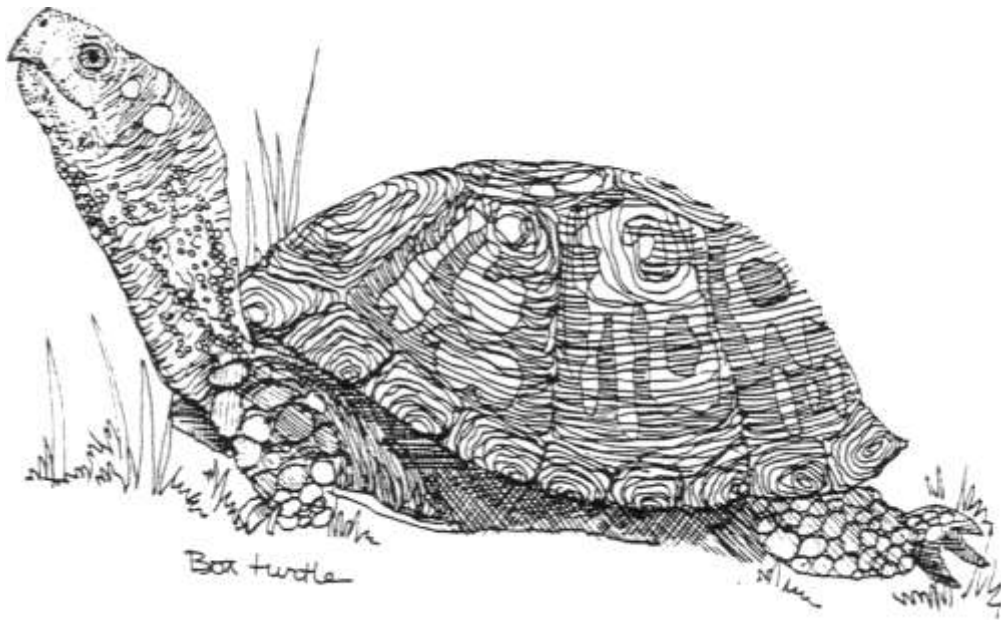


GA Project Wild Teacher Resource Guide: Introduction to Georgia's Natural History



Georgia Department of Natural Resources
Wildlife Resources Division
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TABLE OF CONTENTS

INTRODUCTION	2
Prehistoric Georgia	3
Physiographic Regions	4
MOUNTAINS	5
CUMBERLAND PLATEAU	6
Caves	6
Key Plants and Animals	7
RIDGE AND VALLEY	8
Etowah River	8
Key Plants and Animals	8
BLUE RIDGE	10
Cove Forests	10
Key Plants and Animals	11
PIEDMONT	13
Flint River	13
Rock Outcrops	14
COASTAL PLAIN	16
Longleaf Pine-Wiregrass Community	16
Key Plants and Animals	17
Carolina Bays	18
Key Plants and Animals	19
BARRIER ISLANDS	22
Beaches	23
Dunes	23
Maritime Forest	24
Salt Marshes	24
Reefs	26
Key Animals	26
REFERENCES	29
APPENDICES	30
Georgia Exotic Species	30
Georgia State Symbols	30
Citizen Science Projects	30
Curriculum Aids	31
Schoolyard Habitat Aid	31
Special Thanks	31
Georgia’s Physiographic regions Map	32
Colonial coastal birding trail Map	33
Georgia River Basin Map	34
Various Animal Fact Sheets	

INTRODUCTION

The purpose of this guide is to supplement the Project Wild (PW) curriculum with natural history information specific to Georgia. One of the strengths of the PW curriculum is the breadth of its scope, dealing with issues from around the United States. This general approach can also be a frustration however, if one is trying to tailor the PW curriculum to local habitats and species that students may encounter in Georgia.

This guide seeks to provide a basic introduction to key habitats and wildlife for each physiographic region within Georgia, and provide references for further study and field trip sites. Throughout, we have suggested links to local topics and PW activities that could be adjusted to add local information and flavor. We have accepted the prevailing scientific view of geologic time, though we are aware that other opinions exist regarding the dates of geologic events. We hope that those who disagree will still find this guide helpful.

We hope this guide helps to generate a greater knowledge and appreciation of Georgia's diverse and increasingly threatened habitats. It is only a deep concern and commitment to these wild places that will ensure their existence for future generations to enjoy.

GEORGIA OVERVIEW

Georgia is the largest state east of the Mississippi River, with a land area of 37 million acres, and is home to over 8 million people (2000 census). This number is expected to increase by 37% over the next 25 years. The state of Georgia is also home to a remarkably diverse collection of plants and animals. The term "biodiversity", may inspire images of Australian Coral Reefs and Brazilian Rain Forests, but for certain taxa, the southeastern United States ranks high in the world, and certainly within the United States for sheer number of species. Georgia is home to 975 vertebrates (ranks 2nd in the

nation), of which 63 are found only in Georgia (**endemic species**). Georgia ranks among the highest of all states for amphibian, freshwater fishes, and crayfish diversity, and is in the top 10 for reptile and vascular plant diversity (3,600 native plant species).

Many excellent field guides are available that provide detailed information on the identification and life history of our plants and animals. This guide seeks to introduce you to some of the important plants and animals, not to replace existing guides.

CHANGING HABITATS

Walking through a cove forest in the mountains, floating down the Altamaha River by canoe, or wandering the Spanish-moss draped hammock forests on Sapelo Island, one may get a sense of permanence and stability. This sense is largely an illusion however, as every habitat experiences subtle and sometimes more obvious changes through time. These change result from internal and external processes.

Internal processes such as plant growth, death, and replacement (called **natural succession**), are constantly at work, subtly changing every habitat, whether a rock outcrop or a mature forest. Habitats often progress towards a theoretical "climax" stage, where the species composition remains relatively stable over long periods of time. If you walk into a forest and the under-story saplings are the same species as the dominant canopy trees, you are witnessing a forest in its climax stage.

External disturbances such as hurricanes, droughts, lightning strikes and fires can interfere with plant succession, setting back the successional clock. In some habitats, external disturbances occur with sufficient frequency that the climax stage is never reached. For example, the Long-leaf pine forests of the coastal plain are fire-

maintained ecosystems, which are rapidly replaced by hardwoods if fire is suppressed.

On a much broader time scale, Georgia's habitats are also changing due to hemispheric and global climate changes. The most obvious example is the oscillating climate associated with the Ice Ages over the last 2 million years.

PREHISTORIC GEORGIA

Georgia's landscape at the peak of the last major Ice Age (20,000 years ago) would be unrecognizable to a modern observer. Ice ages have occurred about every 100,000 years for the last 2 million years in the northern hemisphere. A combination of three distinct cycles in the earth's rotation and orbit seem to cause these predictable climatic fluctuations. Whatever the cause, ice ages dramatically changed the face of North America well beyond the actual extent of ice, which reached only as far south as New York State.

During the ice ages a northern forest of **Jack Pine** (*Pinus sylvestris*), **Red Pine** (*Pinus resinosa*) and **spruce** (*Picea* sp.) found refuge in the southern Appalachians, pushed from its' northern range by vast sheets of ice that in places reached 2 miles thick. Between 14,000 and 11,000 years ago as the climate moderated, the landscape changed, becoming closer in appearance to modern Georgia.

A close look however would reveal a remarkably different fauna. **Mastodons** (*Mammot* sp.) grazed in Pine grasslands and spruce forests along the Atlantic coasts, with 4 – ton **Shasta giant ground-sloths** (*Nothrotheriops shastensis*), and **Giant Beaver** (*Castoroides ohioensis*) the size of Black Bear. Predators such as the **Dire Wolf** (*Canis dirus*), **American Lions** (*Panthera leo*), **American Cheetahs** (*Miracinonyx* sp.), and **Saber-toothed Cats** (*Smilodon fatalis*) prowled the landscape as well. In a relatively short period of time between 12,000-9,000 years ago, 35 - 40 species of large mammals went extinct. The cause of this wave of extinction is still

debated today. However, the arrival of Paleo-Indian hunters, approximately 12,000 years ago, probably played a major role in their extinction.



Mastadon

Parallel tales can be told of early human arrival on other continents, such as South America and Australia, where waves of large mammal extinctions followed close on the heels of human hunters.

RECENT HABITAT LOSS

Recent challenges to wildlife are easier to see and understand than prehistoric climate change and Paleo-Indian hunting. Rapidly expanding human populations exert increasing pressure on wildlife habitat throughout the state. This growing pressure raises concern for the survival of plants and animals that are dependant on the varied natural landscapes of the Southeast.

Habitat provides vital services for wildlife including space, food, water, and shelter. Changes in natural habitats may render them unsuitable for wildlife. For example, impounding rivers to make lakes alters natural water flow, temperature, and sediment levels, destroying habitat for many of our freshwater species. Wetland draining has already destroyed about 50% of North America's wetlands (about 23% of Georgia's), threatening the habitat of about 70% of our endangered species. Water pollution in the form of sediment and

chemical pollutants also threaten our native species.

One of our most damaged habitats must be the bottomland hardwood forest. 77% of our bottomland hardwood forests have been cleared over the last 2 centuries, leading to the recent extinction of 3 of 5 bird species that depend exclusively on this habitat.

North America's largest woodpecker (**Ivory-billed** – *Campephilus principalis*), North America's only native parrot (**Carolina parakeet** – *Conuropsis carolinensis*), and the **Bachman's Warbler** (*Vermivora bachmanii*) have all become extinct. The brilliant **Prothonotary Warbler** (*Prothonotaria citrea*) and skulking **Swainson's Warbler** (*Lymnolthypis swainsonii*) remain, although both are species of concern due to habitat loss.



Ivory-billed Woodpecker

coastal plain, and barrier islands. Each region is defined by its underlying geology, soil types and topography. These physical factors in conjunction with climate (long term weather patterns) and local disturbances (storms, fires and floods), determine the types of habitats that develop in each region. The central role of **soils**, **climate** and **natural disturbance** will be revisited again and again, as these three factors determine what plants and animals can become established in any given habitat.

This guide starts in the mountains and moves to the coast, as if one were hiking from the mountains of northwest Georgia to the sea. This cross-section of Georgia would be wedge shaped, with the high tumbled rocks of the mountains gradually softening to the rolling piedmont, and then dropping to the essentially flat coastal plain and ocean (see page 5).

PW Activities:

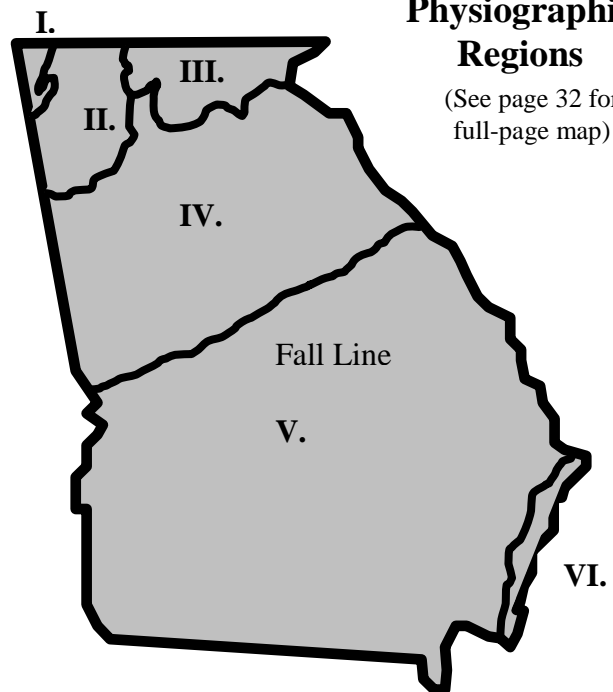
Oh Deer! Habitracks. What's that Habitat? Habitat Lap Sit

GEORGIA'S PHYSIOGRAPHIC REGIONS

From the southern terminus of the Appalachian Mountains to the barrier islands, Georgia includes a wide range of habitats and landscapes. This diversity supports the vast array of plants and animals that make our state unique. This guide divides Georgia into six regions, including three mountain regions, the piedmont,

Physiographic Regions

(See page 32 for full-page map)



I. Cumberland Plateau	IV. Piedmont
II. Ridge and Valley	V. Coastal Plain
III. Blue Ridge	VI. Barrier Islands

MOUNTAINS

Physical Landscape

The mountains of north Georgia only cover 9% of the state's area, yet they contain a significant portion of our animal and plant diversity. Georgia's mountains are ancient, formed from rocks between 200 million and one billion years old. The Rocky Mountains, Andes, and Himalayas are mere children in comparison. Geologic evidence suggests that the entire Appalachian chain has emerged and eroded several times, a slow but dramatic story of repeated continental collisions and mountain building followed by gradual erosion. Geologists estimate that between 5 and 10 miles of vertical rock have been eroded from the Appalachians and washed into the sea. Some of this material now forms the piedmont, coastal plain and barrier islands.

Forests have probably covered Georgia's mountains for the last 2 million years. Trees provided organic material for soil production and root systems to stabilize that soil. Montane forests offer one of many examples of plants stabilizing and gradually altering their environment.

Variations in elevation, slope and aspect create changing temperature and moisture patterns that produce many distinct **microclimates** in mountainous regions. These microclimates dramatically increase habitat diversity, allowing for specialized

plants and animals to become established in often quite local areas.

Typically rainfall increases in mountainous areas as air masses cool and release moisture as they rise and pass over mountains. For this reason you will often see clouds that seem perched on mountaintops, while the valleys are sunny.

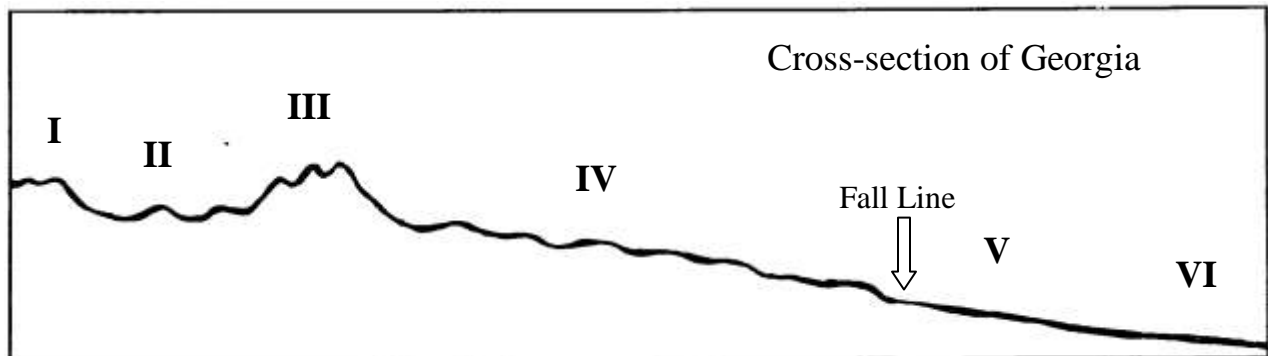
As elevation increases the average temperature decreases. For every 6,000 feet of elevation gained, the climate changes as if one moved 1,000 miles north. A state like Georgia gains a much broader diversity of plants and animals because of the mountains, which house species that would otherwise live far to our north.

Georgia's mountains can be divided into 3 distinct regions based on geologic history. These regions are the **Cumberland Plateau** of northwest Georgia, the **Ridge and Valley** province of north-central Georgia and the **Blue Ridge** province of northeast Georgia.

Mountain Sites to Visit:
Arrowhead Environmental Education
Center – Rome (706) 295-6073

Smithgall-Woods Conservation Area –
Helen (706) 878-3087

Elachee Nature Center – Gainesville
(770)-535-1976



CUMBERLAND PLATEAU

Caves, Crevices and Canyons

Physical Landscape

The Cumberland Plateau is Georgia's smallest physiographic region, encompassing only about 865 square miles or 1% of the state's area. Located in the very northwest corner of the state, this region comprises a high elevation plateau that extends into both Tennessee and Alabama and ranges from 880 to 2,200 feet in elevation.

Sand Mountain and **Lookout Mountain** form most of the Cumberland Plateau region in Georgia. They differ from the mountains of the Ridge and Valley by their flat tops. Both the Cumberland Plateau and the Ridge and Valley provinces are primarily sedimentary rock (formed by marine sediments compressing over millennia) such as **shale** (formed from silt) and **sandstone** (formed from sand).

Much of the Cumberland Plateau is underlain with **limestone**, formed from the shells of marine organisms deposited in a prehistoric sea between 300-425 million years ago. Limestone is a soft and porous rock notorious for cave formations. Caves form when limestone is dissolved by weak acids produced when rainwater combines with carbon dioxide. This process of chemical erosion created some of the deepest caves east of the Mississippi, including Ellison's Cave, which has drops of up to 600 vertical feet. Several rivers have eroded deep canyons into the high plateau, forming impressive landforms such as Cloudland Canyon and Johnson's Crock.

Habitat highlight: Caves

Roughly 500 caves are known in Georgia. They are mostly found in the Cumberland Plateau, Ridge and Valley and Coastal Plain provinces. A recent cave survey documented 173 invertebrate species from 47 Georgia caves, ranging from worms, to mollusks, molds and beetles.

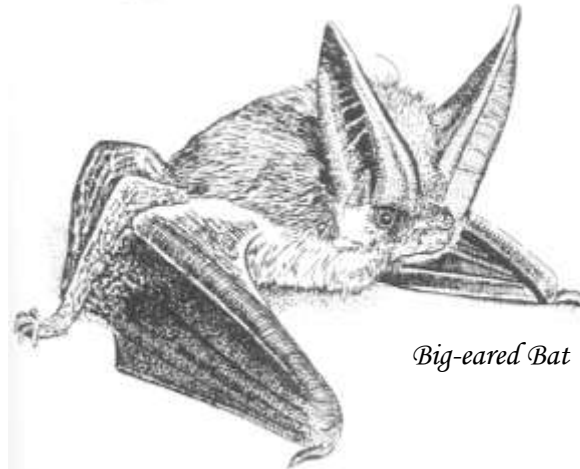
Many vertebrates also make caves their homes, permanently or temporarily.

Troglobites are animals that only live underground, while **trogloxenes** are species that spend time in caves but must come to the surface for food.



Cloudland Canyon

Living underground in caves generates some unique adaptations among many cave dwelling creatures. Troglobites are often



Big-eared Bat

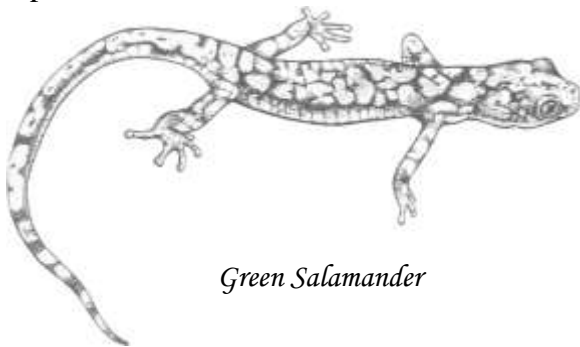
blind and have lost skin pigments, so they appear white. They often find their way around with extensive antennae. There are several species of fish, salamanders and crayfish that live only in caves. Trogloxenes includes bats, rats, and cave crickets (perhaps the most common cave species). One of the most common bats that roost in Georgia's caves is the **Eastern Pipistrelle** (*Pipistrellus subflavus*). Like all Georgia

bats, they are insectivores. They depend on **echolocation** to find their food at night, as well as navigate dark caves. Disturbance to bats during hibernation or during the breeding season can lead to high rates of mortality for both adults and young.

Although cave wildlife is fascinating, geological formations are often the most spectacular aspect of cave exploration. Minerals deposited on the roof, walls, and floors of caves form **speleothems**, such as **stalactites** and **stalagmites**, which create the moonscape appearance of many caves.

Key Plants and Animals

Many animals are restricted to the Cumberland Plateau region in Georgia. Most of them are amphibians that live in and amongst the canyons, cliffs and caves. The **Zigzag Salamander** (*Plethodon dorsalis*) is one such creature. They live in the mountain forests and are found most often near springs and cave openings. The **Tennessee Cave Salamander** (*Gyrinophilus palleucus*) resembles many other cave dwelling organisms with reduced eyes and pigmentation. The **Green Salamander** (*Aneides aeneus*) one of the climbing salamanders is well adapted for its life on the cliffs and caves, where it can compress itself into narrow crevices to avoid predators and inclement weather.



Green Salamander

The **Common Map Turtle** (*Graptemys geographica*) resides only in the Cumberland Plateau. These beautifully patterned turtles tend to live in rivers and lakes, feeding primarily on snails and crayfish. Female map turtles grow much larger than males. Pollution and river

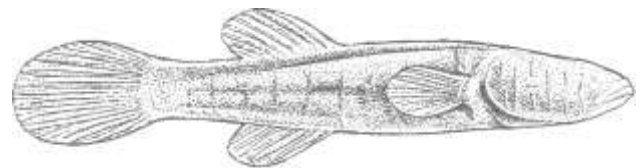
channelization have led to decreased map turtle populations. Also in some Southeastern states populations have decreased due to collection for the pet trade.

Bats often use caves as roosting sites. Two endangered bats are found in northwest Georgia, the **Gray Bat** (*Myotis grisescens*) and **Indiana Bat** (*Myotis sodalis*). These species have only been found in a small handful of caves in the Cumberland Plateau.

Historic records suggest that **Golden Eagles** (*Aquila chrysaetos*) used to nest on the Cumberland Plateau. Much effort was expended to reintroduce this impressive raptor to Georgia without much success.

Other Key Species:

- Northern Spring Salamander** (*Gyrinophilus porphyriticus*)
- Northern 2-lined Salamander** (*Eurycea bislineata*),
- Cave Salamander** (*Eurycea lucifaga*),
- Cumberland Pond Slider** (*Trachemys scripta*)
- Southern Cavefish** (*Typhlichthys subterraneus*)



Southern Cave Fish

Sites to Visit:

- Cloudland Canyon State Park, Trenton, (706) 657-4050*
- Case Cavern*
- Ellison's Cave*
- Lookout Mountain*
- Sand Mountain*
- Pigeon Mountain, Lafayette – includes one of the deepest caves in the world (1,062 feet deep)*
- Crockford-Pigeon Mountain WMA*
- DNR Wildlife Resource (706) 295-6041*

RIDGE AND VALLEY PROVINCE

The Folded Hills

Physical Landscape

The Ridge and Valley province is adjacent to the Cumberland Plateau in northwestern Georgia and occupies about 2,800 square miles, or 5% of the state's surface area. The underlying rock is symmetrically folded, producing long parallel valleys and ridges that are oriented in a northeast-southwest direction. The ridges typically reach 1,000-1,600 feet in elevation, while the valleys range from 600-800 feet.

The Chickamauga Valley and the Great Valley are separated by the Armuchee Ridges. These three features form the majority of Georgia's Ridge and Valley province. The Great Valley runs north-south between Atlanta and Chattanooga. During the Civil War this valley was a major corridor for troop movements for both the Union and Confederate armies.

The Coosa River Basin, which drains the central valley, is one of Georgia's most diverse rivers. It has been called the snail capital of the world, as 82 **gastropods** make it their home.

Habitat Highlight: Etowah River

Georgia's rivers are the most diverse temperate freshwater ecosystems in the world. Between native fish, mussels, snails and crayfish, our rivers are unparalleled for their species diversity. Even freshwater turtle diversity in Georgia and Alabama is among the highest in the world.

The Etowah River offers a good example of a highly diverse Georgia river. The Etowah watershed is located in central north Georgia and drains into Lake Allatoona in Cherokee County. The headwaters of the Etowah are in the Blue Ridge province, but it flows through the Ridge and Valley. Though small in comparison to many other river basins in Georgia, the Etowah river

system is one of the most diverse in the world. Unfortunately, it is also one of the most imperiled. Historically, 91 species of fish were found in the Etowah. Since the late 1800's however, 15 species have disappeared from the watershed. Still, with 76 native fish species, the Etowah is one of the most biologically diverse river systems in the world, rivaling and surpassing many far larger systems. For example, the Etowah is home to more than three times the native fish species than the entire Colorado River system, and more than twice that of the Columbia River System.

Other Key Species:

Cherokee Darter (*Etheostoma scotti*)

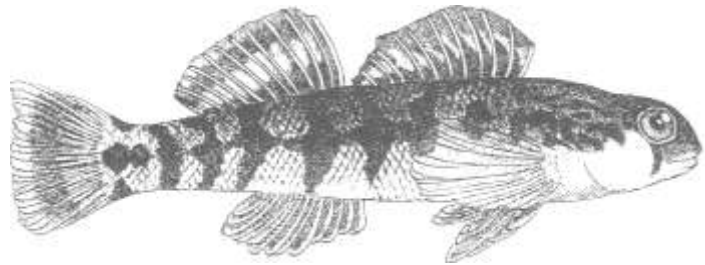
Etowah Darter (*Etheostoma etowahae*)

Upland combshell (*Epioblasma metastriata*)

Southern Clubshell (*Pleurobema decisum*) (fresh water mussels)

Large-flowered Skullcap (*Scutellaria* sp.)

Tennessee yellow-eyed grass (*Xyris* sp.)



Cherokee Darter

PW Aquatic Activities:

Fashion a Fish, Riparian Zone

Key Plants and Animals

Biologically the Ridge and Valley province is more similar to southwest Georgia than it is to the rest of north Georgia. The Great Valley (Coosa River Valley) seems to act like a corridor running diagonally from northwest Georgia,

southwest through Alabama, allowing species more typical of the Coastal Plain to expand their ranges into north Georgia. A number of coastal plain species reach up the Coosa Valley into north Georgia, some continuously and others with disjunct populations. **Pine Woods Tree Frog** (*Hyla femoralis*), **Gopher Frog** (*Rana areolata*), **Southern Hognose Snake** (*Heterodon simus*), as well as **Chicken Turtle** (*Deirochelys reticularia*), **Squirrel Tree Frog** (*Hyla squirella*) and **Oak Toad** (*Bufo quercicus*) extend north of the coastal plain only up the Coosa River Valley.

Species Highlight: Burrowing crayfish

Georgia is home to about 70 species of crayfishes. Of those 70 approximately 25 are classified as burrowing crayfishes. Instead of living in open waters such as streams and lakes, these species construct complex burrows in which they spend most of their lives. They are still aquatic animals however, and require water for survival. They accomplish this by digging down until they reach groundwater. These burrowing species typically are found in low swampy areas or along stream margins where the water table is close to the surface. Small earthen “chimneys” are often the only evidence of their presence. These chimneys are formed as they push small balls of earth out of their burrows, which can be more than 10 feet deep. They can occasionally be seen foraging around the mouth of their burrow or moving over land on warm, damp nights, possibly looking for mates.

The **Conasauga Blue Burrower** (*Cambarus cymatilis*) is a burrowing crayfish known only from the Conasauga River system in northwestern Georgia. This species was first found in burrows in the rose garden of a family in Chatsworth, Georgia. It has since been found at only four additional locations. The Conasauga Blue Burrower lives in complex systems of tunnels that it excavates and maintains throughout its life. Because crayfish are aquatic organisms, at least one of these tunnels must go below the water table. This animal is a beautiful blue color with creamy white edges on its claws and legs.

Sites to Visit:

*New Echota Historic Site – Calhoun
Resource Center (800) 864-7275
Chickamauga and Chattanooga Nat.
Military Park – Fort Oglethorpe
(706) 866-9241
Johns Mountain WMA – Calhoun
(770) 297-3000*

BLUE RIDGE PROVINCE

A Crumpled Landscape

Physical Landscape

The Blue Ridge province includes much of north central and all of northeastern Georgia, forming some of the most dramatic terrain in the state. It occupies about 1,850 square miles, or roughly 3% of Georgia's area. The Blue Ridge is composed of highly metamorphosed and deformed rocks, including some of the oldest rocks in the state. The rocks range from 400 million to over one billion years old. The topography is very rugged with many steep mountains ranging in elevation from 1,600 to over 4,700 feet. Brasstown Bald is Georgia's highest point at 4,784 feet above sea level. An observation building at the summit offers spectacular views of the surrounding mountains, and a museum provides excellent natural and cultural history of the area. The Blue Ridge province forms the backbone of the Appalachian Mountains from North Georgia to Pennsylvania, forming the "eastern continental divide," which separates watersheds draining into the Atlantic Ocean from those draining into the Gulf of Mexico.

Habitat Highlight: Cove Forest

Some of Georgia's most splendid remnants of uncut forest reside in isolated mountain coves that proved inaccessible to earlier generations of loggers. Despite the mountain environs, the coves are still home to some truly massive trees and to a wonderful diversity of both plants and animals. A spring day is well spent in the cool understory of a Cove Forest, surrounded by wildflowers and serenaded by the songs of **thrushes** and **warblers**.

Mountain Cove Forests in Georgia typically are located above 3,000 feet on the cooler north slopes of mountains in the Blue Ridge. Though Cove Forests cover a tiny percent of the state, they are home to a highly diverse assemblage of plants and animals. This diversity is supported by 70

inches of precipitation annually and a temperate climate.

Georgia's Cove Forests are home to many plant species in every level of the forest. The dominant canopy trees are often **Basswood** (*Tilia heterophylla*), **Sugar Maple** (*Acer saccharum*), **American Beech** (*Fagus americana*) and **Buckeye** (*Aesculus* sp.). At higher elevations, more northerly trees are found, such as **Yellow Birch** (*Betula lutea*). In lower elevation coves, southern species appear, such as **Umbrella, Bigleaf** and **Fraser's magnolia** (*Magnolia* sp.). These trees provide thick leaf litter each fall that contributes to the rich soils of the forest floor.

Despite the varied canopy trees, the most striking plant diversity is found in the herbaceous layer of the forest, which also provides the wonderful spring display of wildflowers. Species typical of the Cove Forest include **False Lily-of-the-Valley**

(*Maianthemum canadense*), **Spring Beauty** (*Claytonia caroliniana*), **Trout Lily** (*Erythronium americanum*), **Squirrel Corn** (*Dicentra canadensis*) and **Dutchman's britches** (*Dicentra cucullaria*). Many **Trillium** species are also present.

Many wild flowers bloom from March until May. This early spring window, between cold weather

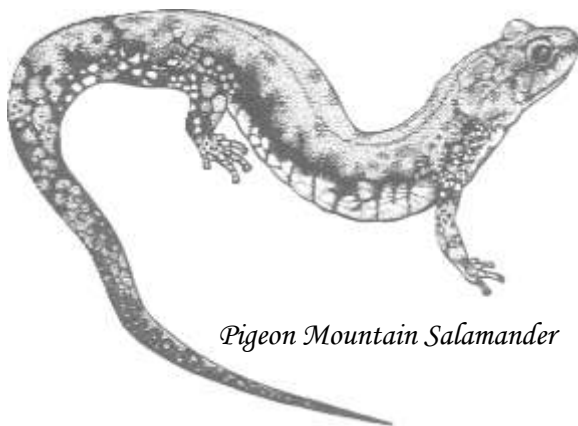
and the period when canopy trees leaf out, is enough time for the herbaceous plants to rapidly grow, flower and produce seeds. By the time late spring arrives, many of the wildflowers will have already passed.



Yellow Lady Slipper

An economically important species, the **Wild Ginseng** (*Panax quinquefolius*), is the basis of a multi-million dollar annual harvest throughout the Appalachian Mountains. The sustainability of the Wild Ginseng harvest is in question, and Ginseng poaching has become a problem in protected areas such as the Great Smoky National Park. Wild Ginseng is a perennial herb that can live up to 60 years, developing a large forked taproot with many medicinal uses. Concerns over the harvest of Wild Ginseng are based in part upon its slow growth, low reproductive rate and long life span.

The Southern Appalachians are also home to 27 species of salamanders, which is more than anywhere else in the world. Georgia's cove forests provide habitat for many of these species. Rich under-story vegetation and rotting fallen logs provide excellent habitat for salamanders. Some salamanders have extremely limited distributions, such as the **Pigeon Mountain Salamander** (*Plethodon petraeus*) which is only found in limestone crevices on the sides of Pigeon Mountain.



Pigeon Mountain Salamander

Natural disturbances of the Cove Forests are generally rare and localized, and usually consist of high winds or insect outbreaks. Though the cool humid climate led these forests to be nicknamed “asbestos forests”, fires occasionally occur during droughts.

Recently human disturbances have altered the cove forest ecosystems. Logging, both selective and clear-cutting, has removed most of the largest trees.

Accidentally introduced diseases have also taken their toll. We have entirely lost the **American Chestnut** (*Castanea dentate*) to Chestnut Blight. **Florida Dogwoods** (*Cornus florida*) and **Eastern Hemlock** (*Tsuga canadensis*) trees are currently suffering from introduced diseases.

Georgia's Cove Forests are home to our largest land mammal, the **Black Bear** (*Ursus americanus*). Black Bears in Georgia are primarily found in the mountains and the Okefenokee Swamp. They are **omnivores** consuming a wide range of plants, animals and even garbage. Black Bear can reach almost 500 pounds but are typically much smaller. They rarely harass people although in areas where people feed them, they can become dangerous.

PW Activities:

Bearly growing. How many Bears can live in this forest? Rainfall and the forest.

Key Animals: Mountain Warblers

The cooler climate of the mountains generates habitat typical of land far to our north. Because of this pattern, the Southern Appalachians form the southern range limit of many species of plants and animals, including a number of breeding bird species.

The diverse habitats throughout the Georgia Mountains provide nesting sites for many colorful breeding birds, but **Wood Warblers** (*Parulidae*) are among the most spectacular. Though we have several species that are year-round residents, the majority of our Warblers are long distance migrants, leaving Georgia for the tropics each fall and returning in spring. Several of our most spectacular warblers nest in the mountains of north Georgia, including some rare species, such as **Cerulean Warbler** (*Dendroica cerulea*) and **Golden-winged Warbler** (*Vermivora chrysoptera*). Both of these birds are species of concern due to recent severe declines in their populations.

Coupled, these two species raises an interesting management dilemma because they require quite different habitat. The Golden-winged Warbler is an early-successional species, requiring recently disturbed habitat in the mountains. Historically, blow-downs and recently burned areas provided nesting habitat for this bird. Today, regenerating clear-cuts can provide habitat for the Golden-winged warbler. The Cerulean Warbler, however, generally nests in old forests, particularly selecting large super-canopy trees for nest locations. These two species are linked by declining numbers, but they require different habitat, illustrating the complexity and often conflicting demands of wildlife management.

PW Activities:

Changing the Land, Bird song survey, Rare bird eggs for sale, Migration Barriers

Habitat highlight: Trout Streams

The cold clear water of our mountain streams offer superb habitat for cold-water fish, such as **Brook Trout** (*Salvelinus fontinalis*) and the introduced **Rainbow Trout** (*Oncorhynchus mykiss*). These fish depend on the cold water because they need high levels of oxygen that only cold water can provide. The rocks along the streambed are often crawling with aquatic invertebrates that provide much of the food for the growing trout (see stream invertebrate guide on page 49). These invertebrates typically press themselves flat to the rocks to keep from being swept downstream and breath with gills until they immerge from the water as adults. Though the cold mountain streams are not as biologically diverse as the warmer rivers further south, they provide an important source of recreation for fishermen and women.



- Sites to Visit:**
- Fort Mountain State Park – Chatsworth, (706) 422-1932*
 - Sosebee Cove - Rte 108 NE of Vogel State Park*
 - Brasstown Bald – (706) 896-2556*
 - Vogel State Park – Blairsville, (706) 745-2628*
 - Tallulah Gorge State Park – Clayton (706) 754-7970*
 - Smith-Gall Woods Conservation Area – Helen (706)-878-3087*



Brook Trout

PIEDMONT

The Foothills

Physical Landscape

Piedmont literally means foothills. Nationally the Piedmont forms a gentle “S” curve from New York State to Montgomery Alabama, bordered to the west by the Appalachian Mountains and to the east by the flat Coastal Plain. Crystalline rocks (mostly granite) underlay the Piedmont. The low-relief landscape found in the Piedmont is a result of millions of years of erosion, gradually transforming mountains into a gentle rolling landscape that is not yet flat like the Coastal Plain.

The Piedmont covers about one third of the state of Georgia (18,100 square miles) and is typically associated with rough hilly terrain in the north and gentle rolling hills further south. The Piedmont extends south from the mountains of north Georgia to the fall line and ranges from 500-1,500 feet in elevation. The **fall line** marks the boundary between the crystalline rocks of the northern part of the state and the mostly unconsolidated sediments of the coastal plain. It is thought to be the furthest inland extent of the prehistoric coastline. The fall line is often associated with waterfalls and rapids formed as rivers tumble from the Piedmont to the coastal plain.

Much of the Piedmont that early settlers found would have been covered with broad-leaf hardwood trees dominated by the now rare **American Chestnut** (*Castanea dentata*). Today much of the Piedmont is covered with pine forests, a result of silvicultural rather than natural processes.

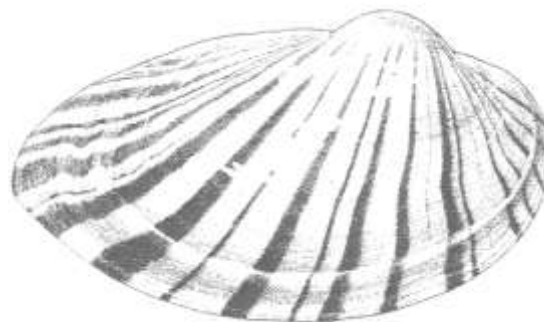
Habitat Highlight: Flint River Basin

The Flint River is often considered the most scenic river in the Georgia Piedmont and Coastal Plain. The uppermost headwaters originate under Hartsfield International Airport. From such inauspicious beginnings the Flint rapidly forms a dramatically carved channel through the red hills region of the Georgia Piedmont and is one of only 40 rivers in the United

States that stretches for over 200 miles virtually unimpeded (without dams).



Like the Etowah River in north Georgia, the Flint River exhibits remarkable biotic diversity, exhibiting a particular abundance of freshwater mussel species. Freshwater mussels are unrelated to marine mussels and clams and are mostly members of the **Unionoid** family. The Flint originally was home to 29 mussel species, though recent surveys suggest that only 22 remain. Though certainly not the most charismatic and high profile species, our fresh water mussels have a fascinating natural history.



Shinyrayed Pocketbook

Freshwater Mussels filter water through elaborate gill structures to collect oxygen and food. One of the most fascinating aspects of our freshwater mussels is their parasitic dependence upon fish for reproduction. Mussel larvae must attach to the gills of specific fish in order to survive. After several weeks, they drop off, and continue their development

independently. In order to lure the required fish host within range, the adult mussels produce elaborate “lures” which look remarkably like the host fish. Once a suitable host approaches, the mussel expels the larvae (**glochidia**) into the water. This form of reproduction aids in mobility of an otherwise immobile species.

Sedimentation, dams, pollution and channelization threaten many species of Unionoid mussels today.

PW Aquatic Activities:

Watershed. To Dam or not to Dam. Silt: a dirty word.



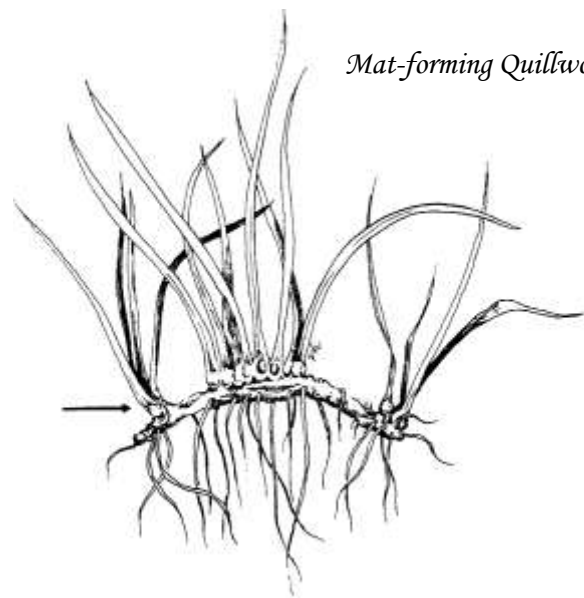
Habitat Highlight: Rock Outcrops

A particularly harsh habitat type found mostly on the Piedmont is the rock outcrop. Georgia boasts a large number of rock outcrops including the largest in the world, Stone Mountain. Rock outcrops can be either **Manadnocks**, which rise above the surrounding piedmont like **Stone Mountain**, **Arabia Mountain** and **Panola Mountain**, or they can be simple “flat-rock” or “pavement rock” outcrops, like **Heggies Rock**. Most outcrops are composed of **granite**, an igneous rock that crystallized from slow cooling magma underground (intrusive igneous rock). The molten domes of magma that cooled to form our outcrops were generated from the heat and friction at the edges to colliding continental plates

about 500 million years ago. The softer rock surrounding these granite domes gradually eroded away, leaving the granite exposed at ground level. In some cases, such as Arabia Mountain, the granite was changed into **gneiss** (a metamorphic rock) due to high heat and pressure long before the surrounding rock eroded and exposed it.

Rainwater falling on rock outcrops fill pools of standing water. These pools are called **solution pits** and provide habitat for rare plants and animals. If rainfall is consistent these wet depressions support **dish gardens**, a unique rock outcrop community that exhibits distinctive rings of progressively drier **habitat** further from the wet center. Standing water in the center of a dish garden may contain **Fairy Shrimp** (*Branchinella* sp) and **Mat-forming Quillwort** (*Isoetes tegetiformans*), species that only occur on rock outcrop pools. Both species can survive desiccation as the outcrop pools often dry up in summer.

Because of their harsh exposed environment, rock outcrops offer a good place to observe primary succession and early soil development. The first organisms that can survive on the bare rock surface are **lichens** and **mosses**. These organisms actually dissolve rock with weak acids. After many years, through chemical and



Mat-forming Quillwort

physical decomposition, a thin soil layer is formed. Soil allows other tolerant plants to establish, such as **Diamorpha** and **Sedum**, both **succulent plants** (fleshy leaves that hold moisture) well designed to withstand long periods of dry weather. As the soil continues to thicken, **Broomsedge** (*Angropogon* sp.), **Sandworts** (*Caryophyllacea* sp.) and **Orange grass** (*Ctenium aromaticum*) can colonize the rock. **Confederate Daisy** (*Viguiera porteri*), an endangered and endemic species, is quick to follow. Eventually small shrubs and trees will entirely cover the rock outcrop. This entire progression from rock to forest can often be seen on a single rock outcrop transect starting on bare rock and walking towards the encroaching forest at the outcrop's edge.

Rock outcrop plants are vulnerable to disturbance of vehicle and even extensive foot traffic. Many of the rock outcrops in Georgia are or have been actively quarried for granite, making Georgia the world's largest granite producer.

Outcrop Sites to Visit:

Davidson-Arabia Mountain Heritage Area - Lithonia (770) 484-3060
www.arabiaalliance.org
Heggie's Rock - Columbia County - 11 endemic species and 21 species that are characteristic of rock outcrops. Nature Conservancy (404) 873-6946
Panola Mountain State Park – Lithonia GP Resource Center (800) 864-7275
Stone Mountain Park – Stone Mountain (770) 498-5690

Key Species: Birds of Prey

Georgia is home to over twenty species of birds of prey. These range in size from the massive **Bald Eagle** (*Haliaeetus leucocephalus*) to the diminutive **Eastern Screech-Owl** (*Otus asio*). **Birds of prey** share a suite of impressive adaptations

allowing them to catch and kill live prey. Talons, or sharp curved claws, are the principal weapons of the bird of prey, although a formidable hooked beak is also put to good use. Birds of prey are known for their eyesight, which approaches the limits of vision possible with the vertebrate eye.

Our **diurnal** birds of prey (those that hunt by day), include the hawks, eagles, falcons, harriers and osprey. Our only nocturnal birds of prey are the owls. In Georgia we have three breeding species of owl and several others that winter sporadically throughout the state. Owls' eyes see only in black and white but are extremely sensitive to low light conditions, allowing them to fly through the woods chasing prey in the middle of the night. Owls' hearing is particularly acute, allowing them to pinpoint the location of their prey before they can even see it. Owls are also well known for their ability to fly almost completely silently, allowing them to sneak up on their prey without being detected.

PW Activities:

Owl Pellets. Birds of Prey. Seeing is Believing. Quick frozen critters.

Piedmont Sites to Visit:

Charlie Elliott Wildlife Center – Mansfield (770) 784-3059
Hard Labor Creek State Park – Rutledge (706) 557-3001
McDuffie Environmental Education Center Dearing (706) 986-4997
Newman Wetland Center – Jonesboro Carol: clambert@ccwa.us (770) 603-5606
Piedmont National Wildlife Refuge – Juliette (478) 986-5441
Ocmulgee Indian Mounds National Monument - Macon (478) 752-8257

COASTAL PLAIN

Ancient Sea Floor

Physical Landscape

The Coastal Plain of Georgia stretches from the **fall line** to the Atlantic Ocean, covering 35,650 square miles (60% of the state). The Coastal Plain was once a sea floor and is composed mainly of unconsolidated sediments with little hard rock at the surface. Coastal Plain sediments originated in the Piedmont and even in the mountains beyond and have been deposited over thousands of years. Near the fall line the Coastal Plain can be highly dissected but it becomes nearly completely flat closer to the coast. The current soils of the Coastal Plain tend to be sandy, a result of prehistoric oceans advancing and retreating across them. Prehistoric wave action dissolved and reduced soils to the sturdiest of substrates, quartzite or sand.

The Coastal Plain typically has a moderate climate with hot humid summers and mild winters. There is an average of 51 inches of rain, which comes from both convective thunderstorms in spring and summer and occasional hurricanes in fall.

Habitat Highlight: Longleaf Pine-Wiregrass Community

The Longleaf Pine-Wiregrass community is unique to the Coastal Plain and among the most endangered habitats in the United States. This is made more significant by the fact that the extent of **Longleaf Pine** (*Pinus palustris*) forests just 200 years ago was almost unimaginably large. It is estimated that over 90 million acres of Longleaf Pine forests stretched from Texas throughout the gulf coast states, peninsular Florida, Georgia and up the east coast to Virginia. Currently, only several thousand acres of good quality old-growth Longleaf Pine remain scattered throughout the southeast. The remaining stands of Longleaf Pine are mostly found on private quail hunting plantations and military land. Longleaf Pine forest was without a doubt the

dominant woodland of the Southeastern coastal plain before European settlement.



Longleaf Pine trees tend to grow widely spaced, creating an open park-like forest. Sometimes these forests appeared more like grasslands with scattered pine trees than true forests. At first glance a Longleaf Pine-Wiregrass forest appears to be composed of only two or three species, but the herbaceous understory forms one of the most diverse plant communities north of the tropics. In some areas over 40 plant species per square meter is not uncommon. In all, hundreds of species of grasses, legumes and other herbaceous plants grow beneath the pines. Many of these plant species are only found in the Longleaf Pine forest. Another defining feature of the Longleaf Pine forest and one that played an important role in its decline, is the forest's dependence upon fire. In fact, fire is a crucial factor in maintaining

many plant communities and is absolutely essential to the survival of the Longleaf Pine –Wiregrass community. Without fire hardwoods grow up through the Longleaf Pine, competing for light, nutrients and space. Fire suppression throughout much of the last century contributed to the decline of Longleaf Pine forests

PW Activity:

Fire Ecologies. Smoky Bear said what?

Historically, fires started by lightning strikes swept through the understory every three to five years, burning back shrubs and hardwoods. Mature Longleaf Pine were protected from fire by thick heat-resistant bark. Native Americans also burned the understory to manage for game, and early European settlers burned to maintain good forage for cattle in forest understory.

Blow downs are the chief natural cause for mortality among mature Longleaf Pine trees. Older trees rise above the canopy, exposing them to direct wind. Without windstorms, it seems that the Longleaf Pine trees show very little signs of aging and can live for many hundreds of years.

Key Plants: Longleaf Pine

The namesake of the Longleaf Pine forest is a tree with a fascinating natural and cultural history. Its dependence on fire and unique growth strategy set it apart from most other trees. Its cultural history is as interesting as its natural history, and much of the United States was built with Longleaf Pine. It is estimated that 200 billion board feet of lumber were cleared from these southeastern forests over the last 200 years.

Every stage of the Longleaf Pine’s life depends on fire. The seeds require bare mineral soil to germinate. These soils are typically found after a fire has burned off the

leaf litter. The germinated seed grows into the **grass stage**, which looks like a low growing bunch grass. Closer observation will show that the leaves are actually pine needles. The Longleaf Pine can remain in the grass stage for many years, awaiting a fire to clear the way for its growth. The dense clusters of needles protect the growth cells from this releasing fire. After a fire burns through, clearing brush away from the pine seedling, the tree enters the **rocket stage**. This involves a rapid period of growth during which the tree is vulnerable to fire. Once freed from the understory, the tree can continue to grow and eventually become a canopy tree. As it grows, it develops thick bark that protects it from subsequent fires.

Key Animals: Birds

The Red-cockaded Woodpecker

(*Picoides borealis*) and the **Bachman’s Sparrow** (*Aimophila aestivalis*) are two birds that are dependant upon the Longleaf Pine forest. The Red-cockaded Woodpecker (RCW) is listed as an endangered species largely due to its exclusive dependence on a diminished habitat. As habitat specialists, RCW’s require large old pines suffering from **red-heart rot**, a

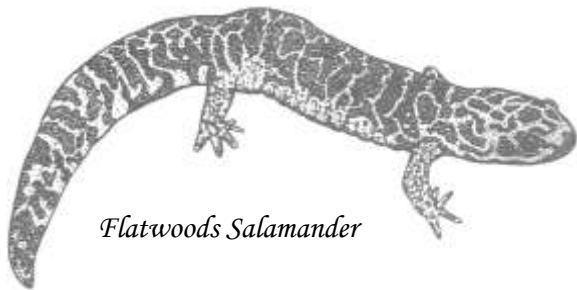


Red-cockaded Woodpecker

disease that softens the wood enough for them to drill nest holes. RCW’s are the only North American woodpecker to nest in living trees. This means that building a nest hole is a difficult task that can take years to complete. This fact leads to high site fidelity in areas with cavities already excavated and has led managers to create artificial cavities for RCW’s.

Predators, such as rat snakes and other woodpeckers, can significantly decrease nest success. In order to discourage predators RCW's often drill many small holes around their nest hole to release sap making it difficult for snakes to get into the nest.

Longleaf Pine Sites to Visit:
Jones Ecological Research Center –
Newton (224) 734-4706
Fort Stewart – Hinesville (229) 734-4706



Flatwoods Salamander

Other Key Species:
Sherman's Fox Squirrel (*Sciurus niger shermani*) The largest North American squirrel
Gopher Tortoise (*Gopherus polphemus*) Threatened species
Eastern Indigo Snake (*Drymarchon corais*) Threatened Species
Flatwoods Salamanders (*Ambystoma cingulatum*) Threatened Species

Habitat Highlight: Carolina Bays

A unique wetland feature of the Southeastern Coastal Plain is the Carolina Bay. **Carolina Bays** are oval or teardrop shaped wetlands oriented along a Northwest-Southeast axis, and are found from Maryland south to Georgia. Some support permanent lakes while others experience more irregular water levels.

Carolina Bays range from 6 to 30 feet deep and from several acres to 6,000 acres in size. Due to varying water levels, the vegetation differs dramatically from one Bay to another. Some are characterized by cypress forests, others marsh and some shrub bogs. Georgia is home to more than 1,000 Carolina Bays, covering 250,000 acres.



Carolina Bay

The unique distribution, shape and orientation of Carolina Bays have generated some interesting speculation about their origins. Some hypothesized that meteor showers caused craters, which then filled with water. This dramatic origin is supported by the similar alignment of the Bays, but no meteoric fragments have been found. A more probable hypothesis suggests that gale-force winds during the last glacial period scooped these depressions out of the sandy soil. Sandy ridges occurring on the eastern side of many Carolina Bays support this hypothesis. Whatever their origin, Carolina Bays along with cypress and gum ponds are important inland wetlands that provide habitat for a wide range of plants and animals.

Carolina Bays are underlain by a clay layer that keeps the water from draining through the otherwise porous soil of the Coastal Plain. Carolina Bays tend to be isolated from other bodies of water, so their only access to water is rainfall. Water loss comes from evaporation and plant transpiration.

Carolina Bays tend to have some peat development, which is a layer of partially decomposed plant matter. **Peat** forms when plant production exceeds the rate of decomposition. Decomposition rates are slow in wetlands due to the lack of oxygen in the soil. Several Georgia Bays have peat deposits over 14 feet deep, the end product of about 9,000 years of plant decomposition.

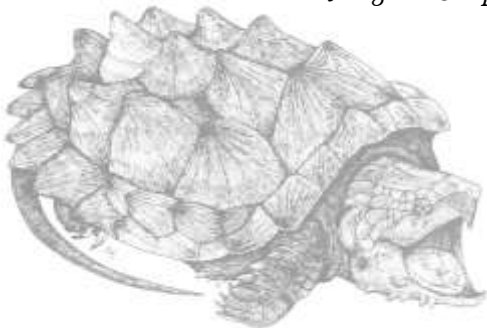
Peaty saturated soils tend to become highly acidic (pH 4.5) creating a stressful environment for plants, leading to a limited plant community. Plants that can thrive in these oxygen poor acidic soils are called **hydrophilic** or “water loving”. **Pond Cypress** (*Taxodium acendus*) dominate in bays that are flooded for extended periods, while more irregularly flooded habitats maintain **Blackgum** (*Nyssa sylvatica*), **Red Maple** (*Acer rubrum*) and **Pond Pine** (*Pinus serotina*) as well. **Pickerel Weed** (*Pontedara cordata*) and **Water Lily** (*Nymphaea stellata*) dominate open water habitat.

Though it may seem counterintuitive, fire plays an important role in the maintenance of Carolina Bays. During dry periods, peat becomes flammable, and lightning strikes can ignite fires that burn off woody vegetation and layers of peat. Historically, Bays probably burned about every 25 years, keeping them from growing over with vegetation. This is a great example of how a disturbance regime can play an important role in habitat maintenance.

PW Aquatic Activities:

*Pond Succession. Fire Ecologies.
Smoky Bear said what?*

Alligator Snapping Turtle



Human impacts on Carolina Bays have been dramatic. Many have been drained and cut for farming and timber. Peat mining and fire suppression have both led to declining quality of our Carolina Bays.

Carolina Bays offer an excellent place to learn about the importance of wetlands in the Georgia landscape. Unfortunately, wetlands are often viewed as inhospitable wastelands, dominated by things that bite, sting and otherwise impede human “progress”. This attitude has led to a loss of more than 50% of our wetlands in the US and threatens many of our unique wetlands in Georgia.

The benefits of wetlands are hard to overestimate. They provide critical habitat for many plant and animal species that could not survive in other habitats. They are also critical for water management as they absorb and store vast quantities of storm water, helping reduce floods and recharge aquifers. Not only do wetlands store water like sponges, they also filter and clean water as well, absorbing toxins and other pollutants.

PW Aquatic Activity:

Wetland metaphors.

Key Animals: Altamaha Spiny mussel

The **Altamaha Spiny mussel** (*Elliptio spinosa*) is found only in the Altamaha River drainage of Georgia. This animal reaches a length of about four inches, a height of nearly three inches and is dark greenish to black in color. What makes this species so interesting is the three to five, long spines that develop on each of its valves (shells). The spines begin growing when the mussel is a juvenile and can reach an inch or more in length. However, they often break off as the mussel gets older and many adult individuals show little evidence that a spine was ever there. It has been suggested that the spines help to anchor the mussel in the sandy habitats of the Altamaha River drainage. There are two or three additional “spiny mussels” in North America

but none as large and handsome as the Altamaha Spiny mussel.

Key Animals: American Alligator

The **American Alligator** (*Alligator mississippiensis*) is our largest reptile in Georgia. Today it is rare for one to exceed 14 feet in length, but alligators have reached over 19 feet. Alligators have lived mostly unchanged for 180 million years, coexisting with and surviving the extinction of the dinosaurs. Until human settlement in the Southeast they remained the unchallenged rulers of swamps and bayous from Texas to North Carolina.

Due to excessive hunting and wetland draining, American Alligators were placed on the Endangered Species list in the 1970's. In the last 30 years American Alligators have made a remarkable comeback, and there are currently an estimated 2 million Alligators in the southeastern United States.

Alligators serve many important roles in the swamps of Georgia. They keep rodents and other grazing species under control. Alligators also create wallows, which stay wet even if the surrounding swamp dries out. These wallows or "gator holes" provide watery refuges for aquatic plants and animals that would otherwise dry up and die during times of drought.



American Alligator

PW Activity:

Back from the Brink.

Key Plants: Pond Cypress

The **Pond Cypress** (*Taxodium acendus*) is the dominant tree in still water wetlands. The similar **Bald Cypress** (*Taxodium distichum*) prefers moving water wetlands. Both are impressive trees that can reach 150 feet tall and live over 900 years. They are deciduous conifers, shedding their needles in late November and re-growing them in March. Cypress require varying water levels at different stages of their life history. Cypress seeds need bare wet soil to germinate, while the adults dominate in flooded areas where other trees cannot survive. The most distinctive features of both Cypress species are the splaying **buttresses** at their base and the **cypress knees** projecting above the ground surface. The buttresses provide structural support in the muddy soils. It is thought that the knees may aid in gas exchange allowing oxygen to reach the roots despite saturated soils.

Both species of Cypress are valuable timber species, and many of the states most impressive stands have been cut. The wood is of particular value due to its resistance to rot and insect infestation.

Key Plants: Pitcher Plants

Throughout the Coastal Plain, wherever there are bogs, wet savannas, low areas in Pine Flatwoods and other wetland habitats, a variety of **Pitcher Plants** (*Sarracenia* sp.) may be found. Pitcher Plants are a fascinating group of plants adapted to the low nutrient soils of wetlands. In order to meet their nutrient requirements, Pitcher Plants are carnivorous, feeding off a wide variety of insects. Georgia has 7 species of Pitcher Plants, some of which can be found in the Piedmont and Mountains but most are restricted to the Coastal Plain. All of our Pitcher Plants are protected due to concern over their declining populations. The **Green Pitcher Plant** (*Sarracenia oreophila*) is Federally Listed as an endangered species.



Pitcher Plant Bog

Pitcher Plants have tube-shaped leaves (known as “the pitcher”) that form a trap when partially filled with water. Insects are lured into the pitcher with sweet nectar. A waxy layer on the inside of the pitcher, coupled with many downward pointing hairs, makes it difficult for insects to escape. Once they fall into the water, they drown and are digested by enzymes the plants produce.

Building a Pitcher Plant Bog is a fairly easy way to encourage children to observe these carnivorous plants close up. (See Web Resources page 30).

Other Key Species:

Alligator Snapping Turtle

(Macrolemys temminckii) – Our largest freshwater turtle, the Alligator Snapping Turtle is a species of concern in Georgia. It can reach 300 lbs in weight.

Sandhill Crane *(Grus canadensis)*

Grazing disturbance helps maintain open prairie in Carolina bays and the Okefenokee.

Sites to Visit:

Big Hammock Natural Area Glennville
(478) 994-1438

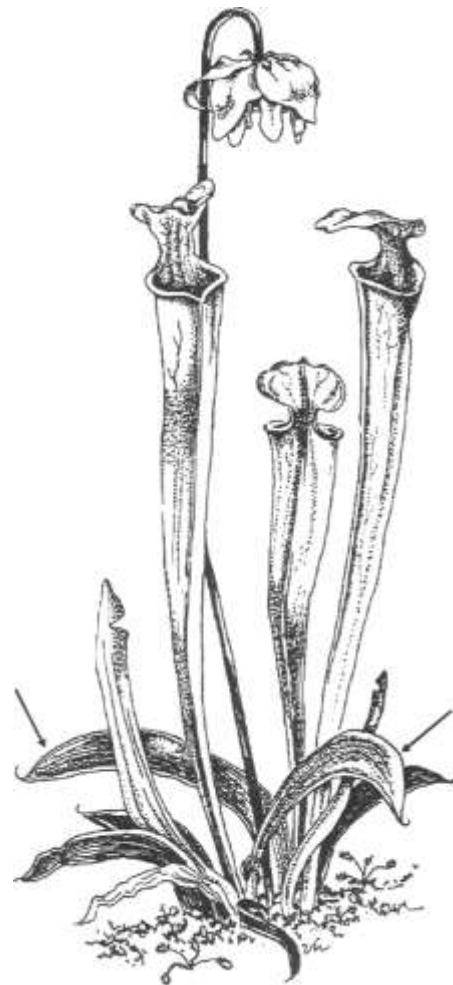
Radium Springs -Albany,
Largest springs in State.

Grand Bay Wetland Center – Valdosta- Coastal
Plains (229) 546-4094

Providence Canyon Conservation Park –
Lumpkin, (229) 838-6870

Oxbow Meadows Environmental Learning Center
Columbus (706) 687-4090

Okefenokee Swamp – Folkston
(912) 496-7836, (912) 637-5274



Green Pitcher Plant

BARRIER ISLANDS

The Coastal Jewels

Physical Landscape

Surely the crown jewels of the Georgia coast are the undeveloped barrier islands. Due to a fascinating history of land ownership and farsighted conservation laws (The Marsh Protection Act) Georgia has the least disturbed coast on the eastern seaboard.

Our coastline is roughly 110 miles long, stretching from the Savannah River in the north to the St. Mary's River in the south. The soils are typically sandy and habitat disturbances include wind, waves and tides. The Georgia Coast enjoys a subtropical climate with long hot summers and mild winters during which temperatures rarely fall below freezing. The coast receives 30-50 inches of rain annually. Thunderstorms generate most of the summer rainfall as the **Bermuda High Pressure system** dominates the region keeping low-pressure storms away.

There are 8 clusters of barrier islands off the coast of Georgia, four of which are accessible by car (Tybee, Sea, Jekyll, and St. Simons Islands). The remaining islands are more difficult to reach but are well worth the effort because they are much less developed than the accessible islands. These island clusters protect the mainland and salt marshes from the constant onslaught of wind and waves.

Barrier Islands are, by their very nature, in a state of constant change, reshaped by the ongoing action of wind, currents and tides. Depending on the relative strengths of these three forces, barrier islands will assume radically different shapes. Even a cursory glance at a map illustrates the difference between the barrier islands of Georgia and those of the Carolinas. Georgia's Islands are generally rectangular in shape in sharp contrast to the narrow linear islands forming North Carolina's Outer Banks.

Due to the location of Georgia in the heart of the **South Atlantic Bight**, a large

indentation in the southeastern coastline stretching from Cape Hatteras in the north to Cape Canaveral in the south, and the **continental shelf** far off shore, Georgia's coastline is well protected from major storms, waves and currents. This protection, coupled with a fairly high tide range (7-9 feet), makes the daily tidal fluctuations the most important shaping force on our islands. Tidal currents generally run perpendicular to the coastline, forming wide, short islands from the sands and silts of the coastal sediments. These wide, short islands are called **mesotidal islands**. In sharp contrast, the North Carolina coast is exposed to the brunt of many Atlantic storms and has a much smaller tidal range than Georgia. This situation generates a strong **longshore current** running parallel to the coast that creates long narrow islands that are called **microtidal islands**.

The short rectangular islands of the Georgia coast are more stable than the islands of North Carolina and have developed more extensive maritime forests. Our islands have been in roughly the same



Little Tybee Island

position for the last 4 -5,000 years.

The actual formation of Barrier Islands requires a gently sloping continental shelf and a rising sea level. These two parameters were met in Georgia over the last 20,000 years, as sea levels rose from melting glacial ice at the end of the last glacial period.

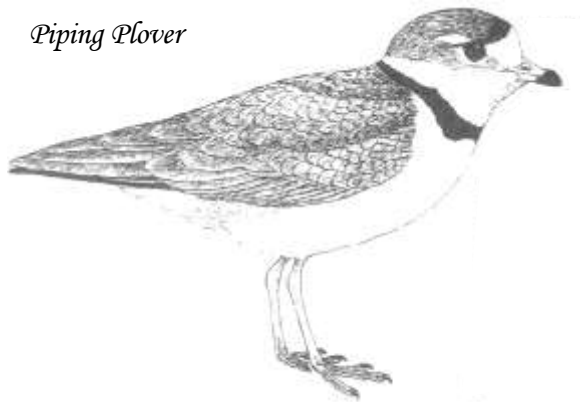
Rising sea levels surrounded and isolated existing dunes, forming islands. Sediments carried downstream settled in behind these islands to form the rich salt marshes of the tidal zone.

The typical form of our barrier islands includes a wide beach facing the open ocean, with slightly elevated dunes above the high-tide line. Behind and protected by these dunes is the **maritime forest** of the interior. Vast expanses of salt marsh stretch between the islands and mainland with scattered hammock forests protruding from the otherwise unbroken waves of saltmarsh cord grasses.

Habitat Highlight: Beaches

Constant wave action prohibits the establishment of plants along active beaches, and a quick glance might suggest a lifeless boundary between sand and water. Closer observation however reveals a more complex reality. Shorebirds continuously probing into the sand provide evidence of an invisible host of invertebrates beneath the uniform sands.

Piping Plover



Dark cylinders reminiscent of chocolate ice cream “sprinkles” surround the opening of **Ghost Shrimp** (*Callinassa* sp.) holes in the low tide zone. **Ghost Crab** (*Ocypode ceratophthalmus*) tracks and holes are also evident to the careful observer. These are white crabs up to 3 inches wide that scavenge along the upper beaches at night. The high-tide line of seaweed and driftwood is often hopping with **Sand Fleas** (*Orchestia agilis*) and provides cover for the elusive

Piping Plover (*Charadrius melodus*, an endangered species). Further evidence of life includes washed up coral fragments, shells, **Sand Dollars** (*Dendraster excentricus*) and seaweed.

Glancing over the Atlantic Ocean itself often yields diving terns and pelicans, rafts of ducks and flocks of shorebirds. In winter **Northern Gannet** (*Morus bassanus*) may be seen diving from up to 50 feet above the surface. **Dolphins** are also commonly seen at points along the Georgia Coast.

PW Aquatic Activity:

Kelp Help

Habitat Highlight: Dunes

As you walk inland from the beach towards the maritime forest, you will pass through distinct vegetative zones as the effects of direct wave action, salt-spray and wind diminish. The first plants you meet are the hardiest most salt tolerant species such as **Sea Oats** (*Uniola paniculata*), **Prickly-pear Cactus** (*Opuntia* sp.) and **Beach Morning Glory** (*Ipomea stolonifera*). These plants can survive the harsh sandy landscape. They play an important role in stabilizing the Dunes with their extensive but shallow root systems. Plant cover and diversity generally increase as you move inland from the fore-dunes, across the dune meadow to the more stable back dunes. **Wax Myrtle** (*Myrica ceriferus*) shrubs will often form dense thickets on the back-dunes, both stabilizing the soil and providing habitat and food for wildlife such as wintering **Yellow-rumped Warblers** (*Dendroica coronata*).

During storm surges, waves may break through and obliterate the protective dunes carrying saltwater inland. These **washover events** can form **salt pans** that are highly resistant to plant establishment. Few environments exhibit such an obvious struggle between plants and natural disturbances as the Dunes, where plants

constantly work to stabilize and winds and water to destabilize.

Habitat Highlight: Maritime Forest

Crossing into the back dunes and beyond you will enter the realm of the **maritime forest**. The maritime forests of the southern coast are as unique and enchanting as any other forest in the United States. The intricately gnarled **Live Oaks** (*Quercus virginiana*) cloaked in **Spanish Moss** (*Tillandsia usneoides*) and **Resurrection Fern** (*Polypodium polypodioidies*) and surrounded by **Saw Palmetto** (*Serenoa repens*) seems to be an anachronistic remnant of a slower and quieter past. The spreading canopy of Live Oak, **Southern Pine** (*Pinus* sp), **Southern Magnolia** (*Magnolia grandifolia*) and **Cabbage Palm** (*Sabal palmetto*) temper the harsh forces of wind and water that assault the dunes and beaches. Temperatures and winds are moderated under the tree canopy, which increases moisture levels and allows a dense understory of herbs and shrubs to develop.

Spanish Moss and Resurrection Fern are both **epiphytes**, plants that live on other plants entirely independent of the soil. Typically epiphytes require humid environments where they can absorb moisture directly from the atmosphere, so they are more common in the humid tropics than temperate regions. In the understory dense clusters of Saw Palmetto provide excellent hiding places for **Eastern Diamondback Rattlesnakes** (*Crotalus adamanteus*), Georgia's most dangerous

snake, which hunts rabbits and other mammals across the Coastal Plain and islands.



Habitat Highlight: Salt Marshes

A combination of heat, biting insects and the odor of decomposing vegetation can make salt marshes a challenging habitat to enjoy in the summer. During the cooler times of the year however, Salt Marshes are great places to visit, affording good views of many birds and other wildlife.

Georgia contains one third of the Salt Marshes along the entire eastern seaboard. Vast expanses of marsh grasses live between the mainland and the protective barrier



Key Species:
Live Oak (*Quercus virginiana*)
Georgia's State tree, the live oak is a magnificent tree that is often characterized by a broad spreading canopy. Live oaks are evergreen broadleaf trees with a small waxy leaf that protects them from salt spray and desiccation.

islands all along the Georgia coast. The lack of plant diversity belies the incredible biological importance of coastal Salt

Marshes. They are some of the most productive systems on earth, producing vast amounts of biomass annually. They provide important habitat for a wide range of fish, shellfish and bivalves, many of which form important staples of the human diet.

Many species of birds such as **Great Blue Herons** (*Ardea herodias*), **Bald Eagles** (*Haliaeetus leucocephalus*), **Clapper Rails** (*Rallus longirostris*) and various ducks and sparrows use these coastal marshes seasonally. **Raccoons** (*Procyon lotor*) regularly hunt the edges of salt marshes leaving their characteristic handprint tracks as evidence of their nocturnal forays.



Salt Marsh and Hammock

Salt Marshes form behind barrier islands where they are protected from the relentless wind and waves of the ocean. They also form along estuaries where rivers enter the ocean. Salinity of these marshes decreases as one moves farther inland, and one eventually finds an entirely fresh water marsh that is still tidal, as the fresh water backs up behind the tidal bulge of salt water closer to the coast. This salinity gradient offers a wide range of habitats for plants and animals.

Salt Marshes exhibit some of the harshest environmental conditions of any Georgia ecosystem. As the tides ebb and flow, temperature, salinity and water levels drastically change. Plants and animals must be able to survive these environmental fluctuations if they are to last in the Salt Marsh. The star of the salt marsh is **Cord grass** (*Spartina alterniflora*), which is well

adapted to surviving the rigors of life in the inter-tidal zone.

Key Species:

Cord Grass (*Spartina alterniflora*).

Few species can handle the environmental hardships of tidal life. Temperature, salinity and water levels change drastically twice a day, and there is a complete lack of oxygen in the muddy soil. *Spartina* is ideally adapted to this life, and is essentially the only plant that can survive in the low marsh. *Spartina* absorbs oxygen through folds in its leaves, channeling it to the roots. Excess salt is secreted through pores along the leaves. If you slide a blade of *Spartina* between your fingers, you will wipe off a fine salty residue that the plant has emitted through its pores. *Spartina* plays a critical role in trapping and stabilizing sediment in the marsh. Without the grass, mud would rapidly erode away.

Perwinkles (*Littorina* sp.) are salt-water snails that crawl up and down the *Spartina*, grazing on algae that grow on the leaves. Some suggest that these snails actually weaken the *Spartina*, making them more susceptible to environmental stresses. This has been raised as one idea explaining why many areas of coastal marsh are dying off. (To view this die-off, look at the Jericho River on I-95 just south of Savannah).

Tidal creeks and streams meander through the marsh draining and flooding the salt marshes twice each lunar day. Though tides create a harsh environment, they also provide the sustaining nutrients and carry wastes from the entire system. Along these channels **Oysters** (*Crassostrea virginica*), **Ribbed Mussels** (*Geukensia demissa*) and **Blue Crab** (*Callinectes sapidus*) can be found.

PW Aquatic Activity:

Marsh Munchers

Habitat Highlight: Reefs

Probably the least known habitat in Georgia, and certainly the hardest to visit, is the reef ecosystem off the Georgia Coast. The largest example is called **Gray's Reef**, and it is located 17 miles offshore from Sapelo Island.

If you imagine the Georgia (South Atlantic) Bight, the vast majority (> 95%) of the seafloor is composed of loose sediments that provide very little habitat for marine species. Any hard substrate on the sea floor allows animals and plants to attach, and forms an ecological island in an otherwise barren under water plain. Rocks or shipwrecks can provide a hard surface for reef formation.

Ridges of sedimentary rock exposed on the sea floor form Gray's Reef. Though these ridges only rise about 6 feet off the sea floor, they form a critical substrate for soft **corals** and **sponges** to grow, attracting large numbers of marine fish, mammals and even reptiles. Burrowing marine worms dig through the soft rock, creating even more habitat. Due to the location of Gray's Reef, there are both tropical and temperate species found there. Temperate fish such as **Sheepshead** (*Archosargus probatocephalus*) share space with tropical reef fish, such as **Angel Fish** (*Centropyge* sp.) and **Butterfly Fish** (*Chaetodon* sp.).

Several endangered species can be found at Gray's Reef. During the calving season, **Atlantic Right Whales** (*Eubalaena glacialis*) have their young within the sanctuary and endangered **Loggerhead Sea Turtles** (*Caretta caretta*) feed on the sponges, whelks and crabs found on the reefs. Gray's Reef is so critical for marine wildlife that it was designated a National Marine Sanctuary in 1981.

Attempts have been made to increase the amount of reef habitat off the Georgia coast. Divers have long known that shipwrecks are often great places to observe marine animals and plants, as the physical structure of the wreck provides habitat. This knowledge has

led to the intentional sinking of ships, subway cars and artificial cement reef structures to provide habitat for fish and other species. Marine plants and animals rapidly colonize these artificial reefs.

PW Aquatic Activity:

Fishy Who's Who

Key Animals:

Manatee

Manatee (*Trichechus manatus*) are fascinating, large endangered marine mammal that can be found off the Georgia coast between March and November. It is one of only 4 **Sirenians** (order Sirenia) in the world, a group of aquatic mammals that are closely related to elephants. Generally it is found in shallow coastal waters and up tidal rivers. Manatees eat *Spartina* (cord grass) as well as other emergent vegetation. The Manatee primarily stays in Florida though they do swim north to Georgia in spring and summer. They often bask near the surface, leading to frequent boat collisions and associated mortality.



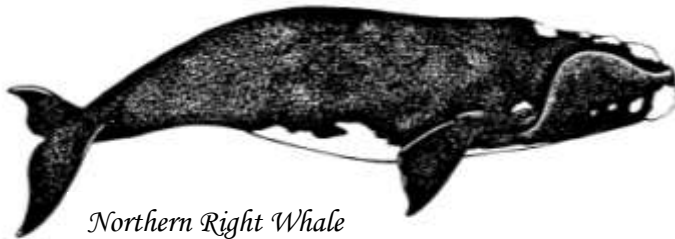
*West Indian
Manatee*

PW Aquatic Activity:

Mermaids and Manatees

Northern Right Whale

The **Northern Right Whale** (*Eubalaena glacialis*) is Georgia's state marine mammal, and is the most endangered whale in the world. Estimates put their population at around 350-400 individuals. The Right Whale is a **baleen** whale, meaning that it feeds by filtering vast amount of water through hundreds of baleen bristles hanging from its top jaw. Right Whales generally feed on tiny zooplankton called **Calanoid Copepods** off the coast of Cape Cod and Nova Scotia, and do not feed during their southward visit to Georgia and Florida where they calf.



Northern Right Whale

The Right Whale received its name from whalers because of the ease and profitability of hunting them. Right Whales are large and produce huge amounts of blubber. They are also slow and float once they are killed. This combination made them easy prey for early hunters, and their numbers rapidly declined until they were first protected in 1935.

Today the most serious threats to the Right Whale are entanglement in fishing nets and collisions with ships. A communications network has been established to alert commercial vessels of the presence of Right Whales so that collisions can be averted.

PW Aquatic Activity:

When a Whale is Right. Whale of a Tail

Loggerhead Sea Turtle

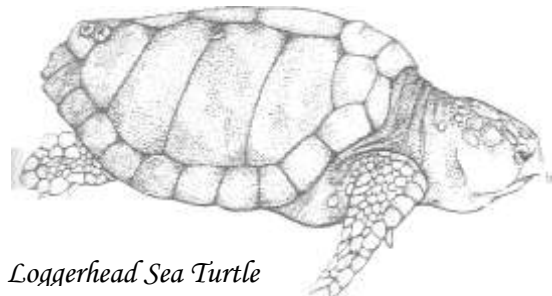
The **Loggerhead Sea Turtle** (*Caretta caretta*) is the most common of 5 sea turtle

species that use the coast of Georgia and is the only one that regularly lays eggs on our beaches. The other species include the **Leatherback** (*Dermochelys coriacea*), **Kemp's Ridley** (*Lepidochelys kempii*), **Green** (*Chelonia mydas*), and **Hawksbill Sea Turtles** (*Eretmochelys imbricata*).

Sea Turtle's have navigated the world's oceans and beaches for more than 200 million years. Despite this remarkable longevity (surviving major catastrophes such as those triggering the dinosaur extinctions), most of the world's sea turtles are currently endangered or threatened.

The Loggerhead Sea Turtle can reach 400 lbs in weight. It nests from North Carolina to Texas. Georgia averages between 1,000-1,300 nests annually between May and August. Female sea turtles usually return to the same beaches every time they nest (every 2-3 years after they reach 15-30 years old), these are often the same beaches where they hatched.

Once young Loggerheads make it to the ocean they enter the **north Atlantic gyre**, a massive current that carries them clockwise around the entire north Atlantic. During the first 12 years of their lives, they stay in this current feeding at the surface and hiding from predators in floating mats of seaweed. When they leave the gyre, they become bottom feeders, eating mollusks, crabs and other invertebrates that they pluck from the sea floor.



Loggerhead Sea Turtle

Sea turtles face many challenges throughout their lives. A wide range of animals, including humans, predate turtle eggs. Once hatched young turtles have to make it to the ocean, running a gauntlet of predators. Once at sea new predators await,

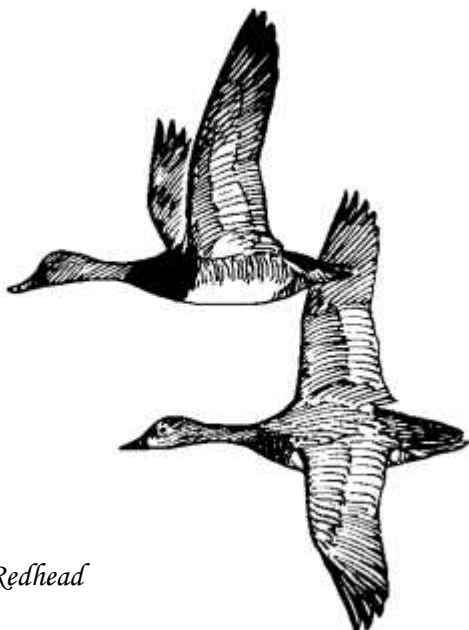
and many are caught in fishing nets or suffocated from ingesting floating garbage. This array of threats leads to a remarkably high mortality rate, especially early in life. Biologists estimate that only about one in 1,000 eggs survive to reproductive age.

PW Aquatic Activities:

Sea Turtles International. Plastic Jellyfish. Here Today – Gone Tomorrow. Turtle Hurdles.

Waterfowl

Though Georgia is not on one of the largest migratory flyways for waterfowl, a wide variety of ducks do winter in Georgia’s lakes, marshes and islands. Wintering ducks offer a great opportunity for wildlife watching, and many sites along the coast and inland are suitable for field trips. Only four species of ducks nest in Georgia. They are: **Wood Duck** (*Aix sponsa*), **Mottled Duck** (*Anas fulvigula*), **Mallard** (*Anas platyrhynchos*) and **Hooded Merganser** (*Lophodytes cucullatus*). During the winter however, many more species can be found. Sea Ducks and mergansers, as their name suggests tend to winter off the coast of Georgia, and can be viewed from beaches in



Redhead

winter. These include various species of **Scoter** (*Melanitta* sp.) and **Red-breasted Mergansers** (*Mergus serrator*). Diving Ducks, or Bay Ducks, can also be seen along the coast, but tend towards large inland lakes, such as lake Seminole, where they stay in deep water, diving for fish. Bay Ducks include **Scaup** (*Aythya* sp.), **Bufflehead** (*Bucephala albeola*) and **Canvasback** (*Aythya valisineria*). The Dabbling Ducks are most commonly seen, as they tend to stay in water shallow enough to “tip-up” and reach the bottom. Dabblers include **Northern Shovelers** (*Anas clypeata*), Mallard and **Blue-winged Teal** (*Anas discors*). Stiff-tailed ducks are the last group and only one species makes it to Georgia: the **Ruddy Duck** (*Oxyura jamaicensis*).

PW Activity:

No Water off a Ducks Back. Migration Headache.

Coastal Sites to Visit:

(By Car)

Colonial Coast Birding Trail

Map on page 34

Tybee Island 4-H Camp

(912) 786-5534

Skidaway Island State Park - Savannah

(912) 598-2300

Oatland Island Education Center

(912)-898-3980

Jekyll Island 4-H Center

(912) 635 4115

Harris Neck National Wildlife Refuge

(912) 652-4415

(By Boat)

Ossabaw Island info@ossabawisland.org

Cumberland Island (888) 817-3421

Sapelo Island Environmental Education

Center – (912) 485-2300

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- The Georgia Environmental Education Teacher Resource Guide: Environmental Education Alliance of Georgia – Guide to all nature centers in the state
- Web Page Resources:*
- Atlanta Audubon Society
www.atlantaaudubon.org
- Carolina Bay information
<http://thumper.valdosta.edu:8001/gb/Guide.htm>
- Cornell Lab of Ornithology web site. This offers many excellent citizen science projects that schools can get involved with, such as Project Feeder Watch. <http://birds.cornell.edu/>
- Freshwater Mussels information and pictures
<http://courses.smsu.edu/mcb095f/gallery/>
- Georgia Dept. of Natural Resources
www.georgiawildlife.com
- Georgia Museum of Natural History
<http://museum.nhm.uga.edu/gawildlife/gaww.html>
- Georgia Ornithological Society
www.gos.org
- Clearinghouse for Environmental Education in Georgia. www.eeingeorgia.org
- Journey North offers a migration program that schools can become involved in.
<http://www.learner.org/jnorth/>
- Pitcher plant bog instructions
www.uga.edu/~botgarden/GEPSN2d.html
- Real bird population data for most North American species.
<http://www.mp2-pwrc.usgs.gov/bbs/>
- State Park website <http://georgia.com/parks/>

APPENDICES

Appendix A:

The top ten exotic pest plants in Georgia:

Kudzu (*Pueraria Montana*),
Chinese privet (*Ligustrum sinense*),
Japanese honeysuckle (*Lonicera japonica*),
Hydrilla (*Hydrilla verticillata*),
Chinese tallow tree (*Sapium sebiferum*),
Nepalese browntop (*Microstegium vimineum*),
Bamboo (*Phyllostachys aurea*),
Autumn olive or **silverberry** (*Elaeagnus umbellata*),
Chinese wisteria (*Wisteria sinensis*),
Mimosa (*Albizia julibrissin*).

Appendix B:

Georgia State Symbols

Reptile – Gopher Tortoise
Marine Mammal – Atlantic Right Whale
Bird – Brown Thrasher
Game Bird – Bobwhite Quail
Tree – Live Oak
Flower – Cherokee Rose
Fish – Largemouth Bass
Butterfly – Tiger Swallowtail
Gem – Quartz
Insect – Honeybee
Seashell – knobbed whelk
Wildflower – Azalea
Mineral - Staurolite
State Fossil – Sharks tooth
State Vegetable – Vidalia Onion
State Fruit – Peach
State Crop – Peanuts

Appendix C:

Citizen Science Activities for School Groups:

Georgia Adopt-a-Stream

Monitoring program for stream invertebrates and water quality.

(404) 675-6240

<http://www.riversalive.org>

Project Feeder Watch

Winter-long bird count. Starts 2nd Saturday of November. Longest running citizen science project (since 1976). Receive a research kit. Data forms, posters, basic birding information

<http://birds.cornell.edu>

Great Backyard Bird Count

Collect data in mid-February to help track population trends for common wintering species. Web site has helpful bird identification and bird feeding tips. For more information visit www.birdsource.com

The Birdhouse Network

Build or buy bird boxes for cavity nesting species. Bluebirds, Chickadees, nuthatches, tree swallows, titmice, wrens etc...

Students can monitor nests throughout breeding season, collect data, send to Cornell Lab of Ornithology.

For more information:

<http://birds.cornell.edu/birdhouse>

Project Pigeon Watch:

Urban bird research to help scientists discover why pigeons come in so many colors.

<http://birds.cornell.edu>

For plans to build your own bird houses

<http://www.choosefreedom.com/birdhouse.html>

Appendix D: Curriculum Aids

Audubon Adventures – 4-6th grade curriculum. A classroom kit includes materials for 32 students: Student Newspaper, lesson plans, tips for outdoor study, hands on activities and guide to a healthy schoolyard.

www.atlantaaudubon.org

Friends of Feathered Fliers, Interactive Educational Activity Box: FREE
Includes: Videos, binoculars, bird eggs, nests, lesson plans, books, posters.
Sign out from local nature centers around state. For information for locations:

www.partnersinflight.org

The Georgia Conservancy

Native Seasons Curriculum and teacher workshops

www.georgiaconservancy.org

Georgia Youth Science and Technology Centers: 13 regional centers to help science teachers

<http://www.spsu.edu/gystc/home.html>

Project Wet –

Water education resources for teachers.

K-12

(404) 675-1638

Project Learning Tree

Georgia Forestry Commission

K-12 Forest education

(912) 751-3528

Environmental Education in Georgia Web Site.

Wealth of information and lesson plans.

www.eeingorgia.org

Appendix E: Develop Schoolyard wildlife habitat

Several organizations help schools develop wildlife habitat in schoolyards for education and conservation.

Atlanta Audubon Society

www.atlantaaudubon.org

Georgia Wildlife Federation

www.gwf.org

National Wildlife Federation

<http://www.nwf.org/schoolyardhabitats/>

For funding ideas visit:

http://birds.cornell.edu/schoolyard/teaching_css

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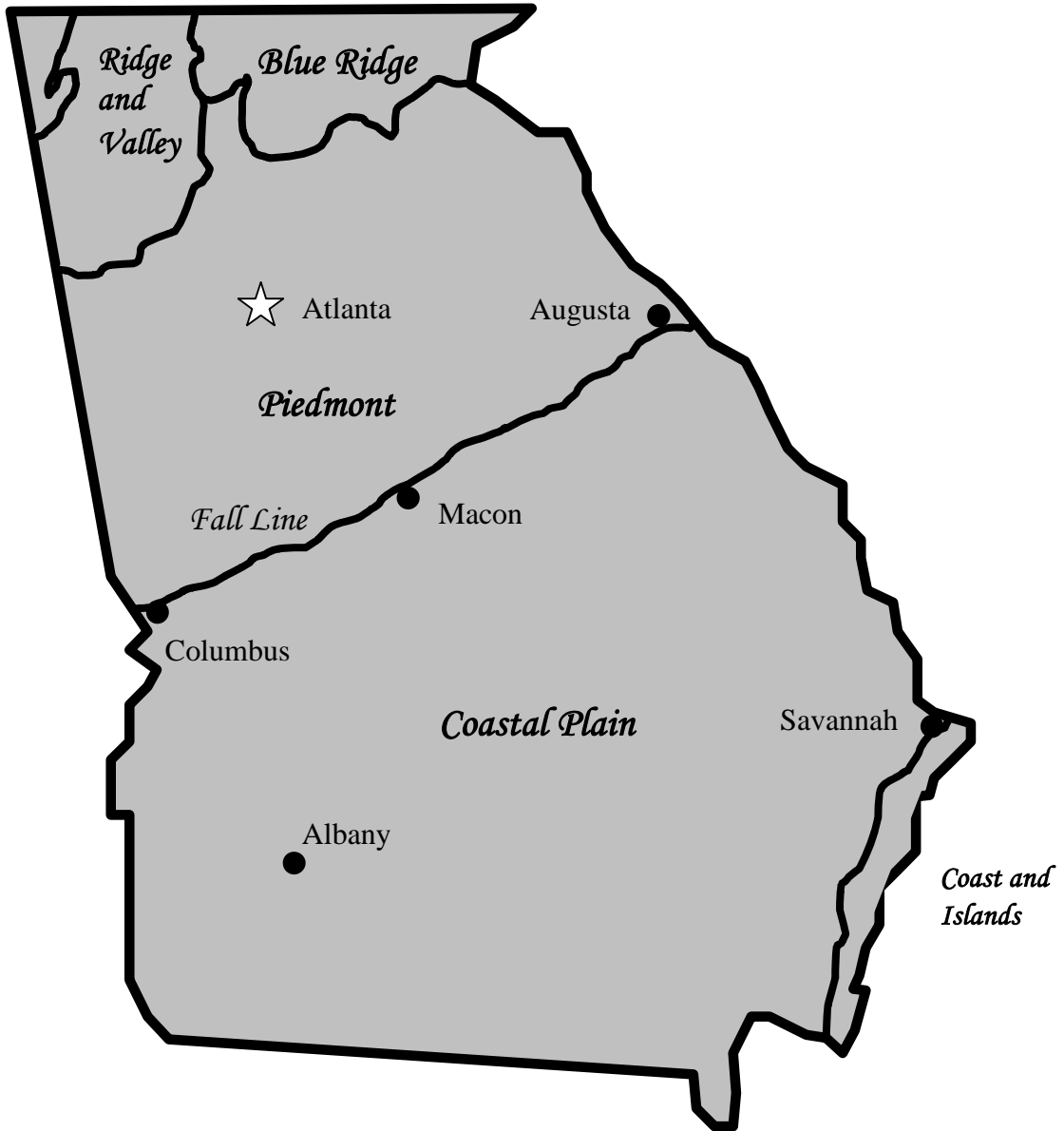
Photo Credits

Jim Allison: Carolina Bay, Marsh Hammock, Tallulah Gorge

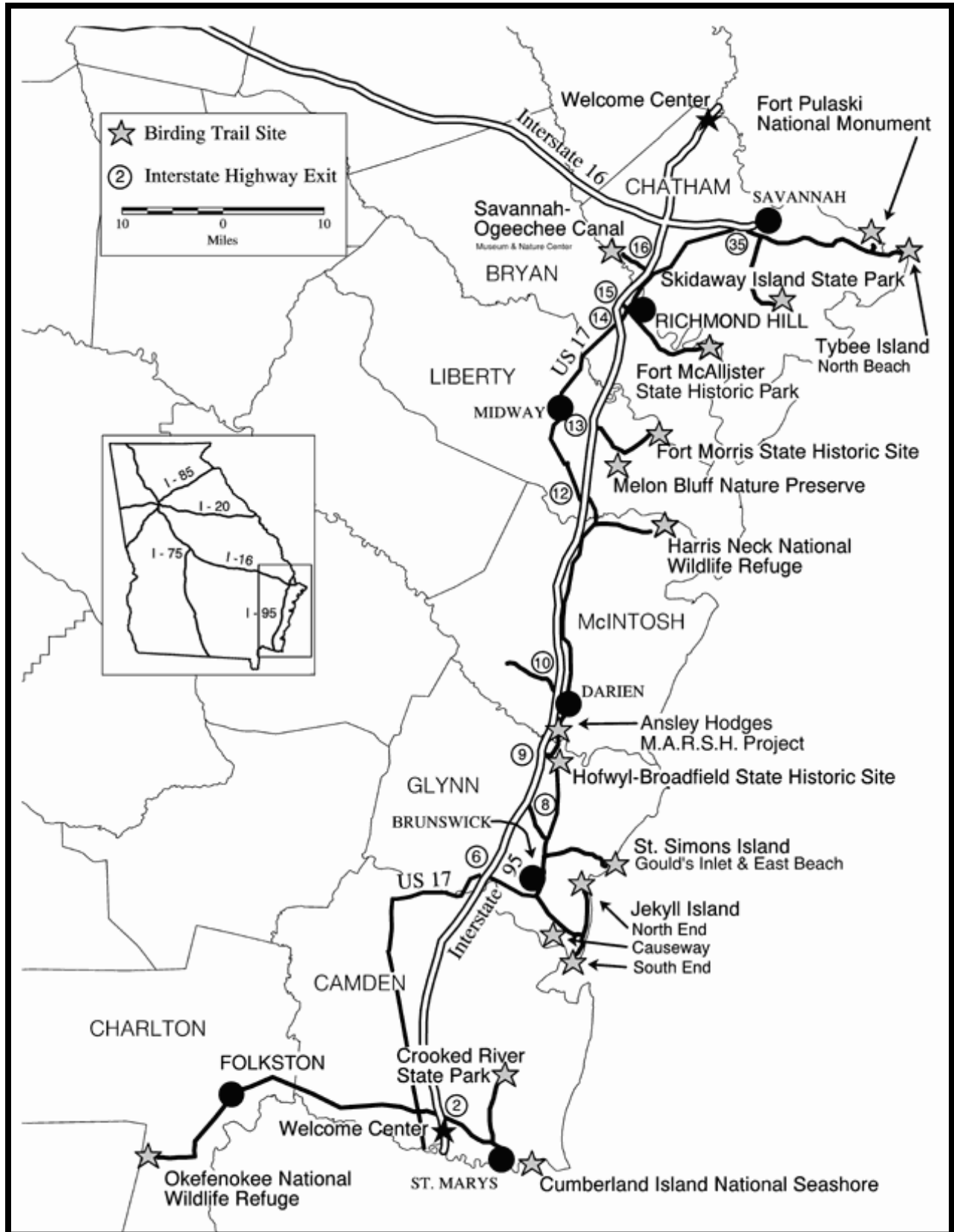
Jon Ambrose: Longleaf Pine, Cloudland Canyon

Georgia's Physiographic Regions

Cumberland Plateau



Colonial Coast Birding Trail



Georgia River Basin Map

