What are the history, status, and projected future of native plant communities in the South?

Chapter 2:
The History of Native Plant Communities in the South

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Key Findings

Nowhere in America is there a greater variety of native plant communities, native plant species, or rare and endemic native plants than in the forests of the Southeast. However, this exceptional bounty of diversity is under increasing stress from habitat conversion, alterations in community composition, and exotic pest and disease species. Human activities have impacted native plant communities since the first aboriginals settled in the region, and humans are likely to remain a formative part of the southern landscape for the foreseeable future.

The human use of native plants and their communities mirror contemporary societal needs. At the beginning of the 21st century the forested plant communities of the South are producing more than ever. Although the vast majority of the region's plant communities have been altered to a greater or lesser extent, an increasingly important societal need is the conservation of natural areas and the restoration of public lands. Rare vascular plant species are not evenly distributed throughout the South. Peaks of rare species diversity occur in the Southern Appalachians, the Florida Panhandle, and the Lake Wales Ridge region of Florida. Secondary peaks of rare species diversity are located in Arkansas' Ouachita Mountains and on the Cumberland Plateau.

Introduction

Native plant communities in the South have been much studied and written about since the Bartrams explored the region in the 18th century (Bartram 1791). Bartram noted that Native Americans as well as European settlers altered native plant communities by intentional burning, land clearing for agriculture, clearcutting of timber, and introductions of exotic species from Europe and the Caribbean. The plant communities of the South were not pristine in Bartram's time, and they were not pristine when Europeans first arrived on these shores. The southern landscape had already seen 10,000 years of human history. The last 400 years, however, have brought more radical changes than any caused by Native Americans.

Today's landscape and vegetation are not only the result of a very long history of change; they are also the starting point of tomorrow's vegetation. To better understand the resource at hand, it is valuable to remind ourselves of how we got here so that, perhaps, we can do better in the future. For the purposes of this Assessment, a native plant community is defined as a set of populations of plants naturally indigenous to an area that are interacting to the extent and degree that would have been observed prior to European settlement and share critical physiognomic and compositional traits.

It is somewhat arbitrary to define what is natural in terms of a pre-European timeframe, because it is impossible to separate the influences of native cultures from the historical landscape. However, even at the height of aboriginal culture in the Southeastern United States, Native Americans could not have had the impact on native vegetation to the degree that the Europeans had.

Plant communities, both native and otherwise, are defined not only by their inter- and intraspecific interactions and composition—which species are present and in what numbers—but also by their structure. Major structural elements include seral stage; the relative abundance, age distribution, and spatial arrangement of dominant species in each canopy layer; as well as physical metrics such as the height, size, and spatial arrangement of individuals. Natural disturbances such as hurricane blowdowns, ice storms, and drought are common events that markedly influence the structural condition of plant communities and have contributed to the perpetuation of a full spectrum of structural and seral conditions.

Methods

The literature was reviewed for information about the history of southern vegetation. There are already several reviews of this material. The better treatments of the subject include Delcourt and Delcourt (1993), Mac and others (1998), Ricketts and others (1999), and Stein and others (2000). An extensive and detailed primary literature exists on the paleobotany of the region based on palynology (the study of ancient pollen). Only a small portion of that information was used in this work, but anyone interested in

further reading can consult the reviews of Watts (1980) and Delcourt and Delcourt (1998).

Results

Prehistory of Southern Native Plant Communities

Through providing an understanding of the history of native plant communities in the South, this Assessment hopes to put into context the background against which change has occurred. It is important to understand the roles that global climate change and indigenous human cultures played in shaping the plant communities that are considered native or natural today. In this Assessment, only those works that address the Quaternary, 2 million years before present (BP), and later floras are discussed. The primary focus is on the vegetation history of the Holocene, 10,000 years BP.

For the majority of the Quaternary, the climate of the Southeast has been colder than at present (Greller 1988). During this period, there were multiple continental glaciation episodes that did not affect our region directly, but nonetheless had significant impacts on the composition of our native plant communities. These glaciations have been attributed by most to Milankovitch (1941) variations in the orbit of the Earth about the sun. The components of the Milankovitch cycle are expressed at periods of approximately 100,000, 41,000, and 21,000 years (Delcourt and Delcourt 1993). The effects of each of these cycles have been correlated with the relative severity of glacial periods and the rapidity with which glacial advances or retreats occurred.

The coastlines of the Southeastern United States achieved their present approximate position and shape during the early Quaternary (Christensen 1988). Changes in sea level associated with Quaternary glaciations have profoundly affected the vegetation of the historical Coastal Plains, though due to normal coastal processes, most of the evidence of paleocoastal plant communities has been obliterated. Likewise, the major Quaternary glaciations also profoundly impacted the depositional landscape, especially in the Mississippi Basin.

The composition of native plant communities of the Southeastern United States has changed less than that of any other region in the country during the last 20,000 years (Delcourt and Delcourt 1993). This is not to suggest that plant communities in the South have been static over that period. About 18,000 years ago, at the peak of the last major glacial period, the influence of Arctic air masses and boreal vegetation extended to about 33º N. latitude, the approximate latitude of Birmingham, AL, and Atlanta, GA (Delcourt and Delcourt 1993).

These forests were dominated by various spruce species (*Picea* spp.) and jack pine (*Pinus banksiana*); fir (*Abies* spp.) was abundant in some locations. The understories of these forests were generally typical of modern spruce-fir forests, with the exception of the absence of certain prairie elements (Wright 1981). Today, jack pine is essentially limited to boreal forest types and higher elevations in New England, Wisconsin, Minnesota, and northward. Modern boreal forests dominated by spruce and fir are similarly restricted to New England and Canada.

Temperate deciduous forests dominated the landscape south of 33º N. latitude, to about 30º N. latitude, including most of the then Gulf Coast from about 84º W. longitude. The climate of this region was similar to or slightly drier than modern conditions, based on the analysis of the species present in pollen profiles collected from lake sediments deposited during this time. Oak (*Quercus* spp.), hickory (*Carya* spp.), chestnut (*Castanea dentata*), and southern pine species were abundant. Walnuts (*Juglans* spp.), beech (*Fagus grandifolia*), sweetgum (*Liquidambar styraciflua*), alder (*Alnus* spp.), birch (*Betula* spp.), tulip tree (*Liriodendron tulipifera*), elms (*Ulmus* spp.), hornbeams (*Carpinus* spp. and *Ostrya* spp.), tilias (*Tilia* spp.), and others that are generally common in modern southern deciduous forests were also common then. Pollen of members of the grass, sedge, and sunflower plant families (Poaceae, Cyperaceae, and Asteraceae) were also common in samples from this time period (Delcourt and Delcourt 1993, Greller 1988, Watts 1980).

The vegetation south of 30º N. latitude, in peninsular Florida, was dominated by sand-scrub communities with xeric pine-oak forests in the uplands. Swamps and marshes occupied low-lying and coastal areas (Delcourt and Delcourt 1993, Greller 1988, Watts 1980). The areas that were occupied by coastal marshes at that time are now submerged because sea levels during the time of peak glacial extent were significantly lower than modern levels. The sand-scrub communities still occupy significant areas of upland central Florida (Ricketts and others 1999).

During glacial periods, extensive mesophytic forest communities, similar in character and overall composition to modern lowland and bottomland forests, occurred along major river drainages, especially the Mississippi embayment, the Alabama-Coosa-Tallapoosa Basin, the Apalachicola-Chattahoochee-Flint Basin, and the Savannah River Basin (Delcourt and Delcourt 1993, Greller 1988).

From approximately 15,000 years BP to approximately 10,000 years BP there was a gradual warming trend throughout the region, but the period of 14,000 years BP to about 12,000 years BP was marked by a high degree of climatic variability, including increased seasonality and other climatic extremes (Delcourt and Delcourt 1993). By approximately 10,000 years BP, deciduous forests had expanded northward throughout the region, with pockets of boreal elements remaining only at high elevations in the Appalachian Mountains and in a few other refuges. Broadleaf evergreen and pine forests occupied an area similar in extent to what they occupy today, primarily in the Coastal Plains. Mesophytic and bottomland forest communities continued to occupy the major river drainages of the region (Delcourt and Delcourt 1993).

Although the exact date is in question, this was also the period in which humans first colonized the Southeast. Archeologists date the earliest potential human habitation at approximately 12,500 years BP. Between 12,500 and 10,000 years BP, the human population of the region is thought to have been largely nomadic and very sparsely distributed. Human influence on the region's vegetation was almost certainly trivial and highly localized.

At about this time, many large herbivores that heretofore had been

common in the region went extinct (Martin and Klein 1984). Among these animals were the mastodon, ground sloth, and giant bison. In other parts of the World where large grazing animals still exist, they are known to exert a profound influence on the composition and condition of the native plant communities. Likewise, their extinction would lead to a variety of (largely unpredictable) changes. It is not clear why this guild of plant-eating animals disappeared from the region, but overexploitation by aboriginal Americans and an inability to adjust to climatic changes are most often posited. It is certain that their disappearance altered regional patterns of vegetation (Martin and Klein 1984).

At the beginning of the Holocene (10,000 years BP), the climatic conditions in the Southeast were comparable to conditions today (Delcourt and Delcourt 1993). However, the existence of modern climatic conditions does not necessarily imply the existence of modern native plant communities. Although the major modern community types were flourishing in the Southeast by 10,000 years BP, the understory flora had not yet come to resemble modern herbaceous floras. Mixed hardwood forests dominated the majority of the upper Coastal Plains, Piedmont, and lower Mountain regions. Southern pine communities dominated the middle and lower Coastal Plains, whereas evergreens and some remnant boreal elements occupied higher elevation sites. Canopy openings in the mixed hardwood and high-elevation forest regions are thought to have been infrequent and due either to local edaphic conditions or natural disturbance (Delcourt and Delcourt 1993, Watts 1980).

Evidence of human habitation in the region becomes common at about 10,000 years BP (the Paleo-Indian period), but there is little evidence that these cultures had significant or large-scale impacts on the landscape (University of Illinois 1997).

Around 8,700 years BP to approximately 5,000 years BP, a period of significant warming and drying, often called the hypsithermal period, began impacting the vegetation of the Southeast. During the hypsithermal period, extensive expansions of prairies and savannas occurred throughout the region (Delcourt and Delcourt 1993), and xeric oak and oak-hickory forest types proliferated. Many species with more northerly affinities migrated northward and, to the extent possible, upward in elevation. Given the limited heights of the Appalachian Mountains, many of these boreal elements were extirpated during this period. Others were relegated to isolated refuges (Delcourt 1979, Delcourt and Delcourt 1998). Further retraction of boreal forest elements caused a proportional increase in pine-dominated forests in the Appalachians. The hypsithermal was also responsible for the expansion of sand and scrub habitats in central Florida (Delcourt and Delcourt 1993, Watts 1971). The grasslands and savannas of the time expanded and were also linked to the great interior plains grasslands to the west of the region. As a result, elements of the prairie flora became established throughout the region, first by simple migration, but then also by invading disjunct openings (including glades and barrens) that were forming in the canopy of more mesic forests (Delcourt and Delcourt 1993).

During most of the climatic shifts of the last 100,000 years, most plant migration in Eastern North America occurred along a more or less north-south axis. The hypsithermal was significant because it made conditions favorable for the invasion and establishment of species from the center of the continent.

With the warming and drying of the climate throughout the region, species with more mesic proclivities retreated to shrinking riparian and riverine areas.

During this period, the population density of aboriginal peoples increased substantially. The hypsithermal also saw the transition from Paleo-Indian to Archaic Indian cultures. During this period, the Archaic Indians' settlements and populations tended to increase in size. Archaic Indians remained; like their Paleo-Indian ancestors, they were largely nomadic but were able to remain in some areas for extended seasons by practicing more concentrated resource usage. Increased resource use was made possible by technological advances that improved the efficiency of the harvest, collection, and processing of, for example, native plant materials. More concentrated occupation had significant but still local impacts on the abundance and regeneration of tree species (University of Illinois 1997).

At the end of the hypsithermal interval, about 5,000 years BP, all of the components of the modern southern forests were in place. As the climate cooled and precipitation increased, species migrated so that communities were reassembled in new form. The boreal elements of the early Quaternary enjoyed a modest expansion. Riparian, bottomland, and wetland plant communities expanded. Grasslands and savannas contracted and retracted westward.

Within approximately 1,000 years of the end of the hypsithermal, the distribution of species within plant communities of the Southeast had more or less stabilized and would see only minor changes until the colonization by Europeans (Delcourt and Delcourt 1993).

At about 4,000 years BP, the Archaic Indian cultures began practicing agriculture throughout the region. Technology had advanced to the point that pottery was becoming common, and the small-scale felling of trees became feasible. Some of their crop plants, such as corn and squashes (*Zea mays* and *Cucurbita* spp.), were acquired through trading with cultures from the South that had a longer tradition of agriculture (Delcourt 1987). Other crop plants were selected from local natives on the basis of desirable cultivation and harvesting traits. This period also saw increasing emphasis on some forms of passive agriculture, in which existing perennial plants were cared for to increase or improve their output of desired products such as beechnuts or cranberries. Concurrently, the Archaic Indians began using fire in a widespread manner in large portions of the region. Intentional burning of vegetation was taken up to mimic the effects of natural fires that tended to clear forest understories, thereby making travel easier and facilitating the growth of herbs and berry-producing plants that were important for both food and medicines.

Approximately concurrent with the transition from the Archaic Indian culture to the Woodland Indian culture, around 2,800 to 2,500 years BP, aboriginal groups began to establish relatively large settlements. People from these settlements visited sites to exploit

specialized resources such as fish, medicinal plants, and cherts. There was a trend, however, toward more permanent occupations to maintain local agricultural plots (University of Illinois 1997). It was during this time that the Mound cultures began to develop and flourish. Woodland Indian Culture evolved into the Mississippian Indian Culture in large portions of the region approximately 1,000 years BP (University of Illinois 1997). Mississippian Culture agriculture became more highly developed, and villages, both large and small, were able to support a more specialized citizenry (Delcourt 1987). Mounds became larger and more numerous, and the amount of land needed to support these populations increased. The majority of Mississippian Culture sites are associated with wetland, riparian, or riverine habitats, and these people became quite expert at altering local hydrological patterns to keep their villages dry and their fields irrigated, and to supply community water needs. In some places, soil erosion became locally significant.

Indian use of fire in land management continued from approximately 4,000 years BP to approximately 500 or 600 years BP (Adams 1992, Cowell 1998, Delcourt and Delcourt 1997). This practice significantly affected the structure of forest stands and the relative abundance of species over large portions of the region. It is not clear to what extent fire influenced the composition or richness of regional floras.

For reasons that are unclear, approximately 500 years ago, aboriginal populations declined significantly throughout Eastern North America and more broadly throughout the Americas. Most anthropologists attribute this depopulation to the transmission and spread of pathogens brought to North America by Europeans. Some communities are known to have lost 98 percent of their population; in general it seems that approximately two-thirds of the Indian population of the Eastern United States was eliminated in a very short time. As a consequence, large areas that had been cleared, burned, and farmed by native peoples were left fallow. Thus, by the time the first European observers were reporting the nature of the vegetation of the region, it is likely to have changed significantly since the regional peak of Indian influence.

A myth has developed that prior to European culture the New World was a pristine wilderness. In fact, the vegetation conditions that the European settlers observed were changing rapidly because of aboriginal depopulation. As a result, canopy closure and forest tree density were increasing throughout the region.

When Europeans started making regular visits to the New World approximately 500 years BP, and during subsequent colonization (specifically in Florida, but also shortly afterwards northward along the Atlantic coast), they also began introducing Eurasian and nonnative tropical plant species. Exotic plants first became prevalent around permanent settlements, especially along the coasts, and then spread inland along travel routes to other suitable locations.

The earliest exotic plants to become established in the region came originally as packing material (often rough hay) in shipping crates or animal bedding material. Later, food, forage, and medicinal plants were introduced in support of the settlements (Carrier 1923). The introduction of exotic animals (especially hogs, cattle, and rats) also began at this time. These animals also have had a significant and permanent impact on the vegetation of the region.

In June of 1527, a group of Spaniards, including Cabeza de Vaca, began a 10-year expedition from Florida along the gulf coast into Texas and on into the American Southwest (Cabeza de Vaca 1542). In his account of the journey, Cabeza de Vaca reported that: (1) the natives of Florida cultivated large quantities of corn; (2) palmetto was abundant and was used commonly for food, fiber, and fuel; and (3) extensive areas of heavy timber (almost certainly longleaf pine) were present with a considerable amount of large woody debris on the ground. The chronicles of other early Spanish explorers, such as Hernando de Soto and Ponce de Leon, contain similarly superficial accounts of the existing native vegetation. The first really useful and widely available information on the natural vegetation of the Southeast was not published until more than 200 years after the Spanish exploration of the region.

Southern Native Plant Communities in Historical Times

Information about the historical native plant communities of the region can be difficult to interpret. Since the modern concept of a plant community did not evolve until the late 19th and early 20th centuries, earlier writers seldom included the kind of information we would like to have for this Assessment. Also, most common paleobotany methods have limited value in the study of historical vegetation, because they have poor resolving capabilities over the relatively short period of the last 500 years. These difficulties aside, there is currently a great deal of interest in the nature of native plant communities at the time of European settlement, largely motivated by the current trend toward restoring such plant communities in the South.

Although Europeans began to explore and settle the Southeast by the mid- and late 16th century, their impact on the native plant communities of the region was limited largely to Coastal Plain, savanna, and bottomland forests. For the most part, the earliest settlements were established in coastal areas and on broad river terraces accessible by boat and barge. Even the rare interior settlements, such as the Arkansas Post established in 1686, were built along major rivers to avail themselves of local patterns of commerce. These areas were often cleared to make way for agriculture. Some of the clearings were made for subsistence farming, but the largest were made for commercial farming and livestock production. The quantity of timber taken during this time was limited both by technology and local demand. Consequently, large areas of upland forest in the South went essentially untouched until the 19th century.

The exploitation of natural resources, such as timber and forage, increased as population increased and as an industrial base was built in North America. Improved agricultural efficiency, a growing population, and better access to European markets by the end of the 18th century provided both the motivation and the capital necessary to expand the conversion of native vegetation to agriculture (Carrier 1923). People began to move westward

into the interior of the region and began to clear increasingly large tracts of land. In this era of increased trade, additional exotic species were introduced to the South, and exotic plants that had become well established moved with the expanding population.

Although the Native American population had declined significantly, these people were sufficiently common in the early 18th century to exert a continued impact on wide areas of the southern landscape through their agriculture and, more importantly, their use of fire as a means of manipulating vegetation. The aboriginal practice of burning the forests was adopted by European settlers soon after permanent settlements were established.

Like the Indians, the European settlers of the interior South tended to choose specific areas in which to build homes and farms. Relatively flat topography, access to water and timber, and proximity to trade routes via waterways or overland were important criteria for settlement sites. Such places are most typically found either along the terraces of large river systems or on the Coastal Plain. Consequently, riverine forest communities and longleaf pine communities were the first natural vegetation types in the interior South to be impacted by the expansion of European settlement. However, these native plant communities had long been inhabited by aboriginal people. In some cases, the Europeans removed the Indians by force so that they could occupy their land. Europeans selected and exploited other areas on the basis of their strategic value for military outposts or their proximity to mineral resources. These areas were less common but usually had equally significant impacts on the local vegetation.

Until the 20th century, the economy of the South was based largely on agriculture. Technology changed the kinds of crops grown, especially for the export market. From the late 18th century until the early 20th century, resin extraction from pines, especially longleaf pine, for use by American and European navies shaped the management of longleaf pine forests in the Coastal Plains. The naval stores industry, based on the processed and unprocessed resin, or tar, used to seal the hulls of ships and many other things, began to decline with the development of metal hull ships at the end of the 19th century. Large farms became common in the region by the early 19th century, due in great part to technological improvements like the invention of the cotton gin in 1793. Until the beginning of the 19th century, tobacco accounted for the majority of southern exports; thereafter and well into the 20th century, mechanized cotton production dominated the South. Large tracts of agricultural land were created out of the native plant communities of the Coastal Plain where cultivation was relatively easy. This form of land use also greatly affected longleaf pine communities, as well as a wide range of hardwood communities that existed on river terraces.

Increases in farm size had the effect of concentrating economic power in the hands of relatively few established families and companies. There was little incentive for these families to develop new centers of agriculture or diversify the crops being grown. The majority of new settlements in the interior South were based either on a subsistence economy or service to relatively small areas. Certain areas were completely converted to agriculture, with permanent and deleterious implications for the native plant communities. In areas dominated by subsistence farming, less obvious impacts to the native plant communities occurred, such as the disruption of population processes caused by fragmentation, the introduction of exotic species, impacts on rare communities such as mountain bogs and glades, and widespread alterations in forest community structure related to timber harvesting and fuel-wood gathering.

There was considerable curiosity in 17th and 18th century Europe about North American ornamental and medicinal plants. In fact, most of the "botanists" of this time were collectors for wealthy Europeans. These botanists, however, usually did not catalog the natural resources of the region. It was left to the early 18th century botanists from the Northeast to first explore and describe the vegetation of the Southeast. Most notable among these early explorers were John (1699-1777) and William Bartram (1739-1823).

The Bartrams made several journeys of botanical exploration and collection and published accounts of the natural history of the areas that they visited. William Bartram's "Travels through North and South Carolina, Georgia, East and West Florida . . ." became an international bestseller shortly after being published in 1791. This success was no doubt due in part to John Bartram's reputation and to his and William's extensive correspondence with European botanists. William Bartram states that the purpose of his trip through the South was the "discovery of rare and useful products of nature, chiefly in the vegetable kingdom," and to "obtain specimens and seeds of some curious trees and shrubs (which were the principal objects of this excursion)."

Although "Travels through North and South Carolina, Georgia, East and West Florida . . ." is full of details of soil conditions in various places, lists of species encountered, and in some cases detailed descriptions of particular species, Bartram did not generally offer useful accounts of the native plant communities. He did record the occurrence of many of the broad community types we are familiar with, including forests, savannas, glades, and swamps, described in such terms as ". . . expansive green meadows or savannas, in which are to be seen glittering ponds of water, surrounded at a great distance, by high open pine forests and hommocks, and islets of oaks and bays projecting into the savannas . . . ."

He also noted large areas of clearcut longleaf pine (Bartram 1791, p. 312) and "expansive ancient Indian fields" (Bartram 1791, p. 458). Bartram was particularly interested in the agricultural potential of the South, noting not only the areas used by the aboriginals for cropping (e.g., Bartram 1791, p. 511), but also areas that would be suitable for the cultivation of European crops as diverse as olives and oranges (Bartram 1791, p. 337). He also documents the early trade in useful native plants such as ginseng (Bartram 1791, p. 327) and rosinweed (*Silphium*) (Bartram 1791, p. 398). Bartram also offers accounts of introduced species such as barnyard grass (*Echinochloa*) (Bartram 1791, p. 430) as well as a description of Franklin tree (*Franklinia altamaha*) (Bartram 1791, p. 467), a species that is now extinct in the wild. Perhaps most remarkable about the landscapes described by Bartram is that many

of these places remained unchanged until the late 19th century.

Thomas Nuttall, traveling in the Arkansas Territory around 1819 (Nuttall 1821), also described what he saw in general terms: thickets of dwarf oaks, hills of pine and oak, and scattered areas of prairie. He too noted the effect of the human hand on the landscape, mentioning annual fires set by the white settlers and extensive areas of cutover pine. Nuttall cataloged many nonwoody plants as well. As was customary at the time, he did not elaborate about the specific conditions in which these plants were growing, but simply stated this or that species was growing under oaks, along streams, or high upon a hill.

Bartram and Nuttall are the most important of the early botanical explorers of the South, but their work is of limited value in determining the nature of native plant communities in existence at the time. Their approach reflected the contemporary philosophy of natural history and botany. At the beginning of the 19th century, ecology was not yet a word, much less a science. Linneaus had developed his natural classification system only a half century earlier; there was not yet a concept of natural selection or evolution, and it was a time of global exploration and discovery. All of the major seafaring European nations were establishing colonies around the World. The purpose of this exploration was the acquisition of power and wealth, and because many plants were the source of great wealth, botanists were needed to travel to "unexplored" parts of the World to catalog the plant life. At the time, this was called phytogeography, a term that describes the endeavor well enough. The primary concern of phytogeographers was to identify the location and distribution of plant species. While phytogeography was a necessary step in the development of plant ecology, at the beginning of the 19th century little effort was expended on describing the interrelations among the species that were being so faithfully cataloged.

After Bartram and Nuttall, a procession of botanists and naturalists, often physicians with an interest in botany, collected plants in the areas around their homes. For the most part, these collectors did not directly contribute to the understanding of the distribution of native plant communities. However, their work would become important later, in the late 19th and early 20th centuries, as regional floras for the South were developed.

In 1835, the first railroad system in the South began operating in North Carolina, in the heart of the longleaf pine forests of the Coastal Plain (Croker 1987). The industrial revolution had brought to the South the means by which its abundant forest resources could be transported great distances and still turn a tidy profit. The longleaf pine forests of the Coastal Plains were not only a source of high-quality timber for a growing population, but also the Nation's most important source of naval stores. The naval stores industry began in North Carolina and spread throughout the Coastal Plains with the railroad (Croker 1987). By 1854, the railways had reached the Mississippi River.

In the mid-19th century, clearcutting was the primary logging method employed. Modern forestry, as practiced in Europe at the time, would not become commonplace in North America until the early 20th century. In the first half of the 19th century, extensive areas of forest were leveled to create pastureland. In many places the native forest has never recovered. Forested areas surrounding major river ports were extensively cut to fuel steamboats. Vast acreages of wetlands and river terraces were drained or plowed by the mid-19th century, causing significant losses to local biodiversity in some areas. Strip mining, especially for coal to stoke hungry steamboats and railroad locomotives, became commonplace where deposits were sufficiently shallow to exploit, such as the Upper Cumberland Plateau. Strip mining eliminated forest cover and frequently altered or killed riparian and aquatic plant and animal communities downstream from the spoil piles. Although much of this activity in the region slowed during the 1860s, logging resurged quickly thereafter. By the 1880s, a broad sector of Americans, mostly in the Northeast and West, were becoming concerned about the unbridled exploitation of the Nation's forest and wetland resources.

The evolution of forest protection laws and the establishment of national forests in the South parallel the development of the modern conservation movement in the United States (Williams 2000). Issues such as farmland erosion, forest clearcutting, and the hyperexploitation of buffalo were on the national conscience. The first use of the word conservation in the context of the protection of natural resources was in 1875, by John Warder, president of the American Forestry Association. The leadership of America's conservation movement was borne by Gifford Pinchot, John Muir, Charles Sargent, and Theodore Roosevelt.

The Federal Government began setting aside tracts of land as forest reserves when Congress passed the Forest Reserve Act of 1891 (Williams 2000). This legislation allowed the President to "from time to time, set apart and reserve, in any state or territory having public land bearing forests, in any part of the public lands, wholly or in part covered with timber or undergrowth, whether commercially valuable or not, as public reservations . . . ." Federal forest administration was consolidated under the leadership of Gifford Pinchot in 1905 with the establishment of the U.S. Department of Agriculture's Forest Service (Williams 2000). The first national forest established in the South was the Arkansas National Forest (1907). Two national forests in Florida were added to the growing system in 1908 (Ocala and Choctawhatchee). Most of the national forests throughout the South are a result of the Weeks Act of 1911. This act broadened the mandate of the Forest Service and provided for the purchase of land, largely for watershed protection. From the time of their establishment until the beginning of the Second World War, the national forests of the South served primarily as conservation areas (Williams 2000). National forest lands have since been critical refuges of functional native plant communities in the South.

At the turn of the 20th century, the logging industry in the South was producing lumber at its historical peak. So much forest land had been logged out that timber companies were finding it difficult to access merchantable trees and were beginning to close mills and move to the newly opened virgin timberlands of the Northwest. Although the First World War caused a short-lived resurgence in the demand for

timber and naval stores, the conversion of the shipbuilding industry to steel by 1920 caused demand for southern timber and naval stores to fall drastically. By 1930 the majority of the Coastal Plains longleaf pine communities had been essentially cut over (Croker 1987), as had the interior shortleaf pines (*P. echinatus*). Upland hardwood forests fared somewhat better, at least in some places.

After 300 years of land conversion and alien plant introduction, it is no surprise that in the early part of the 20th century exotic plant species were common throughout the region. Some had been planted purposefully as ornamentals, as forage for livestock, or increasingly as erosion control agents by State and Federal agencies. Others were simply accidental tourists that made their way across the region without the direct assistance of people, in stocks of hay or the coats of domestic animals. Palmer (1926) notes an abundance of "introduced species [and] adventive woody species" in the vicinity of Hot Springs, AR. He specifically noted Japanese honeysuckle (*Lonicera japonica*), Princess tree (*Paulownia tomentosa*), and many other introduced species.

Vascular plants were not the only exotic species introduced to the United States during historical times. Among the most destructive exotics were fungal pathogens of trees. Chestnut blight (*Cryphonectria parasitica*) was introduced into this country in New York in 1904. It spread rapidly and was actively killing trees in the Southern Appalachians by the 1920s. By the early 1950s, American chestnut (*Castanea dentata*) was ecologically extinct throughout its range in Eastern America. This species once was a dominant tree of Appalachian forests. In some areas, one tree in four was a chestnut. Although loss of the chestnut was significant in terms of change in forest composition, there is some disagreement about the ecological impact of chestnut blight. Only one species extinction is suspected to have resulted from the blight (American chestnut moth, *Ectodemia castaneae*); and the greatest impacts to native plant communities seem to have been a change in tree density (a temporary result of canopy gaps created by the death of chestnuts) and a realignment of dominant overstory tree species resulting from competition (Stein and others 2000, Woods and Shanks 1959). Different trees have replaced the chestnut as the dominant canopy species in different portions of the chestnut's former range.

Dutch elm disease (*Ophiostoma ulmi* and *O. nova-ulmi*) entered the United States in 1930 in logs imported from Europe. There is differential susceptibility among *Ulmus* species, but the American elm, a common street and landscaping tree, has been the hardest hit. By the late 1970s Dutch elm disease was known to have impacted elm trees throughout the country (Schlarbaum 1997).

Butternut canker (*Sirococcus calvigigenti-juglanacearum*), which impacts *Juglans cineria*, was first observed in the United States in 1967, but it is believed to have been infecting trees for many years by that time. By 1995, the USDA Forest Service estimated that over three-quarters of all butternut trees had perished from the disease (Schlarbaum 1997).

There have been many other exotic disease-causing fungi and insects that have had significant impacts on the native plant communities of the South. Examples include white pine blister rust (*Cronartium ribicola*), the gypsy moth (*Lymantria dispar*), and the balsam wooly adelgid (*Adelges piceae*). Many introduced disease organisms are still impacting our native plant communities, and it is likely that new pests will be periodically introduced to our region. No one can tell what damage they might bring in the future. For a more thorough discussion of the impact of exotic diseases of forest trees, see chapter 17 of this report.

The study of the flora of the South was in some respects dependent on the publication of local and regional floras. Improvements in the knowledge of the botany of the region required these tools. Several local floras had been published for portions of the South, including Walter's Flora Caroliniana (1788), Mohr's Flora of Alabama (1901), and Gattinger's Flora of Tennessee (1901). The first comprehensive flora of the Southeast was published in 1860 by Chapman. It was an important though incomplete work. Unfortunately, it seemed to stifle further serious assessments of the local flora of the region until the early 20th century. It was not until 1903, with the publication of Small's Manual of the Southern Flora, that the region had a comprehensive, systematic flora. Revised in 1933, Small's Manual is a monumental work of 1,500 pages and was the standard of southern botany floras for over 50 years (Reveal and Pringle 1993). The last 20 years have seen the development of several important new floras [e.g., Smith (1994) and Wunderlin and Hansen (2000)].

The lack of specific information about native plant communities in the South from settlement times to the end of the 19th century is the product of two conspiring circumstances. First and foremost, the Southeast has been continuously occupied for longer than any other region of the United States: by the early 19th century, when the Nation became interested in its natural resources, the focus was on the wild and unknown West rather than the familiar South.

Secondly, the development of plant ecology as a modern science took place largely in Europe beginning in the early and mid-19th century. There and then the concepts of succession and plant associations were first developed into forms recognizable today. However, at the time, the study of plant ecology was a subdiscipline of plant geography. Plant geography, the description of the distribution of plants, was the primary concern of European academics, capitalists, and naturalists. In the 19th century, naturalists from many nations were traveling around North America cataloging plants. The pinnacle of plant geography studies was reached in the early 20th century and coincided with the rise of the modern study of plant ecology. The earliest focus of the fledgling field of ecology was the study of plant community succession. That research was done in the midwestern plains and eastern forests.

Henry Cowles first described the dynamic (changing) nature of vegetation. Prior to Cowles, plant geographers were content to map the current condition and extent of vegetation. Many of Cowles' students went on to make important contributions to the study of succession throughout North America. E. Lucy Braun became renowned for her descriptions of virgin forests in the Eastern States, especially the

Appalachian Mountains. Her work is still read and used as a reference.

Fredrick Clements was arguably the first community ecologist in America. Working largely with prairie and old-field communities in the Midwest, Clements described much of the vegetation of North America, named many plant associations, and identified successional stages for his named communities. He described the plant community as a form of superorganism to indicate his perception of the interdependence of all of the parts of a community, and he described succession as the development or life cycle of the organism.

Clements notion of the superorganism was not universally accepted. In 1926, Henry Gleason, who conducted his research in forested communities similar to those common throughout the South, wrote an influential paper that criticized Clements views and posited that the nature of plant associations is determined by the individualistic behavior of plant species. Gleason's individualistic notion of plant communities eventually won out over Clements idea of the superorganism.

The complexity of southern forest plant communities hampered the development of a comprehensive and consistent community classification system, such as those developed early in the history of land management in the Midwest and West.

Beginning with the study of plant succession in the first quarter of the 20th century, a practical science of plant and community ecology evolved. From this point forward meaningful data became available about the nature of native plant communities. However, because the South had been settled for centuries, by the early 20th century, vast tracts of native plant communities had been converted, planted, logged over, infested with weeds, or otherwise impacted, so opportunities to study intact native communities were rare.

The Great Depression of the early 1930s was exceptionally difficult for the people of the South, but it did a lot for the native plant communities of the region. The Federal Government purchased land and established many national forests. The Civilian Conservation Corps (CCC), established in 1933 during the Franklin Roosevelt administration, did extensive reforestation in the South. The formal teaching of forest sciences in the United States had finally matured by the 1920s and 1930s, so that an abundance of well-trained foresters working for the USDA Forest Service, State forestry agencies, and the CCC itself were available to supervise and direct the work (Williams 2000). The fledgling USDA Forest Service was working to control unauthorized timber cutting on Federal land. Unfortunately, this was also the time in which widespread fire suppression activities began. Although this practice was well intentioned at the time, it eventually led to significant declines in native plant communities throughout most of the Southeast.

The timber industry in the South remained depressed until the outbreak of the Second World War. At about the same time, serious scientific research was started at government and university labs to increase the productivity of forest land. Much of this work focused on the development of "improved" tree selections and cultivation practices. One of the innovations that arose was the growing of pines in plantations.

Plantation cultivation of pines turned out to be exceptionally productive. Newly developed tree selections thrived in the prepared conditions of the plantation. Large tracts of cutover land, especially in the Coastal Plain and Piedmont, would eventually be converted to pine plantations. This method focused timber production on developed sites. Although those sites were forever altered, this intensive form of silviculture saved many acres of native forest from more traditional timber harvesting.

The next large threat to native plant communities in the South came from another, unlikely advancement in technology. From the time of settlement the South was largely rural, agrarian, and sparsely populated. The widespread availability of air conditioning in the 1950s and 1960s made living and conducting business much easier in the sweltering heat of southern summers. The South, therefore, began to see significant increases in immigration and urbanization. Land was developed, and large tracts were fragmented. These trends led to rapid increases in demand for building materials, electricity, and additional agricultural production.

Improvements in technology and mechanization (especially in agriculture) and decreasing Federal commodity price supports led to significant consolidations in the timber and farm industries. Former farmers migrated to cities in the North and South. In the 1940s, 42 percent of the population in the South lived on farms. By the 1950s, only 15 percent of southerners lived on farms. The majority of the population of the region became isolated from the landscape, forever changing the way southerners viewed their forests.

After the end of the Second World War, pine forests in the South, including those on State and Federal land, were predominantly managed for timber production. The birth of the modern conservation movement in the 1960s came, in part, as a reaction to concerns about public land management priorities and the lax enforcement of environmental laws.

The Current Condition of Native Plant Communities in the South

Ecosystems—In the Southeastern United States, interacting aggregations of plant and animal communities and the abiotic factors affecting them are as diverse as any in the World. No place in North America has more diverse forests in terms of plants or animals, or more different types of forests. One very important source of this diversity in plant communities in the Southeast is the exceptionally high degree of endemism (occurrence restricted to a particular region or area) in the regional flora, especially in Coastal Plain conifer forests and in Appalachian forests.

In contrast, the South has the greatest absolute number of introduced plant species in North America. Florida alone reports 800 introduced species existing outside of cultivation (FLEPPC 2001).

One of the most important tools in the study of any system, including plant communities, is a comprehensive means of classifying the observed diversity. Several large-scale vegetation classification methods are in current use; the most important are those described by Kuchler (1985), Bailey (1994, 1998), and The Nature Conservancy (TNC) (1999). Each of

these systems divides the region on the basis of either general physiography or potential natural vegetation. Although many other methods exist, these methods illustrate the basic philosophies of large-scale vegetation classification. Although most vegetation classification systems are in agreement on the general distribution of regional plant communities, there is still much discussion and continuing research concerning how to define the transitions between vegetative communities.

Small-scale community classification can be generally useful in understanding the dynamics of local vegetation. Hierarchical and geographically comprehensive systems such as TNC's National Vegetation Classification System (Anderson and others 1998, Grossman and others 1998) define literally thousands of plant associations based on the presence of dominant and associated species. The utility of this system (and similar systems) is its inherent flexibility.

One of the most useful qualities of TNC's National Vegetation Classification System is the assignment of rarity ranks to plant communities (Association for Biodiversity Information 2001). A comprehensive system of rarity ranks across the Nation allows for an assessment of the geography of community diversity.

According to TNC figures, the Southeastern United States has the highest number of endangered ecosystems of any region of the country. More than 30 percent of all natural plant communities throughout the Southeast are critically endangered, and the Southeast has the highest proportion of imperiled plant communities in the United States, exclusive of Hawaii (Stein and others 2000). A great number of the rare plant communities in the Southeast are inherently rare, and their rarity is a function of the great plant diversity in the region. However, the majority of rare communities in the Southeast are rare because of habitat alteration or degradation.

The majority of inherently rare plant communities are relatively small patches of plants in unique combinations, often due to the presence of equally rare edaphic conditions. These patch communities can be seen as occurring within a matrix of more common, widespread community types. Most habitat conservation activities tend to focus on the patch habitats.

Because there has not been a single consistent convention for the identification of plant communities during the majority of the history of the Southeast, it is essentially impossible to discuss the specific changes to those plant communities over time. However, this is not to say that we cannot assess the overall trends in conditions of plant communities. On the basis of conversion, alteration, and impedance of function, more than 99 percent of all plant communities in the South are not in the condition they were in prior to European settlement. Some of these changes have been subtle, but most are readily distinguishable. It is impossible from the perspective of current times to know precisely what has been lost, but we can estimate the general loss sustained by southern native plant communities.

Among the communities to have seen the greatest change in historical times are the region's forests. All of the forests of the South have been touched, directly or indirectly, at one time or another, by the hand of humanity. Sometimes that hand has been gentle, but in most cases it has not.

By some estimates, all of the upland hardwood forests of the Appalachians have been altered. The hardwood forests have suffered from chestnut blight, Dutch elm disease, and butternut canker. Even if the impact of disease is discounted, less than 10 percent of the original native forest area of the region has not been eliminated or altered. Most was cleared prior to the 1930s. Estimates vary from State to State, but, on average, approximately half of all presettlement hardwood forest has been eliminated (Walker and Oswald 1999), and the majority (essentially all) of what remains is compromised by fragmentation, exotic pest and disease organisms, and altered natural processes such as fire and livestock grazing (Mac and others 1998, Noss and others 1995).

Coastal Plains longleaf pine forests, renowned for their high levels of diversity, endemism, and species rarity, have been reduced by more than 98 percent, compared to presettlement conditions. Most have been converted to agriculture or pine plantations, two plant communities notable for their lack of diversity, endemism, and species rarity. Most of the longleaf pine forests were cut by the 1920s, but longleaf pine habitat was still being clearcut and converted into plantations in the 1980s (Noss and others 1995, Stein and others 2000). They were used as a source of timber since aboriginal times, but European settlers were clearcutting vast areas of longleaf pine by mid-18th century. Longleaf that was not cut for lumber was commonly used as a source of naval stores beginning in the 17th century, a practice that continued into the early 20th century (Croker 1987). The remaining large blocks of longleaf exist almost exclusively in public forests (notable privately owned large tracts of longleaf include the Moody tract in southern Georgia and Green Swamp in North Carolina). Many areas of longleaf forests are being managed for the endangered red-cockaded woodpecker. Remaining blocks are, in some places, threatened by exotic plant species, such as Cogon grass (*Imperata cylindrical*), fire suppression, and some forestry (site preparation) practices that disturb the forest understory plants, in lieu of burning, to facilitate the growth of the trees. There is also much concern, but little that can actually be done, about the fragmentation of the original longleaf community (Croker 1987). Only minor fragmentation agents, such as roads, can be managed to increase longleaf habitat continuity, whereas the major fragmentation factors—conversion to agricultural and urban land uses—are essentially intractable. Many public land management agencies are currently practicing longleaf forest restoration activities, and others are encouraging restoration on private land. These efforts, while very important, vary greatly in their success. While it is relatively simple to successfully grow longleaf pine, the reconstitution of the original plant community is very difficult.

Fewer than 50 percent of the presettlement spruce-fir forests still exist in the Appalachians (Noss and others 1995). Of that quantity, more than 98 percent either have been altered or are under attack by introduced pests. Over 90 percent of the red spruce forests in central Appalachian forests have been lost (Noss and others 1995).

Approximately 90 percent of the forested habitats in Florida have been altered or eliminated, including 60 to 75 percent of the forested uplands of Lake Wales Ridge, an area of exceptionally high species rarity and endemism. Only on the Atlantic and Gulf coastal barrier islands does a majority of the natural forest cover remain. It has survived due to its isolation and unsuitability for agriculture or development (Noss and others 1995, Stein and others 2000).

More than 98 percent of the presettlement old-growth forests in the South have been altered or lost (Stein and others 2000). The vast majority of the remaining old-growth forests in the South are on Federal land in national forests and national parks. Of the original 60 to 90 million acres of Coastal Plain pinelands, only 3 percent survive today as old growth (Croker 1987, Noss and others 1995, Walker and Oswald 1999). Less than 2 percent of the forests in Kentucky have old-growth characteristics (Noss and others 1995). In Tennessee, only about 5 percent of the presettlement old-growth forest on the Cumberland Plateau remains, and no more than 20 percent of the forest of Tennessee's Blue Ridge Province can be classified as old growth (Noss and others 1995). Those few tracts of old growth not on public land are mostly in fragments of 100 acres or less, which reduces their value (Stein and others 2000). Most of the forest types classified as old growth today are actually second- or third-growth forests that have or are developing the structural characteristics of old growth.

Open habitats in the South such as glades, barrens, and prairies were common at the time of European settlement, as noted by the earliest travelers to the region. There are, however, no good estimates of how much of the landscape was occupied by these open areas. The current best approximation suggests that as much as 10 percent of the plant communities of the South were historically open habitats (Mac and others 1998). Today, approximately 1 percent of the forested landscape of the South is occupied by openings such as barrens, prairies, and glades. In most cases these areas are very small, and they are not integrated across the landscape (Mac and others 1998, Stein and others 2000) as they once were.

Among open habitat types, prairies seem to have suffered the greatest losses. Settlers saw these relatively flat, treeless, and fertile areas as productive and easy to clear. In Kentucky, less than 200 acres of an original 3 million acres of native prairie remain (Noss and others 1995). In Texas, Louisiana, Florida, Mississippi, and Arkansas, nearly 99 percent of acres originally in prairie types have been lost (Noss and others 1995).

The majority of glades that survive today tend to occur in mountainous regions that were never converted to agriculture, and they typically have very stony soil. There is no information on the total area in glades throughout the region, but estimates are that less than half of the original glade habitat in the region survives intact, and the majority of that which remains is ecologically compromised due to either the presence of exotic species or the lack of fire. In Tennessee, approximately one-half of all the area in cedar glades has been converted (Noss and others 1995). Limestone glades throughout the region have been disturbed at higher rates (Noss and others 1995), probably because they are more commonly located at lower elevations and in areas of gentler topography.

High-elevation grassy balds are mountaintop treeless areas. Although the mountains on which these open areas occur are not high enough to have alpine plant communities, various edaphic and historical circumstances have conspired to keep these areas treeless. Grassy balds tend to support herb-rich communities that require frequent disturbance (Greller 1988). Their ecological origin is still a matter of debate. About 50 percent of the area that was occupied by grassy balds in 1900 remains today (Mac and others 1998).

Almost all of the wet hardwood forests, such as those that occur in bottomlands and hammocks on the tropical Coastal Plain, have declined to approximately 20 percent of their presettlement cover (Mac and others 1998, Noss and others 1995). A slightly larger percentage of the original floodplain forests has survived (Noss and others 1995), but most of it was cleared at some time in the past and has returned to forested cover in the last century. In the last 25 years, accelerated efforts have been made to restore floodplain forest, especially in the Mississippi Valley.

The Southeast comprises only 16 percent of the land area of the lower 48 United States, but it contains 36 percent of all wetlands and 65 percent of forested wetlands. About 78 percent of all wetlands in the Southeast has been altered to some degree (Noss and others 1995).

Unique or isolated wetlands have fared worst overall. Although the Southeastern United States has the highest diversity of carnivorous plants in the World, the habitat in which these plants occur has declined by approximately 97 percent. Reed wetlands, known as canebrakes, have been reduced by more than 98 percent (Mac and others 1998). Mountain bogs, especially those in the Southern Appalachians and Blue Ridge, are home to a great variety of unique native plant species. Although approximately 10 percent of these bogs remain, few are in fully functioning ecological condition (Mac and others 1998).

Pocosins, upland wetlands that occur on the Coastal Plain, have been reduced to about 20 percent of their original area (Mac and others 1998, Noss and others 1995). Similarly, only about 10 percent of the original Atlantic white-cedar forests, which require frequent, low-intensity fires and are typically only seasonally wet, are left (Noss and others 1995).

Table 2.1—Percentage of wetland acres lost in Southeast, 1780s through 1980s

State	Loss
	Percent
Alabama	50
Arkansas	72
Florida	46
Georgia	23
Kentucky	81
Louisiana	46
Mississippi	59
North Carolina	49
Oklahoma	67
South Carolina	27
Tennessee	59
Texas	52
Virginia	42

In the early 1600s, there were approximately 220 million acres of wetlands in the lower 48 States (Mitch and Gosselink 1993). Nationwide, over one-half of wetland acres have been converted to other uses. The degree of wetland loss has been less on the Coastal Plains, thanks in part to restoration and conservation activities that began in the 20th century. Today, only 28 percent of Coastal Plain wetlands have been permanently converted (Noss and others 1995), but a significantly higher proportion have been impacted by human management and exotic plant species.

The degree of loss of wetlands varies widely among States within the South (table 2.1) and is complicated by the large-scale alterations of wetlands and hydrology conducted by humans. Countless acres of wetland have been drained either for agriculture, pasture, or urbanization, and countless other acres were lost during stream channelization, diking, or deforestation (Mac and others 1998, Mitch and Gosselink 1993, Noss and others 1995). The rate of wetland conversion was greatest (Mitch and Gosselink 1993) from the 1950s through the mid-1970s. Since the 1970s the States with the greatest rate of wetland loss nationwide are all in the South: Arkansas, Florida, Mississippi, North Carolina, and South Carolina (Mitch and Gosselink 1993).

The condition of the native plant communities discussed in this chapter is reflective of the condition of the majority of native plant communities in the South. In fact, it is exceptionally rare to find pristine plant communities. Even the most remote places have been affected by invasive exotic plants, introduced disease organisms, changes in community structure and function stemming from altered fire and hydrological regimes, and even changes in the local seed- and pollen-dispersing animals.

Rare Plant Species in the Southern Region

Plant communities, whether rare or common, comprise species that share similar ecological needs and tolerances. The diversity of plant species in the South is rivaled in North America only by the California flora. This diversity is due in part to a broad array of species that are either highly localized in their distribution or are very sparsely distributed over large areas.

Two widely accepted classes/categories of plant species endangerment are protected under the Endangered Species Act of 1973 (ESA); and TNC has commonly used the category of "imperiled species" (Association for Biodiversity Information 2001).

Within the Assessment area, approximately 115 plant species are listed as either threatened or endangered under the ESA (U.S. Department of the Interior, Fish and Wildlife Service 2001). Of this number, 52 occur in Florida. Those species are clustered in the Appalachicola and Lake Wales Ridge areas. The Southern Appalachians contain the next greatest concentration of threatened and endangered plant species.

Figures 2.1 and 2.2 show the distribution of rare plant taxa in the South by equal-area hexagons and counties, respectively. These maps were derived from data held by State Heritage programs and represent the occurrences of vascular plant species with a TNC rarity rank of G1-G2. These are species considered to be critically imperiled or imperiled (Stein and others 2000) based on the number, size, and condition of populations known to exist. The distribution of rare taxa is used here as a proxy for the distribution of plant diversity. Low-diversity plant communities such as agricultural lands or beaches rarely contain uncommon taxa, whereas there is a Worldwide pattern of uncommon species being associated with highly diverse plant communities. The occurrence data represented in figures 2.1 and 2.2 should not be interpreted as the distribution of plant species on a trajectory toward extinction. Most of the rare plants in the South (or the World for that matter) are species that are naturally rare (Rabinowitz 1981). These data are, in all likelihood, incomplete in that private lands may be under-surveyed for rare plants, and some States have generally better surveys than others. However, figures 2.1 and 2.2 represent the best available data at this time and are more than adequate to elucidate the overall pattern of species diversity and rarity in the South.

These figures display three hotspots of plant diversity in the South: the Southern Appalachian Mountains, the Appalachicola lowlands of the Florida

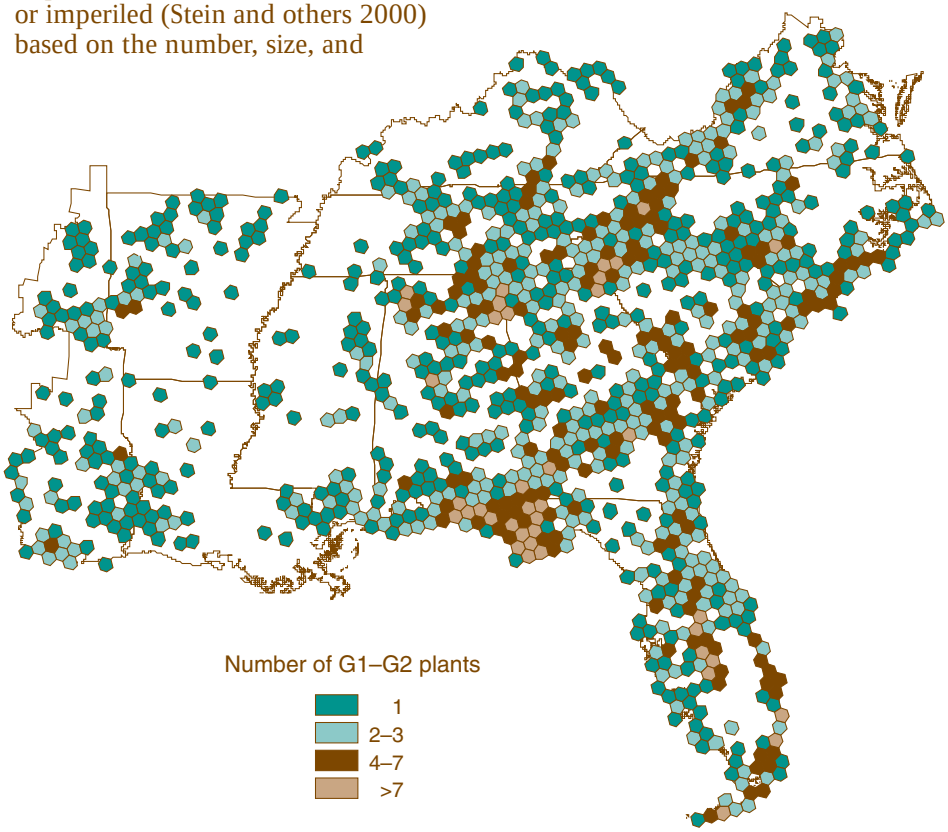

Figure 2.1—Distribution of imperiled vascular plant species in the South based on the number of occurrences in equal-area hexagons.

Panhandle, and the Lake Wales Ridge region of central Florida. The Southern Appalachians are a refuge for a wide range of species in genera with generally more northerly affinities. Many of the rare taxa in the Southern Appalachians are thought to be relicts from periods of glaciation in the distant past. The Lake Wales Ridge hotspot is a portion of Florida that was submerged during times of rising sea levels, such as during the hypsithermal period from 8,700 to 5,000 BP. Many of the rare plants on Lake Wales Ridge are thought to have been more widely distributed in the past. The Apalachicola lowlands plant diversity hotspot is more difficult to explain. Although the area has a striking diversity of habitats such as karst features, a variety of bogs, and wiregrass communities, these factors alone are unlikely to be the cause of the richest endemic flora in the South. Some scientists have suggested that some combination of habitat diversity, generally markedly low levels of soil nutrients, and a long history of frequent fires has made the area a challenge for most plant species and an opportunity for the evolution of specialized taxa.

Other areas with important levels of plant diversity in the South include the Coastal Plain, the Ozark-Ouachita Highlands, and the Cumberland Plateau.

Although most of the rare plant species in the South are species that are naturally rare, forest fragmentation and land conversion have significantly impacted the distribution and abundance of a large number of species. Other factors associated with human density, such as over-harvesting and hydrologic alterations, have diminished many species that were formerly common.

Many of the plant diversity hotspots represented in figures 2.1 and 2.2 occur primarily or largely on public land. This result highlights the importance of public land for the conservation of rare plants. Although not all public land management practices favor rare plants, in many places public land is the only place in which rare plant conservation is politically or economically possible.

Discussion and Conclusions

Plant communities of the South deserve many superlatives. They are exceptionally diverse, being rich in both the number of species and the number of endemic taxa. Forests of the South are also among the most heavily impacted in North America. They are severely fragmented, have experienced greater levels of human habitation for longer than any other forests in North America, and have the greatest number of exotic species. The native plant communities of the South have a history of increasingly intensive use, but recent changes in social attitudes are a source of great hope to those who appreciate the very special qualities of the native southern landscape. There is no chance that the South will ever see the communities that Cabeza de Vaca and De Soto saw, or even the relatively more modified landscapes first described by Bartram and Nuttall. In fact, continuing urbanization and population pressures will almost certainly conspire to keep the majority of the South's landscape working hard to support its people (table 2.2). However, the remaining public land in the region is increasingly being managed for uses other than commodity production, and native plant community restoration and species protection activities on both public and private land are at an all-time high. Changes will continue into the future, most of them detrimental to the overall health of native plant communities in the South. Increasing human populations and resource demands will further fragment the remaining forests and natural areas. Invasive species will occupy increasingly larger proportions of the southern landscape. Global climate change will also impact the composition and distribution of plant communities in the South. However, increasing awareness of the value of forests and natural areas has slowed the pace of land conversion in the South, and recent efforts by State and Federal Government landowners to improve forest conditions through restoration suggest that, at least in part, some of the inevitable changes coming to southern native plant communities will be improvements. The native plant communities of the South will never be what they were, but if the future brings increasing functionality to the remaining intact ecosystems of the

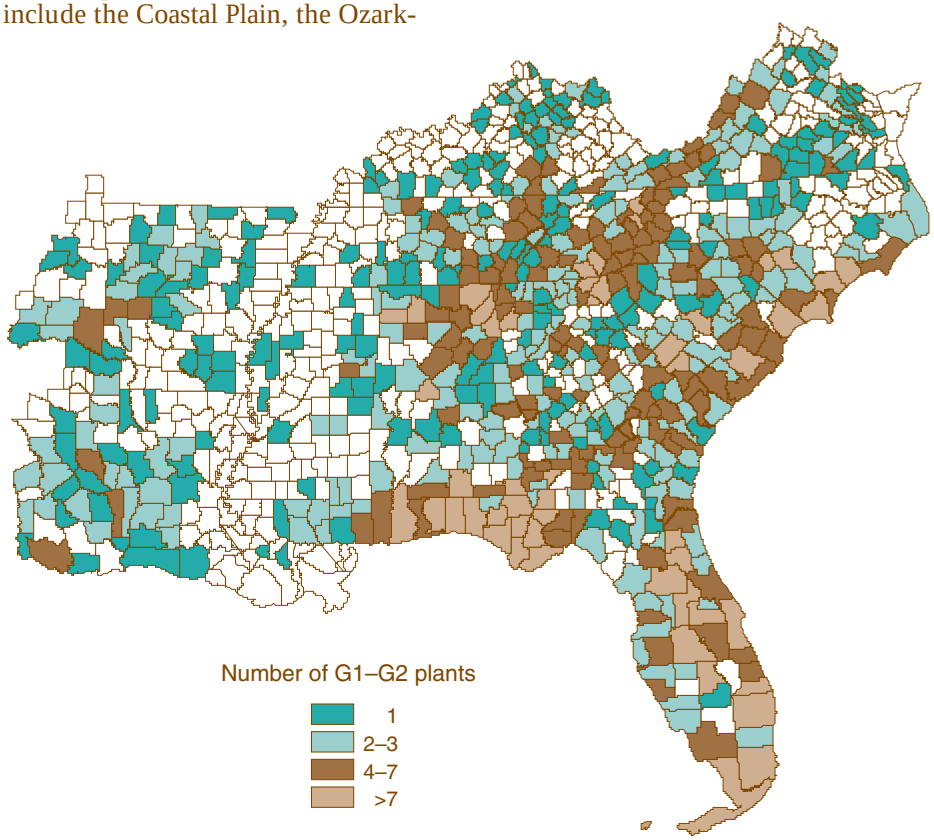

Figure 2.2—Distribution of imperiled vascular plant species in the South based on the number of occurrences in counties.

Table 2.2—Timberland in Southern States by ownership class

State	Hardwoods			Softwoods		
	All ownerships	National forests	Industrial forests	All ownerships	National forests	Industrial forests
	Acres (thousands)					
Alabama	21,931.9	605.4	5,499.4	7,447.1	237.2	2,789.9
Arkansas	18,392.1	2,371.8	4,514.6	5,077.0	831.8	2,450.3
Florida	14,650.7	1,029.5	4,601.5	7,437.8	725.5	2,921.9
Georgia	23,796.1	710.7	4,890.5	10,805.4	192.4	3,154.3
Kentucky	12,347.3	698.9	204.5	682.1	64.2	0
Louisiana	13,783.0	568.5	4,422.5	5,006.7	327.9	2,357.1
Mississippi	18,587.4	1,106.6	3,314.1	5,751.0	505.3	1,579.7
North Carolina	18,710.4	1,082.4	2,420.4	6,261.9	168.0	1,528.2
South Carolina	12,454.9	560.0	2,394.3	5,561.5	311.2	1,492.3
Tennessee	13,965.0	556.8	1,393.0	1,468.9	93.3	336.6
Virginia	12,094.9	1,360.9	714.5	3,352.8	137.2	840.3
Total	180,713.7	10,651.5	34,369.3	58,852.2	3,594.0	19,450.6

Source: Data from Southern Region Forest Inventory and Analysis, http://www.srsfia.usfs.msstate.edu/.

South, then the conservation and restoration efforts of today will have been successful.

Needs for Additional Research

TNC's National Vegetation Classification System is the most important development for the study of natural plant communities in the last decade. This uniform, standardized method for classifying plant communities will provide a reliable means for comparing where we are with where we have been. Alternatively, efforts to model the current and projected distributions of plant communities or forest trees can substantially aid our understanding of the distribution of plant diversity throughout the South. For example, Prasad and Iverson (1999) have developed multiple maps of the current and projected distributions of 80 eastern forest trees based on a variety of sets of projected conditions.

Even though trained botanists have been exploring the Southern United States for over 300 years, the mapping of native plant communities has just begun. A full accounting of the variation and geography of species and their communities is critical. This information is essential to make an accurate assessment of the conservation needs of the region.

The greatest challenges to natural plant communities throughout the nation, but particularly in the South, are conversion to agriculture, the creation of tree plantations, and urbanization. The fourth common source of degradation of natural plant communities is the incursion of exotic invasive plant species. There is a great need to investigate more effective methods of control, whether chemical, biological, or physical. There are many safety concerns associated with chemical and biological control methods, but physical methods usually prove slow and expensive. It is impossible to eliminate exotic species from our region, but we can still take steps to reduce their impact on native plant communities and learn to better manage the impacts.

There is currently a management emphasis on the retention and development of old-growth forests, or forest stands with old-growth characteristics, on public land. However, concerns over the habitat needs of wildlife, especially migratory birds, has recently highlighted the broader need for forests with a range of structural traits. Early successional forest stands in particular support a very different array of native plant communities than do mature forests. There is a significant opportunity for research to contribute to a better understanding of the historical abundance and distribution of open areas in the South.

Finally, a future research priority for native plant communities should be restoration ecology. In the past, restoration has meant the establishment of any kind of vegetative cover on denuded landscape such as eroded farmland or strip mines. In the last decade, there has been a significant trend toward restoration of native communities using native plant material. However, the availability of native material is limited, and there is

a growing concern about the source of the plant material used in restoration. We have much to learn about the distribution of genetic diversity in the native species commonly used for restoration, and even more to learn about the potential for use in restoration of the majority of plant species native to the South.

Acknowledgments

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The southern forest resource assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States. Twenty-three chapters address questions regarding social/economic systems, terrestrial ecosystems, water and aquatic ecosystems, forest health, and timber management; 2 additional chapters provide a background on history and fire. Each chapter surveys pertinent literature and data, assesses conditions, identifies research needs, and examines the implications for southern forests and the benefits that they provide.

Keywords: Conservation, forest sustainability, integrated assessment.