, flying and walking even in the dark of night. Night offers special opportunities for animals that can exploit them. Species that are most active at night are known as nocturnal animals. Species active by day are diurnal animals. Species active at dawn or dusk are crepuscular animals.

In many cases, the lines aren't always clearly drawn between the three types. Some species, such as shrews, are active during all three periods, while others, such as white-tailed deer, might be diurnal in remote areas but are crepuscular or nocturnal in locations heavily populated by humans. For these adaptable species, darkness offers safety from people.



1. *Persimmon tree*
2. *Southern flying squirrel*
3. *Luna moth*
4. *Great horned owl*
5. *Southern short-tailed shrew*
6. *Cecropia moth*
7. *Ironweed*
8. *Big brown bat*
9. *Opossum*
10. *Raccoon*
11. *Cardinal flower*
12. *Southern leopard frog*
13. *Freshwater mussel*
14. *Crayfish*
15. *Queen snake*

LIFE IN A PIEDMONT STREAM FOREST

The Piedmont stream forest is one of the most common types of habitat in central North Carolina. There are literally thousands of streams and creeks that begin or flow through the Piedmont. Many wildlife species, both rare and common, are found here.

To understand how wildlife uses a Piedmont stream forest, think of the habitat as a road and as a cafeteria, as well as a home.

Often, the small ribbon of forest that runs alongside streams is the last wooded habitat left for wildlife in many urban areas or in heavily populated areas of the Piedmont. Wildlife use these greenways, as they are often called, as roads or corridors for travel and migration.

Forested streams also provide miles and miles of what is called “edge,” where one type of vegetation or habitat meets another. In this case, it’s where forest vegetation meets water. In this corridor, you’ll find a rich variety of fish and wildlife—aquatic species such as fish and mussels; terrestrial species such as birds and mammals; and species such as reptiles and amphibians

that are adapted to life on land and in water.

Because the edge attracts so many animals, it becomes a kind of cafeteria where one type of animal feeds on another. The stream acts like a conveyor belt bringing food down its length to fish and mussels in the water. The moisture also encourages lush plant growth, attracting insects and animals that feed on vegetation. In turn, predatory animals are attracted by these animals.

If the water quality is good, the stream will support a healthy population of **freshwater mussels**. Mussels feed by filtering from the water tiny particles of organic matter such as decomposing plants. In a clean creek, mussels can be the most abundant life form found in the water. In creeks in urban areas, however, only species that can tolerate pollution, if any, will exist.

Popular game fish like the Roanoke bass and green sunfish feed on small minnows and **crayfish** in the creek. Also hunting crayfish at night is the **queen snake**. Found from the Piedmont west to the mountains, this non-venomous water snake is usually found hiding in the daytime under rocks or debris at water’s edge. It is dark brown, with yellowish stripes and can grow up to almost 3 feet long.

The stream provides plenty of moisture for plant growth in the fertile, low-lying ground. Numerous ferns, vines, wildflowers and brush species are found along the stream banks. The **cardinal flower**, for instance, is a beautiful member of the bellflower family. Its flowers are brilliant red-orange. (These flowers are poisonous, by the way, and should not be eaten.) **Ironweed** is another wildflower species found in low-lying moist areas. Its flowers are pink and attract a wide variety of insects. The **persimmon tree**, with its orange fruit that ripens in October, also grows along streams.

Bullfrogs and the **Southern leopard frog** are common nocturnal noisemakers along streams. These amphibians feed on the insects found around the stream. The Southern leopard frog usually breeds in early spring, but occasionally in the fall. It lays its eggs in clusters on vegetation just below the surface of the water. During summer, frogs are active nocturnally as their noisy nighttime calls attest.

Mammals are also attracted to the water and the food they find there. Common **opossums** and **raccoons** are two of the most active mammals using the stream forest at night. Raccoons will eat just about any plant or animal that they can get their paws on. Raccoons have a highly developed sense of touch in their “hands.” By feeling around underwater rocks, they find much of their food—mussels, crayfish and small fish.



Opossums are among the most common and unusual mammals in the state. They are nocturnal but are most active in the hours just after dark and just before dawn. It is the only North American marsupial species. Marsupial young are born as embryos and mature in the mother’s external pouch. Like the raccoon, they are omnivores, eating nuts, earthworms, mushrooms, vegetation, frogs, snails and carrion.

Other ground-dwelling mammals in the stream forest are rabbits and various rodents—mice, rats, shrews and voles. The **Southern short-tailed shrew**, usually about 3 to 5 inches long, is quite common but is only rarely observed in the daylight. That’s because shrews nest under the leaf litter and travel through runways they make under the leaves.

Shrews have incredibly high metabolisms and must eat their total weight in food each day or else they will starve. Because of their high-food needs, they are active at all times of the day and night. Short-tailed shrews also produce a toxin from the salivary glands that paralyze prey such as spiders, centipedes and moths.

Bats are mammals with an ability to fly. The **big brown bat** is almost entirely nocturnal, usually becoming active about 15 minutes after sunset. During the day it may hide in hollow trees, then come out at night to eat. It forages over streams and open areas, eating a wide variety of insects, although this species rarely eats moths. Bats hunt at night using a unique radar-like sense called echolocation. With this sense, bats are able to produce a series of highly pitched sounds, pulsing at a rate of perhaps two hundred times per second. The sound bounces off objects—including insect prey—and is picked up by the bat’s sensitive ears, thus allowing the bat to “see” by sound.

AT NIGHT, BUTTERFLIES, WHICH ARE largely diurnal, are replaced by the nocturnal moths. Both the **Cecropia moth** and the **luna moth** are large but common species that belong to the giant silkworm moth family.

Up in the trees will be the **Southern flying squirrel**. Although some people think of flying squirrels as being rare, they are actually fairly common, although



usually unseen. Unlike the often seen gray squirrel, flying squirrels are fully nocturnal, emerging from their tree cavity nests only in the black of night.

Flying squirrels’ most distinguishing trait is their ability to fly—glide, actually. On each side of their body is a loose fold of skin running from their forelegs back to their ankles on the hind legs. The squirrel flies by leaping with outstretched limbs, using its tail as a rudder to steer in the air. Sharp turns and agile acrobatics are possible. While flying squirrels eat acorns, nuts and berries, they will also consume bird eggs, carrion and insects.

Of all nocturnal predators, the various owl species are among the most specialized and formidable. These raptors have unique adaptations for nighttime hunting. Their wings are covered with fluffy feathers that muffle sound when flying and allow the owls to attack prey without being heard. They also have large eyes adapted for keen night vision. In addition to their eyesight, owls are equipped with highly developed ears that enable some species, such as the barn owl, to locate prey by sound alone. Their neck twists as much as 180 degrees, enabling owls to remain almost motionless while scanning the darkened landscape for any movement or noise. Like hawks, which are diurnal hunters, owls have powerful talons for snatching and grasping prey.

The **great horned owl** is a permanent resident of North Carolina’s Piedmont stream forests. It eats mainly rodents, reptiles and birds.

IMPORTANCE OF PIEDMONT STREAM FORESTS

In some areas, Piedmont stream forests are the only habitat left to many animals, especially those in urban areas. These stream forests also help preserve water quality. The roots of forest trees and plants help keep soils intact during heavy rains. Water runs off the land slowly, keeping sediment out of the water. A forested buffer along a stream also helps filter out pollutants contained in runoff from roads and urban areas.

Many of the rarest mussels are found in Piedmont streams. For instance, the Tar River spiny mussel is found only in a portion of the Tar River and in Swift

Features of PIEDMONT STREAM FORESTS



- Aquatic species such as mussels serve as valuable indicators of stream water quality. Rivers and streams cover only about 1 to 2 percent of our state, but they provide habitat for approximately half of the 200 animals that are listed by the state or proposed as endangered, threatened or of special concern.
- Generally, most small creeks flow into, or join to make, a bigger stream. The stream then flows into a river or joins with others to form rivers. The area drained by one large river and its smaller streams is called a watershed. There are 17 major watersheds in North Carolina from the coast to the mountains.
- The mussels and other aquatic life found in streams serve as indicators of water quality. North Carolina’s freshwater mussel populations have been especially hard hit by water pollution. Of the approximately 70 species found in the state, virtually all are declining.

Creek. Sadly, many species have already disappeared from Piedmont streams or rivers because of pollution and water-quality problems. When mussels begin disappearing, it’s a sure sign the water quality is being affected. Remember, this is the water we drink.

THREATS TO PIEDMONT STREAM FORESTS

Most of North Carolina Piedmont streams have been degraded by human activity to one degree or another. Toxic discharges from wastewater treatment plants can threaten all aquatic life, especially sensitive filter-feeding organisms such as freshwater mussels. Urban and industrial development can increase sedimentation, destroy forests and wildlife habitat and increase pollution runoff into streams. Reservoirs, constructed by damming small creeks and rivers, destroy stream ecosystems. Farms pollute rivers and streams with farm chemicals such as fertilizers and pesticides, as do suburban yards. Timber harvesting can cause stream sedimentation when improperly done. Land clearing temporarily destroys the older trees needed by cavity-nesting creatures.

Examples of PIEDMONT STREAM FORESTS



Uwharrie National Forest (Montgomery, Davidson and Randolph counties). Forest roads give easy access to numerous creeks, streams and small rivers. Write District Ranger, Uwharrie National Forest, USFS Route 3, Box 470, Troy NC 27371. (919) 576-6391.

Pilot Mountain State Park (Surry County). Has a 2-mile trail along the Yadkin River and exhibits. Contact Pilot Mountain State Park, Route 1, Box 21, Pinnacle, NC 27043. (919) 325-2355

Pee Dee National Wildlife Refuge (Amon and Richmond counties). Wildlife drive and a half-mile Pee Dee River nature trail. Contact Refuge Manager, Pee Dee National Wildlife Refuge, Route 1, Box 92, Wadesboro, NC 28170. (704) 694-4424.

Eno River State Park (Durham and Orange counties). Hiking trails. Contact Superintendent, Eno River State Park, Route 2, Box 436-C, Durham, NC 27705. (919) 333-1686.

Beaver Pond

It's a cool mid-May morning on the path skirting the shore of this urban lake. You've decided to spend the entire day in the wooded upper reaches of this old millpond park where a colony of beavers has created a beaver pond.

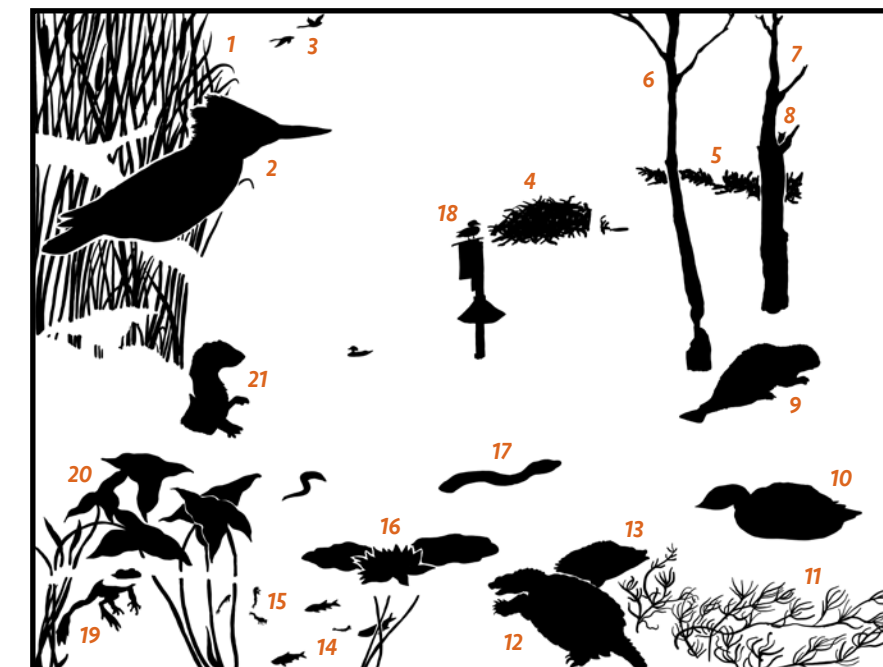
The lake edge is soggy and your shoes quickly get wet. A dank smell of decaying vegetation hangs heavy in the mist over the water. Many of the trees have died and stand starkly gray. Others have fallen and now lie criss-cross like giant pick-up sticks. Thickets of alder, cat brier and marsh grasses form a green tangle where once there were trees. You realize that walking through a beaver swamp may not be easy.

Beaver ponds have their own life cycle. The initial flooded woodland swamp stage may last five years. In the next five to 10 years, it flourishes as an open marsh with a woody border. In the final stage, when beavers have exhausted their preferred-tree supply and have abandoned the pond, the beaver dams disintegrate and a

stream channel develops. Gradually the marsh reverts to a wet meadow and then to a bottomland forest. At this point beavers may re-enter the woodland and begin the process anew.

Populations of plant and animal species change throughout this pond cycle. During the flooded stages, many species of fish, reptiles and amphibians prosper. Muskrats, mink, river otters, gray foxes and other mammals are quick to inhabit beaver ponds. So are Canada geese, mallards and wood ducks, and swamp nesting birds like the red-shouldered hawk and the prothonotary warbler. Habitat for woodland species like the gray squirrel is poor during these stages.

It feels strange and disquieting, this drowned and girdled woodland. Last autumn, the pond was alive with color and creatures. When winter came, the silence was broken only by a creaking tree or digging woodpecker. At any time of year, you see felled trees, peeled twigs and girdled stumps—the unmistakable signs of the pond's chief engineer, the beaver.



1. Cattails
2. Kingfisher
3. Canada geese
4. Beaver lodge
5. Beaver dam
6. Beaver-killed tree
7. Water-killed tree
8. Screech owl
9. Beaver
10. Mallard hen
11. Waterweeds
12. Snapping turtle
13. Bluegill
14. Minnows
15. Dragonfly nymphs
16. Waterlily
17. Red-bellied water snake
18. Wood duck
19. Green frog
20. Arrowleaf plant
21. Mink

LIFE IN A BEAVER POND

It's difficult to spend time around a beaver pond without recognizing the extraordinary numbers of creatures that live there. Some are big, some small. They come in all shapes and colors, from the most minute water flea to the great blue heron. Each depends in some way on others and all, ultimately, depend on the beaver.

On this morning, your presence is loudly announced by the rifling call of a **kingfisher** that you spy as it leaves its perch to circle and scold overhead. A small animal swims toward you. Only its furry snout appears above the surface. It approaches within 10 feet and pauses. Is it a beaver? No, it's the beaver's smaller rodent cousin, the muskrat. It senses danger, quietly dives and swims toward its burrow.

You climb atop a log to look across the wooded swamp. Everywhere there are snags—dead trees that are now in various states of decay. Most have

been **killed by water**, drowned in the months or years since the beavers flooded this woodland with their dam. Others are **beaver-killed trees**, succumbing to **beavers** chewing the bark from their trunks, which cuts off the flow of water and nutrients from the tree roots to crown. Red maples and black willows, however, seem to survive the immersion intact. Alders, elderberries and last summer's growth of cattails fringe sections of the pond. Pools and channels of open water are sprinkled with mats of marsh grasses, floating **water lilies**, **arrowleaf** and other **water-weeds**. Part open freshwater marsh and part wooded swamp, the pond is more sunlit than a forest.

Take a closer look at the dead trees (snags). They are peppered with woodpecker diggings—the birds have chipped dead wood while searching for insects or excavating nest cavities. The snags remind you of high-rise apartments with a variety of tenants. You see a pair of red-headed woodpeckers on one snag and a few other birds perching, singing and flying about. The small hollows made by the downy woodpecker might be suitable for a Carolina chickadee or an Eastern bluebird. An abandoned red-headed woodpecker cavity, being larger, might provide a residence for a crested flycatcher or flying squirrel or even a tree lizard, the broad headed skink. The largest excavations by flickers and pileated woodpeckers can house species as large as **screech owls** and wood ducks.

It matters little to the wood duck hen that some of these cavities are 30 or 40 feet above the surface of the water. On hatching day, all eight to 12 ducklings climb to the cavity entrance and jump—free falling balls of fluff that with few exceptions reach the water safely. And so the tree snags, even in their death, bring forth life to the beaver pond.

Dragonflies dart about. They chase one another as well as mosquitoes, moths, midges and other flying insect prey. Then they perch on a twig, wings glistening in the sun. A group of turtles, small Eastern painted turtles and larger yellow-bellied sliders, have climbed atop a floating log to bask. Heat from the sun helps these cold-blooded reptiles digest the water weeds, minnows, dragonflies and the carrion that is their food.

YOU SLOWLY TRAVEL AROUND THE POND edge until you come upon the **beaver dam**. It's a long, winding mud and stick structure perhaps 3 or 4 feet high and half as wide. The dam has sprouted swamp wildflowers like touch-me-nots and ditch daisies and you imagine the dam would be hard to walk on, or even find, in late summer. A **red-bellied water snake** slithers away from the dam and you suspect you've upset its plans to make a meal of a frog or tadpole. You respect its need to be wary. Red-shouldered hawks and gray foxes prey upon this snake, but perhaps his worst enemies are the misguided people who needlessly kill it.

A musical trill bursts forth from ahead, its source unknown. You hear another trill and what sounds like the twang of a banjo string. That, you know, is the call of a **green frog**. Another long trill, then finally, swimming lazily into view are three American toad males clinging to a female. It's near the end of their breeding season and you see that the shallows are alive with thousands of tadpoles, **dragonfly nymphs** and **minnows**. Few will survive all the pond predators—**bluegills**, **snapping turtles**, water snakes, raccoons, **mink** and herons, among many others.



In deeper water looms a large mound of earth and sticks, and you wonder how you could have missed seeing it. It's the **beaver's lodge**. Whereas the dam traps the stream's water and creates a beaver's pond, the lodge is a beaver's actual residence. This lodge seems enormous. It rises 6 feet above the water's surface and spreads nearly twice that at its base. It's tucked snugly against a snag but completely surrounded by water. The sides are freshly packed with mud and the peeled branches and twigs of trees. Inside the lodge may be as many as two adult beavers and a fresh litter of three to five kits.

The sun is setting and activity on the pond increases. A barred owl heralds the arrival of nightfall with loud hooting. Fish break the surface snapping up insects. **Wood ducks** sail across the pond, the female landing atop a nest box. A **mallard hen** ushers her seven ducklings through the reeds. The moans, croaks and trills of frogs and toads grow louder and more confident as the evening progresses. A **Canada goose** honks its presence from across the marsh.

Then you hear it—it's a low grating sound. Something grawing! You move closer. It's almost too dark to see, but there's no longer any mystery. It's the architect of this place, the beaver. And once again, it's at work.

IMPORTANCE OF BEAVER PONDS

Naturalist Ernest Thompson Seton estimated that there were 60 million beavers in the United States when European settlers first arrived. The importance of beavers to the exploration and settlement of North America cannot be underestimated. Beaver fur was North America's most important export for many years and great fur-trading companies like the Hudson Bay Company helped many colonists become wealthy.

Today, beavers are still trapped for their furs, but their most important role is in creating wetland habitats for other wildlife species.

Beaver ponds are also used as feeding areas by migrating and wintering waterfowl, thus providing an expanding source of wetland habitats for these species at a time when there is concern that wetlands for waterfowl nationwide are declining dramatically.

Still, species that live in moist bottom lands may be flooded and killed when beavers move in and flood the area. In a well-known instance, one of the few known populations of the endangered dwarf trillium was lost beneath a Wake County beaver pond. On the other hand, many aquatic and marsh-loving plants colonize the same ponds.

Beaver ponds also have an important role in reducing water pollution. They store water and their stick and mud dams filter silt, chemical and solid pollutants from our rivers and streams. The value of this function in our rapidly developing Piedmont communities should not be underestimated. Sediment from housing and commercial development, from road-building activities and even from farmland, can settle in the bottom of our reservoirs, drastically shortening their life spans. Excessive silt can also clog the gills of aquatic insects, amphibians and fish. By removing the silt before it enters man-made reservoirs, beavers provide an important water quality service to people and downstream organisms.

THREATS TO BEAVER PONDS

Until settlers arrived and began trapping beavers, cougars and especially wolves served as key predators on beavers. So successful were trappers, however, that by 1900, C.S. Brimley, one of the founders of the North Carolina Museum of Natural Sciences, found that beavers were, in fact, extinct in North Carolina.

In 1939, 29 Pennsylvania-caught beavers were released in the North Carolina Sandhills in Richmond County. In 1957, 15 additional beavers from Alabama were stocked in Umstead State Park, Wake County. From these original introductions beavers have been transplanted or have naturally expanded to most parts of the state. By 1985, 80 of North Carolina's 100 counties were occupied by beavers.

Today there are few natural predators left that are large enough to catch and kill an adult beaver, which can weigh as much as 50 pounds. Bobcats, foxes, alligators, minks and occasionally a bird of prey may take a few young animals. But conflict between beavers and people can be expected to increase as beaver

Features of
BEAVER PONDS



- Beaver ponds are created when a colony of beavers dam streams. Normally from one to 10 of these large rodents occupy a colony. They use mud, twigs and branches from felled trees to construct dams that can flood less than an acre or hundreds of acres of bottomlands.
- As beavers girdle trees, they kill them. These dead trees, or snags, are quickly used by woodpeckers and a host of other animals seeking cavities for nesting or shelter.
- Beavers help to create wetlands that provide habitat for fish, waterfowl, reptiles and amphibians, and for furbearing mammals like the muskrat and the mink.
- Beaver ponds filter pollutants, prevent flooding by storing stormwater and perform other wetlands functions.



populations continue to expand. The reasons are simple: beavers flood bottomlands that humans use for growing timber, raising crops and pastures, parks and greenways, and even for housing and commercial development. Currently both lethal and non-lethal means are used to manage local populations.

Examples of
BEAVER PONDS



Beavers are found throughout the state. Contact your local parks department, Audubon Society or Sierra Club chapter for information on beaver pond sites near you.

Durant Nature Park (Wake County). Has two beaver colonies with extensive hiking trails. Ask for the self-guided "Beavers of Blind Water Lake" trailguide. Write Naturalist, Durant Nature Park, Raleigh Parks and Recreation, Box 590, Rakigh, NC 27602. (919) 831-6856.

Falls Lake State Park (Wake County). In the Beaverdam Lake reservoir, there are extensive beaver colonies. Contact Falls Lake State Park. U.S. Army Corps of Engineers, Resource Manager, Falls Lake Management Center, 11405 Falls of the Neuse Road, Wake Forest, NC 27587. (919) 846-9332.

Merchants Millpond State Park (Gates County). Canoe among cypress and beavers. Write Merchants Millpond State Park, Route 1, Box 141 A, Gatesville, NC 27938. (919) 357-1191.

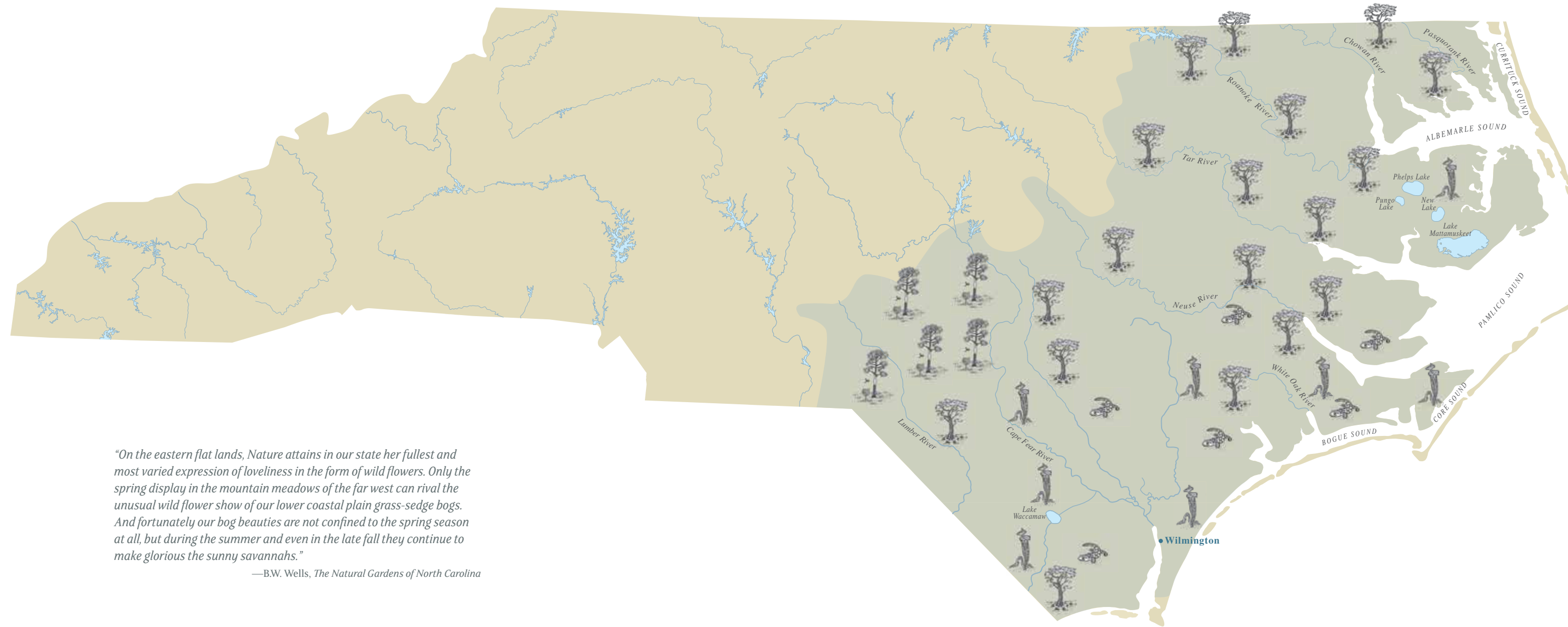
Morrow Mountain State Park (Stanly County). Beavers inhabit many sections of the Pee Dee River. Write Morrow Mountain State Park, 49104 Morrow Mountain Rd., Albermarle, NC 28001. (704) 982-4402.

5 | COASTAL PLAIN HABITATS

This low, flat region extends from the fall line to the Atlantic Ocean, as much as 150 miles in width. So flat is this area of the state that at its highest at the fall line it's only 500 feet in elevation. With so little slope and with little hard rock to flow through, the rivers entering the Coastal Plain from the rocky Piedmont meander in broad, graceful loops through the soft layers of sand.

Its sandy soils makes clear that the Coastal Plain was once wholly under water. Over the last 2 million years, it has been inundated by the sea many times, leaving a series of terraces across the landscape to mark its advances. As recently as 18,000 years ago, the shoreline would have been many miles east of where it is today.

The Coastal Plain is a land of great natural diversity, where most of our state's wetlands occur—bald cypress swamps, deep peat bogs, freshwater marshes and mysterious Carolina bays. Historically, its uplands were covered in longleaf pines and scrubby oaks. It's a region where fire has occurred naturally and frequently over the centuries, carving out a rich variety of plant and animal communities adapted to fire.



"On the eastern flat lands, Nature attains in our state her fullest and most varied expression of loveliness in the form of wild flowers. Only the spring display in the mountain meadows of the far west can rival the unusual wild flower show of our lower coastal plain grass-sedge bogs. And fortunately our bog beauties are not confined to the spring season at all, but during the summer and even in the late fall they continue to make glorious the sunny savannahs."

—B.W. Wells, *The Natural Gardens of North Carolina*

MAP KEY



Bottomland hardwood forest



Sandhills longleaf pine forest



Longleaf pine savanna and pocosin



Carolina bay

Bottomland Hardwood Forest

As you walk through a bottomland hardwood forest in the early fall you may not see many animals because they are hidden by the dense green foliage. But you can see tracks and other animal signs present in the muddy margins of the stream banks and sloughs.

You can hear the songs of birds and can see colorful flashes of their feathers around you. The tall, mature hardwoods form a closed canopy, casting a deep shadow on the relatively open, park-like understory.

The fall is usually that driest time of year. The only water lies in the deepest sloughs. Vines are everywhere. Only a couple of inches difference in elevation marks a dramatic change in the type of vegetation you walk through. Passing through a forest of oak, hickory, beech and sweet gum trees, you will walk down a small slope to the edge of a swamp where cypress and gum trees grow. Last spring's flood waters have left a distinct dark waterline on their trunks. If you had been here in March, you

would have been wading in a foot or more of water!

Bottomland hardwood forests are composed of a variety of broad-leaved hardwood trees that grow in the flood plains of our rivers and streams. Why are they called bottomland forests? One reason is that they grow in low areas that are flooded for a portion of the year when rainfall causes the rivers and streams to overflow their banks. Not only have the plants and animals of the bottomland hardwood forest adapted to this annual flooding cycle, they depend on it.

In a typical bottomland, for example, the lowest areas, often referred to as sloughs or swales, contain trees such as tupelo gum and bald cypress. These trees are adapted to long periods of flooding and, once established, can even thrive in areas that are flooded year-round. Oaks, hickories, ash, sycamore, beech, elm and other trees grow on higher and dryer portions of the floodplain. These higher areas, also known as ridges, terraces or levees, flood only occasionally and usually for brief periods. Geologists refer to this



1. Prothonotary warbler
2. Cherrybark oak tree
3. Dead shumard oak tree
4. Barred owl
5. Pileated woodpecker
6. Bald cypress trees
7. Tupelo gum trees
8. Mallard ducks and black ducks
9. Overcup oak tree
10. Great blue heron
11. Bobcat
12. Pawpaw
13. Zebra swallowtail butterfly
14. Cottonmouth
15. Sedge
16. Wild turkey
17. White-breasted nuthatch
18. Beauty berry
19. Male wood duck
20. Giant cane

alternating pattern of high ground and low ground as “ridge and swale” topography.

LIFE IN BOTTOMLAND HARDWOOD FORESTS

In early fall, the bottomland hardwood forests are still in a lush green hue. On the higher, better drained parts of the floodplain, oaks such as the water oak, willow oak, **shumard oak** and **cherrybark oak** are producing acorns. Cherrybark oak is a type of red oak whose acorns take two years to ripen. In wetter areas of the floodplain, the **overcup oak** grows. This oak is named because its acorns are almost completely covered by woody cups.

In the spring, summer and early fall you may spot the golden flash of a **prothonotary warbler** as it flits

Examples of BOTTOMLAND HARDWOOD FORESTS



Roanoke River Wetlands (Halifax and Martin counties). Extensive bottomland hardwood forest and swamp habitats. Over 200 species of birds recorded. Lower Roanoke River Wetlands: <https://www.ncwildlife.org/Portals/0/Hunting/Game-Land-Maps/Coastal/RR-Wetlands-RRNWR.pdf>. Upper Roanoke River Wetlands: <https://www.ncwildlife.org/Portals/0/Hunting/Game-Land-Maps/Piedmont/Upper-Roanoke-River.pdf>

Roanoke River National Wildlife Refuge (Bertie County). Extensive bottomland hardwood forest and swamp habitats. www.fws.gov/refuge/roanoke_river/

Merchants Millpond State Park (Gates County). Millpond containing cypress-gum swamp forest. Canoeing, hiking trails and camping available. www.ncparks.gov/merchants-millpond-state-park

Pee Dee National Wildlife Refuge (Anson County). Mature bottomland hardwood forest in the Brown Creek floodplain is the best example remaining in the Piedmont. www.fws.gov/refuge/pee_dee/

River Park North (Pitt County). A 324-acre nature park offering a variety of activities including boating, camping, fishing and hiking with trails through an extensive bottomland hardwood forest. www.greenvillenc.gov/government/recreation-parks/river-park-north

from tree to tree. This colorful bird, only 5 inches long, is a common inhabitant of bottomland swamps, and is sometimes called the swamp canary. It is the only warbler in North America that nests in cavities, and is a member of a special group of songbirds called neo-tropical migrants. Neo-tropical songbirds nest in the United States but spend the winter months in the tropics of Central and South America, thousands of miles away.

Many birds in the bottomland forest feed on insects around the abundant acorns produced by the various oak trees. One of these is the magnificent **wild turkey**, one of the wariest inhabitants of the forest. The turkey is most common in large tracts of mature forest. Other common residents are the **bobcat** and the colorful **wood duck**. Woodies make use of the wet sloughs, but they also move to the drier oak forest to feed on acorns.

Bottomland hardwood forests contain many small habitats for birds and small mammals. One of these micro-habitats is the abundant cavities that are found in older trees when branches fall off or when the tree becomes diseased. Many of the forest birds and animals use these natural cavities for nests and for shelter. Wood ducks and prothonotary warblers raise their young in cavities, and so do the **white-breasted nuthatch** and the **barred owl**. The **pileated woodpecker** excavates its own cavity in dead trees or limbs. These holes later provide homes for other wildlife species.

Nuthatches hunt for insects along the limbs and trunks of trees. They are often seen going head first down the tree, one of the only birds that normally do this. Barred owls are often heard but only occasionally seen in the forest. Their hooting call sounds like “who cooks for you, who cooks for you all,” and can be heard during the day, but is most often heard at night. They feed on small rodents, frogs and other small animals that they catch by relying on their excellent eyesight and hearing. The pileated woodpecker, with its fiery red crest, is our largest woodpecker. Its relative, the ivory billed woodpecker, once inhabited our swamps and bottomlands of southeastern North Carolina, but the last ones disappeared over 100 years ago and are now extinct in the United States. Logging and

fragmentation of our virgin forests as well as indiscriminate hunting spelled doom for the ivory-bill as it also did for another colorful bird that once graced our swamps, the Carolina parakeet.

THE HIGHER PARTS OF THE FLOOD PLAIN provide habitat for several interesting understory plants such as **sedges** and cane. **Giant cane** grows in large colonies on the forest floor. This native grass has a woody stem that can grow to heights of 10 feet or more. Another under-story plant that grows on the higher portions of the flood plain as the **pawpaw**. Pawpaw produces a greenish, banana like fruit, 2 to 4 inches long, that is eaten by many wildlife species including wild turkey, raccoon, opossum and gray squirrel. The beautiful **zebra swallowtail butterfly** lays its eggs on the pawpaw tree leaves. The caterpillars feed exclusively on these leaves, so whenever you see a zebra swallowtail, there must be a pawpaw patch somewhere nearby.



A shrub that is frequently encountered in dryer and more open areas of the bottomland forest is **beauty berry**. Also known as French mulberry, this shrub produces clusters of bright purple berries that are eaten by a variety of wildlife.

Low areas in the floodplain, often called sloughs, contain a distinctive plant community called the cypress-gum swamp, named after its two dominant

trees. This community is often flooded during the fall months when other parts of the floodplain are dry. Most trees are unable to grow when their roots are submerged in water, but the bald cypress and tupelo gum are adapted to standing water. The **bald cypress** is a member of the *Taxodium* family, which includes the giant redwoods and sequoias of the American West. Because it bears needles instead of broad leaves, the bald cypress looks like a coniferous tree, but it is really deciduous, dropping its needles each fall. It can grow large and old, and it is not uncommon to find individual trees that are 5 to 6 feet in diameter, over 100 feet tall and 500 to 600 years old. In fact, the oldest stand of trees in eastern North America are bald cypress trees growing along the Black River in southeastern North Carolina. Some of these trees are over 1,600 years old!

Among the many interesting features of these ancient trees are the strange knobs, known as cypress “knees,” that grow straight up from the submerged roots. These structures can grow to more than 5 feet high and are believed to assist the tree and oxygen exchange during periods of flooding, as well as support the tree in place during high wind events.

Tupelo gum is a species of hardwood tree that grows with bald cypress. In the spring it produces flowers that attract bees. The bees help to pollinate the flowers, and the nectar that they collect is used to make a type of honey that is a favorite with every one with a sweet tooth: tupelo honey. The standing water in the cypress-gum swamp provides ideal habitat during the fall and winter months for migratory waterfowl such as **mallards** and **black ducks**. The **great blue heron**, a permanent resident of these swamps, hunts for fish, crayfish and small amphibians in the shallows.

Floating logs in the swamp provide a micro-habitat for the swamp nettle and other plants that actually grow on the log. These logs also provide an ideal sunning spot for the **cottonmouth**, sometimes called the water mocosin. This aquatic snake is one of the pit vipers, a venomous species related to rattlesnakes and copperheads. Cottonmouths are an important

part of the food chain, feeding on fish, amphibians and other small animals in the wetlands.

IMPORTANCE OF BOTTOMLAND HARDWOOD FORESTS

The bottomland hardwood forest is a very important part of our natural heritage. Bottomland hardwoods are a type of wetland that occurs throughout the Southeastern United States. In North Carolina, they are most extensive along the floodplains of our major Coastal Plain rivers such as the Roanoke, Cape Fear, Neuse, Tar, Black and Lumber rivers.

Bottomlands flood regularly with water that flows out of the banks of the rivers during periods of high rainfall. When this happens, the forests acts as a natural flood control filter. As the water overflows and then recedes, sediments, nutrients and pollutants flow back and forth between the river and the forest. Pollutants in the river water are filtered out into the floodplain, helping to clean the water. Some sediments and nutrients are left behind where they enrich the floodplain soils. Other nutrients are carried downstream to the estuaries where they provide much of the nutrition for many young fish and shellfish that grow in these coastal waters.

By slowing and cushioning the enormous force of the floodwaters, bottomlands help to control erosion. Though seasonal floods can be destructive, they also contribute to the high productivity of bottomlands. Flooding not only increases soil fertility by depositing soil and nutrients, it also speeds up decay, releasing nutrients stored in leaves, downed logs and other dead material on the forest floor. So rich are floodplain soils that many tree species reach their greatest size and fastest growth in bottomlands.

Bottomlands are also rich in wildlife both large and small. The seasonal flooding provides shallow waters where many different kinds of aquatic animals spawn and feed on the submerged leaves and other dead matter. Abundant tree cavities in the mature forests are used by many animals. In most areas of the country, the only remaining large forested acreages are located in bottomland hardwood forests in

Features of BOTTOMLAND HARDWOOD FORESTS



- Of the approximately 5.7 million acres of wetlands in North Carolina, about half, or 2.7 million acres, are bottomland hardwood forests.
- Between 1955 and 1974, North Carolina lost about 500,000 acres of bottomland hardwood forests, much of it because of conversion to forestry and agriculture uses.
- Bottomland hardwood forests perform many important functions in our environment. They control floods, improve water quality and provide high-quality wildlife habitat. They also provide spawning habitat and food for fish. For humans, they offer recreation, as well as paper and other wood products.

floodplains of our larger rivers. In an increasingly fragmented landscape, these wide ribbons of forest offer the last remaining large tracks of habitat for wide-ranging animals such as wild turkey, bobcat and black bear that require thousands of acres for their survival.

THREATS TO BOTTOMLAND HARDWOOD FORESTS

The major threat to bottomland hardwood forests is clearcutting and conversion to pine or hardwood trees farms. The practice of “high-grading,” a timber cutting practice that removes the economically viable tree species and leaves less desirable species behind, has degraded many bottomland hardwood stands by altering the natural composition of the forest. Drainage and conversion to agricultural fields for pasture also threatens bottomlands.

Construction of dams to control flooding on many of our rivers and streams, particularly in the Piedmont, has unintentionally contributed to the permanent flooding and destruction of many bottomland hardwood forests. Below the dams, the water releases may be causing long-term changes to the bottomland hardwood ecosystem. For example, some tree species may not be reproducing because their seeds are drowned by artificial floods that last into the summer months, long after natural flooding would have stopped.

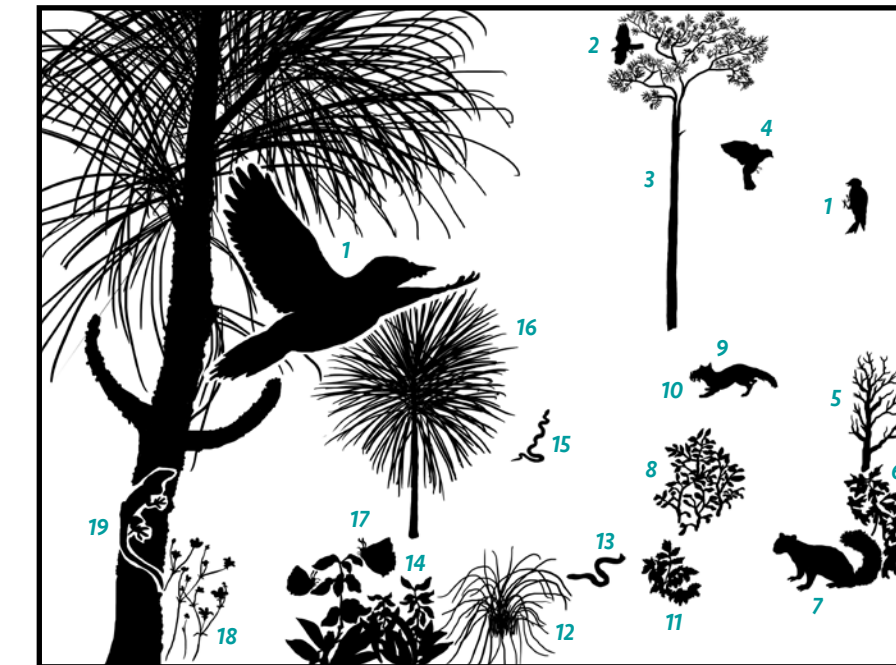
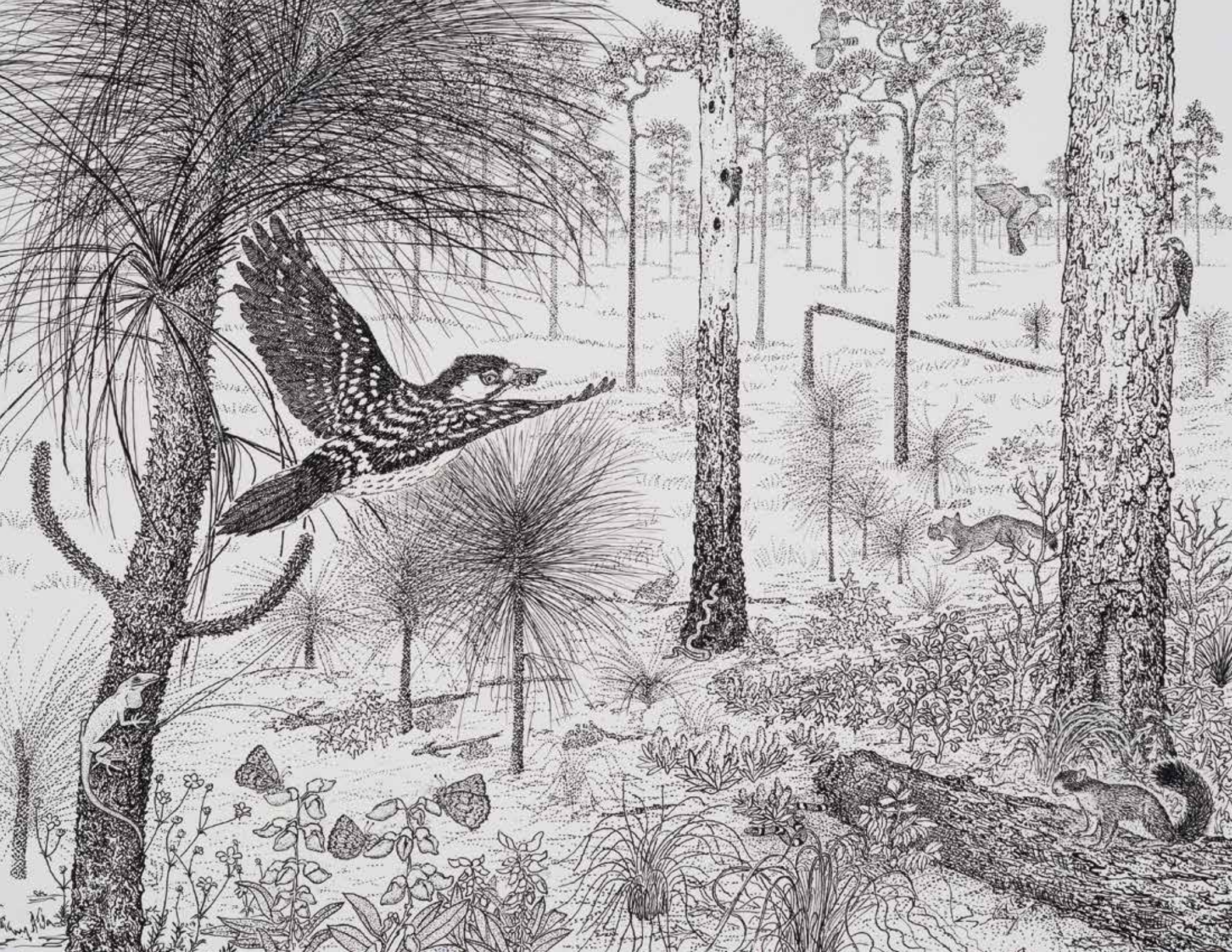
Sandhills Longleaf Pine Forest

Even in May, the heat is punishing but the mostly evergreen forest looks open and park-like. At mid-day, the tall pine trees drop dark shadows on the grassy forest floor. The wide spaces between the trees are occupied by high grasses.

If it weren't for the pleasant rolling hills, the forest would look a lot like a savannah, another habitat where longleaf pine grows. Here and there beneath the grasses you can see the sandy soil covered with a brown carpet of fallen pine needles. As you walk to a ridge where the sand is especially deep, the grass gives way to broad mats of lichens, one of the few plants that can grow in the Sandhills water-starved soil. The first travelers described the region as a "dreary" wasteland consisting of monotonous vistas of pines. Indeed, the deep sands make the Sandhills look almost like a desert or a beach, which it once was. Rainfall wets the soil only briefly before drying up or percolating down, and only special plants and animals can adapt to these dry conditions.

Once, the sand in the region was thought to be laid down by ancient seas. Today, however, scientists believe that the sand came most probably from river sediments deposited near the coast. Winds blew the sediments into dunes that were cut by streams, forming the rolling, sandy hills that we see today.

The North Carolina Sandhills region lies in the Coastal Plain in an area east of the fall line, consisting of portions of Moore, Montgomery, Richmond, Scotland, Hoke, Cumberland, Harnett and Lee counties. On early maps it was referred to as the "pine barrens," yet as early as the 18th century, Scots Highlanders began to settle in the area, making a living from the forest and its naval-stores products (tar, pitch, turpentine and rosin). Later, Southern Pines began to achieve renown for its healthy climate and Pinehurst and other resorts began to open. Today the region is known for its many golf courses.



1. Red-cockaded woodpecker
2. Sharp-shinned hawk
3. Mature longleaf pine tree
4. Bluebird
5. Bluejack oak
6. Turkey oak
7. Fox squirrel
8. Post oak
9. Gray fox
10. Cottontail rabbit
11. Michaux's sumac
12. Wiregrass
13. Scarlet kingsnake
14. Lupines
15. Ratsnake
16. Pole-stage longleaf pine
17. Pine elfin butterfly
18. Sandworts
19. Carolina anole

LIFE IN THE SANDHILLS LONGLEAF PINE FOREST

Longleaf pine ecosystems once covered vast areas not only in North Carolina, but in large areas of the Southeastern United States. As much as 92 million acres of longleaf pine trees grew in a wide arc from southeastern Virginia to the eastern Texas. The Sandhills longleaf pine forests differ from other kinds of longleaf pine forest, but it shares one thing in common: its dependence on fire. The warm and humid climate of the Southeast offers perfect conditions for summer thunderstorms. Over thousands of years, lightning from these storms ignited fires that ran throughout the longleaf pine region. So common was fire, that plants and animals developed many adaptations to resist, avoid or even take advantage of it.

In fact, almost everything that grows here is a result of fire and many plants even help to kindle blazes. For example, the longleaf pine's resin filled and flammable needles make excellent fuels for frequent fires that move quickly along the ground and that rarely harm the trees. So does **wiregrass**, the tall grass that grows abundantly throughout the forest. Following a summer fire, the wiregrass quickly regenerates and produces a fertile seed head. The

Examples of SANDHILLS LONGLEAF PINE FORESTS

Weymouth Woods Sandhills Nature Preserve (Moore County). Trails through longleaf pine forest showing typical Sandhills landscape. Visitor center with natural history exhibit, as well as guided tours and school groups. www.ncparks.gov/weymouth-woods-sandhills-nature-preserve

Sandhills Game Land (Moore, Richmond and Scotland counties). Extensive managed longleaf pine habitats with red-cockaded woodpecker colonies. <https://www.ncwildlife.org/Portals/0/Hunting/Game-Land-Maps/Piedmont/Sandhills.pdf>

Bladen Lakes State Forest (Bladen County). Managed longleaf pine habitats with exhibits. www.stateparks.com/bladen_lakes.html

erect clumps of wiregrass provide cover after burning for ground-welling wildlife species such as bobwhite quail and cottontail rabbits.

The **longleaf pine tree** has also adapted to frequent fire by delaying its growth. In its early years the pine doesn't appear to be growing at all. In fact, it looks very much like a clump of grass, which is the reason why the early years of a longleaf pine is called the grass stage. During this stage, the vulnerable growing tip is protected from fires by a dense growth of pine needles while the pine grows a deep tap root. A fire may consume the needles, but generally the growing tip is unharmed. The tree's roots will quickly pump nutrients and water to restore the young tree. After about seven or eight years, (it can take as many as 13 years), the tree begins to grow rapidly, spurting upwards of 3 to 4 feet a year. Now in its "**pole**" stage and looking very much like a bottle brush, the pine has lifted its growing tip above most blazes.

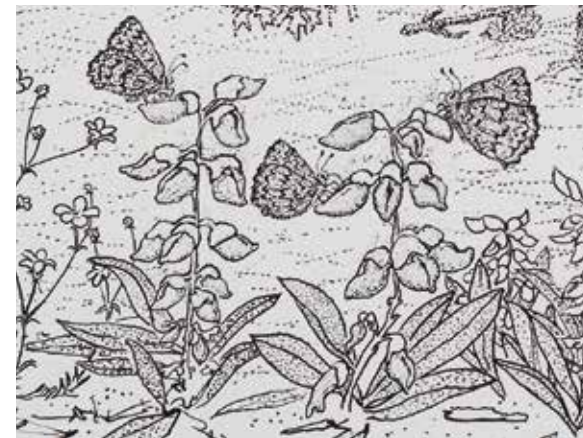
Fire helps longleaf pine in other ways. The seeds of this pine need bare ground to germinate and plenty of sunlight to grow. Fire prepares the ground for the pine's seed by clearing the way of the accumulation of pine needles, grasses and dead leaves. Also, fire keeps the scrub oaks under control. Without fire, dense thickets of **turkey oaks**, blackjack oaks, **blue-jack oaks** and **post oaks** would grow up, shading out the young longleaf pines and preventing them from growing.

Longleaf pine and wiregrass are not the only plants that need open conditions to flourish. **Michaux's sumac** used to range from North Carolina to Florida, but today only a few populations of this endangered shrub exist, most of them in the Sandhills. This plant is adapted to fire, putting its food resources into below ground rhizomes that can survive hot blazes. Indeed, the sumac needs fires to survive since it can't compete in shaded, overgrown conditions.

Other plants are adapted to the desert-like conditions of the Sandhills in other ways. Sapling turkey oaks, for example, turn their leaves vertically to the ground in the heat of the day. This adaptation, called tropism, is thought to protect the tree in periods of drought by preventing it from losing too much water

through transpiration. The leaves themselves have a waxy coating, another adaptation to the dry and hot conditions.

Among other plants adapted to the dry and hot conditions of the Sandhills are pyxie moss and **sandworts**. Pyxie moss is not really a moss, but a flowering plant that grows in mats so close to the ground that it looks like moss. This rare plant is endemic to the Sandhills region, meaning it grows only in a restricted area in North Carolina and South Carolina. Flowering from December to March, the plant is covered with white flowers. Sandworts also like the very dry, sandy soils of the Sandhills and they bloom with small white flowers.



IN THE EARLY SPRING, MANY BUTTERFLIES seeking nectar hover around bright wildflowers. The **pine elfin butterfly** is small but it can be seen near **lupines** with their lovely blue flowers. The female butterfly also lays her eggs on the longleaf pine needles where the caterpillars feed on the tender needle tips.

Many wildlife species also depend on the open forest maintained by fire. The **red-cockaded woodpecker**, for example, is adapted to open longleaf pine forests. With fires burning every few years, this woodpecker found few dead trees for its nesting and roosting cavities. It adapted to these conditions by excavating its cavities in live longleaf pine trees, the only woodpecker to adopt this habit.

The red-cockaded woodpecker lives in colonies consisting of from two to nine birds, but only one breeding pair. The red-cockaded woodpecker selects older, mature trees for its cavity making, especially those with a disease called red heart that softens the tree's interior wood, making it easier for the bird to dig. The bird flakes away the bark surrounding its cavities and also digs resin wells around it. From these wells flows a sticky gum (resin) that coats the tree in the area, turning in a light color. This is thought to be an adaptation that helps protect the young from predators such as **rat snakes**.

Ironically, its successful exploitation of longleaf pine forest has made the red-cockaded woodpecker an endangered species today. One reason is that longleaf pine forests have declined throughout their range; today no more than 5 percent of the original forest is left. Also, this wildlife specialist generally relies on older trees for its cavities, but longleaf pine trees are often harvested before they reach maturity. Many previous longleaf pine forests have also been replaced by the loblolly pine, which is harvested before the tree is old enough to develop red heart disease. Lastly, because of misguided forest management, fire has been prevented from burning many longleaf pine forests, allowing dense oak thickets to grow up. Red-cockaded woodpeckers need open forests in which to forage.

Another animal adapted to the open longleaf pine forest of the Sandhills is the **fox squirrel**. This large rodent travels mostly on the ground, an adaptation to the widely scattered trees in the deep, sandy soils of the Sandhills. The large size of the squirrel enables it to carry and eat the large cones from the longleaf pines.

The **Eastern bluebird** is not an endangered species, but its numbers were once very low. In longleaf pine forests, the bluebird often will hunt for insects in the bark along with the red-cockaded. Both birds will have to beware of the **sharped-shinned hawk**, a small woodland raptor that preys on small birds.

Among the many other wildlife inhabitants of the Sandhills longleaf pine forest are the bobwhite quail, the **gray fox** and the **cottontail rabbit**. The quail has traditionally been one of the favored game species of



the Sandhills region. The native gray fox is one of two foxes that are relatively common in the Sandhills, the other being its relative, the red fox. Unlike the red fox, the gray fox prefers woodlands over fields, utilizing its ability to climb trees.

Cottontails are one of the gray fox's favorite foods, although it will also eat insects and fruits. In the spring, the fox, which mates for life, hunts not only for itself but for its young which were born in late winter. Other creatures that reside in the Sandhills longleaf pine forest include the **Carolina anole** and the **scarlet kingsnake**. The kingsnake forages under the bark of dead trees and logs, hunting lizards, mice and other snakes. The anole is a lizard with a surprising ability to change colors from green to brown or even gray, depending on weather conditions and even mood. Courting males display a pink throat fan, or dewlap, that contrasts with their green bodies.

IMPORTANCE OF SANDHILLS LONGLEAF PINE FORESTS

As these forests have diminished, many plants and animals that depend on them have become rare. What's left of these Sandhills longleaf pine forests is critical habitat for such rare and endangered species as the red-cockaded woodpecker, Michaux's sumac and pixie moss. Protecting the forests from conversion to other uses and burning them during the growing season will ensure that the species of longleaf pine forests will continue to exist.

The forests also yield valuable products such as timber and pine straw. If landowners manage them well, longleaf pine forests can produce both ecological and timber resources.

Features of SANDHILLS LONGLEAF PINE FORESTS

- Sandhills longleaf pine forests are "deserts in the rain," wrote North Carolina ecologist B. W. Wells. Though rain falls throughout the region, the sandy soils drain quickly, leaving the ground as dry as if it never rained.
- This forest is a fire dependent habitat, requiring frequent fires to maintain the open conditions favored by the longleaf pine trees and by many plants and animals found there.
- The longleaf pine tree has adapted to frequent fires by growing slowly at first and then spurting upward. This staggered growth rate enables the tree to rise quickly above the level of most blazes.
- Red-cockaded woodpeckers have adapted to the lack of dead trees in the longleaf pine forest by excavating their nesting and roosting cavities in live, longleaf pine trees. The is the only woodpecker to exhibit this habit.
- Wiregrass is one of several plants that depends on fire. It only puts forth its fruiting stalk after fire.
- Large numbers of plants in the bean family—lupine, beggar's lice, butterfly pea, milkpea, partridge pea and wild lespedeza—live in frequently burned longleaf pine forests.

THREATS TO THE SANDHILLS LONGLEAF PINE FOREST

The main threat to all longleaf pine forest and their plants and animals is unwise management. An appropriate management scheme for this habitat will always include the use of fire because Sandhills longleaf pine forests depend on frequent fires for survival. Without fire, the ground would not be prepared to receive the tree's seeds. Without fire, scrub oaks would grow up and shade out the sun-loving longleaf pine saplings. The open forest would be choked with dense thickets of scrub oak, and red-cockaded woodpeckers and fox squirrels would not be able to forage for food.

Longleaf Pine Savanna and Pocosin

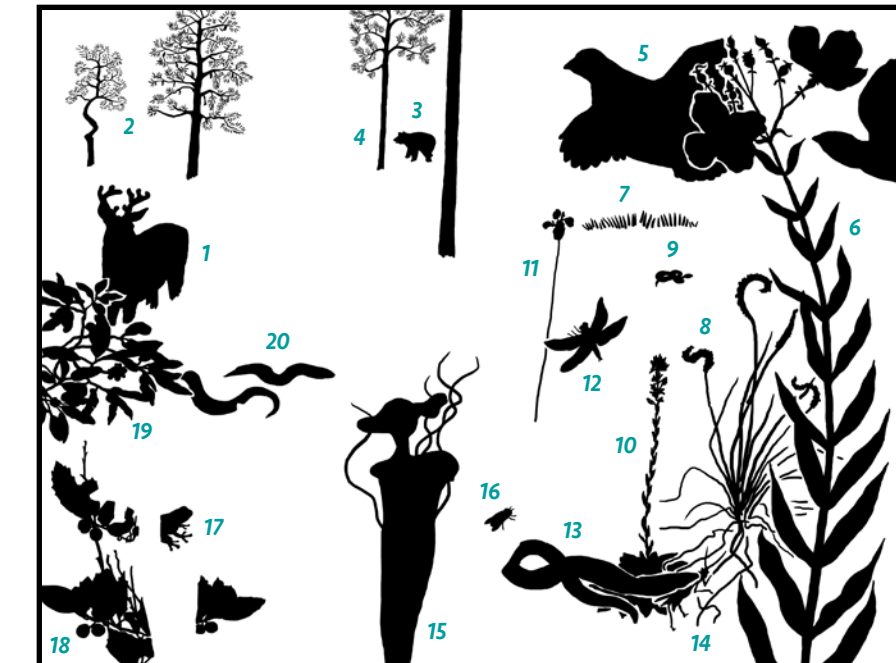
Once, much of our Coastal Plain was covered by broad, grassy pine savannas bordered by thick, brushy wetlands called pocosins. Riding their horses through the Southeast, many early naturalists were enchanted by the open savannas and compared them to meadows or parks.

One of these travelers, the Philadelphia botanist William Bartram, described a savanna in 1791 as “always green, sparkling with ponds of water.” Another early traveler said that they appeared “at a distance like so many Pleasure Gardens.”

As you walk through a savanna in late summer, you get a feeling for what they were talking about. The tall grass whips your legs and you are aware of swaying pine trees and multicolored wildflowers all around. The breezes moving the trees make a sound like the surf crashing on a far-away shore. The dominant color is green, yet hundreds of orchids and other wildflowers add jewel-like dots of color to the scene. In another few months, the grass will turn a tawny gold but other wildflowers will continue to bloom, even in winter.

As you cross a savanna, you find yourself blocked by a border of almost solid evergreen vegetation. This is a pocosin (pronounced “puh-ko-sin”). The ground is wetter and more sponge-like here. Though the longleaf pines still grow in the area, you begin to see pond pines now, shorter and more stunted than longleaf.

What a contrast between savanna and pocosin! The savanna is grassy and open, the pocosin is choked with shrubs. The savanna soil is sandy, often white or gray or a salt-and-pepper color; pocosin soil is peaty and mucky, and it feels soft and spongy when you walk on it. Yet both habitats are wetlands. Dense with evergreen bushes and trees, pocosins are among the most forbidding habitats in the state to human intrusion. Yet pocosins are so thick and brushy that many animals find excellent shelter there, and in the fall they eat berries and other foods. Most often, animals need more than one habitat in which to find food, shelter and water, and so it is with savannas and pocosins.



1. White-tailed deer
2. Pond pine
3. Black bear
4. Longleaf pine tree
5. Bobwhite quail
6. Meadow beauty
7. Wiregrass
8. Toothache grass
9. Canebrake rattlesnake
10. Vanilla plant
11. Yellow-eyed grass
12. Dragonfly
13. Eastern glass lizard
14. Grasshopper
15. Yellow pitcher plant
16. Blackfly
17. Pine barrens tree frog
18. Sweet gallberry
19. Sweetbay
20. Eastern king snake

LIFE IN A SAVANNA AND POCOSIN

In the early fall, the savanna is still green as the **wire-grass** keeps its summer hue. The longleaf pines are widely spaced, contributing to the savanna's park-like atmosphere. **Longleaf pine** was once one of the most important trees in the state. Its wood made strong and durable timber. Perhaps the most valuable product, however, was a natural gum that flows from the tree when it is wounded. This gum was used to produce naval stores; tar, pitch, turpentine and rosin. These products had a multitude of uses, from waterproofing the hulls of wooden ocean-going ships, to the manufacturing of soap and candles, to treating cuts and bruises. For 200 years, they were among North Carolina's most valuable economic products, and for much of that time North Carolina was a world leader in their production. Ships from all over the world tied up in Wilmington and other coastal cities to buy naval stores in barrels.

You'll notice that the lower bark of many of the longleaf pine trees have been scorched by fire. The

savanna is another habitat type where fire is natural and necessary. In the centuries before Europeans settled in this country, lightning strikes caused the longleaf pine forest to burn every few years. Today, responsible forest managers imitate nature by purposely burning longleaf forests with prescribed fire practices. (For more about the role of fire in longleaf pine forests, see "Sandhills Longleaf Pine Forest.")

The open sunny savannas are known for their tremendous diversity of plant species. In one savanna study plot measuring about a square yard, botanists found an impressive total of 50 plant species. The savannas put on a colorful orchid display during the growing season, and wildflowers bloom there almost all year long.

Savanna wildflowers such as the **meadow beauty** can survive fire because of their underground stems. Many of these plants won't flower at all unless they are burned frequently. In winter, meadow beauties produce a seed pod that looks like a tiny, exquisitely shaped urn. **Toothache grass** responds abundantly to fire. Its name comes from its use by Native Americans as a painkiller for toothaches.

In longleaf pine trees that are 80 years old or more, you'll find cavities excavated by red-cockaded woodpeckers. But sometimes, there's a surprise resident in these holes: Southern flying squirrels. This squirrel, as well as red-headed woodpeckers, compete with the endangered red-cockaded woodpecker for its cavities, but normally the squirrels like areas with more trees. (To learn more about red-cockaded woodpeckers, turn to "Sandhills Longleaf Pine Forest.")

Another savanna and pocosin resident you may want to be wary of is the canebrake or **timber rattlesnake**. These snakes are extremely venomous, but they eat rodents and are beneficial to humans for that reason. **Bobwhite quail** also inhabit savannas and its grassy cover, which provide seeds and insects as well as protection from predators. In early spring, these birds lay their eggs on the ground. The male has a white throat and a white stripe above the eye; the female has a buff-colored throat and a stripe leading away from the eyes.

For example, the black bear, shown crossing the savanna on its way to the pocosin, require several habitats throughout the year to satisfy its needs. It will eat foods growing in the savanna and pocosin, although at different times of the year. In the fall, it may feast on such pocosin foods as **gallberries**. And in every season, the pocosin's dense thickets of gallberry bushes, titi, greenbrier and **sweet bay** trees offer shelter for the bear that is lacking in the open savannas.



ON THE LOW FRINGES OF THE POCOSINS is another adaptable species, the **white-tailed deer**. Deer can be found in many habitats from the Coastal Plains to the Mountains. In the late summer and early fall, the antlers of male deer, or "bucks," are encased in a soft, velvet-like skin filled with blood vessels that nourish the antlers. Soon they will scrape the velvet from their antlers and polish them. Bucks often use their antlers in fights with other bucks in the fall, but they are mostly use for display. Normally, the bucks' antlers will fall off in late winter.

The edge between the savanna and pocosin is a good place to find the **Eastern glass lizard**. This legless reptile looks very much like a snake. It preys mainly on insects like the **grasshopper** seen in the illustration. But it must beware of being beaten by the **Eastern kingsnake**, shown sunning on a log.

The wet and mucky border between the savanna and pocosin is home to some of the most peculiar plants on earth. These are the insectivorous, or insect eating-plants such as pitcher plants, the Venus flytrap, sundews and others. Tall and a greenish yellow with

purple stripes, the **yellow pitcher plant** has a hollow stalk topped with a little hood. This species is only one of several pitcher plants that grow here, and all of them are constructed so that insects like the **black fly** are lured by nectar inside the open trumpet. Trapped, these insects fall into digestive juices created by the plant. By digesting the bodies of insects, the plants get nutrition that the poor soil cannot give them.

Pitcher plants may provide a perch and shelter for the tiny **pine barrens treefrog**, shown shading itself under the hood of the pitcher.

Another spectacular insect-eating plant that grows alongside pitcher plants is the Venus flytrap. The leaves of this plant are like a trap. They lie open most of the time, but when an insect lands on a trigger in the center of each leaf, the leaf closes and clasps the helpless insect. These plants occur only in a few coastal counties in southeastern North Carolina and northeastern South Carolina, and nowhere else in the world!

Other plants in the ecotone are the tall, purple-flowered **vanilla plant**. In the past, its leaves were used to flavor tobacco, hence its name. The large flower of the **yellow-eyed grass** attracts insects like the **dragonfly**.

As you push into the pocosin, you begin to see another kind of pine tree, the **pond pine**. These trees are mostly short and stunted because the wet, peaty soil offers little nutrition. The pond pine has adapted to fire as well as the longleaf pine, although in a different way. The pond pine's cones will open and drop its seeds only in the heat created by fire.

**IMPORTANCE OF SAVANNAS AND POCOSINS**

As important as they are to the state's natural heritage, most of North Carolina's once extensive savanna and pocosins have been lost to other uses. Pocosins are unique to North and South Carolina, (there are a few in southern Virginia, too), while longleaf pine savannas are shared by several states in the Southeastern United States.

Pocosins are wetlands that are watered by rainfall. Because the soil is so peaty, it absorbs rainfall like a sponge and releases it slowly. This function is especially valuable where pocosins adjoin estuaries, because they filter out pollutants and help maintain the proper water salinity in the estuary. This is important for young fish that grow up in these secluded waters, which is important for North Carolina's commercial fishing fleet and for our economy as well.

Frequent fires, moisture and plenty of sunlight have made savannas one of the world's great natural gardens. Two wildlife species, the fox squirrel and the endangered red-cockaded woodpecker, are also adapted to longleaf pine savannas. Both pocosins and savannas offer complementary habitats for the black bear and other game species.

THREATS TO SAVANNAS AND POCOSINS

The major threat to savanna and pocosin habitats is unwise management. Both of these habitats need to be burned every few years to maintain their characteristics. Without frequent fires, savannas will grow over in thickets of scrub oaks. Pocosins need to be burned to reduce the accumulation of deadwood that could lead to catastrophic wildfires dangerous to both humans and wildlife. Good management plans for both of these habitats include prescribed burning programs.

Many savannas and pocosins continue to be affected and even destroyed when drainage ditches are dug. Drained of their life-giving water, these habitats have been converted into farmland, housing developments and loblolly pine plantations. In this process, most of our regional savannas and many of our pocosins have been destroyed.

**Features of
LONGLEAF PINE SAVANNAS AND POCOSINS**

- Longleaf pine savannas are known for having the largest diversity of plant species in North America. Approximately 600 species of flowering plants, comprising about one-fifth of the state's total native vascular plants, are found primarily in longleaf pine communities.
- The Bachman's sparrow is found in longleaf pine savannas, preferring the open forest habitat. This rare, declining sparrow will perch at the edge of a branch to sing out "Here kitty, kitty."
- Savanna wildflowers bloom in almost every month of the year. The only month they don't bloom is January.
- Pocosin is a Native American term that means "swamp on a hill." Their deep, peaty soils absorb rainwater and release it slowly into adjacent estuaries. This preserves the proper mixture of salt and fresh water that's critical for fish and shellfish species.
- Pocosins are found in North and South Carolina, and nowhere else in the world. North Carolina has 70 percent of the remaining pocosins.

**Examples of
LONGLEAF PINE SAVANNAS AND POCOSINS**

Green Swamp Nature Preserve (Brunswick County). Boardwalks and trails through well-managed longleaf pine with carnivorous plants. Managed by the NC chapter of the Nature Conservancy. www.nature.org/ourinitiatives/regions/northamerica/unitedstates/northcarolina/placesweprotect/green-swamp-preserve.xml

Holly Shelter Game Land (Pender County). Extensive longleaf pine as well as other habitats. <https://www.ncwildlife.org/Portals/0/Hunting/Game-Land-Maps/Coastal/Holly-Shelter.pdf>

Croatian National Forest (Craven and Carteret counties). Longleaf pine and pocosin habitats with carnivorous plants. Camping and trails at various locations. www.fs.usda.gov/recarea/nfsnc/recarea/?recid=48466

Pocosin Lakes National Wildlife Refuge (Washington and Tyrell counties). Pocosin habitats with huge populations of winter waterfowl and black bears. www.fws.gov/refuge/pocosin_lakes/

Carolina Bay

It is February at a Carolina bay. A gentle, cold rain has been falling for several hours. This rain, along with others during the winter, has filled the bay with a foot of water.

By day, the bay is a serene landscape of scattered pond cypress trees looming over dark, still waters. By night, however, the sound of rain gently splashing on the water is drowned out by a chorus of frogs that have gathered at the bay to mate and lay eggs.

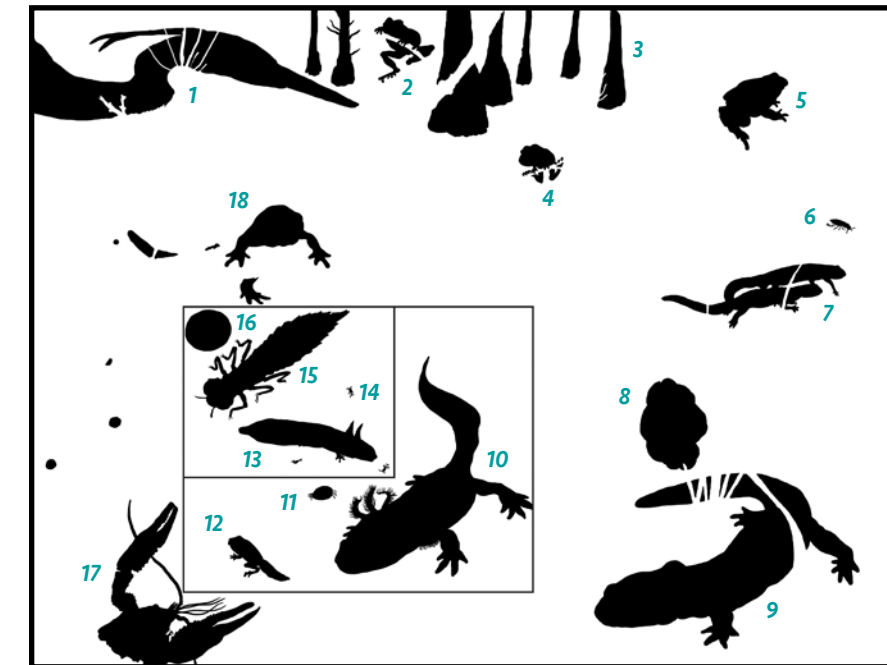
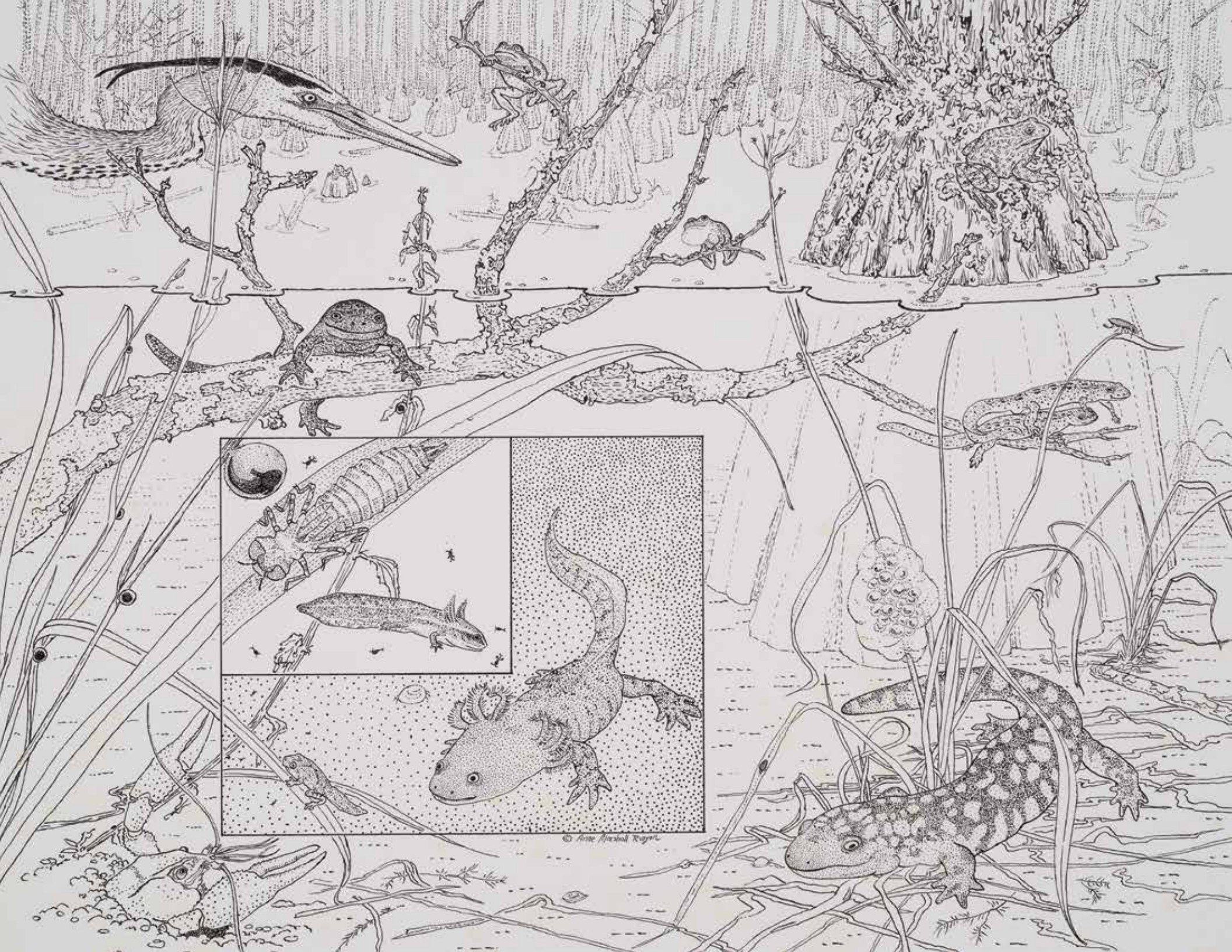
Later on, during the summer, the bay will look very different. Hot, sunny weather will dry out the bay except for maybe a few deep holes. Indeed, the plants and animals of the Carolina bay are adapted for an environment that is sometimes wet, sometimes dry.

Carolina bays are unique and mysterious wetlands found mostly in the southeastern portion of the state. No one even knew they existed until some of the first aerial photographs were taken of the Coastal Plain. What had been subtle or even hidden features to a

person on the ground became obvious from the air—thousands upon thousands of soft oval shapes that covered the landscape. Strangely, all of them were oriented along a northwest-southeast axis, and many of them had a pronounced sand rim on their southeastern ends. There were more than 400,000 of these bays, ranging in size from a fraction of an acre wide to over 5,000 acres wide, and they covered the Coastal Plain from New Jersey to Georgia. The greatest concentration of these formations, however, were and still are in southeastern North Carolina and adjacent South Carolina.

What caused these wetlands to form? An early theory held that the oval-shaped depressions were the result of a prehistoric meteor shower. But geologists have largely discounted this theory because they have never uncovered meteoric rocks or other alien material beneath the bays.

A more recent theory suggests that the bays formed when strong winds blew across a cold, sandy, sparsely vegetated landscape during the last ice age. Over time, these strong



1. Great blue heron
2. Ornate chorus frog
3. Pond cypress trees
4. Spring peeper
5. Gopher frog
6. Water beetle
7. Broken striped Eastern newt
8. Tiger salamander eggs
9. Tiger salamander
10. Tiger salamander larva
11. Clam shrimp
12. Spring peeper tadpole
13. Mabee's salamander larva
14. Red copepods
15. Dragonfly nymph
16. Mabee's salamander egg
17. Crayfish
18. Mabee's salamander

winds shaped shallow ponds into their distinctive elliptical shape. However, argument over the origin of the bays continues to this day.

Bays range considerably in size. The largest may attain depths of 20 feet or more and during at least a portion of the year they all collect rainwater. That's why they are categorized as wetlands. This seasonal flooding has probably been most important in shaping what will grow in the bays.

Some bays are filled with water all the time, forming natural lakes such as White Lake and Lake Waccamaw. Others are only seasonally wet, including bays with a clay layer beneath that traps rainwater and forms temporary ponds. These bays have such good soil that most have been drained to grow crops, one reason why you won't find many in their natural state. Still other bays are filled with peat, an accumulation of dead and decomposing plant and animal matter that rarely, if ever, completely dries out. The peat-filled bays were probably once water-filled bays that have gradually been filled in by decaying vegetation.

Examples of CAROLINA BAYS



Bladen Lakes Educational State Forest (Bladen County). 4470 NC Hwy. 242N, Elizabethtown, NC 28337. Peat-filled and water-filled bays. Email Bladen Lakes Educational State Forest at bladenlakessf.ncfs@ncagr.gov or call (910) 588-4964.

Jones Lake State Park (Bladen County). 113 Jones Lake Drive, Elizabethtown, NC 28337. Peat-filled bays. Trails and recreational areas. Email Jones Lake State Park at jones.lake@ncmail.net or call (910) 588-4550.

Lake Waccamaw State Park (Columbus County). 1866 State Park Drive, Lake Waccamaw, NC 28450. Water-filled bay. State's second-largest natural lake. Email Lake Waccamaw State Park at lake.waccamaw@ncparks.gov or call (910) 646-4748.

Croatan National Forest (Craven and Carteret counties). 141 E. Fisher Avenue, New Bern, NC 28560. Peat-filled and water-filled bays. Tours. Email Croatan National Forest at croatan@fs.fed.us or call (252) 638-5628.

LIFE IN A CAROLINA BAY

This particular bay is located in Hoke County in the upper Coastal Plain. Farmland, interspersed with forests of longleaf pine, occurs in the surrounding uplands. If not for the chorus of frogs and the presence of **pond cypress trees**, you would hardly expect to find a pond situated here so far from the nearest stream. The deciduous pond cypress trees have dropped their needle-like leaves. This tree is a smaller relative of the bald cypress trees that grow in swamps along our coastal rivers and watercourses. Pond cypress typically grows in isolated wetlands such as limesink ponds and Carolina bays. During the winter, teeming aquatic life thrive beneath the surface of calm waters, framed by the leafless pond cypress trees.

One of the most common inhabitants of the Carolina bay is the **crayfish**. Crayfish eat mostly plant matter it finds along the pond bottom, but it also scavenges for dead animal matter as well. Its underwater burrows provide homes for many other creatures during the dry season. **Water beetles** and water bugs are other underwater inhabitants you are likely to find in abundance. Some of these creatures have legs modified for swimming and they dart about with amazing speed and agility. Another aquatic insect you're likely to see is the **dragonfly nymph**, greatly enlarged in the inset picture. This nymph is one of the most voracious of pond predators, hunting other small aquatic animals including salamander larvae.

SOME BAYS ARE "EPHEMERAL" or temporary ponds. Fish have never established in these bays because the bays dry up in the late spring and summer. The lack of fish is good news for the many species of frogs and salamanders that spend all or a portion of their lives in these Carolina bays. If there were fish, they'd eat the eggs and larvae of the frogs and salamanders.

If you dipped a jar into the water you would discover it is alive with tiny organisms. Forming the bottom of the food chain are many thousands of tiny crustaceans, including **red copepods**, **clam shrimp**, fairy shrimp, Daphnia and amphipods. Some of these small animals are so geared to life in a temporary

pond that their eggs will hatch only after a drying-out period. A population explosion of these small organisms occurs almost immediately after the dry bay refills with water in fall and winter. Many are important foods for salamander larvae and other predators.

The **tiger salamander** is one of our rarest salamanders, today largely confined to Carolina bays in Robeson, Hoke and Scotland counties, although it formerly occurred across much of the eastern half of the state. The adult tiger salamander is quite large, growing to a length of 7 to 11 inches, and it gets its name from its coloration that features dull yellow spots and bars on a dark background. The adult spends most of the year—up to 10 months—as a land creature on the adjacent longleaf pine sandhills. It is rarely seen except during the short breeding season because it spends almost all of its time in burrows beneath the surface feeding on earthworms and other creatures. During rainy winter nights, the adults migrate to wetlands, such as Carolina bays, to breed. **Tiger salamander eggs** are a jellylike mass attached to the underwater stem of an aquatic plant. After hatching, the young salamanders, called **larvae**, grow and develop for four to five months and breathe through external gills. They feed on other salamander larvae, frog tadpoles and various invertebrates until they transform into juveniles in May or June.

Another rare salamander characteristic of the Carolina bays is the **Mabee's salamander**. This brown salamander has silvery-white flecks along



its sides and grows to a length of 3 to 5 inches. Like its larger relative, the Mabee's salamander breeds in the Carolina bays during the winter months and spends the rest of its time in burrows on the adjacent uplands. The **Mabee's eggs** (pictured in the inset) are attached singly or in loose chains to underwater twigs or other debris. These eggs hatch into **larvae** (also in inset picture) in about two weeks, and spend the next several months eating copepods and other minute aquatic creatures before they transform into juveniles and leave the pond.

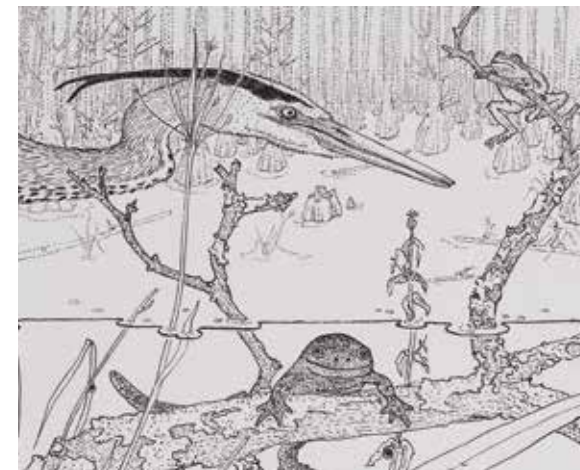
Perched on an underwater twig, two **broken striped Eastern newts** are mating. The newt spends the first months of its life as an aquatic larva and breathes through external gills. Then, in late spring or summer, it crawls out of the water with legs and air-breathing lungs to begin its new life as a land dwelling, juvenile newt, known as an eft. The reddish-brown eft roams moist, mossy areas for a year to several years until one winter's day it crawls back to the Carolina bay, where its coloration changes to a dull green and its tail thickens into an aquatic fin. Over the next several months, the female lays several hundred eggs one at a time, wrapping each one in a leaf. The newt now leads an almost totally aquatic existence.

Above the water on this February day, our attention is diverted by a chorus of different sounds. A deep, human-like snore reveals the presence of a **gopher frog** perched at the base of a clump of sedges. This large, toad-like frog is dark gray with prominent dark warts on its back. Like the tiger and Mabee's salamanders, these rare frogs spend most of their time in the uplands in longleaf pine sandhills, and, except during rainy periods, are usually found in burrows or stump holes beneath the surface. They enter the Carolina bays only to breed. Another very rare frog inhabiting Carolina bays is the **ornate chorus frog**. This colorful species is usually brick red, gray or greenish with dark spots or stripes on its back. A bold black stripe extends from the nostril through the eye to the shoulder on each side.

Probably the most common frog at this season is the **spring peeper**. This tiny frog—it grows to a

maximum of one and a half inches—is tan, brown or gray with a prominent dark, X-shaped marking on its back. The **spring peeper tadpole** lives in the Carolina bay for three to four months before transforming into a juvenile frog.

In the Carolina bay ecosystem, one of the top predators is the **great blue heron**, which feeds on any aquatic creature big enough to catch its eye. Soon the heron will begin its nesting activities in nearby swamps and river bottoms.



IMPORTANCE OF CAROLINA BAYS

Carolina bays are wetlands watered by rainfall. They are isolated depressions located in upland, often sandy areas away from rivers, streams and other watercourses. Some of the bays contain temporary ponds that are breeding sites for many species of amphibians, including several rare and endangered frogs and salamanders. They also harbor several species of rare and endangered plants. Other bays contain peat soils that act like a giant sponge, absorbing rainfall and controlling excessive runoff. These peat-filled bays may also serve as recharge areas, replenishing underground aquifers with fresh water.

Large Carolina bays with dense pocosin vegetation also serve as important refuges for large mammals such as the black bear, whose habitat in eastern North Carolina is disappearing.

Features of CAROLINA BAYS



- Unique wetlands known in the world only in the Coastal Plain from New Jersey to Georgia. Largest concentration in southeastern North Carolina and adjacent South Carolina.
- Most of North Carolina's natural lakes are actually water-filled Carolina bays. Examples include popular recreation areas such as Lake Waccamaw, White Lake, Jones Lake and Salter's Lake.
- Carolina Bays are egg-shaped depressions oriented in a northwest-southeast direction along their long axis, usually with a pronounced sand rim on the southeastern end.
- The origin of Carolina bays has been the subject of much scientific controversy. Recent research indicates that they probably originated in sandy, dune environments during a cold, windy climate during the last ice age.

THREATS TO CAROLINA BAYS

The major threat to the remaining Carolina bays is habitat destruction. Many continue to be drained, cleared and converted to farmland and loblolly pine plantations. Others may be affected by the lowering of regional water tables caused by drainage canals and ditches in the vicinity of the bays. Even if not drained, timber cutting can damage or destroy the natural vegetation of the remaining bays. Roads and housing developments around the margins of existing bays also fragment and destroy adjacent upland habitats that are crucial for many amphibians. Additionally, a lack of prescribed fire in these habitats, both the wetlands and the uplands, has severely degraded the quality of many of our Carolina bays.

Decades of drainage, conversion and fragmentation have destroyed many of our Carolina bays and threaten to harm or destroy most of the remaining ones. Carolina bays are therefore one of our most threatened wetland ecosystems.

6 | MARITIME HABITATS

Along the easternmost edge of North Carolina are the barrier islands, a thin chain of sandy beaches and marshes. Situated between the pounding sea on one side and the shallow sounds or estuaries on the other, they are popular vacation destinations for millions of people who enjoy the sea air and the gentle waves.

Forming a series of graceful arcs, these connecting islands protect the mainland from the destructive effects of powerful storms and their mighty waves. They were probably once the dunes of ancient beaches formed when the sea level was much lower. During the past 15,000 years, however, rising seas breached the dune line, creating the shallow sounds behind them and leaving the dune islands high and dry.

Sandy as a desert and scoured by frequent and fierce storms, barrier islands and the nearby waters of the continental shelf host several important wildlife habitats. Out on the shallow continental shelf not far from the islands, are underwater habitats known as hardbottoms. Behind the dunes lie the cool maritime forests while on the western sides of the islands, fringing the sounds, salt marshes nurture countless numbers of fish, shellfish and wildlife.



"All of us are drawn to the sea's edge as to a fire. Its vast reaches roll and heave in the light. There is an incalculable weight of waters withheld just beyond us, a roaming kept in check. What an exalting things it is to see those waters dancing with silver castings from the moon!"

—John Hay, *The Great Beach*

MAP KEY



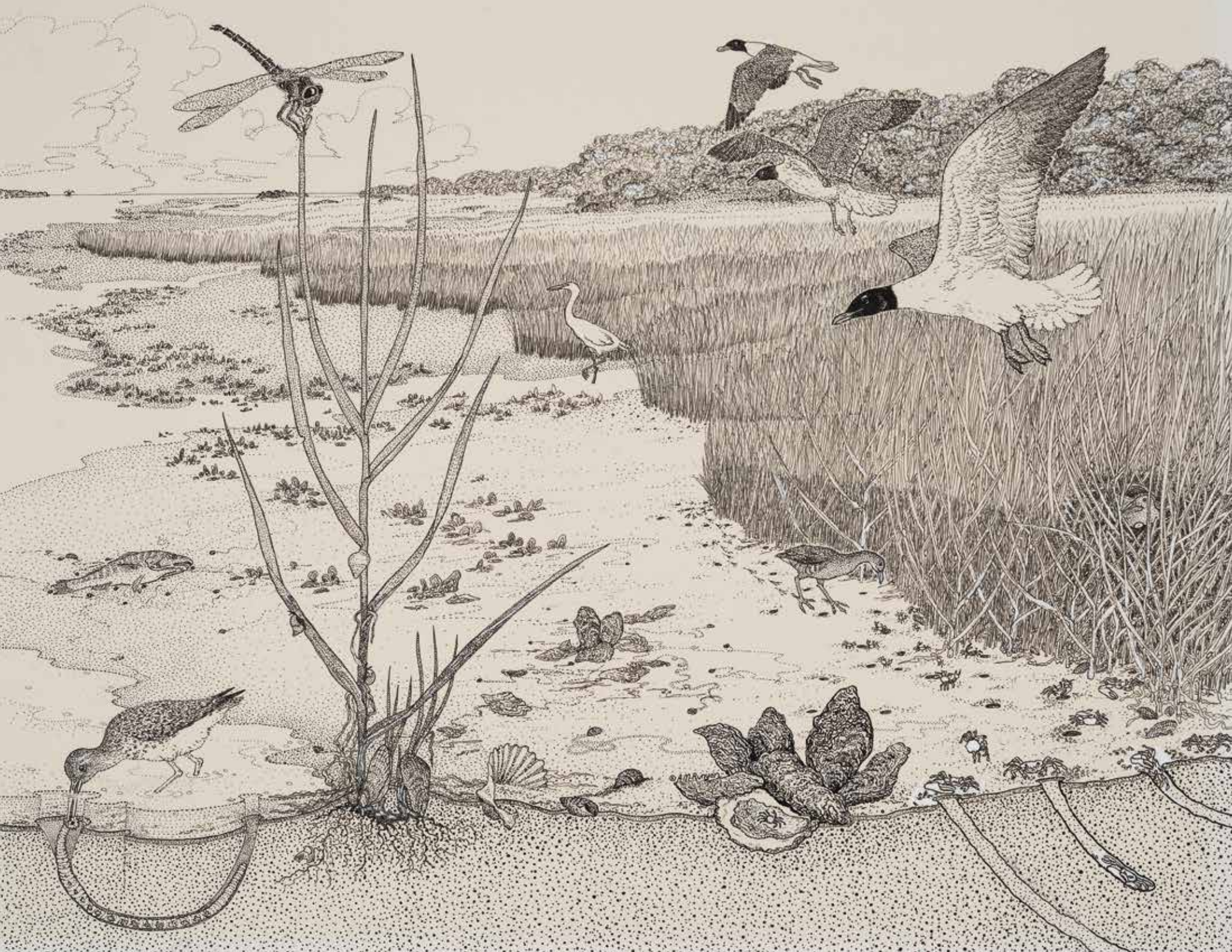
Salt marsh



Maritime forest



Ocean hardbottom



Salt Marsh

Between the land and the sea lies a special habitat called the salt marsh. When you go to the beach, you may see what looks like a broad, flat, treeless meadow covered with waving grasses.

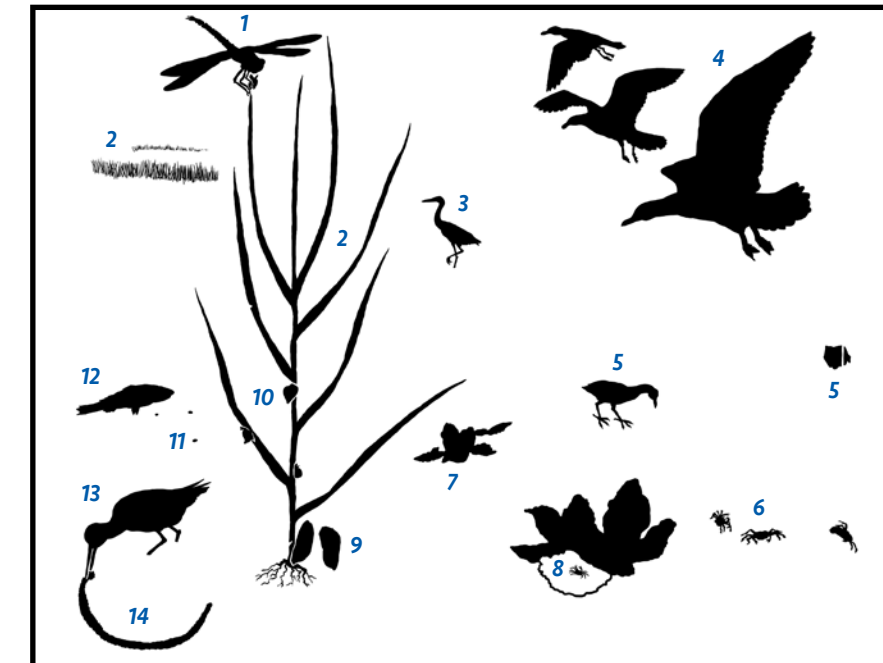
There's no mistaking a salt marsh—it's unlike any other habitat in North Carolina. Perhaps the only other habitat it looks like is the tall grass prairies of the Midwest. Salt marshes are found in the protected environment behind our barrier islands. They border the large, shallow sounds and estuaries where our inland rivers empty.

Let's visit a salt marsh in summer. The air smells salty but you can also detect an unpleasant odor, too. (This "rotten egg" smell is evidence of plant and animal decomposition, a natural process that's important for the marsh.) Because there are no trees to block your view, you can see quite far in a salt marsh. The grasses are tossed by coastal breezes and from deep in the marsh you can

hear the sounds of insects and birds, especially the "laughing" of the hidden clapper rail.

Meandering through salt marshes are tidal creeks that rise and fall regularly twice a day, flooding the marsh and then retreating. (North of Beaufort, the tides are caused by the wind and are not regular.) If you were to walk from the land side of the marsh to the creek, you'd pass several important zones. Near the trees and shrubs, in the upper marsh, you'd find marsh elder, silverling, wax myrtle and sea oxeye. As you walked into the lower marsh, you'd pass salt-meadow hay, black needlerush and glasswort, a plant that turns blood-red in midsummer. Flooded the longest is an area near the creek where salt marsh cordgrass grows, one of the most important plants in the marsh. In summer this grass is green, but when it dies in late fall it turns a deep golden color.

When the tide is high, the water may reach to the outer edges of the marsh, but low tide empties the marsh of almost all its water. You might think you could walk through the grass all the



1. Dragonfly
2. Salt marsh cordgrass
3. Snowy egret
4. Laughing gulls
5. Clapper rail
6. Fiddler crab
7. Oyster beds
8. Peacrab
9. Ribbed mussels
10. Periwinkle
11. Mud snails
12. Croaker
13. Yellowlegs
14. Lugworms

way to the creek, but before you got too far, of course, your feet would sink deep into the mud. This deep muck is made up of sediments brought down over the ages by rivers from inland areas of the state. With each high tide more silt is deposited in the marsh and trapped by plant roots, a daily process that makes the salt marsh one of the most fertile ecosystems on Earth.

LIFE IN A SALT MARSH

Like night and day, low tide and high tide are the daily events that mean the most to marsh creatures. Everything that lives in or depends on a marsh is adapted in some way to these great daily rhythms.

When the tide is low and the mud flats are exposed, the salt marsh is a lively place. Acres of deep green **salt marsh cordgrass** (also called spartina grass) wave in the breezes. One of the most amazing things about spartina grass is that it's immersed in salt water twice a day and yet thrives. Salt water will kill most plants,

Examples of SALT MARSHES



N.C. Aquarium at Roanoke Island (Dare County). Educational programs, field trips. For calendar of events, visit www.ncaquariums.com/roanoke-island or call (252) 475-2300.

N.C. Aquarium at Pine Knoll Shores (Carteret County). Educational programs, field trips. For calendar of events, visit www.ncaquariums.com/pine-knoll-shores or call (252) 247-4003.

N.C. Aquarium at Fort Fisher (New Hanover County). Educational programs, field trips. For calendar of events, visit www.ncaquariums.com/fort-fisher or call (910) 772-0500.

N.C. Aquarium Society. For advance notice of all field trips, call 1-800-832-FISH (3474) or visit ncaquariumsociety.com/.

N.C. Maritime Museums (Carteret, Dare and Brunswick counties). Educational programs, field trips. For calendar of events, visit ncmaritimemuseums.com/.

Cedar Point Recreation Area (Croatan National Forest). Features the Cedar Point Tideland Trail that includes a short section of boardwalk over a marsh. Email Croatan National Forest at croatan@fs.fed.us or call (252) 638-5628.

but not spartina. This miracle grass has developed ways to tolerate the salt it takes in through its roots, eliminate some of it through its leaves. In the harsh saltwater environment of the intertidal zone (between the low-tide mark and the high-tide mark), spartina is essentially without competitors.

Spartina grass has also found a way to deal with soil that is essentially without oxygen. All plants need oxygen to grow, and spartina is no exception, but in the mud where the plant is rooted oxygen is in short supply. Spartina manages to survive because wide air spaces in its leaves enable oxygen to be absorbed and directed to the roots through special air tubes.

But spartina also has other functions. The roots also provide a footing for oysters and **ribbed mussels**. This mussel buries itself in the mud and feeds by filtering food particles out of the water. Every hour that it's covered by water it pumps and filters almost two gallons of water. It also removes phosphorous, a nutrient, from the water and making it available for the spartina plant to take in.

Other animals depend on the spartina plant. The **periwinkle** is a small snail that lives on the spartina feeding on algae. During high tides it crawls up the stalk to stay above the water; during low tides it crawls down again. In particularly high tides, it may be totally submerged, yet its lung enables it to survive for an hour or so until the tide drops. The **dragonfly** uses the leaves as a resting station and hunts for insects that crawl up and down the stalk.

The living spartina plant is unpalatable to most



animals—grasshoppers are a notable exception—yet when it dies, it plays a major role in the marsh food web. Bacteria and fungi immediately break down the dead grass into small pieces that become a wonder food called detritus. Detritus is the base of the marsh food web, and it is an important reason why North Carolina's sounds are so rich in seafood.

The dead grass and its community of tiny organisms are eaten by small crustaceans, mussels, oysters, clams, worms and shrimp. It attracts young shrimp and mullet. Blue crabs, in turn, scuttle in on the tides to eat the shrimp, as will flounder and gray trout. Bluefish and Atlantic croaker eat mullet. A fish-hunting osprey is one of the top predators in the marsh food web, and so are we.

PERHAPS THE MOST COMMON CREATURE on a mud flat is one of the smallest: the **fiddler crab**. Fiddler crabs crawl in large numbers over the exposed mud. They live in burrows in the mud and in the sandy soil higher in the marsh. Males have oversized claws which they wave like "fiddles" to attract females. They eat detritus, using their claws to scoop up mud and eat the organic parts of it. Some fiddlers plug up the mouths of their burrows when the tide rises and live inside in a pocket of air until the tide falls again.

Across the mud you can see large groups of oysters in **oyster beds**. If you look close enough, you may find a tiny crab called a **pea crab** in an oyster shell.

Much smaller than oysters are **mud snails**. This black mollusk leaves a visible trail on the mud as it crawls about feeding on microscopic algae called diatoms. It also feeds on the bodies of dead creatures, like the **croaker** that has washed up onto the mud flat.

Low tide draws many wading birds into the shallow creeks. **Snowy egrets**, great egrets, great blue herons, tricolored herons and smaller herons like to wade in the creeks hunting for small fish, insects and other small creatures. These wading birds have long, jointed legs and move slowly. When they see a fish, they cock their heads and dart forward to grab their prey. During the courtship season, the snowy egret grows long, feathery plumes to attract mates. Once,

these plumes were sought by market hunters who sold them to make fashionable women's hats. The small egret was almost exterminated before the practice was outlawed.

Among other birds in a salt marsh is the common **laughing gull**. Shorebirds such as the **yellowlegs** feed in the marsh, too. With its long bill, the yellowlegs probes in the mud for **lugworms**. This worm burrows into the mud and stirs up so much surface sediment as it feeds that it muddies the surrounding water, driving out competitors like clams.



One of the most common birds is all but invisible, although you can see it here sitting on its nest. You'll hear it cry "Kih-kih-kih-kih-kih-kih-kih-kih." About the size of a small chicken, the **clapper rail** is probably the marsh's most vocal resident. It has strong legs and rarely flies, preferring to slip silently between the grass stems. It builds its nest high among the grass stalks to avoid high tides, but sometimes, especially when there's an unusually high tide, it has to make an emergency move and it hikes up its nest even higher.

Other animals that use the salt marsh at low tide are birds like the black skimmer and the American oystercatcher. Raccoons also prowl the marsh mostly at night. At high tide, many of these creatures are missing from the marsh. This is the time when fish, crabs and other shellfish come into the marsh to feed in the tidal creeks.

IMPORTANCE OF BRACKISH MARSHES

The brackish water of some marshes comes from the intermingling of salt water from the ocean and fresh water from rivers. This mixing of fresh and salt water takes place in the estuaries, the great bodies of water that lie behind the barrier islands. Here in these estuaries occur one of the most productive ecosystems on Earth.

One reason why the estuaries are so fertile is that they contain immense quantities of nutrients. Some of the nutrients are brought into the estuary by the rivers that flow from the interior. Other nutrients are deposited by the salt marsh itself. In the salt marsh, great fields of grass grow and die. When it decomposes, this grass makes a nutritious "broth" that forms the basis of a complex food web. The daily tides ferry this organic soup into the estuary where it feeds economically important fish and shellfish such as flounder, mullet, croaker, shrimp, blue crabs and oysters. These fish and shellfish support a multimillion dollar seafood industry in North Carolina.

The salt marsh food web also supports the numerous waterfowl that winter in salt marshes. And for young fish that need a protected place where they can grow bigger, the salt marsh is a critical nursery. Without the marshes, many of the most valuable fish and shellfish like flounder, mullet and shrimp would not be able to grow.

THREATS TO MARSHES

The marsh is one of the most valuable habitats. Like many other wetlands, people once considered them as wastelands. They dumped garbage in them and filled them in so that houses, condominiums, shopping centers and marinas could be built on them. Today laws protect these valuable habitats from indiscriminate destruction, yet some salt marsh acres are still destroyed each year to make way for beach development. Marshes are also vulnerable to pollution that washes into them from rivers draining towns and cities in the Piedmont and Coastal Plain. Sewage, industrial chemicals and agricultural pesticides can eliminate important links in the marsh food chain.

Features of SALT MARSHES



- A salt marsh annually produces almost 10 tons of organic material per acre, compared to 7 tons per acre in the most productive wheat fields. Salt marshes are one of the most fertile habitats in the world.
- Just about every salt water fish eaten by humans, except for the open-water species, is either born in or spends a portion of its life cycle in the estuarine system with its fertile salt marshes.
- The twice daily tides in the salt marsh perform useful services. They flush out waste products from the marsh and spread rich sediments and nutritious detritus back and forth across the marsh like a gardener.
- Marsh grass can tolerate total immersion in salt water twice a day.
- Salt marshes provide wintering habitat for waterfowl.



Maritime Forest

As you walk into a maritime forest on a spring day, a canopy of tall trees shades you. Live oaks, pines and hickories knit together above you and the understory of trees shimmers with new, pale green leaves.

It's cool in the forest—usually 15 degrees cooler than it is on the beach nearby. You smell pine and the leaves from red bay trees, and you hear songbirds, woodpeckers and the buzz of mosquitoes.

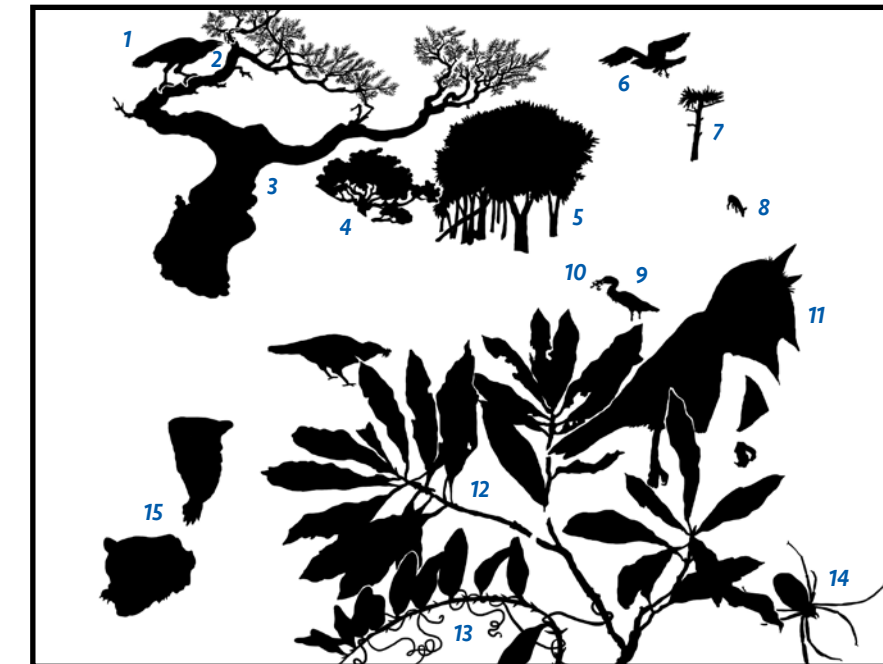
And be on the lookout for a host of mammals scampering through the forest. Reptiles, amphibians and insects, too, pick up activity as the days grow longer and warmer.

What you see and sense all about you inside the maritime forests is what European explorers of the 16th century saw. As they sailed toward what is now the North Carolina coast, a beautiful sight greeted them on the barrier islands. Maritime forests of sprawling live oaks, loblolly pines and laurel oaks blanketed the thin chain of islands that fringe the coastal mainland.

For years, Native Americans had used these bountiful forests that had been shaped by wind and salt spray. They hunted game there and foraged for nuts, berries and other foods. Centuries later, loggers cleared live oak and red cedars from maritime forests for ship timbers. Leaves from yaupon holly supplied tea for American colonists rebelling against the British tea tax. Locals harvested dogwoods to sell the wood for spindles for cotton mills and red cedar was cut for pencils. Horses, cows, hogs and other livestock grazed the brushy thickets and forest floor until a ban was passed in 1937.

Grazing, fires, logging, harsh weather and development gradually have chipped away much of these forests, so that today, they are largely reduced from their original size on our barrier islands.

For the most part, the remaining maritime forests look like the dense thickets and trees that the explorers saw 400 years ago. Maritime forests rise up from dunes several hundred years old. Most of the forest topography looks like a washboard, with ridges



1. Fish crows
2. Carolina anole
3. Red cedar tree
4. Live oak tree
5. Gum trees
6. Osprey
7. Dead pine tree with osprey nest
8. White-tailed deer
9. Great blue heron
10. Leopard frog
11. Male prairie warbler
12. Wax myrtle bush
13. Smilax vine
14. Garden spider
15. Baby raccoons

and valleys, called swales, that fill with water and make critical habitats for many wildlife species. Behind the front dunes, thickets of shrubs that are tolerant to strong winds and salt spray create a protective hedge around the forest.

LIFE IN A MARITIME FOREST

Throughout North Carolina's maritime forests, the **live oak** stands out as the dominant tree. This hardy canopy tree has a twisted trunk and branches that spread out as wide as 160 feet. It grows up to 50 feet tall, although wind and salt spray can prune live oaks to squat bushes the size of footstools. A waxy coating on the small, gray-green and evergreen leaves protects them from the ocean's salty touch. Thriving in a hostile environment, live oaks shade and protect trees that are less well adapted to salt spray, and they shelter animals such as raccoons and deer.

People have used the forest, as well. Shipbuilders of the 17th and 18th centuries prized the tree for its heavy wood and the long, natural curves of the live oak's trunk and branches that made strong boat frames.

Examples of MARITIME FOREST



Nags Head Woods (Dare County). Highest diversity of vegetation of all maritime forests on the Outer Banks. Visitors' Center. Contact Nags Head Woods, 701 W. Ocean Acres Drive, Kill Devil Hills, NC 27948. (919) 441-2525. Nature trail.

Buxton Woods (Dare County). Buxton Woods serves as an important resting place for migratory birds in the fall. More than 360 species, including bald eagles and peregrine falcons, have been recorded. Nature trail. Contact NC Coastal Reserve, www.nccoastalreserve.net, (252) 261-8891. Hiking trails.

Hammocks Beach State Park (Onslow County). Passenger ferry (fee). Contact Hammocks Beach State Park, 1572 Hammocks Beach Road, Swansboro, NC 28584. (919) 326-4881.

Theodore Roosevelt Natural Area and N.C. Aquarium at Pine Knoll Shores (Carteret County). Swamp maritime forest. N.C. Aquarium at Pine Knoll Shores, Box 480, Atlantic Beach, NC 28512-0580. (919) 247-4004.

Near the live oak in the illustration stands a mix of trees fringing the pond. Tall loblolly pines and laurel oaks intertwine with live oaks to create an umbrella that shields such trees as red bay, dogwood, Carolina laurel cherry, devilwood and persimmon that grow in the forest interior. **Gum trees** with swollen trunks grow in the shadowy, swampy wetlands near the pond. Species such as tupelo gum and black gum thrive on the forest's wetter soils.

The seaside timberlands rap and anchor sand and gradually add soil to barrier islands threatened by rising sea level. On some islands, winds and ocean forces bulldoze sand—and dunes—across the island. Over the years, this natural process can bury thickets and trees of maritime forests, cutting off vital oxygen to roots. A sand dune buries a **red cedar tree** pictured in the illustration. As the dunes move, existing vegetation also becomes more vulnerable to salt spray. Development and even hurricanes can rip holes in the protective shield, allowing salt to rip trees and plants.

Between dunes, freshwater ponds make up another prominent feature of many of the state's maritime forests. Rainwater collects in the swales between the dunes on the barrier islands, forming a layer of fresh water over the underlying sea water. The freshwater pond serves as a center of activity for aquatic animals such as snakes, salamanders, frogs, fish and turtles. In the early spring, for example, spotted salamanders migrate from the woods to the ponds, leaving egg clusters floating on the surface. Water moccasins, garter snakes, hognose snakes and corn snakes slither around the water.

Wading birds such as **great blue herons** and egrets find plenty of food in and around the pond. In the illustration, a great blue heron has caught a **leopard frog** along the pond's edge.

Fish largely make up the diet of the impressive **osprey** or "fish hawk." When fishing for food, this large bird of prey with black and white markings and a pure white breast hovers over water and then dives, grasping a fish with its long talons. Ospreys build bulky nests of sticks in tall dead trees like this **dead pine** or on stumps in water. They return to the same nest every

year, usually in March, to repair and enlarge it so the female can lay her eggs.

Another bird frequently seen in the maritime forest is the large, black **fish crow**. Fish crows favor foods from the swampy areas, too—they eat lizards, skinks, spiders, frogs, small snakes and especially the eggs of herons, gulls, terns and other shorebirds. The feisty birds often band together to search for food. Sometimes they forage in groups, with one bird knocking food out of a tree while another gathers it. Other times they may use group tactics to steal food from the heron.



A fish crow in the foreground of the drawing catches caterpillars, snakes or grubs in leaf litter while another one at the top of the illustration eyes a **Carolina anole** for its next meal. The anole is one of the most common lizards in maritime forests. Some coastal people often mistakenly call anoles "chameleons" because they can change colors. On a tree limb, an anole may change from its vibrant green to a mottle brown to shades in-between. The changes are responses to changing light conditions, temperature or the anole's mood, not so much to camouflage itself from predators. When anoles mate in the spring, the male extends a bright red sac from its neck while bobbing its head.

Spring brings flocks of another bird, the bright yellow **prairie warbler**, to North Carolina's maritime forests. Prairie warblers flit about and sing fizzy little squeaks in the groves and bushes of the forest, not the prairie, as their name implies. A male prairie

warbler, identified by rusty streaks on his back, sings to mark his breeding territory.

Wax myrtle, a hardy, fragrant evergreen shrub, makes up much of the protective shrub thicket surrounding the forest and can be found throughout the Outer Banks. A waxy coating on the slender green leaves makes wax myrtle one of the most salt-tolerant of shrubs. The plant takes some nutrients it needs from the salty air, while its thick coating helps the plant retain water.

Another common plant is the **smilax vine**, also called greenbrier or catbrier, that covers the maritime forest floor like a spindly, tangled carpet. Tough, thorny stems of this evergreen vine frequently scratch unsuspecting hikers and hunters.

ATOP TALL GRASSES AND SHRUBS near water, a **garden spider** spins a web. This spider appears brown to orange in color with yellowish-brown legs ringed with black. An orb weaver, the argiope spider spins a circular web of sticky silk to trap insects. It injects its prey with venom then crushes it before eating. Many orb weavers replace their entire web daily.

The dunes and swales of the maritime forest support a host of animals that typically hide in the thick brush, feeding mostly at dawn and dusk. Foxes, gray squirrels, river otters, opossums, raccoons, white-tailed deer and even bobcats roam these barrier island forests.



Chances are you might see a **white-tailed deer** browsing along the forest edge where it feels protected by the woodland. Its white tail acts as a flag signaling other deer of danger. This swift, graceful deer feeds mostly on fresh green leaves, shrub twigs and grasses. Among its favorite foods are greenbrier, oaks, dogwoods, mushrooms, acorns and apples.

Also in the spring, litters of **raccoons** roam the forest. They den up in the hollow trees, hollow logs or ground burrows. When the young coons are 10 weeks old, the mother takes them on nightly hunting rounds, scavenging for frogs, fish, salamanders, crustaceans, bird eggs, turtles, snakes, insects and worms.

IMPORTANCE OF MARITIME FORESTS

As maritime forests dwindle from North Carolina's barrier islands, their importance escalates. Vegetation helps stabilize the dunes and sandy soils of the barrier islands that are constantly eroded and built up by the ocean. The forests also serve as a buttress to the island, helping absorb wind and water energy from storms and hurricanes. Since the forests grow on firm ground, they are increasingly seen as prime settings for homes and businesses.

In some areas of the barrier islands such as Dare County's Nags Head and Kill Devil Hills, aquifers—underground storehouses of water—in the maritime forests provide sources of fresh water for human use. Such an aquifer in Buxton Woods holds the main source of fresh water for residents of Hatteras Island.

In addition to adding scenic beauty to the coast, maritime forests make the landscape of the Outer Banks more diverse. The gnarled oaks and sea-swept pines add contrast to the grass, sand and water we normally see. They also provide habitat for many species of animals. And they serve as a stop-over point for many migrating songbirds.

THREATS TO MARITIME FORESTS

Maritime forests have the capacity, like most forests, to regenerate after they are disturbed. But large-scale clearing and commercial development result in a permanent loss of maritime forest habitat.

Features of MARITIME FOREST



- Unique wetlands known in the world only in the Coastal Plain. With 1,000 acres, Buxton Woods in Dare County is North Carolina's largest contiguous maritime forest. When combined with the U.S. National Park Service's Cape Hatteras, the protected area spans close to 3,000 acres.
- Currituck Banks provides a wintering habitat for the migratory waterfowl using the Atlantic flyway. Frequently, cold fronts blow birds such as the solitary vireo and the organe crowned warbler into the Outer Banks' maritime forests, which provide shelter and a rich source of food such as insects. In the fall, migratory songbirds and raptors such as the Northern (or Baltimore) oriole and the peregrine falcon often stop to feed on their way south.
- Bald Head Island supports the only stands of sabal, or cabbage, palmetto. This hardy plant, looking like a short palm tree, grows over a large part of the island. Bald Head marks the limits of the palmetto's northernmost range.
- Many rare and threatened animal and plant species live in North Carolina's maritime forests. The Florida adder's mouth and three-birds orchid are two rare types of wild orchids that grow in the thick maritime woods.

Development of the forests—for roads, houses, businesses, condominiums—poses the greatest threat to North Carolina's maritime forests. Since most of the remaining 12,000 acres are privately owned, the potential is there for even more losses. Development can fragment the forest, opening them up to salt spray. Wetlands and dunes can be altered by this process.

People and their domestic animals can damage the maritime forest ecosystem, too. Packs of dogs and feral cats prey on wildlife. Feral goats and horses have pruned the vegetation. Four-wheel drive vehicles and dirt bikes destroy fragile habitats.

Natural stresses also occur. Hurricanes can tear away large sections of the tightly knit canopy. Wind and waves from nor'easters can dump extra salt on trees and plants. In some areas, dune migration is burying sections of forests and making it difficult for new forests to grow.



Ocean Hardbottom

Splash! You slide off the boat into the cool waters of the Atlantic just beyond Cape Fear. As you sink quietly into the ocean, you hear only the sound of bubbles from scuba gear. The visibility of the water is very good; you can see 50 or 60 feet underwater.

Eighty feet below, the desert-like expanse of sand is broken by a ledge of rubble and rock. You have arrived at one of the special wild places in North Carolina—the colorful, exciting marine communities known as “hardbottoms.”

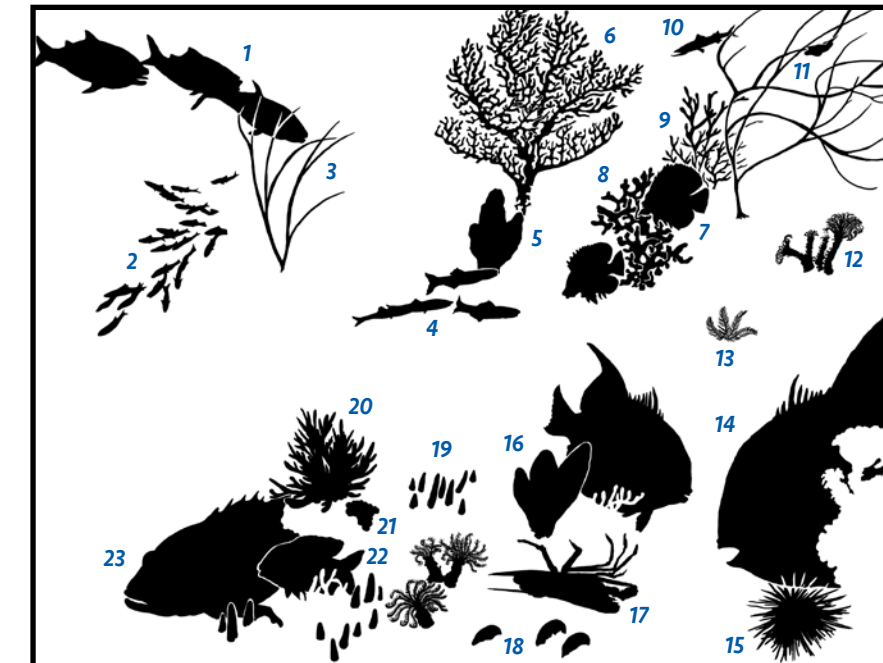
The rocky surface of the outcrop is covered with seaweeds brightly colored red, brown, yellow and green. In the winter months scientists see a lot more seaweeds than in summer. Schools of small baitfish swim just over the surface. This ledge is one type of hardbottom. It is like an oasis in the desert—a center for marine life.

How these undersea oases came about is a geological story. Much of the continental shelf south of Cape Lookout is criss-

crossed with remnants of old river channels. They were cut into hard rock of the continental shelf exposed during glacial periods when sea level was much lower than today. The cliff-like edges of these ancient channels still exist in places. They are called hardbottoms because they are made from rock—limestone, sandstone or consolidated clays. Their margins form breaks in the sea floor’s typically smooth topography. The cliffs range in height from a few inches to over 25 feet. Most occur in Onslow Bay, the area of North Carolina’s continental shelf between Cape Lookout and Cape Fear.

While some of the cliffs are located within sight of shore in 40 to 50 feet of water, other hardbottom habitats are found across the shelf in hundreds of feet of water. People are just beginning to understand how hardbottoms change as they get deeper and farther from shore.

Instead of smooth featureless rock, the cliff faces are eroded into a maze of cavities. Chunks of broken rocks form rubble piles



1. Little tunny
2. Round scad and striped anchovies
3. Sea whip
4. Striped anchovies
5. Sargassum seaweed
6. Sea fan
7. Butterfly fish
8. Hard coral
9. Codium seaweed
10. Barracuda
11. Flamingo tongue
12. Featherduster worms
13. Hydroid
14. Spadefish
15. Sea urchin
16. Palmate sponge
17. Spiny lobster
18. Boring clams
19. Soft coral
20. Finger sponge
21. Damselfish eggs
22. Male damselfish
23. Black sea bass

at the base. Biological and physical forces have formed this very irregular maze. Boring clams and sponges, crabs and other animals have tunneled into the rock face. Currents and waves break off eroded chunks. In every hole lives a creature. On every exposed surface, something grows. Hardbottoms house a multitude of living organisms.

LIFE IN AN OCEAN HARDBOTTOM

Over 300 types of fish live in and about hardbottoms. While most of the big fish average in the 10- to 40-pound class, a few whoppers tip the scales at 400 pounds. These include 12 species of groupers, six species of porgies and four of snappers.

Groupers, porgies, snappers and **sea bass** are resident predators. They are territorial fish, hiding in nooks and crannies. Like tigers, they watch for prey and then rush out to gulp it down. **Barracudas** are another territorial predator. They circle their chosen home, swimming slowly through the water, fearing no fish. When pursuing their prey, barracudas are one of the fastest fish in the sea, topping 40 miles per hour.

Several types of sharks, rays and jacks pass by hardbottoms. Some can be considered residents; others are just passing through. Loggerhead turtles, so cumbersome on land, swim gracefully over the outcrops, diving for dinner.

Delicate **butterfly fish**, often traveling in pairs, pick small worms and crustaceans from the crannies. Feisty little **damsel fish** back into their caves, guarding their **eggs**, ready to rush out if their territory is crossed. They nibble on the seaweed that grows nearby.

There are special sites on these reefs where the big fish come to get rid of parasites and loose skin. Small fish, mostly wrasses, safely move about the big fishes' gills, in their mouths and over their scales removing irritations. Divers have sometimes seen the big fish almost waiting in line for this service. These places are called cleaning stations.

Some reef dwellers emerge only at dusk. Shy squirrel fish, silver with red stripes, are daytime recluses, but come out to feed when sunlight fades. Schools of grunts leave the safety of the reef to feed on the broad

sand flats. Moray eels join the evening smorgasbord. Unwary fish, worms, wandering crabs or other careless invertebrates may become part of their meal. Even sea urchins leave their nooks to graze like deer across multi-colored meadows of algae.

These meadows consist of seaweeds that hold fast to the rocky crust of the cliff. The tall algae fronds of brown **sargassum** and cordy fingers of green **codium** are the most obvious of these seaweeds. Translucent red algae clumps dot the surface like living spaghetti. Moss-like sea lettuce provides the ground cover. As the surface dips toward sand ramps, the meadows disappear. Few seaweeds can survive the abrasive forces of shifting sands.

Many hardbottom fish are common to tropical waters. They probably are carried northward by the mighty Gulf Stream and tossed onto the continental shelf by meandering currents. Those fish that happen upon hardbottoms find a home similar to coral reefs to the south.

Cruising past these oases are schools of pelagic fish. Pelagic fish are the long-distance swimmers. For example, **little tunnies** search miles of ocean for baitfish that congregate over the hardbottoms. Much more slowly, schools of black-and-white striped **spadefish** dip alongside the cliff face. Their tastes lean toward shrimp, crab and small lobster that have ventured too far from shelter. Spadefish move into a hardbottom area as if it were a fast-food restaurant, feed and then fade into the clear water.

MASSIVE, BRANCHING REEF CORALS cannot endure the cool Carolina waters. But **hard corals** do exist. Some are scattered as small coral mounds known as "sea strawberries." **Soft corals** abound. Orange, purple, white, red and yellow **sea whips** are anchored firmly to the rock. Large, lavender **sea fans** sway as they face the prevailing current. If you look closely on the fronds, you might see a tiny spotted **flamingo tongue**—a snail that feeds directly on the individual coral polyps of the fan.

The waters over the Atlantic continental shelf are rich with microscopic plants (phytoplankton) and



animals (zooplankton). While plankton are not as numerous here as in the coastal sounds and bays, they are a major part of the hardbottom food web. Only animals with special adaptations can gather this nutritious food.

For example, corals, colorful sponges and **hydroids** are all filter feeders. They use nets, tentacles and special cells to capture microscopic plants and animals. Tiny coral polyps stun zooplankton with stinging cells on their tentacles. Sponges in all colors, shapes and sizes use special cells to create a current that pulls plankton into their chambers. Big pink and brown basket sponges are the most obvious to divers. However, other colorful types include red beard and red **finger sponges** and purple **palmate sponges**. **Feather-duster worms** stretch exquisitely delicate tentacles into the water to trap plankton.

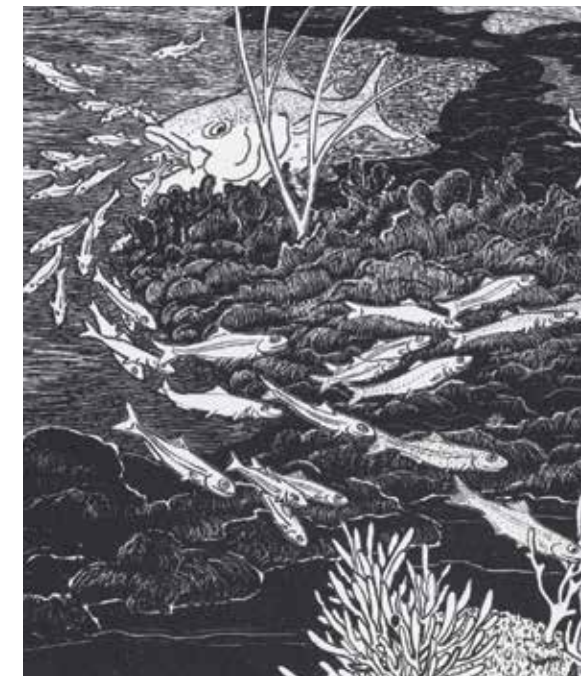
While some of the filter feeders attach to the rock surface, others bury deep into the rock. Siphons of **boring clams** suck phytoplankton in and pit filtered water out. The cliff face is riddled with their holes. Yellow boring sponges line some of the cavities dissolving limestone for their own nutrition in addition to the food they filter.

Just above the corals and sponges are more filter feeders. Baitfish such as **round scad** and **striped anchovies** move through the waters in swirling

schools. Each fish gapes its mouth widely to strain plankton through its gills. These schools hang like clouds drifting over the rim of the cliffs. In a food chain system, baitfish are herbivores. They provide food for most of the larger fish.

Fishermen in boats learn about hardbottoms only by what their hooks capture. Divers can actually see the wonderful diversity of life as they swim along the cliffs and poke into the crannies. Often they are rewarded with the sight of an antenna that belongs to a slipper or **spiny lobster** tucked into a hole. Or they'll see the small but long-legged red and white arrow crabs grasping a piece of coral.

Recently, hardbottoms have been the focus of oceanographers. Using special equipment pulled by ships and cores taken from the sediment, these scientists are gathering data on the structure of the ledges and their geologic origin. Biologists are determining the make-up of the complex food web. There are many questions to answer, and that makes this research exciting.



IMPORTANCE OF HARDBOTTOMS

Hardbottoms are diverse communities of plants and animals that are found on the continental shelf. Rocky ledges provide shelf for fish and invertebrates whose only other homes are in tropical coral reefs or on shipwrecks. In a sense, hardbottoms accumulate more than their share of living creatures. That's why fishermen are so eager to plot their locations.

Recreational and commercial fishermen know that hardbottom communities are home to important food fish. Red snappers, red porgies and black sea bass are highly desirable. And these fish require nooks and crannies for their habitats.

Recreational divers who explore the relatively shallow hardbottoms find them as exciting as coral reefs. Local businesses in Morehead City and the Wilmington area cater to divers' needs.

Hardbottoms are just beginning to be investigated by scientists. New research builds a better picture of the continental shelf and builds an understanding of the fisheries that have economic importance.

THREATS TO HARDBOTTOMS

Since most of the valuable fish living in and along a hardbottom are territorial, it is possible to harvest too many. When a hardbottom site is identified, it is like putting a sign in the water saying, "Fish Here." Once a site has been exploited, it may take many years for fish to replace those taken.

Already there are serious problems. Nine of 19 commercially important fish species are overharvested on hardbottoms from North Carolina to Key West, Fla. The National Marine Fisheries Service listed red porgy, red snapper, white grunt, vermilion snapper, gray snapper, scamp, speckled hind, warsaw grouper and snowy grouper. These are major reef predators. Their loss changes the natural balance of the hardbottom community.

Because hardbottoms are so poorly understood, we are just starting to identify the forces that could harm them. Lots of questions have no answers. The best way to manage this resource is under debate.

Features of OCEAN HARDBOTTOM



- Hardbottom habitats are found along margins of ancient rivers that cut channels into the hard rock of the continental shelf exposed during periods of lower sea level.
- The sides of the river valleys that form the cliffs vary in height. The cliffs are deeply bored and excavated by biological and physical processes. The rims of the ledges lead to sand ramps and on to vast desert-like topography that characterizes most of the underwater scene.
- Hardbottoms concentrate marine life on the continental shelf in contrast to the desert-like sand expanses. The nooks and crannies are home to many marine algae, mollusks, crustaceans and fish.
- Fish such as sea bass, snapper and grouper are valuable food fish. They are territorial in one hardbottom area. Therefore, overharvesting by commercial and recreational fishermen is a big problem.

7 | PROTECTING WILD PLACES

On a warm spring afternoon, a dozen people gather on the viewing deck at Jordan Lake, a reservoir near Raleigh built by the U.S. Corps of Engineers in 1982. Many of them scan the water with binoculars.

“There’s one!” someone cries and everyone strains to catch a glimpse of a large bird with broad wings and a white-feathered head—unmistakably a bald eagle. The eagles at Jordan Lake demonstrate that a man-made habitat like a reservoir is just as capable of attracting wildlife as a natural habitat.

There are approximately 48,000 lakes, ponds and reservoirs in North Carolina and almost all of them are manmade; natural lakes and ponds are rare in the state and occur only in the Coastal Plain. Reservoirs perform important services—supplying water for towns and cities, protecting buildings from floods, providing recreation, or generating electricity. And although bald eagles seem to have singled out Jordan Lake as a primary habitat in North Carolina, lake habitats aren’t biological deserts. Species such as ospreys and wading birds respond to these open aquatic habitats, along with complete food chains of many fish and animals that are stocked in or attracted to these waters and their surroundings.

Farms and residential backyards are also man-made habitats. Yet, natural habitats are of greater value to native plants and wildlife than man-made habitats. For one reason, natural habitats support a greater diversity of species. Indeed, our natural habitats are the main reason why North Carolina has such an extraordinary number of plants and wildlife, from the world-famous varieties of mushrooms and salamanders in the mountains to the unique insect-eating plants of the Coastal Plain. Man-made habitats, on the other hand, are created at the expense of these diverse ecosystems. Reservoirs flood and destroy wetland habitats such as bottomland hardwood forests and river forests that are increasingly rare in the state and that serve as wildlife corridors. As a result, the wildlife changes accordingly. Wild turkeys disappear and wading birds, ospreys and even bald eagles exploit the new habitat. Yet, the total diversity of wildlife in and around lakes declines.

Natural habitats are important also because they have been shaped through the long evolutionary processes of time rather than by human manipulations. And in many cases, they represent remnants of habitats that once were more extensive. For these and other reasons, truly wild places are the rarest and most valuable habitats in the state.

“I have faith in man’s future, faith in the possibilities latent in the human experiment: but it is faith in man as a part of nature, working with the forces that govern the forests and the seas; faith in man sharing life, not destroying it.”

Marston Bates, *The Forest and the Sea*

WHO OWNS OUR WILD PLACES?

Fortunately, at least some of our wildlife places are being well-protected. Many outstanding habitats discussed in this book are being managed in parks, national wildlife refuges, national forests, conservation preserves and other public and private properties across the state.

National Parks. In 1872, the United States created the first national park for the “benefit and enjoyment of the people.” Since then, other national parks have been created throughout the country, including three here in North Carolina: The Great Smoky Mountains National Park, the Cape Hatteras National Seashore and the Cape Lookout National Seashore. The National Park Service manages all of them. Within the Great Smoky Mountains are splendid examples of old-growth mountain cove forests and spruce-fir forests, some of the oldest forests on the East Coast, while the two national seashores host remnants of maritime forest.

National Wildlife Refuges. Managed by the U.S. Fish and Wildlife Service, national wildlife refuges in North Carolina encompass some of the most valuable wildlife habitat around. In the Roanoke River National Wildlife Refuge and the Pee Dee National Wildlife Refuge are some of the Southeast’s best preserved bottomland hardwood forests; pocosins and savannas are located in the Alligator River National Wildlife Refuge; salt marshes can be found in Swan Quarter National Wildlife Refuge.

The U.S. Fish and Wildlife Service is also in charge of identifying and protecting plant and wildlife species that are endangered or threatened. Recovery plans may include research, preserving habitat, captive breeding and reintroducing species into habitats from which they were extirpated in the past.

National Forests. In 1891, the United States took the first step toward a national forest system by establishing the Yellowstone Park Forest Reserve. In a little over 100 years, 156 national forests have been formed encompassing 191 million acres. In North

Carolina, the U.S. Forest Service manages 1.2 million acres of national forests.

These forests embrace a diversity of natural habitat types. For example, in the Croatan National Forest visitors can see examples of salt marshes, longleaf pine savannas and pocosins. The Nantahala and Pisgah national forests contain examples of mountain cove forests, spruce-fir forests, hemlock forests and mountain balds. Some of these forests are old-growth despite routine logging of most mature stands.

State Parks. Though by no means as extensive as national parks, our state parks still encompass nearly 130,000 acres of land in 29 parks, nine natural areas, four rivers and other trails, recreation areas and lakes. That’s a lot of land and it’s being managed not only for recreation, but to protect the natural ecosystems that lie within park boundaries. Jones Lake and Singletary Lake state parks, for example, are built around two of the few remaining water-filled Carolina bays. Weymouth Woods State Park contains a splendid example of a Sandhills longleaf pine forest. In the mountains, Mount Mitchell State Park’s spruce-fir forests show the sad ravages of environmental pollution.

State Forests. The N.C. Division of Forest Resources owns and manages a state forest and five state educational forests, comprising almost 40,000 acres of land. Among the reasons for establishing Bladen Lakes State Forest was to protect important natural areas within the forest. The area has deep sandy soils with sandhills types of longleaf pine forests, Carolina bays and swamps.

Wildlife Game Lands. The N.C. Wildlife Resources Commission owns and or has a managing interest in 90 game lands comprising 2 million acres. Among these game lands are such important wild places as the Sandhills Game Land in Richmond, Scotland and Moore counties where large remnants of the Sandhills longleaf pine forest are found, and Holly Shelter Game Land in Pender County where savannas and pocosins are found. The Wildlife Commission

manages these lands not only for featured game species—white-tailed deer, rabbits and quail—but for the entire ecosystem.

Nature Preserves. In addition to federal and state agencies that own and are managing significant wild places, private conservation groups have also protected natural areas. One of the most successful has been The Nature Conservancy’s North Carolina chapter, which has identified and protected over 330,000 acres of land, most of which it transfers to public agencies like the Wildlife Commission or the Fish and Wildlife Service. Still other properties are purchased with an eye to managing them for their valuable natural communities. The Nature Conservancy is managing several properties that include such wild places as savannas, pocosins, Carolina bays, maritime forest, bottomland hardwood forest, mountains balds and mountain bogs.

While the North Carolina chapter of The Nature Conservancy looks to the entire state, other land trusts focus on smaller areas, seeking to protect lands important to the diversity of local regions within the state.

THE IDEAL OF STEWARDSHIP

Despite the fact that many of our last and best remaining wild places are being managed by public agencies and conservation groups, most natural habitats are owned by private landowners. What can landowners do to protect wild places? In many cases, they can think of themselves as “land stewards” as well as landowners.

The ideal of stewardship comes from the belief held by many cultures across the globe that land is not so much inherited from the previous generation as it is borrowed from the next generation. The implication is that landowners are caretakers, that they have a duty to pass their land on to their children in as good a shape as they received it.

That was not the attitude that President Theodore Roosevelt found as he grew up in the last part of the 19th century. Then the prevailing idea was that land was to be exploited for its resources with no thought

given to the future. The virgin forest of the Northeast, the Lake states and the Southeast had been wantonly devastated without any heed paid to reforestation. Egrets, songbirds and other birds were being casually slaughtered for fashionable women’s hats of the day. The vast herds of buffalo had been decimated and the passenger pigeons that had flown in flocks of millions would soon be exterminated. Reflecting on these dismal matters, Roosevelt wrote: “I do not recognize our right to waste [our natural resources], or to rob by wasteful use the generations that come after us.”

It was the ideal of stewardship that drove Roosevelt and others among the first conservationists to set aside the first national parks and to establish a competent forest service that would manage the nation’s forests professionally. Stewardship meant that exploitation should be balanced by conservation, that tomorrow’s needs should help guide today’s actions. Roosevelt argued that we are caretakers of the land, holding it in trust for the future.

Another spokesperson for the ideal of stewardship was Aldo Leopold, a wildlife biologist who set forth some of the first principles of wildlife management. *A Sand County Almanac*, published in 1949, the year after his death, is one of the bibles of the conservation movement, continually inspiring young people with one of Leopold’s most influential ideas that he called “the land ethic.”

To Leopold, land was more than a commodity to be bought and sold. A landowner had a special relationship to his land, a relationship that was ethical as well as economical. “All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts,” wrote Leopold.

Leopold’s sense that we have responsibility to the land is a key to understanding ourselves as stewards of the Earth. It’s only when we understand that the future is largely shaped by the values we hold and the actions we take today that positive changes can take place. Only then will we begin to slow the devastation that yearly threatens so many of our wild places and the plants and animals that they shelter.

GLOSSARY

Acid precipitation: The process by which chemical compounds from factories are emitted into the atmosphere and deposited into mountain ecosystems in North Carolina when it rains or snows, or when heavy fog coats the mountains. These chemicals increase the acidity of mountain streams and soils, and can threaten wildlife and plants.

Adaptation: An evolutionary process by which living things adjust to their environment over time. Biologists distinguish between physical adaptations and behavioral adaptations. An example of a physical adaptation is the shape of a bird's wing; a behavioral adaptation would be the way canids hunt in packs.

Carnivore: An animal that eats meat.

Carrying capacity: The ability of a habitat to support a specific number of animals of a given species. A habitat offers enough food, water and shelter for only a limited population of any species. If carrying capacity is exceeded, many animals may starve or die of other causes.

Community: The plants and animals in a habitat, each located in a separate niche, and interacting in food chains and in other ways.

Coniferous: Having to do with trees that bear their seeds in cones, also known as “conifers.” Coniferous trees are pines, firs or spruces.

Consumer: An organism in an ecosystem that makes its living from eating producers. Consumers are generally animals and can be primary or secondary. Rabbits, which eat grass, a producer, are primary consumers; rabbit-eating hawks and other predators are secondary consumers.

Deciduous: Having to do with trees that shed their leaves on a yearly basis, such as oaks and maples.

Decomposers: Plants or animals that feed on dead organisms and help break them down. Their chemical components are then recycled by other organisms.

Disjunct: An isolated population of plants or animals that is located far from the main area occupied by the species.

Diurnal: An animal that is active during the day.

Ecologist: A scientist who studies the ways that living things interact in an ecosystem.

Ecology: The study of the ways that living things relate in an ecosystem.

Ecosystem: A natural system—salt marsh, Carolina bay, Mountain Cove Forest, etc.—in which living things (biotic) and non-living things (abiotic - soil, air, etc.) are linked.

Ecotone, edge effect: The transitional zone between two habitats that is particularly rich in wildlife because of the diversity of food and cover types offered by both habitats.

Endangered species: A species in danger of extinction throughout all or a portion of its range.

Endemic: An organism that is restricted to an area; found nowhere else.

Environment: The total surroundings of a plant or animal including other plants and animals, climate and location.

Ephemeral pond: A temporary pond, one that dries up during a portion of the year.

Erosion: The process by which soil is stripped from the land by rain or wind.

Estuary: Semi-enclosed coastal areas with brackish water formed by the mixture of fresh water from inland rivers and salt water from the sea. Brackish water estuaries serve as nurseries for young fish and support large numbers of shellfish as well.

Exoskeleton: The skeleton of an insect or crustacean that forms the external surface of the body.

Exotic species: A plant or animal introduced into an area from somewhere else and not originally native to the area.

Extinction: No longer living on the earth; the fate that laws protecting endangered species are intended to prevent.

Food chain: The way that energy is transferred from a plant to a plant-eater and then to a predator of the plant-eater.

Food web: A more embracing concept of the food chain, based on chains that combine to form a web of relationships.

Generalist: An animal that is adapted to many different habitats; the opposite of a specialist.

“Conservation is a state of harmony between man and land.”

—Aldo Leopold, *“The Land Ethic”*

Habitat: An area where an animal can find enough food, water, shelter and space to carry on its life needs.

Habitat fragmentation: The reduction of a large habitat into smaller pieces through development activities of one sort or another.

Herbaceous: Having the characteristics of an herb, a flowering plant or fern that lacks woody tissue.

Herbivore: An animal that eats vegetable matter; the opposite of a carnivore.

Keystone Species: A plant or animal that is so important to a natural community that its removal, through local extirpation, threatens the collapse of the entire community.

Larva, larvae: The immature form of an insect after it hatches from the egg. As the larva grows, it molts or sheds its exoskeleton several times until it transforms into the pupa or chrysalis, from which the adult emerges.

Limiting factor: A deficiency in a habitat—e.g., lack of food, a surplus of predators—that limits the numbers of a species or a population.

Niche: Most simply, the role that an animal plays in an ecosystem—whether it is a producer, consumer or decomposer, whether it is diurnal or nocturnal; how the animal makes its living in the habitat.

Nutrients: Chemicals necessary for the growth of plants and animals. When present in excess, as when fertilizers containing nutrients such as phosphorus and nitrogen run off agricultural fields and enter rivers and sounds, nutrients can encourage the growth of algae which can deplete the oxygen in the water and cause fish to die.

Old-growth forest: Mature forests in which trees of many different ages grow; a forest characterized by standing dead and dying trees and by tress that are decaying on the forest floor.

Parasites: An organism that lives off another organism, harming it but not killing it immediately. Mistletoe is a parasite that grows on trees. Brown-headed cowbirds are nest parasites that lay their eggs in other birds' nests.

Photosynthesis: The chemical process by which the sun's energy converts water and minerals into vegetable matter.

Pollutant, pollution: A substance contaminating land, water or air.

Population: The number of a plant or animal species in an area.

Predator: An animal that kills and eats other animals called prey.

Prey: Animals that are killed and eaten by predators.

Producers: In an ecosystem, plants that convert the energy of the sun into vegetable matter; the base of most food chains.

Raptor: Hawks, owls and eagles; predatory birds that hunt.

Sediment: Eroded topsoil that is washed or blown into rivers, streams and reservoirs and that settles to the bottom.

Slime mold: An organism that exhibits fungal and animal characteristics at different times in its life history.

Specialist: An animal that is adapted to a small or limited habitat; the opposite of a generalist.

Subimagoes (duns): A stage in the development of a mayfly. Mayfly are laid in water where they hatch out as aquatic nymphs. In about a year, the nymphs swim to the surface where they molt and transform into a winged form, the subimago or dun. After a day, subimagoes transform into the adult form called the imago or spinner.

Succession: An orderly sequence in which habitats change; a process in which plants and animals change in abundance or are replaced by other plants and animals.

Toxin: A poisonous substance.

Understory: A layer of plants that grows under a taller layer of plants. In a hardwood forest, for example, dogwood trees are part of the understory beneath the taller oaks and hickories.

Wetland: A transitional area between terrestrial and aquatic ecosystems. During all or portions of the growing season, wetlands are covered with shallow water or their water table appears near the surface. Wetlands are characterized by specific soils and plants and by a certain degree of water saturation.

Wildlife corridor: A natural pathway along wooded streams or over land by which wildlife can migrate from one area to another. Without these links connecting habitats, wildlife populations can become isolated and lose their genetic variability which is important in preserving the vitality of the species.

RESOURCES

PROGRAMS FOR EDUCATORS AND THE PUBLIC

The N.C. Wildlife Resources Commission's Wildlife Education Division offers a variety of professional development workshops for formal and non-formal educators, as well as the general public. Workshops range from 2 to 10 hours and offer continuing education credits (CEUs) and training hours for N.C. licensed teachers. The workshops also count toward the Environmental Education Certification Program managed by the Office of Environmental Education and Public Affairs (www.eenorthcarolina.org). Commission staff identify and set up workshops throughout the state and throughout the year, but can also bring workshops to your site as a staff development opportunity. To find out more about a workshop near you, visit www.ncwildlife.org/educators or the Office of Environmental Education listserve and calendar at www.eenorthcarolina.org.

At the core of these workshops are five curriculum-based wildlife conservation and environmental education trainings. Each provides educators a variety of activities to help them reach their curriculum objectives. All activities include: objectives, methods, materials, background information, procedures, suggestions for evaluation, and are keyed to grade level, subject area, skills and key vocabulary. These workshops are six hours in length and include a free activity guide.

Project WILD K-12 activities teach about terrestrial wildlife and ecosystems, with a North Carolina focus. For 30 years, Project WILD has engaged teachers and their students through fun, interactive, multidisciplinary games and activities. No one forgets playing “Oh Deer!” to learn about carrying capacity, or creating imaginary animals in “Adaptation Artistry.” Years later, teachers report they are still using these activities in their classroom.

Aquatic WILD K-12 activities teach about aquatic wildlife and ecosystems, with a North Carolina focus and include connections to STEM, field investigations and wildlife careers. The innovative, multidisciplinary lessons offered through Aquatic WILD are timeless and timely. Throughout the workshop, educators recognize connections to Common Core and Next Generation Science Standards.

Growing Up WILD is primarily oriented toward formal and non-formal educators who work with children ages 3-7. This preschool and early grade level offering invites children to explore wildlife and their habitats, with an emphasis on promoting North Carolina resource appreciation and stewardship. Educators love coming to this fun, “make-and-take” workshop, where they share ideas and familiarize themselves with the many ways to teach early childhood skills through an outdoor, nature-based approach.

Flying WILD provides activities to teach middle school students about birds, their migrations and what people can do to help birds and their habitats. Designed to teach middle schoolers content and then have them teach others, the activities provide service-learning opportunities for students. Activities can also stand alone as part of a classroom curriculum.

CATCH (Caring for Aquatics Through Conservation Habits) workshops train educators to teach youth ages 8–15 topics such as fishing skills, North Carolina fish species, fish adaptations and biology, habitat requirements, water safety and conservation ethics.

In addition to the five, curriculum-based trainings, Commission staff also offer wildlife topic and outdoor skills-based workshops. Wildlife workshops provide in-depth information on a variety of mammals, birds, fish, reptiles, amphibians and the habitats that these animals utilize. Participants also learn about current wildlife management and research topics involving these species in North Carolina. Outdoor Skills Experiences are designed to increase enjoyment of our state's wildlife resources, and include tutorials on game cameras, bird watching, fishing, outdoor cooking, archery and shooting sports. In addition, day-long and weekend workshops for women provide skill-building and fellowship through the Becoming an Outdoors Woman program.

The Commission also offers hunter education classes throughout the state. More than a firearm safety course, instruction includes ethics and responsibility, conservation and wildlife management, wildlife identification, survival and first aid, and tree stand safety. There are no minimum age requirements, however, classes are taught at a sixth grade level and tests must be completed without assistance. Courses are a minimum of six hours, taught by wildlife officers, hunter education specialists and certified volunteer instructors, and certification is accepted in every state and province in North America. Online hunter education courses are also available, but require participants to attend a local, two-hour review session and exam to complete the certification. Advanced hunting courses are also available, and provide tips on trapping, orienteering, hunting various game species, and field dressing and processing. To learn more visit www.ncwildlife.org.

In addition to the educational opportunities previously mentioned, the Commission owns and staffs three wildlife education centers. These facilities are located in Pisgah Forest, Fayetteville and Corolla. Each center offers programs unique to its region of the state, many of which are aligned with N.C. Common Core and Essential Standards. To find out more about the programs offered at each wildlife education center visit www.ncwildlife.org/Learning/Education-Centers.

“We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.”

—Aldo Leopold, *A Sand County Almanac*

NORTH CAROLINA WILD PLACES: A CLOSER LOOK

“As wildlife conservationists and as responsible citizens, we should be intensely concerned about the preservation of species. Yet as this book suggests, our concern should also encompass the wild places where our native plants and animals are found. As we have seen, habitat is precious and fragile; the entire web of life linking plants and animals rests on the health of habitats. Indeed, the only sure way to protect our native species is to protect the habitats they call home.”

—from *N.C. WILD Places: A Closer Look*