The Presettlement Piedmont Savanna

A Model For Landscape Design and Management

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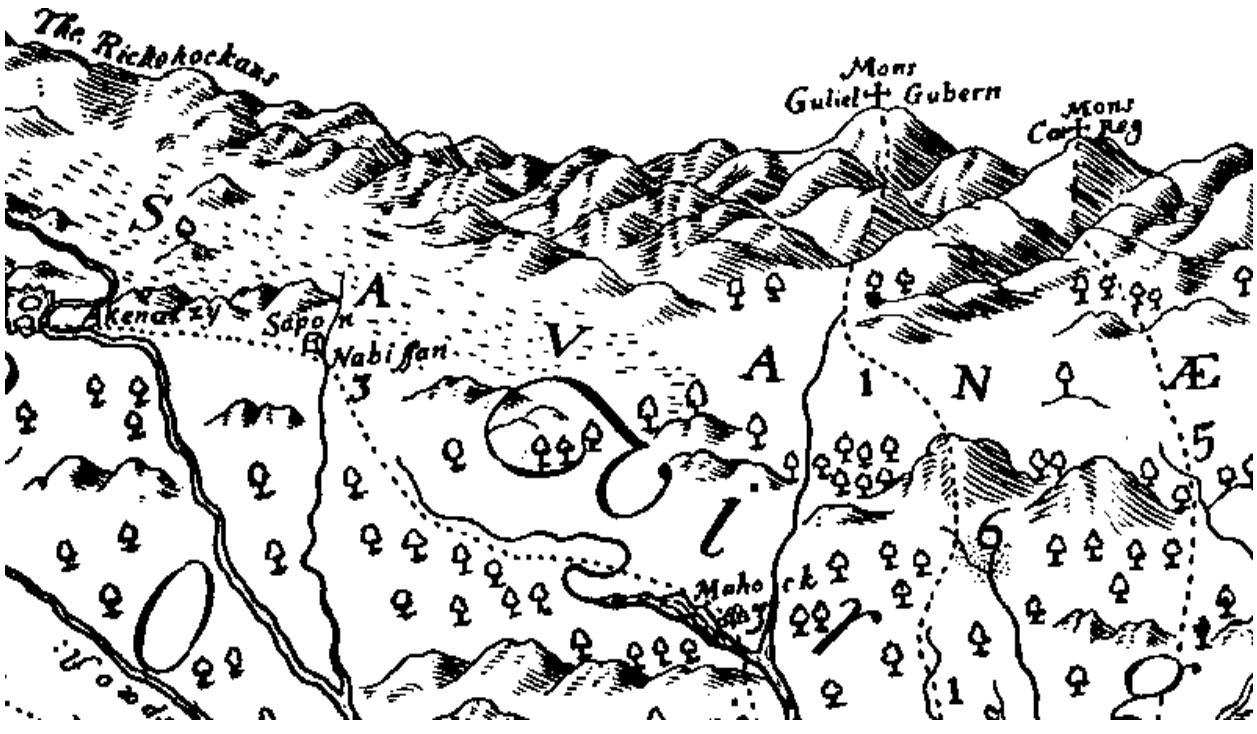

THE PRESETTLEMENT PIEDMONT SAVANNA: A MODEL FOR LANDSCAPE DESIGN AND MANAGMENT

by

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Introduction

Description of Topic

Savannas and savanna-like landscapes are of high aesthetic value to humans and, when in a "natural" condition, are often ecologically rich. Once covering a large percentage of the Piedmont, generally on the uplands, savannas or savanna-like landscapes gave much of the presettlement Piedmont woodland landscape an open appearance, with trees widely spaced amidst a ground cover of grasses and forbs. Whether resulting from conditions on the extreme ends of the moisture gradient, from the influences of human and/or naturally caused fires, or by grazing and browsing animals, this ecologically rich and culturally valuable landscape persisted to various degrees for hundreds and potentially thousands of years. Even though the post-settlement European methods of land use caused presettlement savanna landscapes to all but disappear from the Piedmont, these landscapes can still be of value as aesthetically preferred and ecologically sound models for landscape design and management.

Methods

In order to understand the history, composition, functions, and aesthetics of the Piedmont savanna, I will in this thesis examine descriptive historical information, especially that of early explorers; savanna remnants found in the region; the ecology of nearby tall grass prairies and savannas; general savanna properties; human landscape preference; and Piedmont ecological history.

Application

The application will consist of a restoration design and management program for a demonstration of a Piedmont savanna landscape located at the South Carolina Botanical Garden in Clemson, South Carolina. The program will consider restoration design goals, inventory of site features, restoration design issues, site preparation, site installation, management goals, management units, objectives, strategies, methods, and management implementation and monitoring. A site inventory/analysis, a mass/space plan, a planting design plan, a management zones plan, and lists of potential species will be included.

Need for Research

Different types of savannas are common in today's southern Piedmont. These savannas are manifest in the manicured lawns and specimen trees of suburbia; the perfect rows of pecan and peach orchards; the summer-mown sward and trimmed trees of road right-of-ways; and in the landscapes of private estates, corporate properties, and public parks designed in a manner reminiscent of the English pastoral landscapes of Capability Brown two centuries ago. Though they are widespread and seemingly aesthetically preferred, these landscapes are often expensive to maintain in terms of labor, fuel, fertilizer, etc.; they are usually ecologically impoverished; and they often fall short of their aesthetic potential. In the interest of making these landscapes viable over time by

reducing resource input and increasing ecological and aesthetic value, it is necessary to find a better model for their design and maintenance. The historic Piedmont savanna may serve as the best model. In the Piedmont of today, however, very little exists to give popularity to the concept that there is or was a native savanna or that it is an appropriate regional landscape. This is because the native savanna is neither a part of the present landscape, nor understood as having been part of it in the past. Historical misconceptions about the presettlement landscape result in poorly informed landscape decisions. In this thesis, I will attempt to expose these issues in addition to exploring the aesthetic and ecological properties of the Piedmont savanna in order to provide an informed model for landscape design and management. 41+0

Figure 1.1 Suburban pine savanna in Augusta, Georgia (photo by the author).

Chapter II
The Savanna

World Wide

The term savanna comes from an Amerindian word which was used in a 1535 publication by Oviedo y Valdes to describe "land which is without trees but with much grass either tall or short." In the late nineteenth century the definition was widened to include grassland with trees. Savanna as a descriptive term used by scientists refers to vegetation, climate, and land use. It describes vegetation as characterized by a continuous graminoid stratum, more or less interrupted by trees or shrubs. The grassy ground plane could be up to approximately 6 feet high forming a 25-100% cover while the interrupting trees and shrubs would be approximately 6-40 feet high forming a 10-25% cover. While this definition is applied to tropical savannas, definitions offered later in this thesis referring to the oak savannas of the Midwestern United States allow for a denser tree canopy. The tree spacing in a savanna should be at least greater than the diameter of the individual canopies (Cole 4-12).

The distribution and origins of savannas can be hard to define. Differing views can result from looking at influencing factors such as climate, soils, fires, animals, humans, and various combinations of these (Cole *v*,16). The worldwide distribution of the savanna originates in the tertiary period, tens of millions of years ago, when rising mountain ranges interrupted the worldwide precipitation patterns, causing the vast continental forests to recede, leaving in their wake the savannas, deserts and grasslands that persist today (Wagner 12). In various forms savannas cover 8,391,600 square miles and make up about half the grasslands of the world. Occurring on all continents but Antarctica, savannas tend to develop in subtropical regions, primarily in continental interiors, and/or on open plains. Soil water content and fluctuation, wind and evaporation, wide temperature fluctuation, and seasonality of precipitation all play a role in their formation (Risser et al. 3). Savanna landscapes can also be caused by human intervention rather than natural factors. For instance, landscapes classified as savannas in Asia are thought to be derived from centuries of cutting, burning, grazing, and cultivating the former deciduous forest (Cole 6). If that is the case it may perhaps be appropriate to classify much of the modern cultural landscape as savanna.

Cole describes the plant species of savannas as having morphological features and physiological responses that are mainly influenced by drought and, to a lesser extent, fires. While these conditions are discussed in relation to tropical savannas, it may be reasonable to relate them to temperate savanna species as well. For instance, in some tropical savanna trees, contorted trunk and stem growth, caused by the death of apical meristems and the thick corky bark, are a response to seasonal drought and, to a lesser extent, fire. Such growth patterns can be seen in the contorted limbs of blackjack oaks and post oaks, both members of the former southeastern North American savannas. Other characteristics such as the ability to resprout from rootstocks can be seen in both African and North American species. The majority of native warm season grasses, which are the most abundant species of any savanna, generally grow in a tussock form and usually have

seasonal aerial shoots and protected apical buds (Cole 6-9). They can be highly fire adapted as in the genera of the *Andropogonea* family of grasses, particularly *Andropogon* (Komarek, *Fire Ecology* 212).

Many people can identify the visual aspects of the tropical savanna due to the imagery of popular sources such as the 1970s television show "Wild Kingdom," or any book about African animals. The strongest visual characteristics that emerge from such imagery might be the expansive horizons, the grass covered plains, and the widely spaced trees, sometimes with a very distinct and high browse line.

The Eastern North American Savanna

The popular imagery of African savannas is not, however, entirely transferable to eastern North America. In some geography texts, the savanna is not even included as a biome type in North America. For instance, Muller's *Biogeography* mentions only steppe and forest as North American biomes (214). However "savanna" is used by others to describe vegetation community types where prairie or steppe grades into forest. Because there is no clear definition within this transitional zone, many variations in definition can occur. The range in percentage of canopy cover in the Midwest oak savanna is viewed differently by different observers. While John T. Curtis defines canopy cover as at least one tree per acre but less than 50% canopy cover (330), some observers include stands with up to 80% cover (Nuzzo 9). Generally these savanna canopies are oak dominated, with or without a shrub layer; with an herbaceous, predominantly grassy ground layer of both prairie and forest species; and having the appearance of an open or scrub savanna. It is also considered a fire dependent community, or in the absence of fire, drought dependent (Nuzzo 9-10).

Within North America there are many savanna or savanna-like grassland landscapes. It may be appropriate here to refer to savannas not only as woodland but also as grassland, since grasslands can be defined as biological communities with few trees or shrubs, dominated by grasses with mixed herbaceous vegetation (Risser et al. 2). The term prairie is reserved for grasslands which are maintained by "natural" forces (Joern and Keeler 15). It is used not only to describe grasslands of the central United States, but also their counterparts of similar physiognomic and floristic composition in the East. It is sometimes replaced by the term barren, especially in Tennessee and Kentucky (Deselm and Murdock 89).

Savannas or savanna-like landscapes can be found across the United States, usually as ecotones or edge environments between grassland and forest. Some of these are the oak savannas of the Midwest, the chaparrals of California, and the park lands of the Rocky Mountains. Southeastern grassland communities, shown in Figure 2.1, which should be recognized in a discussion of the modern Piedmont savanna include the Black Belt and Jackson prairies of Alabama and Mississippi; the various savannas and flatwoods of the Atlantic Coastal Plain; the coastal prairies of the Gulf Coastal Plain; the various glades and barrens occurring in most southeastern states associated with limestones, hardpans, shales, and other non-Coastal Plain soil conditions; and the balds found scattered up and down the eastern uplands (90-92). If not cultivated, planted for timber, or developed, some remnants of these grassland communities have persisted where adequate precipitation normally causes forest succession.

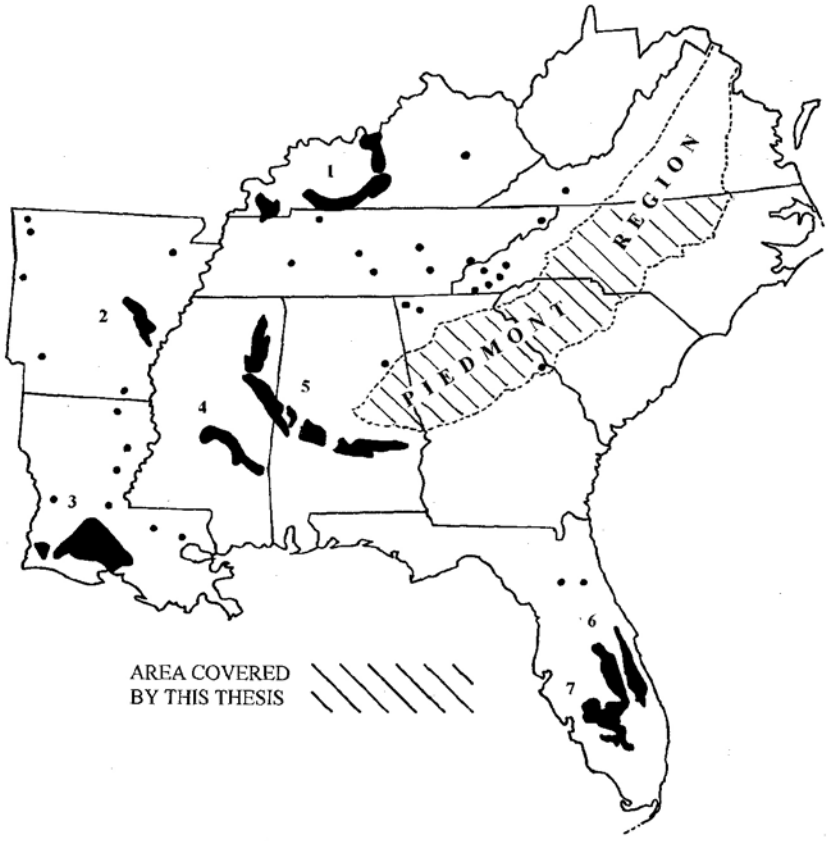


Figure 2.1 Map of southeastern grasslands also showing Piedmont physiographic region. Dots represent small grassland areas; 1, Kentucky Barrens; 2, Grand Prairie; 3, Coastal Prairie; 4, Jackson Prairie; 5, Black Belt Prairie; 6, St. John's and Kissimmee River Prairies; 7, Dry Prairies west of Lake Okeechobee (Deselm and Murdock 88).

It should be mentioned that Radford includes the tall grass prairie among the categories of flora provinces within the Piedmont. It is included in reference to granite outcrops, gabbro depressions, secondary fields, and serpentine barrens (13, 28). Remnant evidence and historical description of the "Piedmont Prairie" of North Carolina and South Carolina and other presettlement Piedmont landscapes suggest that these landscapes would also have related to the prairie floral province.

The distribution of the more eastern and central United States savanna and prairie landscapes can be traced to the climatic changes of the last ice age. Around 6000 years ago the climate was more arid with more frequent fire and drought, allowing more western prairie landscapes to invade further east. This was followed up to now by a wetter period that allowed only patchy remnants of tallgrass prairie, some mentioned earlier, to persist among the eastern forests (Horan 18). Even in New England, savanna landscapes persisted into the era of European exploration. In 1542, Verrazano visited Narragansett Bay (in what is now Rhode Island) and found extensive open areas and forests that could be traversed easily "even by a large army"(Cronon 25).

Though it has not been studied, the extent of the range of the post oak and blackjack oak in the eastern deciduous forest, might reflect the former range of savanna landscapes in the eastern deciduous forest, because of their fire tolerance, shade intolerance, and slow growth. Both have a similar range from in or near southern New England, across the South to the prairie border (Duncan and Duncan 277, 282; Little 397,409; Miller 100-102,164).

Mechanisms that kept the presettlement tall grass prairie and savannas of the Midwest and East from becoming dense forests included factors mentioned earlier in this chapter such as seasonal drought, frequent fires, grazing, and occasionally special soil conditions. Across the climatic moisture gradient from east to west, depending on local conditions, vegetation structure would vary from low, stunted and dispersed to taller and more evenly distributed. These and other ecological characteristics will be explored more thoroughly in Chapter *V*.

Perhaps the aesthetic qualities of the vanished eastern North America savanna landscapes is best understood through the eyes of those who saw it as an intact landscape. The aesthetic qualities of a Wisconsin savanna were described by J. W. Hoyt in 1860.

> Grouped here and there, like so many old orchards, on the summit of a gentle swell of land or on the border of marsh, prairie, or lake, there is nothing in the whole catalogue of American sylva that equals these Burr Oaks for their charming, homestead-like expressions they give to the landscape (Gobster 65).

William Bartram in the late 1700s was always eloquent in his descriptions of the presettlement southeastern landscape. Here he describes an area west of the Oconee river in the Georgia Piedmont and an area west of the Chattahoochee river in the Alabama Piedmont.

> …a pleasant territory, presenting varying scenes of gentle swelling hills and levels, affording sublime forests, contrasted by expansive illumined green fields, native meadows and Cane breaks…(307)
> …the ascents produce grand high forests, and the plains present to view a delightful varied landscape, consisting of extensive grassy fields, detached groves of high forest trees, and clumps of lower trees, evergreen shrubs and herbage; green knolls with serpentine, wavy glittering brooks coursing through green plains; and dark promontories, or obtuse projections of the side long acclivities, alternately advancing or receding on the verge of the illumined native fields, to the utmost extent of sight. (316)

Perhaps the most compelling description of a savanna landscape was written in the 1840s by James Fenimore Cooper, describing the setting for the opening of the novel *Oak Openings*, in the then "unpeopled forests of Michigan" in 1812:

> The region was, in one sense, wild, though it offered a picture that was not without some of the strongest and most pleasing features of

> civilization. The country was what is termed “rolling”, from some fancied resemblance to the surface of the ocean, when it is just undulating with a long “ground swell.” Although wooded, it was not as the American forest is wont to grow, with tall straight trees towering towards the light, but with intervals between the low oaks that were scattered profusely over the view, and with much of that air of negligence that one is apt to see in grounds, where art is made to assume the character of nature. The trees, with very few exceptions, were what is called the “burr oak,” a small variety of a very extensive genus; and the spaces between them, always irregular, and often of singular beauty, have obtained the name of “openings;” the two terms combined giving their appellation to this particular species of native forest, under the name of “Oak Openings.”
>
> These woods, so peculiar to certain districts of the country, are not altogether without some variety, though possessing a general character of sameness. The trees were of very uniform size, being little taller than pear trees, which they resemble a good deal in form; and having trunks that rarely attain two feet in diameter. the variety is produced by their distribution. In places they stand with a regularity resembling that of an orchard; then, again, they are more scattered and less formal, while wide breadths of the land are occasionally seen in which they stand in copses, with vacant spaces, that bear no small affinity to artificial lawns, being covered with verdure. The grasses are supposed to be owing to the fires lighted periodically by the Indians in order to clear their hunting-grounds.
>
> Toward one of these grassy glades, which was spread on an almost imperceptible acclivity, and which might have contained some fifty or sixty acres of land, the reader is now requested to turn his eyes. (10-11)

The general disappearance of the eastern North American savannas is a result of human activity. For eons they were maintained by meteorological and geological conditions, and more recently by human influence. When human influence changed from the use of burning to the practice of fire suppression, open landscapes quickly reverted to thickets, then forests. For instance on Cape Cod, Massachusetts in the early 1600s William Wood described a place the pilgrims had arrived to find as grassland, which was now covered with “much underwood” since the Indians (and their burning) had vanished due to the plague 14 years earlier. Because it had not been burned, parts of Cape Cod had become “unuseful and troublesome to travel through, insomuch that it is called ragged plain because it tears and rents the clothes of them that pass”(Cronon 90). Much later, as European settlers reached the Midwest, oak savannas disappeared within 20 to 40 years of settlement as a result of fire cessation (Nuzzo 11). Nuzzo points out that the extensive fire breaks caused by plowing and grazing of grasslands and construction of roads and rails ended widespread burning, causing the demise of fire dependent communities in the Midwest. Some savanna remnants, however, have persisted where special conditions prevail. For example, of the approximately .02 percent of the original Midwest oak savannas remaining, the vast majority have very droughty conditions. Grazing has also helped preserve some savannas, along with some controlled burning and accidental fires

caused by coal powered trains (Nuzzo 11). Some southeastern remnants, surviving due to such conditions, will be presented later in studying the ecological and aesthetic makeup of the Piedmont savanna.

Chapter III
Savanna Landscape Preference

The preponderance of savanna-like landscapes in the human environment suggests that we as a species prefer such landscapes. This section examines potential reasons for and current perspectives of this preference.

Bioevolutionary Preference

Once dwelling in the relatively pleasant, colorful, elevated environment of the tree-tops, human ancestors developed enhanced abilities such as excellent color bifocal vision, dexterity of digits for grasping, sense of balance as well as a particular body size and shape. Later on in evolution pre-humans developed another set of abilities that reflected their fall from this forest Eden into the dog-eat-dog world of the open ground. As a result humans have a mixture of the flight responses of the timid forest dweller and the fight responses of the aggressive ground dweller (Kaplan and Kaplan, *Humanscape* 10-13). The transition of these human ancestors from tree dwelling to ground dwelling would have occurred near water in a zone between forest and grassland. Such areas could be described as a savanna or park, glade, or forest edge, and they would have been rich in variety and numbers of species. These savanna landscapes would have varied in size from expansive areas to narrow zones between grassland and tropical forest (Komarek, *Fire Ecology* 201). Early humans in this savanna environment would have to have ranged over very large areas of grassland to collect food, facing great danger from predators in doing so. Thus it was that humans developed the abilities to know a great deal about the terrain, their predators, and how to react quickly (Kaplan and Kaplan, *Humanscape* 5). The biological needs of survival and the ability to be immediately aware of their environment caused humans to prefer environments that could meet these needs.

Prospect Refuge Theory

As stated by Jay Appleton in *Experience of Landscape*, "Habitat Theory postulates that aesthetic pleasure in landscape derives from the observer experiencing an environment favorable to the satisfaction of his biological needs." More specifically, "prospect refuge theory postulates that, because the ability to see without being seen is an intermediate step in the satisfaction of these needs, the capacity of an environment to ensure the achievement of this becomes a more immediate source of aesthetic satisfaction" (73). If such is the case, early humans, and thus their modern day descendants, would prefer the spatial arrangements and visible attributes of the savanna where the open grassland offers unimpeded prospect and forest edge or groups of trees offer the opportunity to take refuge.

The uncertainties of modern life may not be all that different from those that greeted our ancestors when they came down from the trees to live on the danger-filled grounds of the open savanna. People generally prefer what they are familiar with and tend to react cautiously to the unknown (Kaplan and Kaplan, *Cognition* 77). The role of the unknown or the predator is played now by strangers, fast cars, biting insects, bad weather,

and crime, and thus the preference for landscapes affording prospect and refuge is expressed by the landscapes in which we live. This can be seen in the light density of trees and shrubs in arrested succession and the abundance of open space found in both consciously designed landscapes and those that developed without a plan. Institutional settings, suburban landscapes and public parks, often of a picturesque nature, exemplify this, as do many managed forests, orchards and farmyards.

Environmental Preference from Kaplan and Kaplan

Another approach to understanding landscape preference that goes beyond the physical need oriented prospect-refuge theory is explained by Stephen and Rachel Kaplan in *Cognition and Environment*. Investigating human psychology in more depth, they describe preference as "the expression of the evaluation of one's possibilities,." of which the two most important components are making sense and involvement. Essential elements to an individual's well being, making sense and involvement have both a more immediate and a longer range aspect (80). Similarly, Aldo Leopold saw knowledge and experience as key components to the aesthetic appreciation of natural ecosystems (Gobster 68). The Kaplans consider space as having a central role in how an individual perceives a landscape, and that a space can be viewed both in an immediate, two- dimensional way and experienced in a longer term, three-dimensional way (*Cognition* 82). The framework shown below combines the two basic information needs of making sense and involvement with the dimensional aspects of the immediate and the future. This yields four distinct combinations which can be defined as coherence, complexity, mystery,

Preference Framework

	MAKING SENSE	INVOLVEMENT
PRESENT OR IMMEDIATE	Coherence	Complexity
FUTURE OR PROMISED	Legibility	Mystery

Figure 3.1 Preference Framework (Kaplan and Kaplan, *Cognition* 81).

and legibility. Specifically comparing the elements of the preference framework (as described in *Cognition and Environment* [82-87]) to the savanna helps explain the human preference for savanna-like environments.

Coherence (Figure 3.2) is interpreted as the ease of organizing and structuring parts, units, chunks, blocks or scene elements. Patterns that result from many similar and repeating parts allow for easier human comprehension. Therefore a savanna-like landscape could be said to rank relatively high in coherence because of its few and repetitious types of elements which create easily recognizable patterns. For instance, the ground plain is essentially grassy throughout, and the trees repeat the same general appearance. A landscape low in coherence, such as a forest, might have many forms, sizes, colors, densities, and distributions resulting in less coherent complicated patterns. The prairie or ocean, on the other hand, can be very coherent due to their singularity.

Complexity (Figure 3.3) is a reflection of whether there is enough present in the scene to keep one mentally occupied. It should merit one's making a mental map of it. Too little is boring while too much is overwhelming. Therefore a savanna-like landscape could be said to be within the desired range of complexity. The ground plain and canopy

are relatively uncomplicated elements on the whole, but the various patterns of ground layer species, the irregular spacing of trees, the indiscernible gradation into adjacent vegetation types, and the openness to the changing atmosphere creates an appropriate and desirable amount of complexity even at an initial glance.

Mystery (Figure 3.4) occurs when a scene provides partial information about what lies ahead, inviting exploration. Things are obscured in such a way as to reveal their presence but not their full identity. Therefore a savanna-like landscape could be said to be high in mystery. Because of its open aspect, views into the distance would be available, but the obstruction of the unevenly spaced trees, the rolling topography, and the atmospheric effects of aerial perspective enhanced by climatic conditions would prevent full disclosure and invite exploration. Some savanna arrangements might have more mystery than others. Mystery might be greatest in the area where the savanna grades into forest on uneven terrain and lowest where it grades into flat prairie.

Legibility (Figure 3.5) is found in an environment that looks as if one could explore extensively without getting lost. Undifferentiated sameness causes low legibility. Thus a savanna-like landscape could be said to rank very high in legibility. There is enough openness to see where one is going as well as distinct tree formations to provide landmarks. By contrast the open prairie has few landmarks and the forest too many.

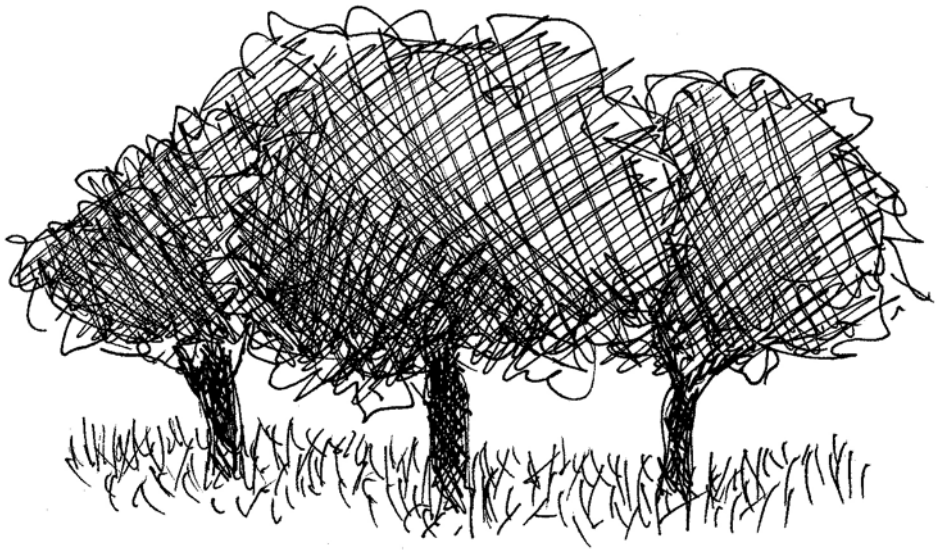


Figure 3.2 Savanna Landscape Illustrating Coherence.

Figure 3.3 Savanna Landscape Illustrating Complexity.

Figure 3.4 Savanna Landscape Illustrating Mystery.

Figure 3.5 Savanna Landscape Illustrating Legibility.

Other Preference Studies

In Paul Gobster's article "The Urban Savanna: Reuniting Ecological Preference and Function" in *Restoration & Management Notes* (pages 64-69), many studies are cited that discuss savannas and savanna elements as they relate to landscape preference. Following is a summary of the conclusions of these studies.

As a landscape, whether in a more natural or cultural configuration, a savanna-like setting is aesthetically preferred. Savanna scenes rated highest compared to coniferous forest, deciduous forest, tropical forest, and deserts. In his own study Gobster found inner city children preferred savanna settings over forests, wetlands, or prairies.

Elements found in savanna landscapes, such as tree form and distribution, are also aesthetically preferred. For instance, studies show mature trees are preferred in park and forest environments, and even-aged stands, without the multiple layering of various aged trees, are also preferred. Stand visual quality is dependent on "visual penetration," seen as a high overstory without any significant understory. The park-like appearance of the savanna is often mentioned as ideal. People prefer between 40 and 65 mature trees per acre in passive use areas, which would be the upper end of savanna density on a forest - prairie gradient. In urban parks people prefer even distribution of trees over tight clumps. Thinning and selective harvests in rural and wild land settings can increase preferences by opening forest canopies.

Savanna landscapes have a broad aesthetic appeal, but ecological integrity can negatively impact aesthetic preference. A survey of inner-city children showed greatest preference for a more formal savanna landscape with elms and lawn, and a lower level of preference for native savanna. Some visitors to the NC Botanical Garden, without special

interest in or knowledge of native plants or ecology, viewed the ecological community displays as unkempt and overgrown. In a wild land setting, however, people prefer savannas with high ecological integrity. These preference findings point out the relationship of savanna landscape ecological integrity to site context and ecological awareness of the viewer. Where an ecological aesthetic is developed, people have a higher tolerance and greater appreciation for the more intricate, subtle and complex aspects of ecological integrity.

Chapter IV
Piedmont Savanna History

Historical notions, whether accurate or not, often inform current perceptions and decisions. Understanding perceptions of ecological history helps explain why savannas are not generally thought of as a part of the historical Piedmont landscape. Laypersons' and professionals' views of Piedmont ecological history could be said to be a synthesis of their perception of the landscape which surrounds them and their academic knowledge of its history.

The Unbroken Forest Myth

Perhaps the most influential factor in forming the modern perception of the presettlement landscape is the widespread secondary forests that cover most of the modern Piedmont. These forests pose as a model for what "nature" would have done when left alone, by returning to the seemingly undisturbed state of a climax forest. This view of the landscape is incomplete, however, in not recognizing, or perhaps not being concerned, that modern human involvement, such as agricultural abandonment and fire suppression, have perpetuated a forest landscape different from that of 300 years ago. Much of forest study has neglected this history by focusing on vegetation dating from only 50 years ago. Such studies would necessarily reflect the post-Depression cycle of land abandonment and fire suppression, and the resulting old field successional forest composition (Skeen, Doerr and VanLear 27).

Another approach to understanding views of ecological history, especially those of the layperson, is to take a brief look at several middle and secondary grade school history textbooks, published in the last three decades, which refer to the Piedmont. They support the popular view of the unbroken presettlement forest. No mention of open lands or savannas in the Piedmont are to be found, though one text mentions the buffalo as a presettlement species. The nearest mention of grasslands is of native American grasses encountered west of the Appalachians (Garraty, *Story* 37). Four texts which mention the presettlement landscape describe it in terms of the settlers clearing the vast wilderness or forests to open them for farming (De Vorsey 49; Garraty, *American* 68; London 63,140; Williams 41). This leaves it up to the student to create a visual image of the wilderness or forest. It is likely that image will spring from traditional descriptions, such as "howling wilderness" or "unbroken forest" that a squirrel could cross from the Atlantic to the Mississippi without touching the ground (Kaufhold 2), and reinforced by the scenes depicted by popular nineteenth century landscape painters. The rugged, wild, densely forested imagery of the Hudson River school may have done much to give a visual identity to the eastern wilderness. A reflection of this might be taken from Lawton B. Evans in his 1908 *A History of Georgia for Use in Schools* in which he writes "…as late as two hundred years ago it was almost unbroken forest, and the people who inhabited it were savages…" (2). There is some merit in these descriptions, since the land was predominantly forested, but to characterize native populations as "savages" ignores their highly developed cultures just as "unbroken forests" ignores the condition of a

cumulatively vast area of eastern grassland communities or savannas. Because these communities are virtually extinct, even more recent academic works on the Piedmont environment do not always recognize their makeup or history. For example, in the beginning pages of *Oaks of North America* published in 1985, Miller speaks of vast endless eastern forest, unbroken except by wetlands and cliffs (*v*).

Piedmont Savanna Ecological History

A closer look at actual presettlement conditions reveals not an "unbroken forest" but a wooded and sometimes grassland landscape with a savanna-like character especially on uplands. While generally forested and sometimes densely so, the Piedmont could more often have been characterized as lightly or "pleasantly" wooded, being more airy and open, sometimes open to the extent of meriting the description of prairie. Because there are virtually no such "natural" landscapes left in the Piedmont an information gap exists which inhibits the process of restoring such landscapes. Filling this information gap and setting up a framework to understand the existence and disappearance of Piedmont savanna communities can be done in part by examining written history relevant to the subject. Following is a brief history, focused particularly on Piedmont savanna landscapes, taken from various historical perspectives, written both recently and as far back as 1846. Original information from accounts of early explorers will be used later to specifically define Piedmont savanna ecology and aesthetic properties.

Change has been a constant in the southeastern landscape just as in all other landscapes. At the end of the Pleistocene or the last ice age, around ten thousand years ago, megafauna such as the mastodon could be found in the Southeast (Cowdrey 12). Fossils of the mastodon and mammoth have been found near Little Keg Creek in Wilkes County, Georgia (Kaufhold 1). Megafauna migrated into the Southeast during the end of the Pleistocene possibly due to drying conditions on the continent. Trailing them were the nomadic human hunters who, from the time of their crossing the Bering Strait tens of thousands of years earlier, had subsisted on hunting the great elephants, camels, horses, sloths and bison of the continent. This marked the beginning of human influence in the Piedmont landscape. As the megafauna became extinct due to a one-two punch of climate change and over-hunting, the humans who subsisted on them looked to different means of existence. This led to the development in the Southeast of the more stationary Archaic cultures which subsisted on gathering and hunting a diverse mix of wild plants and small game. After 1,000 BC, as their cultures matured and their populations grew, Indians of the Woodland period added the growing of some food producing plants and mound building to a base of hunter-gatherer activities. The highest cultural period, the Mississippian from AD 700-1500, was marked by a more agricultural base, particularly the growing of corn, beans, and squash in riverine locations, and by a stratified society in large fortified towns with palisades and temples atop mounds. Before European contact Indian populations were quite large, perhaps 1.5 - 2 million in the Southeast (Cowdrey 20). The growing of corn, the most efficient of plants in converting nutrients and energy to food, made such large, well developed societies possible and restricted their location to lowland sites with richer soils. Because of the intensive settlements and agriculture, lowlands may have appeared more often as farmland than bottom-land forests. The extensively open lands seen by Bartram along the major streams of the still-populated Creek nation might have been a reflection of this, even though populations were already diminished by European-

introduced diseases. Uplands were also undoubtedly affected by such large populations. The effects Native Americans had on lowland and upland landscapes were disproportionate to their numbers, mainly because of their use of fire (Skeen, Doerr and VanLear 6). Indians intentionally burned for many reasons related to agriculture, hunting, and safety, as well as accidentally when fire escaped. Though it is now recognized that Indians were well aware of the effects of fire and used it as a management tool, an earlier perspective is represented by Hu Maxwell who wrote for the USFS in 1910 of the Indians as "wasteful and destructive savages," who were "by nature incendiary" and "squandered the regions resources like pirates plundering a treasure." (Silver 49-59) Whether a result of good or bad Indian management or natural fires, the resulting landscape of hardwood and pine woodland had an open appearance due to frequent burning. In it a herbaceous understory was encouraged while oaks were favored over competing hardwoods (Skeen, Doerr and VanLear 6-7). Grassy openings in these woodlands played an important role not only for the Indians and the resident species but also for the new arrivals from outside the region. Grassland areas in the Piedmont acted as routes for migrating buffalo whose well-worn trails became paths for Indians and subsequently traders and settlers (Keever 41). As Landrum writes, "Long after their departure, their moss-covered bones and deep-worn trails, leading to favorite ranges and licks, were seen marking the country in every direction."(5) Clashes between whites and Indians in such a low density wilderness were a result of everyone using those same trails. In the Appalachian valley in Pennsylvania and Maryland, meadows maintained by Indian burning were a draw for European settlement and migration. As westward settlement encroached on these areas, it was drawn toward the south, bringing the main stream of settlement movement down the Appalachian valley to Virginia through the Roanoke Gap, onto the inner Piedmont, then south and westward across the whole region (Prunty 164,165). European settlers were as averse to the Indians as they were to the dense forests; thus the areas kept open and abandoned by the extirpated Indians were greatly favored. Areas in North and South Carolina were particularly well known for their large areas of open land. Historian William Henry Foote wrote of the Piedmont in his 1846 *Sketches of North Carolina*:

> Emigration was encouraged and directed very much in its earliest periods, by the vast prairies, with the pea-vine grass and cane-brakes, which stretched across the States of Virginia and Carolina. There are large forests now in these two States, where, a hundred years ago, not a tree, and scarce a shrub could be seen. These prairies abounded with game, and supplied abundant pasturage, both winter and summer, for the various kinds of stock that accompanied the emigrants, and formed for years no small part of their wealth. (79)

Describing the area north of Charlotte:

> Previous to the year 1750, the emigration to this beautiful but distant frontier was slow, and the solitary cabins were found upon the borders of prairies, and in the vicinity of canebrakes, the immense ranges abounding with wild game, and affording sustenance the whole year, for herds of tame cattle. Extensive tracts of county between the Yadkin and the Catawba, now waving with thrifty forests, then were covered with tall grass, with scarce a bush or shrub, looking at first view as if immense grazing farms had been at once abandoned, the houses disappearing, and the abundant grass luxuriating in its native wildness and beauty, the wild herds wandering at pleasure, and nature rejoicing in undisturbed quietness. (189)

In his 1897 *Colonial and Revolutionary History of Upper South Carolina*, J. B. Landrum speaks of the Piedmont in that state:

> Up to the breaking out of the revolutionary war, the woodlands in the upper portion of South Carolina were carpeted with grass, and the wild pea vine grew, it is said, as high as a horse's back, while flowers of every description were seen growing all around. The forests were imposing, the trees were large and stood so wide apart that a deer or buffalo could be seen at a long distance; the grasses and the pea vines occupied the place of the young, scrubby growth of the present day." …"It is a fact well authenticated, that in the early history of the upper country there were numerous prairies covered only with the grasses and the pea vine, but which have since been covered with pine, oak, and other growth. (2)

As settlement progressed, introduced diseases and epidemics obliterated Indian populations to such an extent that changing patterns of fire intensity and frequency allowed widespread forest succession, as was observed throughout the early settlement period. Such observations caused the Black Belt Prairie of Alabama to be regarded as myth in spite of documentation (Deselm and Murdock 93). Descriptions of the still open savanna-like Piedmont landscape from explorers such as Bartram, Lawson, Hawkins, Lederer, Fries, and Byrd are still available for interpretation and will be used in the following chapter to understand the form and function of specific Piedmont savanna characteristics.

Though the megafauna of the Pleistocene were long gone, native grazing animals such as buffalo, elk, and deer were found in the Piedmont and probably had an effect on the structure of grasslands. Elk, never a large population, were soon extirpated from the Piedmont and by the time Bartram passed through in the 1770s he found them only in the Appalachian mountains (Silver 100). Deer were extremely abundant prior to periods of intense trading of skins by Indians and settlers to European markets. Georgia in the third quarter of the eighteenth century, for instance, exported about 200,000 pounds of deer skins annually (Cowdrey 15). Deer were hunted almost to extinction in the Southeast early in this century, but have been very successfully restored to most areas (Skeen, Doerr and VanLear16). Buffalo, and their effect on the landscape, may have been relative

newcomers to the Piedmont. In the interior of the Southeast no buffalo were observed by the De Soto expedition in the sixteenth century, only a few buffalo were recorded in the seventeenth century, and hundreds of buffalo at a time were observed in the eighteenth century (Rostlund 401). In 1755 Governor James Glenn traveled though the upcountry of South Carolina to the Cherokee Nation and gave an account of the Piedmont, describing it as having large and extensive plains and savannas full of deer and buffalo. At the earliest period of immigration into the upper country a hundred buffalo grazing on a single acre of ground in the present territory of Abbeville and Edgefield, South Carolina were reported, and it would be reasonable to assume this occurred in other parts of the upcountry as well (Landrum 1,5). Prior to cultivation, buffalo wallows were found in Hart county and there are at least four Buffalo licks in the area of Wilkes, Oglethorpe, and Greene counties (Kaufhold 3). A search of DeLorme's *Street Atlas USA* for place names in the southern Piedmont (not including those of waterways) revealed the name "buffalo" appearing 12 times in different locations; while other terms referring to grassland or savanna environments such as "plain," "meadow," "cowpen," and "grove" were found throughout. The buffalo and any effects they had were extinguished from the Piedmont by the third quarter of the eighteenth century, while at the same time deer populations also suffered greatly. There were soon, however, plenty of domestic livestock to replace the native grazers and browsers (Silver 100). New changes in grassland vegetation composition and structure occurred as horses, cattle, and swine, first introduced by the Spanish in the 1500s and later by the English, entered the open lands of the Piedmont (Deselm and Murdock 93). After De Soto, some of the first Europeans to bring livestock to the South Carolina Piedmont were "stock or cowpens men" (Landrum 19) with free-ranging herds numbering in the tens of thousands in the upcountry of South Carolina in the late 1700s. Cattle may have made a substantial contribution to maintaining the openness of the landscape during the brief period of cowpen culture, especially since the open landscapes were chosen for their pasturing (Westmacott 5,6). As exotics often are, the introduced animals were very successful at reproducing on the open range in spite of predators, to the extent that wild cattle, hogs, and horses were hunted and eaten by settlers (Cowdrey 50).

European colonists viewed the land and its features solely as commodities. The effect they had on the presettlement landscape was a reflection of this. The more "sustainable" farming practices of the land-poor, labor-rich old world, such as crop rotation and manuring, were abandoned. In the new world, settlers had to learn a system that could provide not only food, but also, in the beginning, profit for the investors in the trading companies that sent them there. The system they found most effective was a result of scarce labor and cheap and plentiful land. Newly cleared land provided the cheapest source of nutrients needed for producing profits from soil-exhausting crops (Cowdrey 31-35). Once the soil was exhausted, the land would be abandoned. Essentially, the resulting patterns of old field succession on poor, eroded soils which seem to define the ecology of the Piedmont today are the result of this system.

By the 1850s most of the Piedmont was settled and soon afterward began waves of farmland abandonment. Over the last 130 years, progressively larger percentages of land were abandoned following the Civil War, the agricultural depression of the 1880s, and the boll weevil attacks of the 1920s, as well as additional land after World War II. Old field succession to forests, some now as old as the Civil War, followed the cycles of land

clearing, farming it for a decade, then retiring it (Skeen, Doerr and VanLear 7-8). In the Southeast, complete successional transformation from grassland to forest (usually pine) can occur in a couple of decades without disturbance (Deselm and Murdock114), so it is understandable that after all of these changes the landscapes of the modern Piedmont probably bear little resemblance to those of presettlement times. In some ways, however, the large scale patchy openness of the presettlement savanna is still suggested by the quilt-like patterns of farm land stitched across the matrix of successional forests.

Chapter V
Presettlement Piedmont Savanna Ecology

Rather than an unbroken forest, the Southern Piedmont could have been described in the years of first European contact, as a patchwork of adjacent, dissimilar communities with often indistinguishable boundaries between them. A transect of a several miles could cross many variations of the landscape, exhibiting various oak-hickory-pine forest scenarios, with the occasional appearance of open grassy savannas, all resulting from complex patterns of physiography and landscape disturbances. Understanding presettlement Piedmont savanna ecology is essential, not only in explaining the existence of savanna communities, but also to serve as a model for any related reconstruction of such an environment. In order to understand the condition of this landscape, examples from the nearest documented savanna and savanna-like landscapes will be compared with remnants found within the Piedmont and historical descriptions.

Historical descriptions of presettlement savannas throughout the southern Piedmont were made by explorers including John Lederer in Virginia and the Carolinas in the 1670s, John Lawson in the Carolinas in 1701, William Byrd on the dividing line between North Carolina and Virginia in 1728, Bishop Spangenberg in North Carolina in 1752, William Bartram in South Carolina, Georgia and Alabama in the 1770s, and Benjamin Hawkins in Georgia and Alabama in the 1790s. Figure 5.1 shows a rough

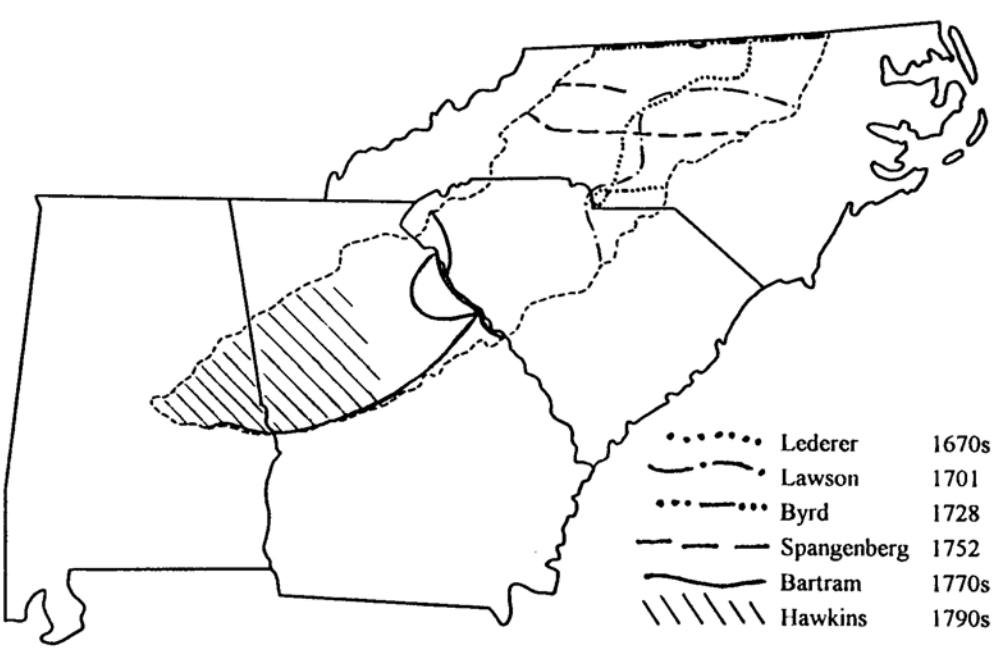


Figure 5.1 Approximation of areas traversed by Piedmont explorers.

approximation of the areas these explorers traversed. As original accounts, their observations will be used throughout this and the next chapter to help explain savanna composition. To the best of my knowledge, all observations cited were made in the southeastern Piedmont region. Consideration will be given to the unique perspectives they offer due to their varied backgrounds as explorer, surveyor, religious leader, farmer, naturalist, Indian agent, and as gentlemen of their times. Except perhaps for Bartram, the naturalist of the group, these men were likely to have viewed the landscapes they encountered in terms of commodity (Cronon 21). Their accounts might be biased in that they may remark only on the unusual, discuss only areas traversed by major trails, and they may differ in their methods and knowledge of the natural elements encountered (Nuzzo 9). Nevertheless, the descriptive evidence they offer of this extinct landscape does provide valuable comparative information, even if some ecological details are distorted in their descriptions.

Savanna Distribution and Function

Savanna studies in the Midwest look at soil type, existing vegetation and historical information to locate the range of presettlement oak savannas (Nuzzo 10). In this thesis, I will look at similar elements; because of limited information, some comparisons will be made to savanna landscapes in the Midwest.

Physiography

The Piedmont (shown in Figure 2.1), which takes it name from the Italian *Piemonte*, or foothills (Godfrey 11), is the oldest, most highly eroded of the provinces of the Appalachian orogeny. It lies between the Atlantic Coastal Plain to the Southeast and the Appalachian mountain chain to the northwest, and between them extends from New Jersey to Alabama. Toward its southern end, the lower elevations along the fall line, which divides it from the Coastal Plain, are approximately 600 feet, and higher elevations near the Appalachians are approximately 1500 feet. It has a rolling topography of broad, convex ridges and is irregularly and frequently dissected by generally southeast running drainages in relatively narrow floodplains (Skeen, Doerr and VanLear 2).

The topography of the savanna landscapes in historical descriptions is a reflection of the general lay of the Piedmont uplands: gently rolling, flat, or sometimes steep; and level lowlands along streams. Of the various configurations in which they were described by early explorers, upland settings, with both wet and dry characteristics, seem to be most common, perhaps in part because they were the location of travel routes, but also because the savannas of relatively dry uplands were most removed from firebreaks and were frequently burned (Cowell 59). Because grassland maintenance is directly related to topography, flat to rolling Piedmont lands would be the most ideal for savannas, since rougher, more dissected topography favors development of woody vegetation over grassland (Wright and Bailey 82). Savanna landscapes were also described in lowlands usually along rivers and streams and often associated directly with Indian settlements. Historic citations illustrate the variety of settings. Near the Roanoke river in Virginia:

> The Countrey here, though high, is level, and for the most part a rich soyl, as I judged by the growth of the Trees; yet where it is inhabited by Indians,

> it lies open in spacious Plains, and is blessed with very healthful Air,… (Lederer 24)

An upland southwest of the Yadkin river in North Carolina:

> We travell'd, this day, about 25 Miles, over pleasant Savanna Ground, high, and dry, having very few trees upon it, and those standing at a great distance. The Land was very good, and free from Grubs or Underwood. (Lawson 51)

The country above the fall line up to the headwaters of the Flint and Ocmulgee rivers in Georgia:

> … open, flat, land, the soil stiff, the trees post and black oak, all small. The land is generally rich, well watered, and lies well, as a waving [hilly] country, for cultivation. (Hawkins 20)

Near the fall line west of the Oconee river:

> …a pleasant territory, presenting varying scenes of gentle swelling hills and levels, affording sublime forests, contrasted by expansive illumined green fields, native meadows and Cane breaks… (Bartram 307)

Uplands, especially hilltops, could present more xeric type savanna settings. A xeric setting north of Augusta, Georgia:

> ...vast forests, expansive plains and detached groves; then chains of hills whose dry, barren summits present detached piles of rocks. (Bartram 263)

Savanna landscapes with wetland attributes could also be found in the Piedmont, perhaps similar in nature to locations where stream headwaters emerged from glades, as Hawkins saw in Alabama (47), or as Lederer describes in Virginia or North Carolina:

> To heighten the beauty of these parts, the first Springs of most of those great Rivers which run into the Atlantick Ocean, or Cheseapeack Bay, do here break out, and in various branches interlace the flowry Meads, whose luxuriant herbage invites numerous herds of Red Deer (for their unusual largeness improperly termed Elks by ignorant people) to feed. (Lederer 34,35)

In the next century, Byrd noted another type of open upland wetland, the "high-land pond" extending for about two miles as they traveled in the area west of Danville, North Carolina. He describes a:

> …dead levil, without the least declevity" that was moist in many places and produced an abundance of grass. the woodsmen called these flat areas,

> "highland ponds" and they are exellent areas to forage worn out horses. (Byrd 212)

Such upland wetlands might be represented in the remnant community of Link Bog (Radford 111-112) at the base of the Brushy mountains in Iredell County, North Carolina. There are also many illustrations of lowland savanna settings particularly within the lands of the Creek Indians in Georgia and Alabama. This, the view from the banks of the Oconee river near Milledgeville:

> This flourishing grove was an appendage of the high forest we had passed through, and projected into an extensive, green, open, level plain, consisting of old Indian fields and plantations, being the rich low lands of the river, and stretching along its banks upwards to a very great distance, charmingly diversified and decorated with detached groves and clumps of various trees and shrubs, and indented on its verge by advancing and retreating promontories of the high land. (Bartram 307)

Though there are no historical maps accurately showing the distribution of savannas in the Piedmont, a demonstration of its pattern in the area of Winston-Salem, North Carolina may potentially exist in a survey map drawn for the Moravian pioneer Community of Bethania in 1766. Shown in Figure 5.2, the white areas between stream drainages could very well represent existing grassland or "prairie" while the shaded areas along creeks may represent forested slopes and bottoms. Support for this idea is illustrated by Keever citing Jethro Rumple's 1881 *Rowan County* in which he gives the account of a recently deceased respected citizen, who would have seen the North Carolina "prairie" landscape at the end of the 1700s. The "old timer" says he remembered open prairies on the uplands between creeks covered with grass and wild pea vines where deer mingled with their cattle (Keever 39-40).

Comparison can also be made to a map of prairie vegetation in Missouri (Figure 5.3) where the light color representing prairies occupies the spaces between the dark colors representing wooded river valleys. Though at a different scale, there seems to be a remarkable similarity in the landscape patterns of the two maps. Further exploration of this concept might reveal models for savanna landscape patterns.

Hydrology and Climate

In the Hypsithermal period, climate expansion may have caused an eastward migration of prairie species into the Piedmont. The more recent Piedmont climate is cooler and wetter, however, and the scattering of prairie-type remnants across the Southeast does not argue strongly for climate as a control over their development (Deselm and Murdock 89,90,92). Annual precipitation over the region ranges from 32-48 inches (Skeen, Doerr and VanLear 3). In contrast to that, eastern prairie regions from Texas to Indiana, where forest-to-prairie transitions occur, have a lower annual precipitation of 29-39 inches. There are, however, other factors that influence grassland

Figure 5.2 "Map of Bethania Tract, 1766" (Fries 374).

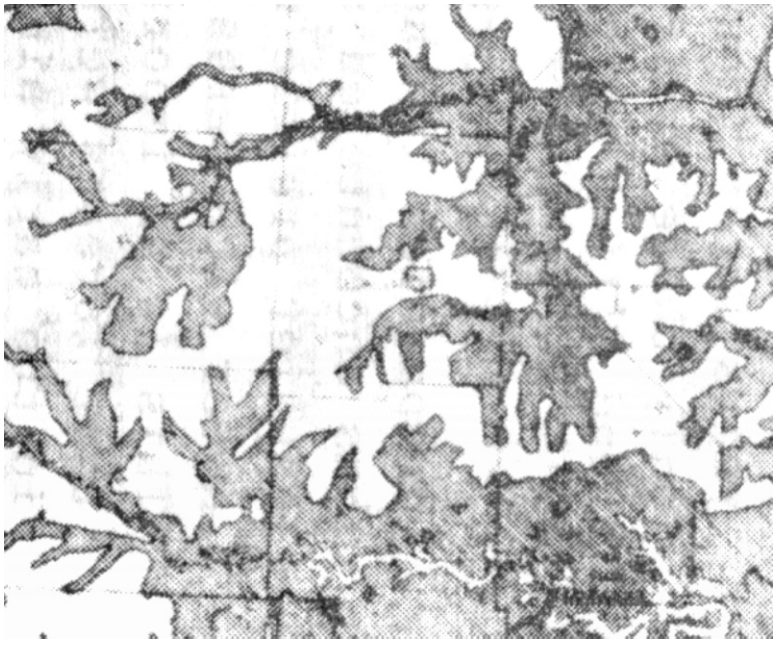


Figure 5.3 Landscape patterns of Missouri prairies and woodlands (Schroeder 20).

development in the Piedmont. Generally, all North American grasslands have a wet period followed by a period of drought conditions (Risser et al. 10). In the Piedmont, precipitation is relatively evenly distributed throughout the year without significant deficit periods (Skeen, Doerr and VanLear 3). The Ultisol and Alfisol soil types of the region, however, are characterized as "dry part of the time" during the "warm season of the year" (USDA SCS *Principal Kinds of Soils*) reflecting the fact that a dry soil season does occur. Soil moisture depletion in the summer occurs to a depth of 66 inches under forest cover and to 30 inches under old-field herbaceous cover, while summer rainfall seldom infiltrates below 30 inches. Partly responsible for drought conditions, grasses can prevent up to .4 inches of rainfall from reaching the soil, precipitation which is then lost to evaporation (Wright and Bailey 25). Other factors responsible for moisture depletion are high summer evaporation and evapotranspiration rates. Recharge of groundwater occurs in the winter months (Skeen, Doerr and VanLear 5). Other factors that help maintain open areas result from climate and microclimate. They include frost damage, soil extrusion by freezing, and moisture stress from higher maximum temperatures and greater wind speeds (Deselm and Murdock 89). Seasonal differences in temperature in the southern Piedmont range from a summer average high of 89° to 99° F, to a winteraverage low of 30° to 40° F with an average of 240 frost free days (Skeen, Doerr and VanLear 3). These temperatures are not unlike those found in prairie regions of the southern central United States.

In the savanna microclimate, sunshine, wind speed and rainfall can either increase or decrease as a result of canopy structure. As canopy height and density increase, wind speed and light intensity decrease near the ground, soil temperature decreases during the growing season, and differences between air temperature within and above the canopy decrease (Risser et al. 149-150).

Soils

The distribution of Piedmont savannas cannot be determined solely by remnants or by incomplete historical information. As a more permanent, more quantifiable entity, soils and soil relationships can be examined for evidence of presettlement distribution. Basic soils, droughty soils, and temporarily saturated soils emerge as being particularly important conditions.

The most widespread soil order in the southern Piedmont is Ultisols while significant areas of Alfisols also occur (Skeen, Doerr and VanLear 4). Both soil orders have clay subsurface horizons which are usually moist but may dry out in the warm season of the year, while Ultisols are more acidic and Alfisols are more basic (USDA SCS *Principal Kinds of Soils*). Soils of the central United States grasslands are usually deep, fertile, neutral to basic, and high in organic matter. Most true grasslands are found on soil orders of Mollisols and Aridisols (Risser et al. 4) though there are many other orders in the prairie region. Within the south, mollisols are associated with the Kentucky barrens and the very small areas of serpentine barrens in the Piedmont. Notably, all Southern grassland communities, except for balds and shale barrens, include Alfisols among the orders on which they occur. These grasslands shown in Figure 2.1, include the Black Belt of Alabama, the barrens of Kentucky and Tennessee, the coastal prairies of Louisiana and Texas, and the serpentine barrens of the Piedmont (Deselm and Murdock 90-92). This suggests a relationship involving the basic soil characteristics of Alfisols (which develop over gabbro, diabase-basalt and serpentine [Radford 23]), to grassland development in

areas of the Piedmont. Figure 5.4 shows the distribution of Alfisols in the Piedmont. Many of the savanna or "prairie" landscapes described by Lederer, Lawson, Byrd, Spangenberg, Foote, and others in the Carolinas and Virginia seem to have a physiographic distribution related to these Alfisols.

Another aspect of soils and grassland development is the texture and behavior of the soil. The Blackland Prairie of Texas and the Black Belt Prairie of Alabama occur in areas with enough rainfall to support forest; however, due to controlling conditions of fine-textured soil, seasonal drought conditions favor grassland development. In the Crosstimbers oak savanna in Texas, post and blackjack oak growth is found on coarser-textured soils while nearby fine-textured soils support fewer trees and more grasses (Risser et al. 60,64). In the Piedmont, fine textured Iredell soils are credited as one of the major factors in the development of the former "Piedmont Prairie" of North Carolina (Horan 9). The map *Soil Associations and Land Use Potential Of Georgia Soils* points out that Iredell and other fine textured soils of the Piedmont are often of basic rock origin. Montmorillonite is the major clay mineral in Alfisols and accounts for their high shrink-swell capacity and plastic properties (Skeen, Doerr and VanLear 4). Being virtually impermeable when wet, they can cause a perched water table on concave topography, and during dry periods become extremely dry (Waldrop *Establishment* 5), even developing wide cracks and breaking roots (Horan 9). Soil freezing is also more severe in these fine-textured soils (Wright and Bailey 29). High shrink-swell soils can also be acidic, such as those developed over acid rock found along the Carolina slate belt,

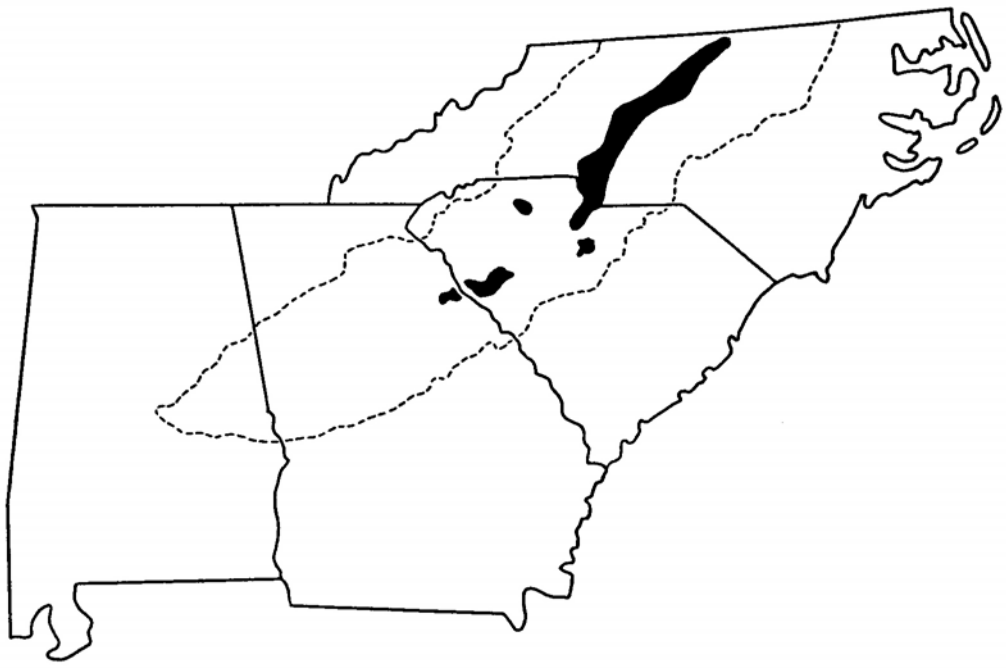


Figure 5.4 Distribution of Alfisols in the Piedmont (USDA, *Soils of the Southern US*).

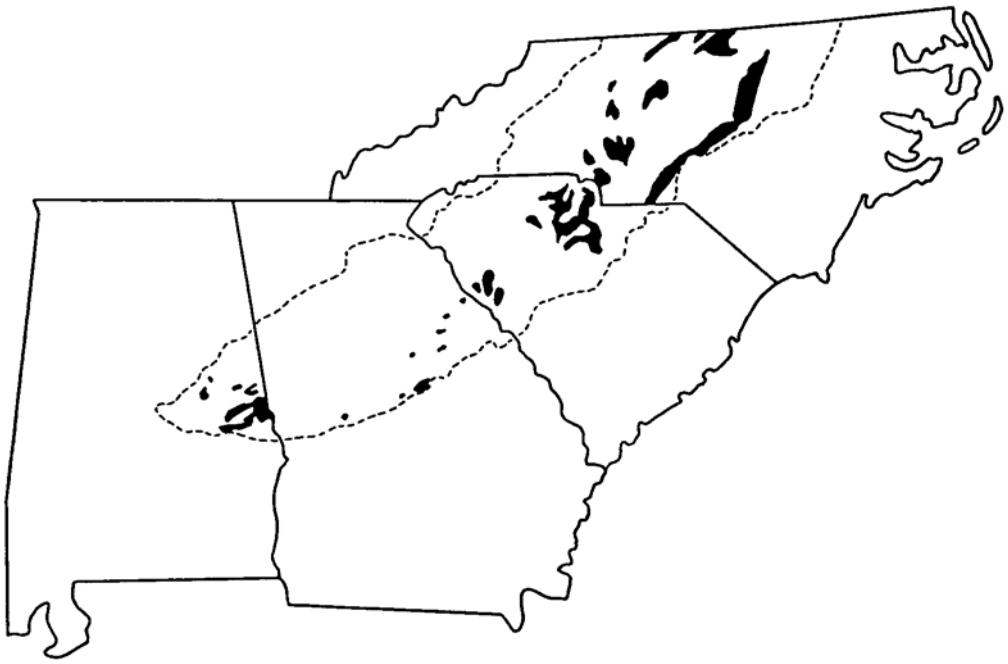


Figure 5.5 Distribution of high shrink-swell soils in the Piedmont based on information available from statewide soil maps. Upland Piedmont soils included in associations described as moderate to extremely plastic include Iredell, Enon, Wilkes, Mecklenburg, Helena, Whitestore, Creedmore, Cecil, Appling, Lignum, Winnsboro, Davidson, and Lloyd (Alabama; Georgia; South Carolina; USDA *General*).

shown on the *General Soil Map Of North Carolina.* Distribution of these plastic soils, shown in Figure 5.5, may be another clue to the distribution of presettlement savannas in the Piedmont.

Most upland soils in the Piedmont are Ultisols including the widespread Cecil, Madison, Musella, and Pacolet series (USDA, *Principal*). Although these soils are generally conducive to oak-hickory forest development (Skeen, Doerr and VanLear 4), presettlement influences, especially that of fire, would have kept these woodlands open. (Deselm and Murdock 89). Bartram and Hawkins offer many descriptions of savanna-like scenes as they traveled through areas shown to be Ultisols on the USDA map *Principal Kinds of Soils: Orders, Suborders, and Great Groups.* It may be reasonable to presume, however, that upland areas of Alfisols, particularly with shrink-swell soils, were more likely to attain the openness approaching that of the prairie than areas of Ultisols. Whatever the degree of openness, soils were only one factor. Savanna openness would be more influenced by drought and/or flooding and the disturbances of grazing/browsing and particularly fire, especially on areas of deeper soils (Deselm and Murdock 93).

Disturbance Mechanisms

Of presettlement Piedmont disturbances, such as extreme climatic events, Indian clearing, and grazing, fire was the most important in facilitating grassland development in

an area where there is more than enough precipitation to grow forests in only a few decades. The often large-scale landscape patches of savanna openings would have required large disturbances for their development. Smaller-scale forest canopy openings of gap-phase regeneration just don't add up to produce the prairie-like landscapes described by Foote in North Carolina. Large-scale catastrophic disturbances, such as the blow-downs from hurricane Hugo, or major ice storms, followed by intense summer fires, could have created ideal conditions for near pure pine establishment (Skeen, Doerr and VanLear 14) or open savanna, if pine seed sources were unavailable (Joern and Keeler 158; Keever 40-41). Of the many disturbance types, fire was undoubtedly the most influential.

Indian-Caused Fires

There is much debate and many questions to answer on causes and effects of fire in the presettlement Piedmont. Different fires caused for different reasons would have had different ecological effects (Bryant, McComb, and Fralish 187), so it is important to understand what factors caused fires, to what extent, and with what result. Unfortunately, there is only indirect evidence of the likely frequency and intensity of historic Piedmont fires. Lake sediments which could provide such data are not available because of Piedmont physiography. In the absence of clear evidence, it is difficult to attribute the apparent fire disturbance regime to either "natural" or anthropogenic causes (Cowell 61, 138). They are examined here, however, being the only two causes to choose from for what was certainly a common and influential disturbance.

That both causes were present was indicated by William Bartram in 1773 as he wrote of fire that "It happens almost everyday throughout the year, in some part or the other, by Indians for the purpose of rousing game, as also by lightning" (Wright and Bailey 363). There have been cases made for both causes, though it seems historical evidence favors Indians as the dominant, though certainly not sole, fire causing agent. Byrd, Lawson, and Spangenberg all mention Indian burning though they do not mention lightning fires. When Byrd travels under skies smoky from wildfires, he attributes it to "the firing of the woods by the Indians" caused by their abandoned campfires (Byrd 218). Lawson refers to driving game as the reason for Indians burning the woods (Lawson 215). Spangenberg echoes European sentiments about fire as he describes a tract of mostly pine and some hardwood as "ruined" because Indians burning it to drive game had eliminated all the smaller trees (Fries 49). For the Indians there were many reasons for burning besides driving game to a place for an easy kill. They burned to encourage new tender growth for attracting grazers and browsers to hunting areas. They burned to clear forest patches for agriculture by killing trees: with the dead trees standing, their roots intact to hold the soil and provide long term fertilizer, annual dormant season burns of the agricultural fields released additional mineral nutrients for fertilizer. They burned the woods to clear underbrush and open them for ease of travel and line of sight for defense against attack; to reduce catastrophic fire hazard from accumulated litter; and to get rid of biting insects such as fleas, chiggers, lice, ticks, mosquitoes, and spiders. They also burned the woods accidentally from unwatched cooking fires (Silver 49-62).

Depending on the reason, there were different times of year and different areas and sizes of land that were burned, but, in general, annual burning was the rule for Indians. Burning activity for agriculture, defense, ease of travel, fire protection, and insect pest reduction was concentrated in the area of settlements, perhaps within an area of a few

miles, and would have occurred at various times of year depending on the purpose and available fuel buildup. Burning for agricultural improvement and most other burns would have occurred in the dormant season, while burning to reduce insect populations might have occurred in the summer. For improving game forage and ease of travel, and driving game to the kill, burning would have been conducted on a larger landscape scale. For the most part, as suggested by explorers' accounts, late fall and winter were the most common burning time. That was the primary hunting season and enough dry fuel had accumulated by that time to carry a fire. According to legend, in the area of Hart County, Georgia, fires were set in the late fall when the wind was from the southwest burning an area across the center of the county to the Tugaloo River (Kaufhold 2). To attract game to fresh forage, however, burns could have been conducted at other times of the year. Accidental fire might occur at any time, but most likely when fuels were dry and plentiful and the need for camp fires great as in the fall of the year. Where burning was not frequent enough to reduce fuel loads, and not infrequent enough to allow mature shady forests to develop, fires might have a very destructive effect on forest landscapes. In an area where no tree of "any bigness" could be seen due to "fire or catapillars," Byrd succinctly discusses the effects of fire and why it "makes such a Havock in these lonely parts".

> The woods are not there burnt every year, as they generally are amongst the Inhabitants. But the dead Leaves and Trash of many years are heapt up together, which being at length kindled by the Indians that happen to pass that way, furnish fewel for a conflagration that carries all before it." (Byrd 228)

Large areas acting as uninhabited wilderness buffers between chiefdoms may have had very infrequent fires and better-developed forests. The area of Jackson and Madison Counties, north of Athens, Georgia, was sparsely populated and only infrequently used as a hunting ground between the Creek and Cherokee nations. Also, most Native inhabitants had removed to more westward locations by the time Bartram saw the area. Given the lack of settlement, the area was probably predominantly mature, mixed hardwood and pine forest (Pluckhan 127-129) similar to the "high forests" of the "great ridge" area to its south (Bartram59). Ten to twenty years or more might be the fire frequency for such a predominantly fire-tolerant oak-pine forest (Cowell 59). It is also interesting to note that as Bartram traveled westward into more heavily populated Creek territory, his descriptions of the landscape include a great deal more of "expansive savannas".

Lightning Caused Fires

Komarek points out that lightning storms are more frequent in the Southeast than any other part of the United States (Barden, *Managment* 5). Cecil Frost, at the 1995 Cullowhee Conference, showed estimates of 15,000 lighting strikes per storm producing 400 strikes per minute. He said it has been estimated that there are 1,100 lightning fires a year in Florida, based on reports of fires sparked on the dry areas at the edges of storms. The usual accompaniment of rain often reduces the intensity of these fires; however, fires can smolder for days till enough drying occurs, then flare up again.

Historic records indicate an average wildfire interval of 2-3 (Cowell 58) or 3-5 (Hughes 155) years in the Coastal Plain, where fire compartments are large and lightning

fires frequent. At the 1997 Native Grass Conference in Asheville, North Carolina however, Lawrence Barden, arguing for more anthropogenic fire causation, pointed out that Piedmont uplands, frequently dissected by drainages, have fire compartments too small to allow lightning fires to frequently burn large areas as they do in the Coastal Plain.

Lightning fires depend on atmospheric conditions for their ignition source and fuel moisture conditions for their ignition and spread. April, before trees leaf out, is the driest month of the year, making fire danger high. The cool dry air masses typical of the spring, however, are not conducive to generating thunder storms. Fall conditions are similar to those of the spring. In the summer, as lightning storm frequencies increase, leafing of vegetation causes moisture levels to rise, and fire danger to decrease. In the savanna setting, however, the drying effects of an open canopy continue into the summer season, often combining with the droughty soils of such sites to keep fire danger high as thunderstorm activity increases. This would suggest that lightning caused fires were more frequent in savanna settings than forests, and were potentially responsible for their maintenance (Barden, *Managment* 5-6).

Because there is only indirect evidence of the likely frequency and intensity of historic Piedmont fire, and even less direct evidence of the causes of such fires, it is difficult to attribute definitively the apparent fire disturbance regime to either non-human or anthropogenic causes. (Cowell 138).

Fire and Vegetation

Fire is very effective at changing or maintaining vegetation composition. A "conflagration that carries all before it" (Byrd 228) can happen when conditions are right and fuel is abundant, having collected over the years. Some Piedmont areas burned frequently, some not for many decades. Ten to twenty year frequencies may have been common in parts of the Piedmont (Cowell 58, 59) causing a "Smoky Bear" nightmare scene as observed by Byrd, turning many acres into dense, woody thickets after several years' growth (Byrd 212, 228; Nuzzo 8). The more frequent fires, potentially set by Indians, with lower fuel loads, would have been less intense, mainly consuming the accumulated understory litter, and causing saplings to be pruned back to their roots. It is likely that frequent fires of this kind were responsible for maintaining the openness of the presettlement Piedmont savanna over most soil types, while perpetuating prairie-like composition over shrink-swell soils. With such a variety of fire related vegetation types across the Piedmont landscape, it would be difficult to argue that the presettlement vegetation structure was a climax community (Cowell 144).

The average surface temperature of the less intense ground fires might be similar to the 216°-498° C observed in prairie fires. These temperatures are more than enough to kill mesophytic plants, which are usually killed at only 122°-131° F. Many species, however, are adapted to survive such extreme conditions and can dominate an environment where fire is a common phenomenon. Such species might sport protective armor, employ special seeding characteristics, or have the ability to resprout vigorously. Trunks of trees, including many pines and oaks with bark half an inch thick, will incur very little damage in ground fires. On the other hand, trees with thin bark, such as the beech, would not survive in a fire prone environment. Seed characteristics such as the ability to sprout in bare mineral soil, windblown dispersal, and the ability to tolerate heat, allow many species to prosper in fire environments. Grass seeds can tolerate up to 241° F

for 5 minutes. Also, grass fire temperatures have little direct effect on buried seeds (Wright and Bailey 11, 16, 18). The ability to resprout from the roots gives a competitive edge to many herbaceous species, especially grasses, as well as some adapted woody species such as oaks. In a Wisconsin brush prairie, oak grubs (oaks that repeatedly resprout from well developed roots) have persisted for over 100 years with annual fires (Nuzzo 8). Midwestern trees such as ash, elm, oak, and sumac can resprout from the roots and are not easily removed by fire (Joern and Keeler 62). Hickory, like many oaks, also sprouts from the roots after burning (Bryant, McComb and Fralish 187). Shortleaf pine, due to its sprouting ability, tolerates more frequent fires than does loblolly (Wright and Bailey 365) and can dominate with 5 year fire intervals, while loblolly prefers 10 years. In the Piedmont, 3-6 year fire intervals prevent most hardwood establishment in pine plantings. Thus fires, especially in the canopy, can promote pure pine stands (Cowell 58).

Burning also encourages an herbaceous ground cover under canopies and into open spaces (Skeen, Doerr and VanLear 6). This can be seen in the modern Coastal Plain woodlands, where many grasses and leguminous herbs increase after burning. These include grass genera such as *Andropogon, Panicum* (Wright and Bailey 372, 376), and *Arundinaria* (Hughes 150), and leguminous genera such as *Cassia, Clitoria*, *Galactia*, and *Lespedeza*. Also in the Coastal Plain, occasional fires prune and stimulate fruiting of huckleberries, blackberries and dewberries, and annual winter fires increase cover of blackberry and flameleaf sumac (Wright and Bailey 376, 377).

Fire frequency and seasonal timing are very important in determining the composition of grassland communities exposed to fire. For instance, increasing fire frequency in the spring from triennial to annual increases total plant production, increases warm season grasses and forbs, and decreases cool season annual production. After several years, however, annual fires can result in decreased production as nitrogen losses add up (Risser et al. 428). Spring burning is most commonly used in tallgrass prairie management because it increases productivity in warm season plants, controls exotic cool season species, and does not greatly influence species composition over the short term. Late spring burns done consistently, however, can reduce species diversity by continually selecting warm over cool season species (Joern and Keeler 65). According to *True Prairie Ecosystem* (Risser et al. 413-432), early spring burning increases stands of little bluestem and late spring burning increases big bluestem and Indian grass. Several studies show that spring burning increases the amount of flowering, especially in big bluestem, and in most species, while mowing and removing clippings also increases it, but only half as much. Seed production is higher mainly the first two years after a burn, and seeds have a better germination rate (413, 414). Spring fires can also increase soil water content for the growing season, due in part to the reduced moisture needs of cool season grasses. For grazing, late spring (more than early or mid-spring) burns maximize forage when done once every 3 - 4 years (418, 431, 432).

Probably most common in the presettlement Piedmont, dormant season fires in the fall and winter remove litter, allow the soil surface to heat up sooner, and favor cool season species. Though grass cover increases after winter fires (414), productivity of big and little bluestem and Indian grass is reduced. Continued over many years, such fires would shift species composition to cool season species (Joern and Keeler 65).

Late summer burns can set back warm season species. When perennial plants have translocated food from underground organs to leaves, as they do in the growing season,

they are more susceptible to fire damage (Risser et al. 411). Unfortunately, not much research has been done on the effects of summer burning even though it was certainly common in prairie areas (Joern and Keeler 65).

Fire and Soil

Fire affects the structure, organic material, nutrients, microbes, and moisture in the soil. In grasslands, the removal of excessive litter accumulations by burning (particularly spring burning) during normal to wet years raises soil temperatures, increasing bacterial activity, nutrient cycling and plant growth. In dry years, however, fires that remove litter function to reduce insulation, increase drought stress and allow erosion from flash floods. Severe fires in forests consume all litter and humus and can destroy up to 65% of the top inch of soil organic matter. This has the effect of accelerating oxidation of organic matter in the soil profile, reduces infiltration and storage capacity, and is detrimental to soil nutrient properties. Under normal fire conditions, the effect on percolation is negligible (Wright and Bailey 27, 29, 35). Upland sites in the Piedmont with thin soils are and were most susceptible to the effects of damaging fires, as noted by early explorers (Silver 61; Lawson 56; Bartram 263; Fries 50).

Though forests are more productive of organic carbon forms, organic matter content in temperate grasslands averages twice the amount found in temperate forests. This building of organic matter in the soil can be attributed to rapid root growth and turnover where grasses dominate due to frequent fires. Though fire consumes above-ground material and generates carbon, most carbon is contributed to the soil by roots. (Joern and Keeler 164, 168, 169; Risser et al. 431). For example, where there is a cover of grasses under pines in the Coastal Plain, frequent burning can increase organic matter content in the upper 4 to 6 inches of soil by up to 60%. A study conducted in Kansas showed that six consecutive years of burning did not reduce organic matter in the soil (Wright and Bailey 28).

Ninety percent of nitrogen in standing grass fuels, and less in woody fuels, is volatilized through burning. Total nitrogen loss can be reduced by burning over moist soil on humid days. Despite the large losses of organic material and nutrients that are volatilized during a fire, large quantities of nitrogen, phosphorus, potassium, calcium, magnesium, sodium, and to some extent sulfur are made readily soluble. This is most important where conditions such as low temperatures or drought make release of these nutrients through decomposition a very slow process. If drought or some other condition inhibits plant growth after burning, however, much of the free nitrate produced, if not consumed by plants, will be quickly lost. In warm, moist environments nutrients are well supplied by decomposition (Wright and Bailey 32,33).

Beneath the soil surface the temperature increase from a grass fire is negligible below ¼ inch and has little direct effect on soil microbes, organic matter, or buried seeds. Indirectly however, harsh conditions resulting from fires can cause reduction in soil organisms' population because of food source depletion, moisture decrease, and temperature and pH increase (Wright and Bailey 11, 31).

Fire and Animals

Animals are a product of their habitat, which is often a product of fire, therefore they are generally well adapted to it. Species composition will change when fires convert one type of habitat to another. The mosaic of seral and climax communities, often referred

to as the "edge effect," that may result from fires over time is the preferred habitat of a high number and diversity of wildlife (Wright and Bailey 49-51). During a fire event various animals are affected differently. Headfires a few feet above the ground burn up to ten times hotter and faster than backfires, though at the soil surface backfires are nearly as intense and burn more thoroughly. Hot, fast-moving headfires could catch and kill larger animals, passing over smaller ground dwellers, while larger animals could escape slow moving backfires that might kill small animals (Joern and Keeler 61). Small, often underground-dwelling mammals usually survive fires that leave unburned patches and are of a low intensity. Following a fire, their populations decrease due to the lack of cover (Wright and Bailey 50).

When 40 percent or more cover for escape is left intact, deer populations increase dramatically after burns. Succulent shoots of sprouting plant material provide easily available and abundant food. The grasses and forbs that increase after burning are generally only important as forage during spring and summer. Browse is the most important food source for deer and should increase where fire resistant grubs resprout prolifically after burning. Increased deer or other prey populations will attract more predators (Wright and Bailey 64-69).

Birds, being very reliant on vegetation structure, are greatly affected by fires. (Risser et al. 424). The absence of fire or other disturbances in forests will generally result in decreased niche diversity and capacity. Forests in preclimax stages generally have the highest bird diversity (Wright and Bailey 52). Turkeys, for instance, prefer park-like or savanna-like habitats where they can both roost and feed. In burned areas they can find new green shoots and a good supply of insects for their poults. Bobwhite, quail, and mourning doves are also attracted to freshly burned areas and will nest in or near them. Quail visit edges of burns while they are still smoking and fill their crops in a matter of minutes on the abundant exposed dead insects and seeds. Its unclear how they manage this with cigarettes in their mouths.

Burning in marsh communities should be coordinated with the migration patterns of waterfowl and with the special requirements of other wetland species (Wright and Bailey 58-64). When burning affects stream and wetland habitat, increased sediment loads and loss of shady cover have a negative short term impact, though not a toxic one. Long term effects such as increased flow due to reduced soil moisture and new beaver-created habitat are beneficial. Beavers prefer the regenerating saplings of burned areas over the large trunks of mature forest trees (Wright and Bailey 70-71).

Grazing and Browsing

Herbivores range from animals such as bison to rabbits to grasshoppers to nematodes. Herbivores and North American grasslands, including those of the Piedmont, have evolved as interacting partners for thousands of years. Grazers and browsers are adapted to the growing habits of plants and plants have adapted strategies and morphology to survive under herbivory (Risser et al. 334). Small mammals' main influence on vegetation may be seed dispersal rather than grazing; however rodents, such as rabbits, are important in maintaining a tussocky character in grasslands, especially on edges (Deselm and Murdock 104). Eastern grasslands support a vast number of insects which are the most significant consumers of plant material in grassland. An invertebrate, the crayfish, on the Black Belt Prairie of Mississippi, was at one time a significant agricultural pest.

Found at a density of several thousand per acre, they could destroy a crop in a few nights (Deselm and Murdock 105, 110).

Grazing can have beneficial effects on prairie-type environments. Midwestern studies showing that moderate clipping under moist conditions increases above-ground production in prairie grasses suggest the benefit of moderate grazing. Annual clipping in the middle of July showed the greatest increase in forage production in Oklahoma. Early growing season clipping is the most detrimental, while in the summer clipping seedstalks will result in increased leaf production (Risser et al. 353). This seems to differ in effect from burning, where late spring burns maximize forage for grazing when done once every 3 - 4 years and where summer fires should apparently be more detrimental to warm season plants (Risser et al. 411, 418, 432).

As in overgrazing, the lower and more frequent the cutting height of prairie grasses, the greater the reduction in root mass and the greater the depletion of food reserves (Risser et al. 353). In defoliated plants, unable to send sufficient food to roots, root growth will slow or cease under overgrazing (Joern and Keeler 180). As a result, most prairie dominants decrease under close, frequent grazing while other prairie species become more conspicuous. They in turn succumb to be replaced by broadleaf weeds and annuals as close grazing continues. Switchgrass is shown to be most susceptible to the effects of clipping while big bluestem and Indian grass may hold out the longest under intense grazing or mowing (Joern and Keeler 352-355).

Grazing also affects soil, as it tends to lower soil water content. Soil trampling reduces soil porosity, particularly on clayey and organic soils. Rates of diffusion of water, oxygen and nutrients to root surfaces lessen and cause a reduction in plant growth (Joern and Keeler 179,180). Compaction from large herbivores especially affects infiltration on fine-textured soils, though effects of compaction may disappear after freeze-thaw cycles (Risser et al. 347-349).

The co-evolution of grazers and prairie species found in the Piedmont savanna has a slightly different history than that of the Great Plains. On the Plains, large grazers have exerted influences on grassland species for thousands of years. In southeastern grasslands that influence was removed from the end of the Pleistocene, until about the 1600s when buffalo began to migrate into the Southeast. In the seventeenth century, when buffalo migrations were greatest and herds of thousands, or at least hundreds, were observed, Indian populations had been seriously decimated, some as much as 80% by disease. The abandoned grasslands the Indians provided may have acted as links in a migration corridor for buffalo into the Southeast (Rostlund 403, 407) just as they did later for pioneering Europeans. As latecomers, it is unclear how much they contributed to the local ecology. Perhaps, as in the Midwest, their grazing helped preserve some savannas (Nuzzo 10). Unfortunately, there is little information about what southeastern bison ate, though it is reasonable to assume that the buffalo, as in the great plains, was mainly a grazing animal that browsed only occasionally (Burt and Grossenheider 224; Rostlund 406). They also tended to graze an area heavily before moving on (Joern and Keeler 184). Herds were commonly described as “feeding,” “pasturing,” or “grazing” in open savannas, prairies, meadows and old fields of the Southeast (Rostlund 406). The Piedmont was described as having “large and extensive plains and savannas full of deer and buffalo.” (Landrum 1) Of the eight genera of grasses that bison feed on in the plains, six genera, including over 50 species, are native to the Southeast (Rostlund 406). It is quite possible that their

unmistakable trails, which are mentioned in many accounts, would have wandered through the tall grass of almost any Piedmont savanna.

Deer, which are primarily browsers, can have a marked effect on vegetation. Deer are denizens of early successional and edge habitats and are one of the most adaptable mammals in the world (Skeen, Doerr and VanLear 16). They prefer edge environments because they are high in forage and refuge (Silver 54). Their diet is composed of tender shoots, twigs, and leaves, herbaceous plants in season, fungi, mast and fruits (Skeen, Doerr and VanLear 16; Burt and Grossenheider 218; Silver 25). Woody plants comprise more than 85% of their diet, even in early successional habitats such as clear cuts, where they eat over 65% twigs and shoots of woody species (Skeen, Doerr and VanLear 16). As very populous herbivores they may have had an important role in controlling woody growth in the Piedmont savanna, although there is no documentation of that.

Elk, drawn from the mountains by the abundant grasslands of the Piedmont, were not very common and probably had little effect on savanna functions. The fact that elk and bison prefer open environments where they can outrun predators and fend them off with horns and hooves (Silver 26) is further evidence of the extent of Piedmont savannas.

Species Composition

For the Midwestern oak savanna, general consensus on composition is an oak-dominated community, having between 10 and 80 percent canopy cover, with or without a shrub layer, with an herbaceous, predominantly grassy ground layer of both prairie and forest species and appearing as either open or scrub savanna. It is also considered a fire-dependent community, or, in its absence, reliant on extremely droughty or otherwise severe conditions (Nuzzo 10). Adding a few pines to the mix might make a useful description of Piedmont savanna composition.

Canopy

Currently, the forest type of the Piedmont is described as oak-hickory-pine by Küchler (Doerr and VanLear 1). Studies indicate that most of the presettlement forest was dominated by hardwoods, mainly of an oak-hickory type, which reached their best development on the widespread deep, sandy loams overlaying the clays of the Cecil, Lloyd, and Davidson series. A survey by Plummer in 1957, examining original land survey records of over half a million acres of Georgia Piedmont, found that forest vegetation at the time of settlement was oak-pine-hickory at a ratio of 53:23:8 (Skeen, Doerr and VanLear 6-7). Old surveys of the Black Belt Prairie in Alabama showed a similar ratio of 52% oak, 9% pine and 5% each of hickory, gum, and ash (Risser et al. 64). Examination of remnant old growth, and studying the patterns following disturbances, show that oaks found on favorable sites were mainly white, northern red, and black; on intermediate sites were mainly black, southern red, and post; and on marginal sites were mainly post and blackjack (Skeen, Doerr and VanLear 14).

On the 1773 *Map of the Ceded Lands* by Phillip Yonge, an area encompassing much of the east Georgia Piedmont is described:

> The lands in general consist of Oak and Hickory in many places intermixed with black walnut, chestnut, and tupelo especially in the vallies, level lands

> and cane brakes, the hilly lands consisting of Oak and Hickory with some few pines.

Benjamin Hawkins, traveling through the west Georgia and Alabama Piedmont in an area form the Chattahoochee to the Tallappoosa and Coosa rivers, noted the tree composition among his descriptions. While informative, his descriptions of species composition are not necessarily specific enough to be used as a model:

> The soil is stiff, with course gravel, and in some places, stone. The trees are post oak, white and black oak, pine, hickory and chestnut, all of them small. (Hawkins 19)
> … open, flat, land, the soil stiff, the trees post and black oak, all small. (19)
> The growth of timber is oak, hickory, and the short leaf pine; pea-vine on the hill sides and in the bottoms, and a tall, broad leaf, rich grass, on the richest land. (20)
> The waving land to its source is stiff. The growth is post oak, pine and hard shelled hickory. (26)
> The timber is post oak, hickory, and pine, all small. (28)
> …post oak, hickory, and pine land…(29)
> The upland is generally stiff, rich and fit for culture. Post oak, black oak, pine and hickory, all small are the growth. (44)
> …there are sharp, stoney hills, the growth is pine, and the branches all have reed. (45)
> …pine, oak, hard shelled hickory, and on the ridges chestnut… (46)
> …oak, hickory and pine, gravelly, trees all small, chestnuts on the ridges…(47)
> …large reedy glades in flat land; red, post, and black oak, all small…(47)
> …gravelly with oak, hickory, and pine…(47)
> …pine, oak and small hickory…(49)
> …red oak and small hickory… (49)
> …oak, hickory and a few poplar… (54)
> …broken land, chestnut, pine, post oak, hickory, and red oak…(54)
> …post, red oak, pine and hickory…(54)
> …broken land, hickory, pine, chesnut, cane along the creek …(55)

In his 1992 doctoral thesis, Charles Mark Cowell examined historic survey records, which note species of marker trees, to reconstruct the structure of the presettlement forest. The study area, between the Oconee and Ocmulgee rivers, is representative of much of the Piedmont in its typical rolling convex topography and eroded Ultisols, mostly of the Cecil series. As seen in Figure 5.6, the 1804-1806 surveys indicate an extensive change in composition frequency from the presettlement forest to today's secondary forest.

common name	species name	% presettlement	% change
pine	*Pinus spp.*	26.8	-24.6
post oak	*Quercus stellata*	17.5	-15.2
black oak	*Quercus velutina*	10.9	-9.7

red oak	*Quercus rubra*	10.5	-1.7
hickory	*Carya spp.*	10.1	7.5
white oak	*Quercus alba*	7.3	14.1
s. red oak	*Quercus falcata*	2.7	3.4
dogwood	*Cornus florida*	2.7	5.0
chestnut	*Castanea dentata*	1.7	-1.5
poplar	*Liriodendron tulipifera*	1.5	4.6
black gum	*Nyssa sylvatica*	1.3	1.8
blackjack oak	*Quercus marilandica*	1.1	-1.2
total		94.1	

Figure 5.6 Forest-wide presettlement species composition and change to the present species composition (Cowell 32,122).

Of the most increased species, white oak has risen 14.1%, hickory 7.5%, dogwood 5.0%, and tulip poplar 4.6%. Of the most decreased is pine at -24.6%, post oak at -15.2%, and black oak at -9.7%. This reflects an increase in fire intolerant species and a decrease in fire tolerant species across the forest spectrum. The differences in the two periods show a recent suppression of large scale disturbance by fire (121-122).

Cowell's study also describes floodplain, lower slope, mid-slope, upper slope and flat upland composition as shown in Appendix A (123-127). Floodplain, now dominated by sweet gum, box elder, birch and ash, was once dominated, though not by great margins, by white oak, hickory, pine, post oak and black oak. The remaining 50% of tree species found on the floodplain included northern red oak, ash, tulip poplar, dogwood, maple, black gum, sweet gum, southern red oak, sassafras, beech, chestnut, persimmon, buckeye, mulberry, willow, holly, basswood, sourwood, cucumber, chinquapin, bay, crab, hawthorn, evergreen, cherry, blackjack oak, elm, ironwood, sugar, chestnut oak, wahoo, water oak, and birch.

The lower slope community, now dominated by hickory, white oak, dogwood, tulip poplar, and red oak, was dominated by pine, post oak, hickory, white oak, black oak, and northern red oak. The remaining 20 % of species included ash, elm, chestnut, blackjack oak, buckeye, persimmon, sugar, sassafras, cucumber, chinquapin, birch, cedar, walnut, alder, basswood, mulberry, water oak, wahoo, southern red oak, sourwood, ironwood, black gum, maple, beech, sweet gum, and dogwood.

The mid-slope community, now dominated by white oak, hickory, and dogwood, was dominated by pine, post oak, red oak, black oak, and hickory. The remaining 21% of species included white, oak, chestnut, blackjack oak, sassafras, elm, persimmon, bay, willow oak, walnut, chinquapin, basswood, cherry, ironwood, mulberry, cucumber, water oak, southern red oak, ash, beech, sourwood, black gum maple, tulip poplar, sweet gum, hop hornbeam, and dogwood.

The upper slope community, now dominated by white oak, hickory, and northern red oak, was dominated by pine, post oak, black oak, northern red oak, and hickory. The remaining 19% of species included white oak, chestnut, blackjack oak, sassafras, persimmon, elm, ash, mulberry, sugar, chinquapin, basswood, wahoo, cherry, cucumber, water oak, black gum, hop hornbeam, beech, dogwood, sweet gum, tulip poplar, southern red oak, maple, and sourwood.

The flat upland community, now dominated by white oak, hickory, southern red oak, and northern red oak, was dominated by pine, post oak, black oak, northern red oak, and hickory. The remaining 15% of species included white oak, southern red oak, chestnut, blackjack oak, sassafras, black gum, persimmon, hawthorn, cherry, wahoo, willow oak, walnut, sweet gum, ash, holly, water oak, dogwood, maple, and tulip poplar.

Interestingly, both upland and floodplain species were found along major streams and rivers, while smaller creeks were dominated by mainly upland species. This reflects disturbances such as upland fire encroachment and Indian agricultural practices (138). Shortleaf pine was probably predominant among pine species in savanna landscapes of the upper Piedmont, as it is more tolerant of frequent fire than loblolly (58), while longleaf pine may have been the dominant among pine species in the lower Piedmont, especially in Piedmont longleaf pine flatwoods (Schafale and Weakley 80).

With large scale landscape disturbances widespread in the presettlement Piedmont, climax forest communities were probably not always of the typical oak-hickory-pine composition. Different varieties of major disturbances, followed by still different variations of subsequent disturbances, might have initiated, and then maintained, different types of stands (Cowell 3). For example, as a result of canopy fires, pines may have formed pure stands in some areas (Cowell 58). On the other hand, Spangenberg in his account transcribed by Fries, and Lawson described the lack of pines for roughly two days' journey in the area of Iredell and Rowan Counties, North Carolina. A trial analysis of corner trees from old land grants also showed only a few pines, though there was a preponderance of oaks and hickories in the area (Keever 40-41). Keever believes the lack of pines to be a result of Indian burning and buffalo grazing. Perhaps in such large open areas, as in the prairie, where forest edges and seed sources were distant, pines were not able to invade (Joern and Keeler 158). Also, pines may not have been able to regenerate fast enough between very frequent fires, leaving only oaks able to resprout. Periodic burns have been shown to stimulate hardwood regeneration of southern red, post and blackjack oaks (Cowell 59).

While Cowell's study is a suitable model for forest structure for much of the Piedmont, a different composition of tree species may have occurred over areas with either more intense Indian population influences and/or more stressful soil conditions. Blackjack oak, which is a minor component in Cowell's study area, may have been more prominent on other Piedmont areas associated with more severe conditions resulting from shrink-swell soils or topography. At Mineral Springs Barren, a Nature Conservancy site near Charlotte, North Carolina, blackjack oaks dominate the canopy with short leaf pines, post oaks, red oaks, southern red oaks, and white oaks. This community is characteristic of xeric hard pan forest, and is believed to be a remnant of formerly extensive prairies and blackjack oak savannas in the Rock Hill, South Carolina area. Where canopies of this forest type have been kept open, a diverse cover of herbaceous flora occurs, with a number of species having prairie affinities (Barden, *Management* 2-4; Schafale and Weakley 78). A similar situation occurs in the post oak savanna being restored in Saluda County, South Carolina, where post oaks dominate an open canopy (Waldrop, *Establishment* 5). This site also has a well-developed herbaceous cover of grasses and forbs over shrink-swell soils. On Burkes Mountain, a serpentine barren near Augusta, Georgia, blackjack oaks are dominant with shortleaf and, formerly, longleaf pines in this blackjack oak savanna (Radford 49-50).

Longleaf pine, now virtually gone from the Piedmont, also deserves mention. Longleaf pine forests once covered large portions of the lower Piedmont along its southeastern side. Occurring over various hapludults, they may have had a flat-woods-like structure, with wire grass dominating the herbaceous layer (Schafale and Weakley 80, 81). Bartram mentions the longleaf pine as one of the savanna tree species encountered along the fall line (305).

Ground Layer

Southeastern grasslands are often described as prairie due to their floristic similarity to prairies of the central United States (Deselm and Murdock 89). The many species with prairie affinities, and others indigenous to the Southeast, composed the ground layer of vegetation, often described by early Piedmont explorers. Most accounts are very general in referring to the ground layer in terms of meadows, fields, plains, savannas, barrens, lawns, cleared ground or simply as open. Some later historians have used "prairie" to describe the same effects. A typical commodity-based description is given by Spangenberg describing a tract encompassing the area around Winston-Salem:

> …much beautiful meadow land, good pasturage for cattle, cane along the creeks… …also a good deal of barren land…
> … one can hardly find 600 acres in NC without having some "barren land" in it. (Fries 59)

Many of their accounts refer to the appearance resulting from grasses being dominant, as with Bartram and Hawkins in Georgia and South Carolina and Lawson in North Carolina:

> …a fine expanse of level grassy plains…
> …and lastly a chain of grassy savannas. (Bartram 316-317)
> …the more barren grassy hills…(268.)
> …very extensive grassy savannas…
> …pleasant grassy open plains… (306)
> …tall, broad leaf, rich grass, on the richest land. (Hawkins 20)
> …well spread with fine bladed Grass…(Lawson 38)

Bartram, as a naturalist, was the only explorer to describe the actual species that composed the ground layer. He recognized that the lists he compiled represent only a few of the "vast variety and abundance" of herbacea. With a translation to modern nomenclature from Harper's *The Travels Of William Bartram: Naturalist's Edition*, the sun-loving species from those lists are shown in Appendix B.

Various terminology used by different explorers, other than Bartram, only adds confusion and highlights the problem of historical accounts as ecological models. For instance, what are the "Strawberry Vines" that Lawson (38) sees growing in and about abandoned Indian fields? Other plants noted by explorers, usually in association with old Indian fields, include "vetch, ground nuts, or wild pea vine". Silver believes these may have been escaped bean plants, as the Moravian surveyor Reuter described: "Indian beans resemble garden Beans, though they are small. They grow abundantly in the woods, especially on good soil." (Silver 50) Bartam noted two leguminous vines, which today are

natives of forest settings, and may have been cultivated by Indians in their clearings. Wild bean, *Phaseolus polystachios,* has legumes, or pods up to 8 cm long (Radford, Alhes, Bell 639) and ground nut, *Apios americana,* was a staple food source for Indians and Pilgrims (Porcher 103). There are also other non-agricultural native legumes present in the herb layer that have pea-like flowers, so it is difficult to identify the "wild pea vine" with certainty.

There is no way known to define accurately presettlement herbaceous layer composition. Decades of soil disturbance, exotic species invasion, and canopy closing from fire suppression have obliterated all but a few tiny ground layer communities found on high shrink-swell soils, basic soils, or topographically exposed sites. These communities include the xeric hardpan forest, the diabase glade, and the ultramaphic outcrop barren. Lists of key herbaceous species found in these communities, many with prairie affinities, are provided in Appendix C. Appendix C also includes ground layer species of the Longleaf pine-wire grass communities, also once part of the southern Piedmont; because of its proximity as the nearest studied prairie, species of the Alabama Black Belt Prairie are listed as well. Over more typical Piedmont soils, such as the Cecil series, no relict communities were identified in this study, though roadsides, ditches, and meadows may provide refuge for savanna species. A list of such species found in the Clemson, South Carolina area (see Appendix D) compiled for use in the thesis application represents the diversity of these potential savanna survivors. Many of the species with prairie affinities found in the xeric hardpan, diabase glade and serpentine barren communities do not appear on the extensive list of roadside/meadow species found in the Clemson area. It is unclear whether this is a reflection of the altered distribution of species due to fire suppression or a reflection of the soil preferences of these species. The great variety of ground layer species on these lists reflects the potential diversity of the savanna ground plane where probably about 40-70 species per acre, as in the tallgrass prairie, would be typical (Morrison, *Design* 22).

Though fire and moisture had the greatest influence on herbaceous composition, variations in species, common on most soil types, would occur under specific conditions such as xeric hardpan barrens and upland wet depressions associated with high shrink-swell soils. Link Bog, a remnant grassland community (Radford 111-112) in Iredell County, North Carolina, is one of six such bogs located along the headwaters of Rocky Creek at the foothills of the Brushy Mountains. It represents a formerly more common ecosystem, perhaps like the "highland ponds" seen by Byrd in the 1700s (Byrd 212). Still found in the bog, though it is growing over, are fire tolerant carnivorous species: *Sarracenia flava, S. purpurea* and *Drosera rotundifolia.* They are virtually unknown elsewhere in the Piedmont. Seasonally wet upland depressions over similar soils occur in other places in the Piedmont, such as in the post oak savanna in Saluda County (Waldrop *Establishment*) and may have once also supported distinct species. Camassia Flat (Radford 189-190) in York County, South Carolina is another wet site over montmorillonitic soils that is now a woodland, but was probably a savanna or prairie in presettlement times. It still supports some herbs with prairie affinities which are very rare east of the Appalachians, or rare in South Carolina, including *Camassia scilloides*, wild hyacinth; *Ranunculus fascicularis*, prairie buttercup; *Scutellaria parvula*, a skullcap; as well as other wet meadow species such as *Allium bivalve, A. canadense, Cardamine bulbosa, Melanthium virginicum, Viola septemloba,* and *Zephyranthes atamasco.* Mineral

Springs Barren in Union County, North Carolina, a xeric site also on montmorillonitic soils, still supports many prairie species including the endangered *Helianthus schweinitzii*, and the rare *Lotus helleri, Aster georgianus* and *Gnaphalium helleri* (Barden, *Management* 8). Other Piedmont savanna areas to consider as having distinct communities of herbaceous species include the former longleaf pine-wire grass communities near the Coastal Plain; and Burkes Mountain, serpentine barren near Augusta, Georgia where Georgia basil, broomstraw, panic grasses, and legumes such as rattlebox, pencil flower, white baptisia, tephrosia, lespedeza, and butterfly pea can be found, as well as the rare *Clematis albicoma, Polygonatum tenue,* and *Manfreda virginica* (Radford 49-50).

The following information on prairie plant characteristics is summarized from Marguerite McCrary Haywood's 1989 thesis (32-40). Of the prairie herbaceous species there are two general categories: grasses and forbs. Grasses dominate the prairie community, composing 90% of the vegetation though composing only a quarter or so of species diversity. This gives grasslands a strong visual continuity. The great majority of prairie and thus Piedmont savanna grasses are warm season perennials. Resprouting year after year from the roots, warm season grasses begin growing when minimum daily temperatures are in the low 60s. There are also cool season grasses to be found that grow in the spring and fall, and in the winter in the south, when minimum daily temperatures are in the low 40s. Grasses with their vertically arranged, long, narrow blades maximize photosynthesis, while minimizing leaf transpiration, making them well adapted to exposed environments. Forbs, by contrast, have a broader, more horizontal leaf pattern. Forbs, only 10% of the total vegetation, make up the majority of the diversity. Forbs and grasses have variations in root depth, plant height, form, and seasonal requirements. This means that during the different yearly, seasonal, and daily conditions, at least some species will be able to capitalize on existing conditions. This also means that many plants of many varieties can occupy a small space while they utilize different levels of soil, canopy light, and other resources through the year. It is this sort of diversity that gives prairie communities a great deal of range and stability and protection from weedy invaders. Distribution of the herbaceous layer is primarily influenced by microclimate, which involves soil type, soil pH, soil depth, soil moisture, fertility, topography, slope orientation, and, in the case of the savanna, light availability. Of these conditions, moisture is the most important and soil pH the least. Along a moisture gradient species composition varies from more spaced, shorter, and less diverse, to denser, taller, and more diverse.

Cane

Canebrakes, sometimes of immense size, were ubiquitous in the wet soils of the Piedmont. Because they very often intermingled and formed edges with Piedmont savannas, it is important to consider them as a component, though not actually part of the savanna. Though cane (*Arundinaria gigantea*) is a grass, and constitutes a graminoid stratum, its height and density obstruct the open characteristic of savannas.

In the presettlement Piedmont the abundant canebrakes provided both cover and forage for deer and buffalo, especially in the winter (Silver 25, 26). Explorers, especially those who traveled along rivers, noted it often. As a member of a survey party, Byrd frequently mentioned canes along the creeks and rivers they had to cross. Along one

creek, he described cane growth of 12-16 feet high, some as “thick as a mans wrist” (Byrd 192). Spangenberg in North Carolina, and Hawkins and especially Bartram in Georgia and Alabama all refer to the abundant cane, often as it relates to adjacent grasslands:

> …rich low land cover with canes, adjacent land is higher also rich where indians plant, grass grows freely, about half the land is barren, but has some trees on it. (Fries 53)
>
> …creeks are “margined with cane or reed, on narrow strips or coves, of rich flats.” (Hawkins 19)
>
> … the face of the country is chiefly a plain of high forest, savannas, and cane swamps…” (Bartram55)
>
> We then passed over large rich savannas or natural meadows, wide spreading cane swamps, and frequently old Indian settlements, now deserted and overgrown with forests. (57)
>
> A large cane swamp and meadows, forming an immense plain, lie S.E. from it; in this swamp I believe the head branches of the great Ogeeche river take their rise.” (58)
>
> …the low lands of the Oconee… …the cane swamps of immense extent, and the oak forests, on the level lands, are incredibly fertile;…(60)
>
> There are extensive cane brakes or cane meadows spread abroad round about, which afford the most acceptable and nourishing food for cattle. (304)
>
> … on the gradual descents of the ridges and their bottoms bordering on creeks, and very extensive grassy savannas and cane meadows always in view on one hand or the other… … here being pleasant grassy open plains to spread our beds upon, environed with extensive cane meadows, … (306)
>
> …a pleasant territory, presenting varying scenes of gentle swelling hills and levels, affording sublime forests, contrasted by expansive illumined green fields, native meadows and Cane breaks… (307)
>
> …low swelling hills and plains supporting grand forests, vast Cane meadows, savannas, and verdant lawns. (308)
>
> …with hills and dales, savannas, and vast cane meadows… … diversified with expansive groves, savannas and Cane meadows… (309)

> …low hills affording high forests, with expansive savannas, Cane meadows and lawns between,… (312)
>
> plains, detached forests and groves… … vast Cane meadows, and lastly a chain of grassy savannas. (317)
>
> vast level plain country of expansive savannas, groves, Canes swamps and open Pine forests (318)

The reasons for the development and disappearance of such large and widespread brakes are related mainly to fire. Ralph Hughes, in his 1966 article "Fire Ecology of Canebrakes" (149-158), explains the relationship of *Arundinaria* to fire, pointing out that fire every 3-4 years is of great benefit to cane stands. Cane has a heavy underground stem or rhizome protecting its food reserves from fire and grazers. Fire reduces canopy competition, and promotes new and immediate growth. Following dormant season fires, new cane shoots grow at a phenomenal rate of as much as 1.5 inches per day in late May and June. Such quick cover would also reduce competition. Unfortunately, canebrakes reach maturity and lose dominance over other plants after only 10 years of fire suppression, causing them to thin out and die. Even when appropriate conditions are restored regeneration is very slow, since stands low in vigor cannot reclaim bare areas due to the plant's sporadic flowering, scant seed production, and slow seedling growth.

Fauna

Piedmont savanna landscapes might have been characterized as high in edges and ecotones. The edge, or ecotone, results where two communities come together to create habitat supporting greater number and variety of creatures than could either community alone. For instance, where forest and grassland abut, species will use one community for feeding and the other for shelter. The barred owl and the great horned owl do not nest in grasslands but use them for foraging where they are adjacent to woodland (Deselm and Murdock 103-105).

It seems reasonable that the majority, if not all, of the major native animal species found in Piedmont edge environments today were present to some extent in the presettlement savanna. There are, however, a few animals that were unique to the Piedmont savanna that are no longer found in the region. As mentioned in the section on fire and animals, large herds of buffalo, and a scattering of elk, were once found in the Piedmont savannas, as were wolves (Silver 26). It has been mentioned by (Kaufhold 3) that prairie chickens may have been present, presumably because the Cherokee had a name for them. However no mention of Piedmont prairie chickens has been found elsewhere. Today prairie species are generally not found in the Southeast, though many southeastern species are adapted to grassland habitats (Deselm and Murdock 103).

Some southeastern bird species are known to frequent maintained areas such as small grass-strip airports, large lawns of school campuses, and golf courses, while a few others are mainly associated with coastal grasslands. As birds associated with modern southeastern grassland habitat, they might have once been found in the Piedmont savanna, although there is no record to show this. These birds include the horned lark, brown-

headed cowbird, cliff swallow, dickcissel, loggerhead shrike, eastern meadowlark, savanna sparrow, and upland sandpiper (Deselm and Murdock 104).

Burrowing mammals such as voles, moles and groundhogs provide soil structural diversity for invertebrates and create burrow habitat for other ground-dwelling species. They also enhance grassland structure by preparing seed beds, contributing to the aeration of the soil, increasing porosity, improving local drainage, and helping incorporate humus and nutrients into the soil. Rodents, especially rabbits, are important in maintaining a tussocky character in grasslands, especially on edges. Prairie deer mouse, meadow vole, and eastern mole are prairie species that are found in southeastern grasslands (Deselm and Murdock 104-105).

In the modern Piedmont, edge communities of grasslands or other human-caused disturbances have increased deer and red fox distribution and may be responsible for the recent eastward migration of the coyote (Deselm and Murdock 104). Such a dynamic resembles the relationship between Indian clearing and southeastern buffalo migration. This comparison points out that humans have been and continue to be very much involved in the “natural” processes of the Piedmont.

Chapter VI
Visual Characteristics of the Piedmont Savanna

Aesthetic Perspectives

Unfortunately, no pictorial images of the Piedmont savanna landscape are known to survive from the colonial period. Colonial art work dealt mainly with identifying and categorizing detailed aspects of the flora and fauna, not with the landscape as a whole (Weekley 3). In such illustrations by Bartram, Catesby, White and others, landscapes occasionally appear as background; however none of them were found to be Piedmont landscapes. Artistic exploration of southern landscapes in paintings did not begin until after settlement. Therefore, recreating an image of the savannas will depend on the written accounts of explorers, visual attributes of remnant eastern North American savannas, and the ecology already discussed in Chapter *V*.

Early explorers seem to have found the Piedmont savanna a "salubrious" environment, much to their liking. Other adjectives they used in describing Piedmont savannas include pleasant, fine, beautiful, charming, rich, and desirable. Such an appreciation may have been due to reasons similar to those discussed in the section on landscape preference, although there were also other motives. In a time well before the advent of modern medicine, peoples of the seventeenth, eighteenth and nineteenth centuries struggled continually with diseases and epidemics. Low, wet, warm environments, where air did not circulate, were justly considered unhealthy and undesirable. The "good" air of the open woodlands and savannas of the elevated Piedmont presented a wholesome and preferable climate:

> The Countrey here, though high, is level, and for the most part a rich soyl, as I judged by the growth of the Trees; yet where it is inhabited by Indians, it lies open in spacious Plains, and is blessed with very healthful Air,… (Lederer 24)

Besides their healthy quality, savannas also presented a bucolic aspect, easily recognizable to European arrivals. Foote recreates the scene in North Carolina:

> Extensive tracts of country between the Yadkin and the Catawba, now waving with thrifty forests, then were covered with tall grass, with scarce a bush or shrub, looking at first view as if immense grazing farms had been at once abandoned, the houses disappearing, and the abundant grass luxuriating in its native wildness and beauty, the wild herds wandering at pleasure, and nature rejoicing in undisturbed quietness. (Foote 189)

Perhaps it is best summed up by Bartram as "a beautiful landscape diversified with groves and lawns." (313)

Some Midwestern savannas provide a glimpse of the potential appearance of the presettlement Piedmont savanna. As fire-dependent communities, Midwestern savannas

are scarce in today's landscape, so their current appearance may only be a shadow of the past. Perhaps it would be appropriate to keep in mind James Fenimore Cooper's description when viewing these remnants:

> Although wooded, it was not as the American forest is wont to grow, with tall straight trees towering towards the light, but with intervals between the low oaks that were scattered profusely over the view, and with much of that air of negligence that one is apt to see in grounds, where art is made to assume the character of nature. …the variety is produced by their distribution. In places they stand with a regularity resembling that of an orchard; then, again, they are more scattered and less formal, while wide breadths of the land are occasionally seen in which they stand in copses, with vacant spaces, that bear no small affinity to artificial lawns, being covered with verdure. (Cooper 10-11)

In the lower Piedmont, pine may have dominated many savanna landscapes. Visual representations of these savannas might be found in images of pine savannas in the Coastal Plain and Sand Hills or even in the managed pine woodlands of the Piedmont National Forests.

Figure 6.1 Oak Savanna at Illinois Beach State Park (photo by author).

Figure 6.2 Pine savanna near Thomson, Georgia (photo by author 1997).

Figure 6.3 Burkes Mountain savanna (photo by author, 1997).

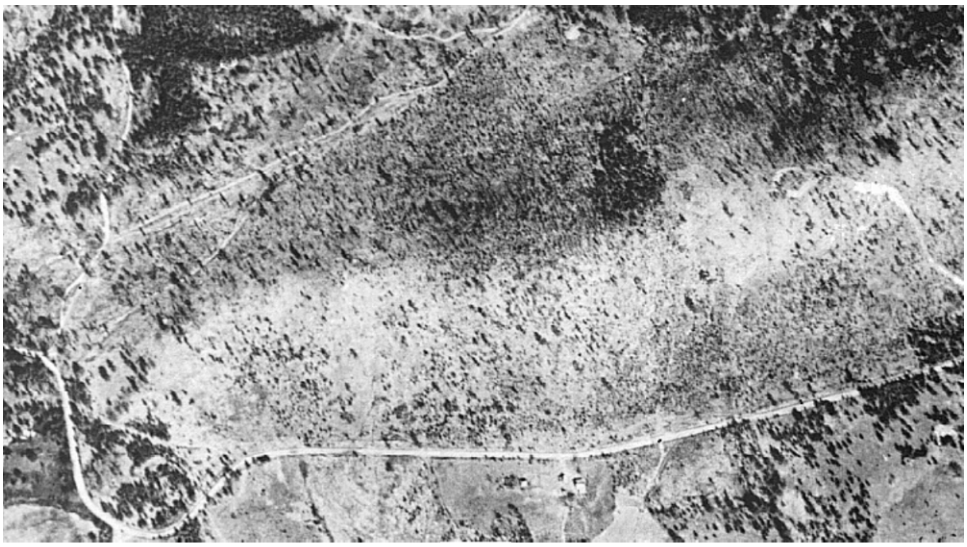
Figure 6.4 Post oak savanna in near Edgefield, South Carolina (photo by author).

Within the Piedmont, there are only a couple of modern "natural" landscapes that may possess the visual characteristics of the former savannas. Burkes Mountain (Figure 6.3), a very rare community, offers some of the aesthetically preferred appearance of savanna structure in a Piedmont setting. The post oak savanna in Saluda County (Figure 6.4) is also representative, though it is undergoing restoration and will take many years to fully regain the visual characteristics once common in the Piedmont.

While the presettlement Piedmont savanna was not by any means an undisturbed landscape, it could be seen, when compared to today's levels of disturbance, as a "natural landscape". In his 1966 paper "Aesthetics of the Natural Environment," Dasmann identifies four characteristics typical of an undisturbed landscape that contribute to our perception of beauty: order, diversity, health, and function (Morrison 168). Holding these up to the Piedmont savanna gives support to its description as aesthetically preferable. In the Piedmont savanna order is provided by the graminoid stratum; diversity is provided by the variations of topography, drifts of ground layer vegetation and by the various arrangements of canopy vegetation; health, attested to by explorers, is evidenced in the lush growth of cane and grasses and the "salubrious breezes"; and function is shown by the abundance of animal life preferring its edge-like environment.

Patterns and Structure

The potential appearance or visual characteristics of the Piedmont savanna can be revealed by examining its patterns (distribution) and structure (form). Potential relationships and specific characteristics can be examined at both a larger landscape scale and at a finer community and species scale.



1941

1967

Figure 6.5 Burkes Mountain, 1941 and 1967 (USDA *JO 3B 08*, USDA *JO 4HH 78*). Persistence over time as a topo-edaphic climax savanna community is demonstrated where, on the upper south slope of the hill, almost the same density of cover occurs in 1967 as in 1941. A personal exploration of the site found similar cover present in 1997.

Landscape Patterns and Structure

Much understanding of the potential "natural design" of the Piedmont savanna can be discovered by examining its horizontal patterns and structure at a landscape scale. Such an examination will describe relationships and changes in canopy vegetation distribution over the landscape as it relates to topography. As an example, the horizontal distribution patterns of the blackjack oak savanna on Burkes Mountain (Figure 6.5) can be observed in aerial photographs.

A table and corresponding illustration (Figures 6.6 and 6.7) have been drawn to describe Piedmont savanna canopy distribution based on the major controlling factors of topographic setting, soil condition, and fire regimen as informed by this thesis. Figure 6.8 is a section representing the vertical structure the canopy might have across a given landscape. While the information on the table and illustrations reflects a summarization of research and not quantitative analysis, it does offer a logical comprehensive cross section of potential savanna landscape situations throughout the Piedmont.

Usually, well defined edges would be hard to find in the savanna, since grassland and forest patterns grade into each other gently. For instance, tallgrass prairie can grade for many miles through thickening oak savannas before it becomes woodland. Abrupt boundaries, however, might be found along rivers and places of rapid soil or topographic change (Risser et al.115). It seems reasonable that edge definition would be weakest on flat or gently rolling uplands of the Piedmont savanna where few sharp changes in topography or soil take place.

The patterns of canebrakes in the landscape would have expanded and contracted with the moist soils along drainage ways. They might have merged imperceptibly, or transitioned sharply into meadow or woodland. The definition of canebrake edges would have depended on soil moisture change and patterns of fire.

Whether related more to soil conditions or the play of fire on the landscape, tree distribution in the Piedmont savanna could be described as having taken the form of a few scattered individuals, groves of various sizes, peninsular incursions into open space, or more or less evenly distributed trees. These various scenarios can be seen as they relate to various topographical and pedological conditions in Figure 6.7.

Vegetation distribution patterns often corresponded with vegetation structure across the landscape. Figure 6.8 illustrates this relationship. The stunted, potentially very old, low trees on uplands seen by Byrd and Hawkins appeared primarily as scattered individuals or groves. Better developed “high forest” trees, such as pines and white oaks, were probably more evenly distributed on lowlands or uplands with better soil. The Revolutionary War Battle of Cowpens in South Carolina was fought in such a savanna landscape. Actual battle documentation can be interpreted to show in Figure 6.9 about 16 trees with 50 ft diameter canopies just touching to occupy one acre (Westmacott 9). Where Indian agriculture opened large patches of tall lowland forests, remaining trees would be distributed as the groves and forest appendages often described by Bartram. Grove formations, whether short and stunted or tall and full, would have been a key element in the aesthetic richness of the Piedmont savanna, and are highly valued aesthetically by many people. Many place names in the Piedmont, though not necessarily all of settlement origin, include the word “grove,” usually preceded by “oak” or “pine,” and many old farm houses can be found situated amidst groves of sometimes even older oaks.

Horizontal Patterns Of The Presettlement Piedmont Savanna

Vegetation distribution related to; soil condition, fire frequency, and topography.

The table used is drawn from conclusions made in this thesis and is organized according to the major controlling factors of topographic setting, soil condition, and fire regimen. It offers a generalized comprehensive cross section of savanna landscape situations throughout the Piedmont.

	Typical Piedmont Soil Conditions		Special Piedmont Soil Conditions	
	Occasional Burning (every 5-15 years)	Frequent Burning (every 1-5 years)	Occasional Burning (every 5-15 years)	Frequent Burning (every 1-5 years)
Steep Hill Tops & South Facing Slopes	1. open woodland matrix with occasional open patches	2. open woodland matrix with sometimes large open patches	3. grassland matrix with scattered wooded patches (ultramaphic outcrop)	4. grassland matrix with few scattered small wooded patches (ultramaphic outcrop)
Flat or Gently Rolling Upland	5. open woodland matrix with occasional open patches	6. open woodland matrix with frequent sometimes large open patches **See figure 6.14.**	7. open woodland matrix with frequent large open patches (shrink-swell, soils)	8. grassland matrix with occasional wooded patches **See figure 6.16.** (shrink-swell, soils)
Stream Head-waters or Wet Upland	9. open woodland matrix with canebrakes patches	10. open woodland matrix with large canebrakes and meadow patches	11. grassland matrix with canebrake patches and small woodland patches (shrink-swell soils including upland depressions)	12. grassland matrix with small canebrakes patches and very small wooded patches (shrink-swell soils including upland depressions)
Upper, Middle & Lower Slope	13. open woodland on upperslope to closed on lowerslope	14. open woodland on upperslope to closed on lowerslope	15. very open woodland on upperslope to closed on lowerslope (shrink-swell soils are less important on slopes)	16. open grassland on upperslope to closed woodland on lowerslope (shrink-swell soils are less important on slopes)
River or Creek-side Lowland	17. open to closed woodland matrix with canebrake patches, and depending on Indian agriculture, small to large open patches	18. open woodland matrix with large canebrake patches, and depending on Indian agriculture, small to large open patches **See figure 6.15.**	19. similar to 17	20. similar to 18

Figure 6.6 Vegetation canopy distribution table.

Horizontal Patterns Of The Presettlement Piedmont Savanna

Vegetation distribution related to; soil condition, fire frequency, and topography.

Illustration is keyed to Figure 6.6

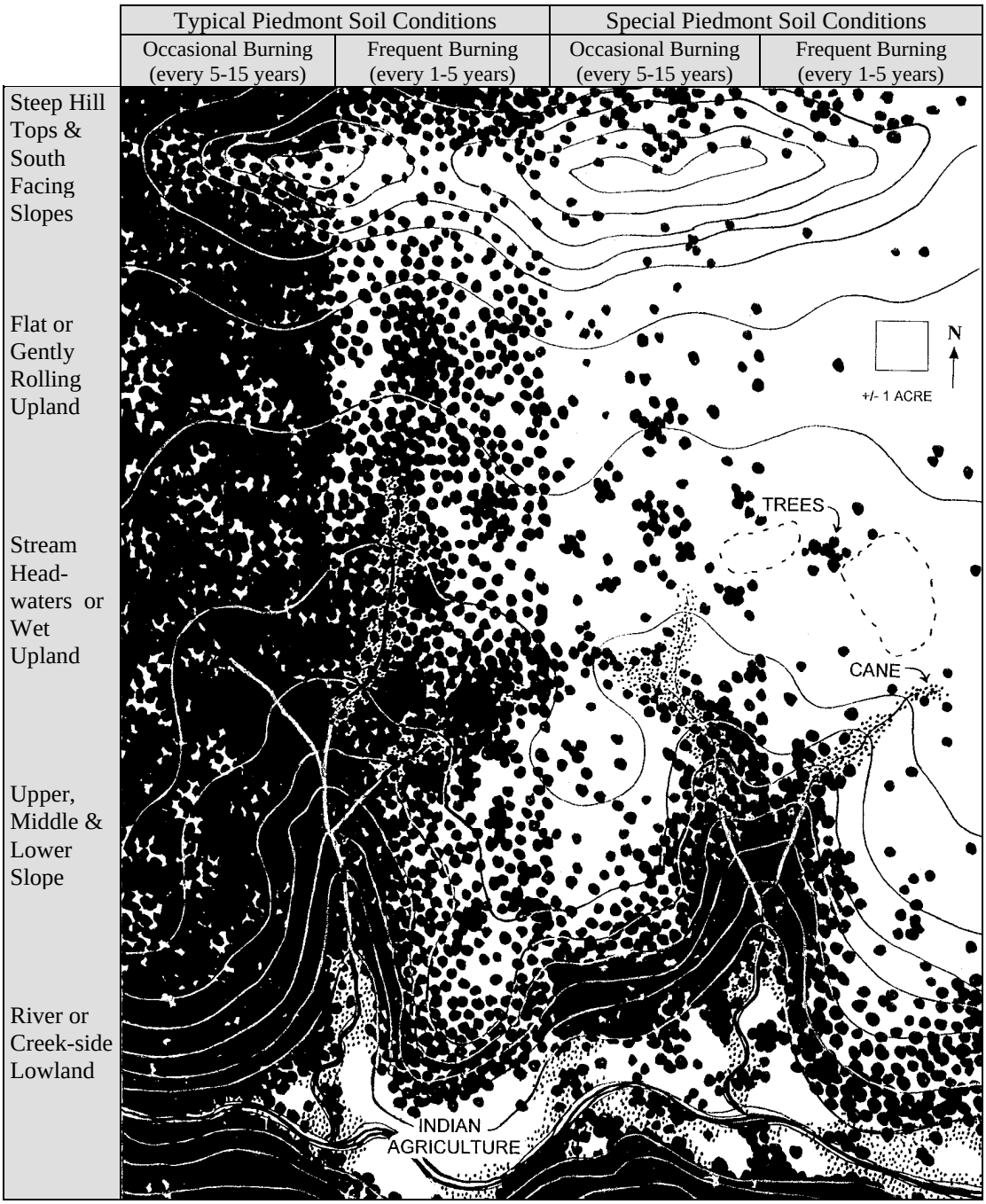


Figure 6.7 Vegetation canopy distribution illustration.

Vertical Structure Of The Presettlement Piedmont Savanna

Vegetation structure related to; soil condition, fire frequency, and topography.

Illustration is keyed to Figure 6.6

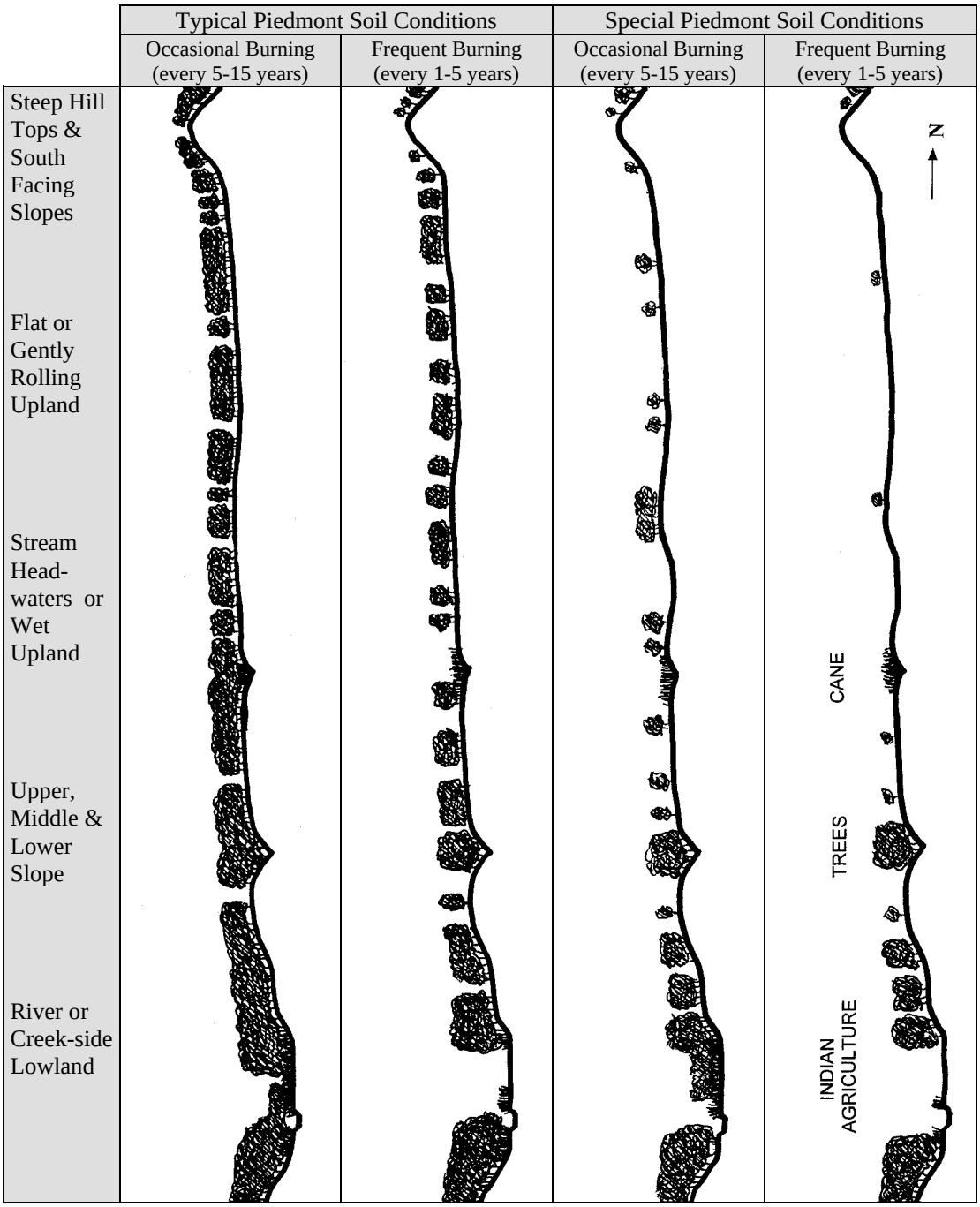


Figure 6.8 Vegetation structure illustration.

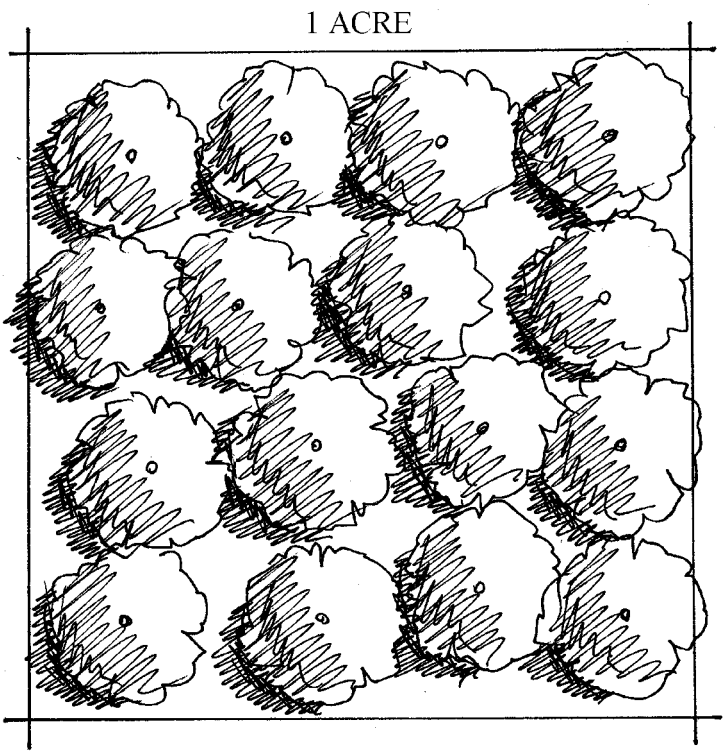


Figure 6.9 Sixteen canopies just touching in one acre.

Figure 6.10 Grove near Ila, Georgia (photo by author)

Community Patterns and Structure

Darrel Morrison in *Landscape Restoration in Response to Previous Disturbance* (169, 170) describes unique aesthetic characteristics which are typical to the tall grass prairie ground plane which may serve as a model for the Piedmont savanna. These characteristics include lines, texture and movement, color, drifts, and edges. Lines, texture, and movement are evidenced in the abundant grasses: vertical to arching lines are prevalent; there is a fine textural quality; and movement is seen in the wavelike motion of grasses, both symbolically and in breezy conditions. Of color, the stratum of grasses provide a background of bright greens in the spring, to yellowish to blue-greens in the summer, to tan, bronze, and purplish tones in the fall and winter. Within this framework flowering forbs provide flecks of mainly pastel colors: pinks, blues, yellows, and whites in the spring and more dramatic golds and purples later in the season. Drifts, resulting from microenvironmental conditions such as soil texture and moisture, and plant reproductive strategies such as wind blown seed (Morrison, *Landscape* 170) reflect the gradation of dominance of one or another species through a given area. Edges, for similar reasons, reflect a more rapid transition from one dominant species type to another. For instance, the "drift" of dandelions in one's lawn reflects the prevailing westerly wind blowing them from their source in the neighbor's weed patch; but their inability to sprout in the driveway creates an edge. In the Piedmont savanna drifts and edges might be revealed as purplish "drifts" of big blue stem, and as canebrakes edging a stream. Drifting patterns of color and texture seen in the prairie (Figure 6. 11) demonstrate the patterns once found in the savanna ground layer.

Figure 6.11 Drifts of prairie flowers in a pasture near Flint, Michigan (photo by author).

In a given plant community, certain species have a visual presence that defines the essence of the community (Morrison, *Landscape* 164). Early explorers made descriptions of Piedmont savannas that often referred to particularly remarkable species. While their descriptions are informative, however, they were made in the spirit of landscape as commodity, so it cannot be assumed that the species most remarkable to them were "visual essence" species. Even Bartram's descriptions, which are much concerned with species diversity, do not necessarily reveal "visual essence" species. Hawkins, in descriptions of the Black Belt Prairie and the western end of the Piedmont, reveals the relatedness of visually key species and the commodity of rich land while also providing a starting point for determining visual characteristic:

> In the wooded parts the growth is generally post oak, and very large, without any under brush, beautifully set in clumps. Here the soil is a dark clay, covered with long grass and weeds, which indicate a rich soil. (Hawkins 23)

> The growth of timber is oak, hickory, and the short leaf pine; pea-vine on the hill sides and in the bottoms, and a tall, broad leaf, rich grass, on the richest land. The whole is a very desirable country. (Hawkins 20)

With tall grass prairie as a model for the savanna ground plane, it may be reasonable to assume that the seed stems of the bluestems, broom sedge, Indian grass, and plume grasses might be considered "visual essence" species in the fall and winter season, while *Baptisia* and other forbs might visually dominate the early growing season and *Helianthus* the later season. Of course different species, such as switchgrass, Joe Pye weed and cane would have been visually dominant in lower, moister savannas.

Trees of any species would be visually important to the savanna because of their contrasting relationship to the grassy ground plane. Which canopy species were of a greater "visual essence" might depend on the type of savanna and the time of year. Longleaf pine would obviously visually dominate the longleaf savannas. In situations where oaks are mixed in with pines, pines might dominate in the winter as evergreens. On the other hand, where post and blackjack oak occurred they may have been visually important, especially in the winter, due to their unique branching pattern.

Tree form is particularly important in the savannas, since trees are set off and strongly contrasted by the grassy ground plane. Generally savanna tree form would reflect development in a full sun environment, meaning savanna trees would have a more open, spreading form than trees of forest habitats. Trees unable to grow above the reach of fire would have a perpetual bushy look, while trees able to mature and grow old in spite of the disturbances of the savanna environment may have taken on unique characteristics. For example, on the glady, steep slopes and poor soils of the Ozark Plateau, post oaks dominate the canopy. These stunted, ancient, trees (up to 300 years old) are characterized by twisted trunks, dead tops and branches, exposed root collars, hollow voids, few thick limbs, leaning trunks, branch stubs, irregular bark, and fire and lightning scars (Stahle 334). It is unclear if post oaks dominating much of the Piedmont savanna were able to reach such ages, but it does not seem unlikely. In some ways the low oaks of Piedmont upland savannas may have resembled the burr oaks of the Midwest.

> The trees were of very uniform size, being little taller than pear trees, which they resemble a good deal in form; and having trunks that rarely attain two feet in diameter. (Cooper 10-11)

That trees of upland Piedmont savanna settings did not reach great size is suggested in many explorers' descriptions. Hawkins many times refers to the upland trees, including oak, hickory, and shortleaf pine, as "all of them small" (19), while Byrd also describes trees "fit for little but fuel and fence-rails." (284) Coincidentally, *The Audubon Society Field Guide To North American Trees* describes the uses for post oak and blackjack oak as posts and cross ties (Little 367, 409). While Hawkins' oaks, hickories and shortleaf pines did not attain great size, the long leaf and loblolly pine stands along the lower Piedmont uplands probably did. These open pine forests may have displayed a "sameness and uniformity of appearance" (Wells 116-117) as their many straight unbranched trunks marched unobscured into the distance. Lowland trees were probably also quite tall and

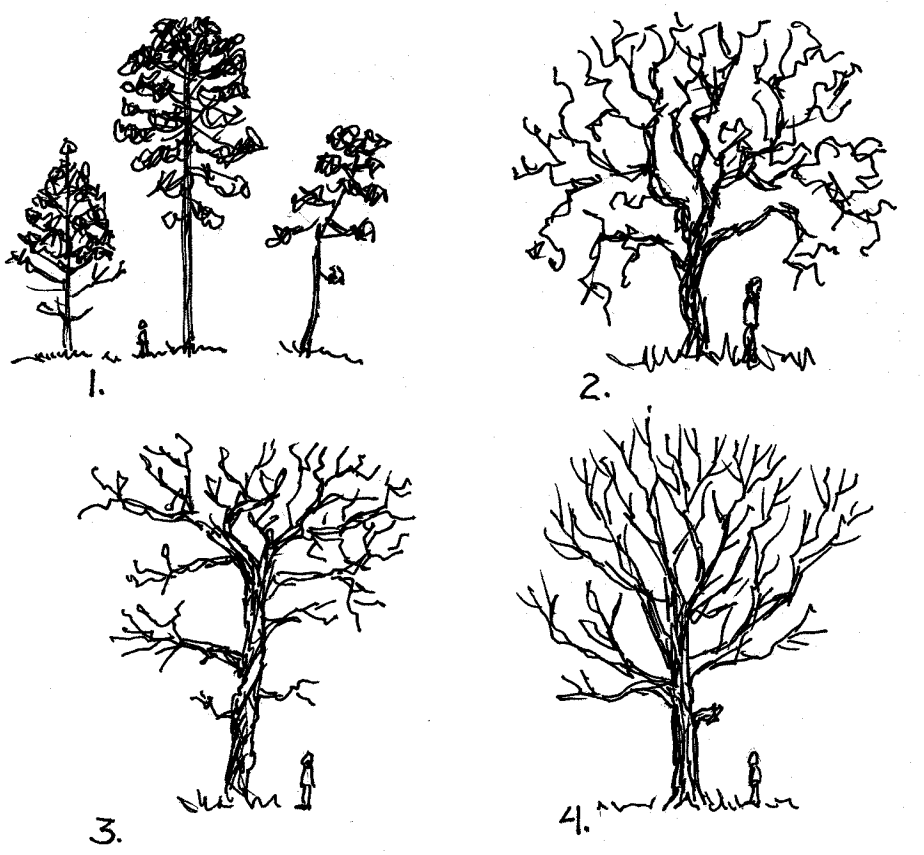


Figure 6.12 Savanna tree forms.

well developed, except where forest succession over old Indian fields was relatively young. In an open plain of the Oconee river valley, Bartram describes a "flourishing grove" as an "appendage of the high forest we had passed through" (307).

It is quite possible and probable that savanna trees were generally "limbed up" to some extent by browsers and/or fire. Deer may have contributed greatly to creating a browse line with the help of buffalo. A discussion with Dr. Frank Golley of the University of Georgia Institute of Ecology supports personal observations as to the sometimes well-defined browse zone of deer. Such a browse zone would probably not have been as pronounced as those seen today where cattle, grazing and browsing intensively in pastures, create a very clean line of open understory at about six feet (Westmacott 14). This is in part because browsing pressures may not have been as high where fences did not restrict movement of herds and because buffalo may have been, as they are on the plains, primarily grazers. Also, deer can stand on their hind legs to reach higher branches, thus reducing the likelihood of a very clean line. Fire also may have somewhat randomly killed lower limbs, as it seems to do in young modern pine stands.

Other Visual Characteristics

Distant Views

In general, the open landscape of the undulating Piedmont savanna offered both wide and long prospects. In the open woods of the Cowpens Battlefield soldiers could be seen at a distance of 500 yards (Westmacott 9) while "prairies" of North Carolina offered virtually unobstructed views. Bartram encountered many vistas in his fall line travels and even described a prospect reaching "to the utmost of sight" (316). In contrast to the forest view, savanna openness provides ability to read the often undulating topography, to view distant features, to perceive atmospheric perspective, and to see a great deal more of the sky and its displays. The relationship to landscape preference that such a prospect affords is included in the discussion in Chapter *III* regarding the studies by Kaplan and Kaplan and Appleton's theories.

The Play of Light

The play of light on savanna surfaces and through the savanna atmosphere is greatly enhanced due to the openness of the environment. Two lighting effects, one warm and one cool, are of particular importance in enhancing the visual aspect of the savanna. The first, spoken of often by Bartram as "illumined green fields" (307), happens when the sun is low in the morning and evening. The resulting effect is strongly back-lit bright yellow-green grasses contrasting with the dark shadows of tree trunks, limbs, and leaves and the dark shapes of limbless tree trunks. Second and equally important is the effect of light passing through moisture in the atmosphere. Viewed over the distances found in the savannas, objects such as receding clumps of trees appear hazier or bluer as more moisture-laden atmosphere comes between the objects and the viewer. All things considered, the visual effects once found in the Piedmont savanna constitute a landscape that would appeal strongly to our human aesthetic disposition.

Figure 6.13 Dark trunks and backlit grass at Illinois Beach State Park savanna, Illinois (photo by author).

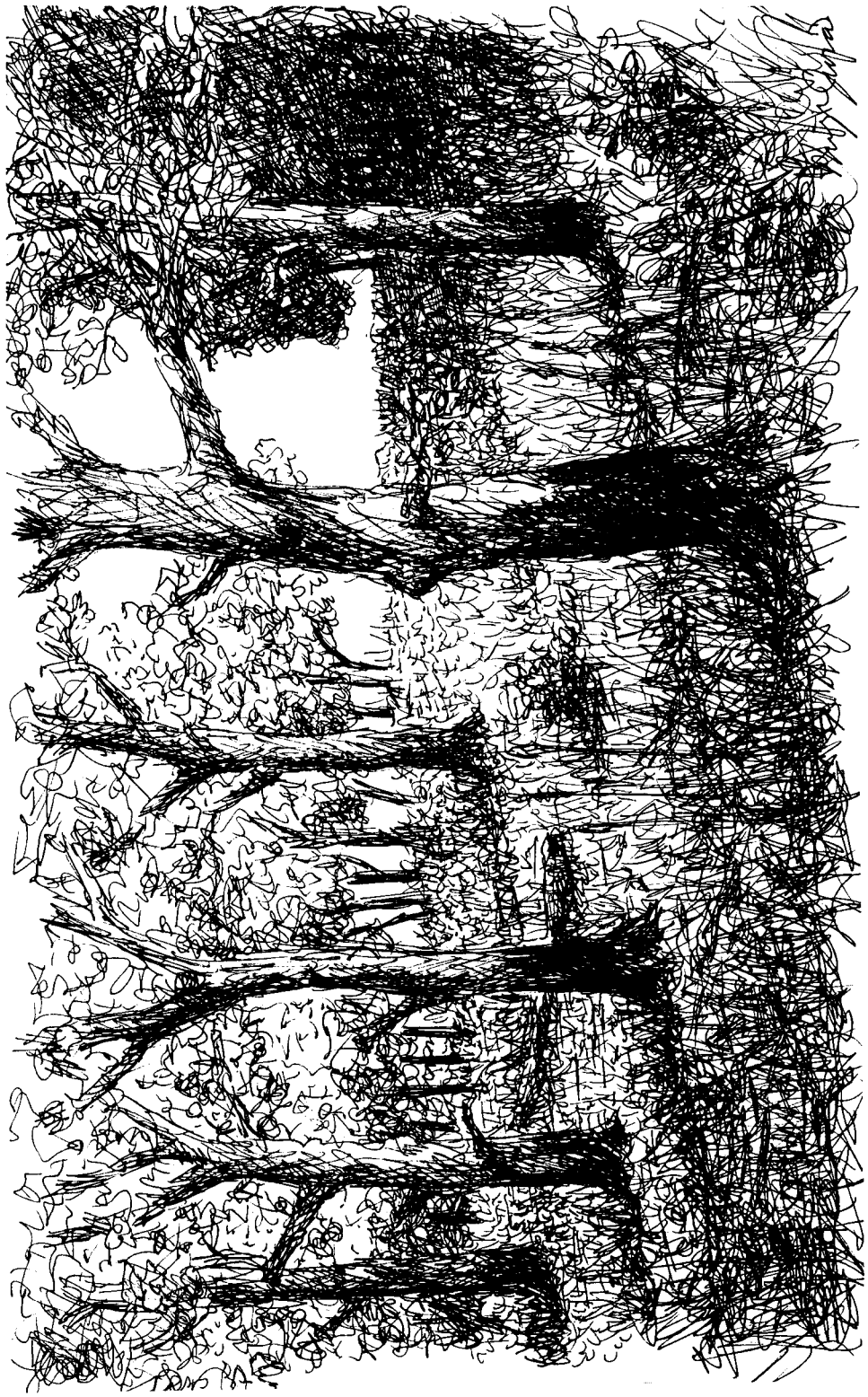


Figure 6.14 Presettlement Piedmont post oak savanna scene.

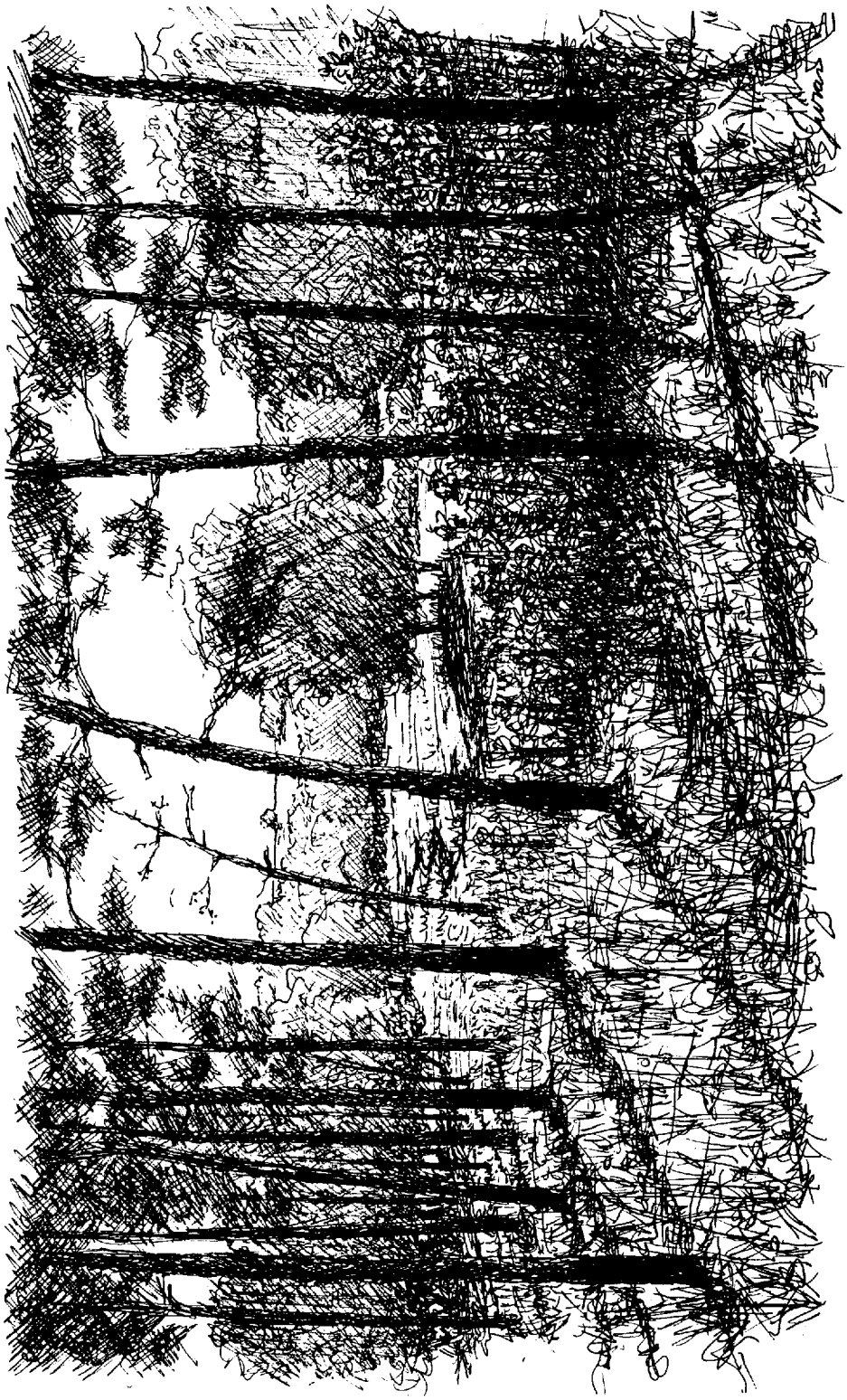


Figure 6.15 Presettlement Piedmont lowland savanna scene.

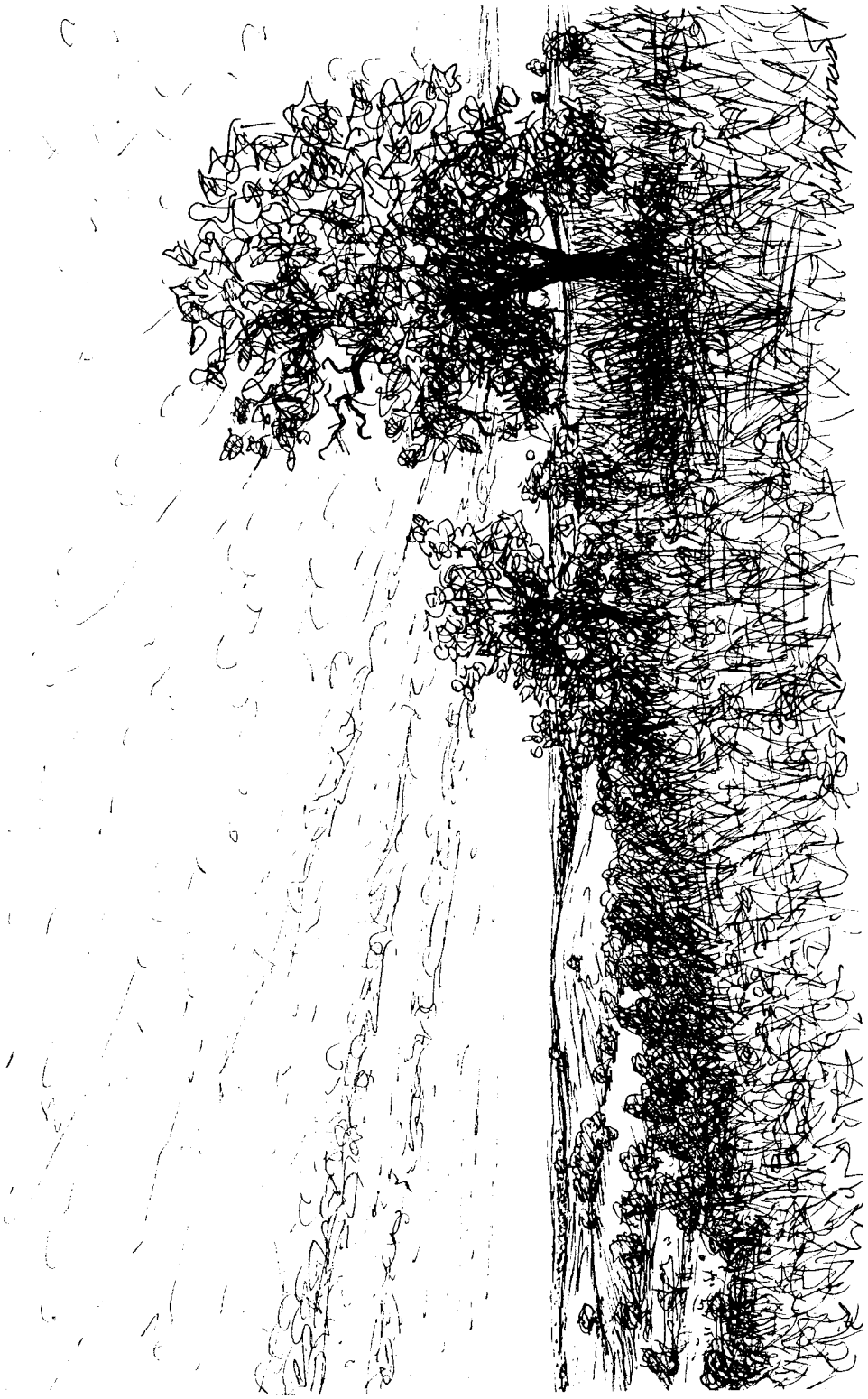


Figure 6. 16 Presettlement Piedmont "prairie" scene.

Chapter VII
Design, Restoration, and Management of a Piedmont Savanna

Introduction

The site chosen for "demonstrating" the Piedmont savanna is a portion of the South Carolina State Botanical Garden in Clemson, South Carolina. (Figure 7.1) The site was chosen because it is located in the Piedmont, has fairly typical conditions, is large enough, is easily accessible, and is located in the Botanical Garden which strengthens its purpose as a model landscape. It has been given the name "Burning Meadow".

Figure 7.1 Site of "Burning Meadow" at the South Carolina Botanical Garden (photo by author).

This chapter describes issues and methods involved in the overlapping activities of restoration design and management of a presettlement-like savanna landscape in the modern Piedmont. Guidelines and specific aspects of native plant community design, landscape restoration and management activities developed by Darrel G. Morrison (*Design*), provide the framework and much of the specific information in this application. Because there is an aesthetic as well as ecological emphasis, a modified version of landscape "restoration", will be used to describe related activities in this application, though landscape "design" might be considered a more appropriate term by some. Morrison offers the modified and more realistic version of "restoration" as:

> "Reintroducing and re-establishing of community-like assemblages of native species to sites which can reasonably be expected to sustain them, with the resultant vegetation demonstrating aesthetic and dynamic characteristics of the natural communities on which they are based." (Morrison, *Design* 41,42)

Restoration Design

Because this restoration is very much concerned with aesthetics, methods involved with native plant community design are interwoven with the following restoration methods. These methods have been used as a structure and have not been followed in order.

Methods Employed In Restoration Planning (Morrison, *Design* 44-56)

1. Goal identification.
2. Site inventory and analysis including:
   soils - nutrients, texture, pH, moisture, and chemicals present.
   topography - slope, aspect, and runoff behavior.
   vegetation - on site and adjacent land, and vegetation history.
3. Identification of target communities based on environmental conditions, human needs, and patches due to disturbances such as fire and windthrow.
4. Species selection based on restoration goals, dominant, prevalent, and visual essence species, and the need for early successional species on disturbed sites.
5. Selection of restoration strategies based on existing site conditions, availability of seed or plants, financial resources, and landscape management prospects.

Restoration Design Goals

The overall goal of Burning Meadow is to create and maintain a landscape that represents the history, aesthetics and ecology of the once common Piedmont savanna. Design, restoration and management of the site as a Piedmont savanna will be based on the ecological, aesthetic model discussed in this thesis combined with considerations of site characteristics and human use of the site. Design, restoration and management should, for the most part, reflect the species composition, distribution patterns, and ecological functions of a presettlement savanna as it might have occurred over typical (not shrink-swell) soils.

Restoration Design Goals

1. Demonstrate Piedmont savanna aesthetic qualities and provide aesthetic scenic enjoyment to visitors.
2. Provide natural and cultural history education.
3. Provide habitat for uncommon and rare plant species (including species that are now uncommon or potentially extirpated due to fire suppression.)
4. Provide a model for research.

Site Inventory

The site is located at the Southeast corner of the South Carolina State Botanical Garden in Clemson, South Carolina. An inventory of its features, described below, is shown in plan view in Figure 7.2. It is accessed from the Botanical Garden parking lot by a gravel drive which borders 1/3 of the site. Fescue turf and a wildflower meadow planting (a propagule source) are the adjacent uses in the Botanical Garden. Adjacent on its wooded sides are the University golf course and a creek. Nearby is Perimeter Road, the

campus, and a residential area. The former Seneca River (now Hartwell reservoir) and a former Cherokee town site are within two miles.

The 15 acre site is between 670 and 745 feet above sea level and generally faces Southeast with an average slope of 10% with steepest being >25% along the creek, 15% along the drainage swale and the flattest averaging 6% toward the back of the site. Except for the swale, which was wet at the road after 2.5 weeks without rain, most of the site is well drained.

USDA Soil Surveys for Pickens County, SC (USDA SCS, Pickens 54-57) show soils are of the Cecil series, a deep, well drained soil weathered from granite, gneiss, and schist. Parent rock is high in potash, as is subsoil. Cecil soils make up the majority of soils in Pickens county. It is not similar to the shrink-swell Iredell soils that are associated with the "Piedmont Prairie," though when more clayey, it can be droughty and crack when dry. Infiltration is slow and runoff rapid, especially on slopes where erosion can be a problem. Most of the original surface, or A horizon, has been lost to erosion. Where the A horizon remains it is described as yellowish-red, pH 5.5, sandy clay loam, with a weak, medium, subangular blocky structure, and friable. Horizon B is similar in structure. Disintegrated parent material (horizon C) is found at 44-60 inches.

Vegetation on the 6-7 acre site can be generally described as approximately 8 acres comprised of weedy old field with fescue and kudzu, and 7 acres of 20-30 year old successional hardwoods and maturing hardwood stands. Existing vegetation is described further on the site inventory sheet.

Recent vegetation history shows kudzu preventing woody growth in what was, essentially, an old field in succession. Much of the open area of the site appears to have been abandoned 20 - 30 years ago, with subsequent disturbances to parts of it occurring as recently as 5 - 8 years ago. Aerial photographs in the Soil Survey of 1972 show the open areas to have been agricultural. From the early 1800s to the 1960s, it is likely that the site periodically produced cotton and other crops, was occasionally abandoned, and was used as pasture.

Pre-European settlement history on the site is largely speculative though it is likely the site was heavily influenced by the nearby Cherokee population for some time. Bartram, who may have passed quite near the site in the 1770s while traveling up the Savanna and "Keowe"(Seneca River.) from Augusta to the Cherokee Lands, describes area landscapes. In the area of Clarks Hill Dam on the Savanna River:

> the downs afford grass and various herbage: the vales and hills forest trees and shrubs of various tribes… …of herbacea a vast variety and abundance, as *Verbesina, Rudbeckia, Phaseolus, Tripsacum, Aconitum napellus, Delphinium, Angelica lucida, Tradescantia, Actaea, Chelone, Glycine, Convallaria, Mediola, Carduus, Bidens, Arum, Coreopsis, Circaea, Commelina, Aster, Solidago, Eupatorium, Helianthus,* and *Silphium.*… (262)

In the area of Lake Hartwell along the Seneca River:

> …the shrubs growing about the tops of the more barren grassy hills, where large trees are few and scattered, shew themselves to great advantage, and make a fine appearance. (268)

Just north of the Clemson area:

> …upon the grassy bases of the rising hills appeared the remains of a town of the ancients. (272)

Even though the Cherokee population was decimated by disease during the preceding decades (Silver, 1990), Bartram still found a landscape very much influenced by humans and fire. The abandoned town sites he often describes were in stages of old field succession and the landscape itself was changing due to the reduction of Indian burning. His descriptions of open lands in the area provides additional footing for the "restoration" of a savanna community. It is reasonable to assume that 250 years ago the Botanical Garden land may have been composed partly of grasslands as Bartram described, especially due to its proximity to a Cherokee town. It is likely that the application site in particular was in some savanna-like condition, though to what extent it was open can only be guessed.

Restoration Design Considerations

In designing and restoring "natural" communities, there is a need to abstract essential community characteristics in order to apply them to a given site, taking into account its restrictions (Morrison, *Design* 3). This process will be accomplished by combining information from the thesis chapters *V* and *VI*, describing aesthetics and ecology of the Piedmont savanna, with information from the site inventory and the user needs and functional requirements identified in the project goals. The next step will be the drawing of a Mass/Space Plan (Figure 7.3) which will be informed in part by the savanna vegetation distribution patterns in Figure 6.7. The vegetation patterns that emerge in the Mass/Space Plan will help to identify target communities in the Planting Design Plan (Figure 7.4). These communities will reflect natural patterns or zones related to soil, light, and moisture as well as color, texture, and form. Potential tree and herb layer species selected for the target communities in the Planting Design Plan are listed in Appendix D and Appendix E. Strategies for implementation and management are discussed in the next section Special attention should be paid to the visual characteristics of the presettlement savanna. In order to demonstrate Piedmont savanna aesthetic qualities, the design should include open views to accentuate the rolling topography, distant tree lines and hills. Tree distribution patterns should take the form of groves and peninsulas, with occasional areas of evenly spaced trees included. Openness and species composition should be informed by fineness of soil, slope exposure, and moisture, in addition to existing vegetation. Sharp canopy edges can occur where the creek bank is becomes steep. All other vegetation should reflect gradual distribution changes in drifting patterns. Natural and cultural history education can be provided with plantings and corresponding information on the "wild pea vines." These plants, of potential Indian agricultural origins, can be represented by including *Phaseolus polystachios* and *Apios*

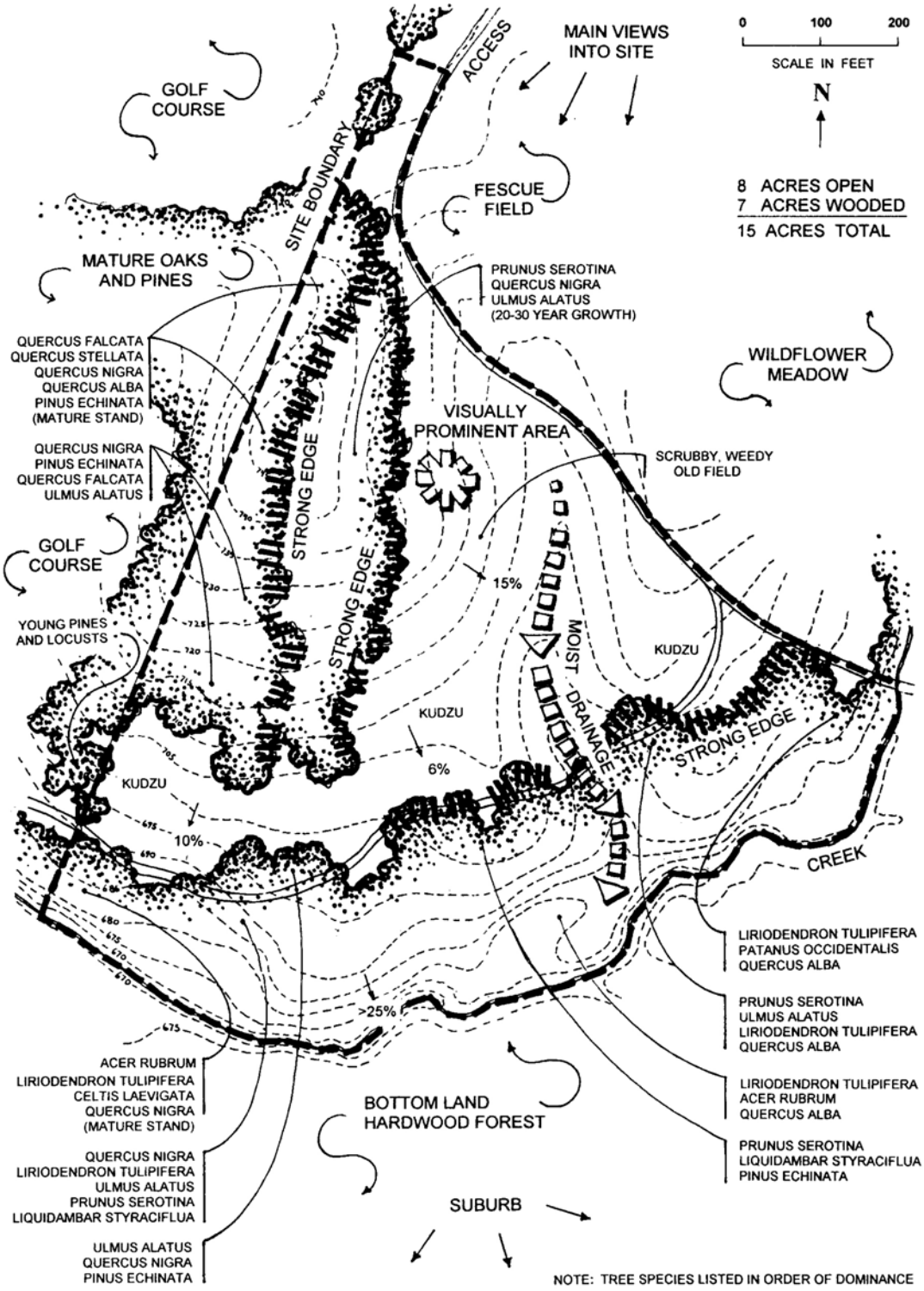


Figure 7.2 Site Inventory.

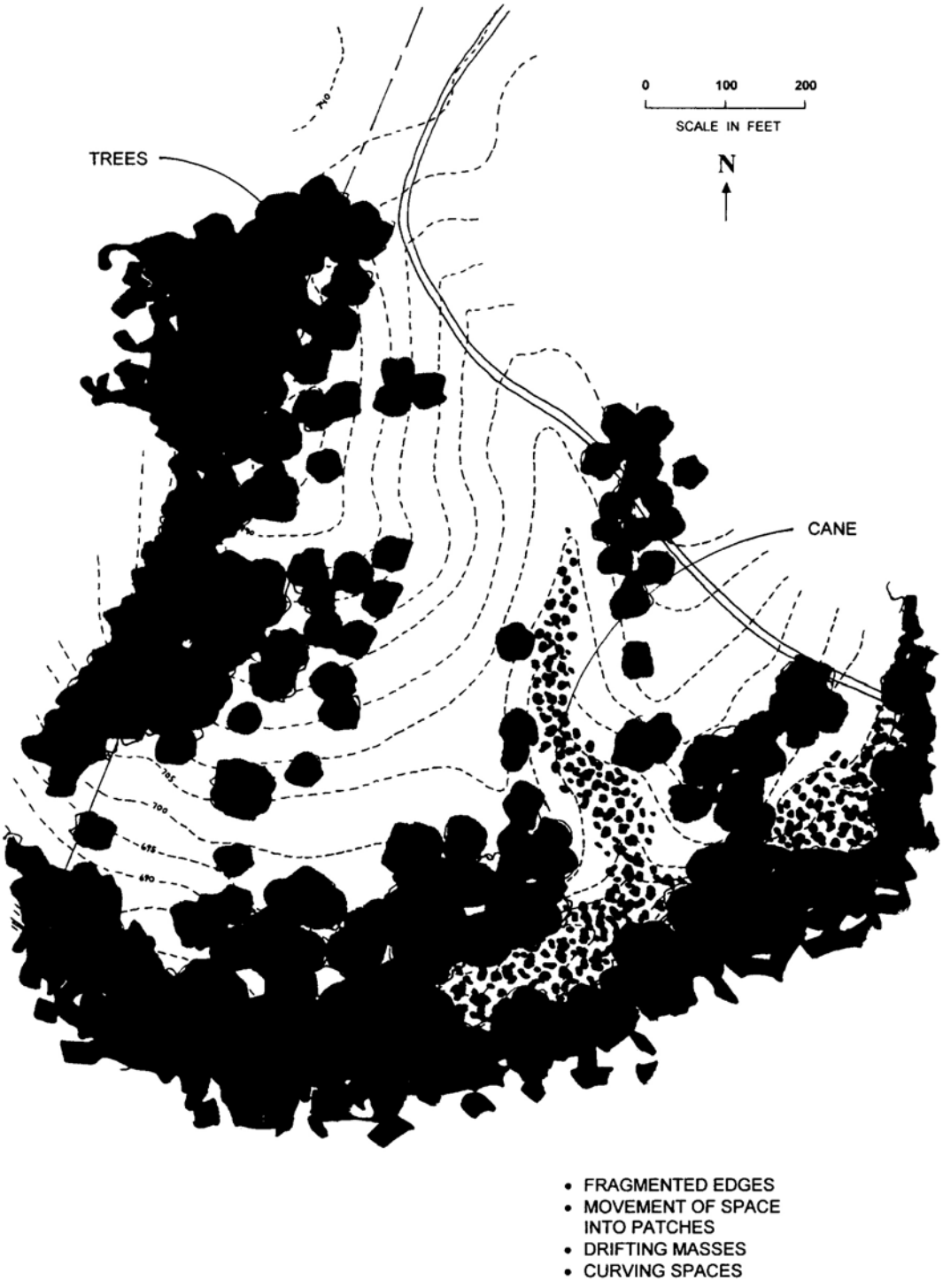


Figure 7.3 Mass/Space Plan

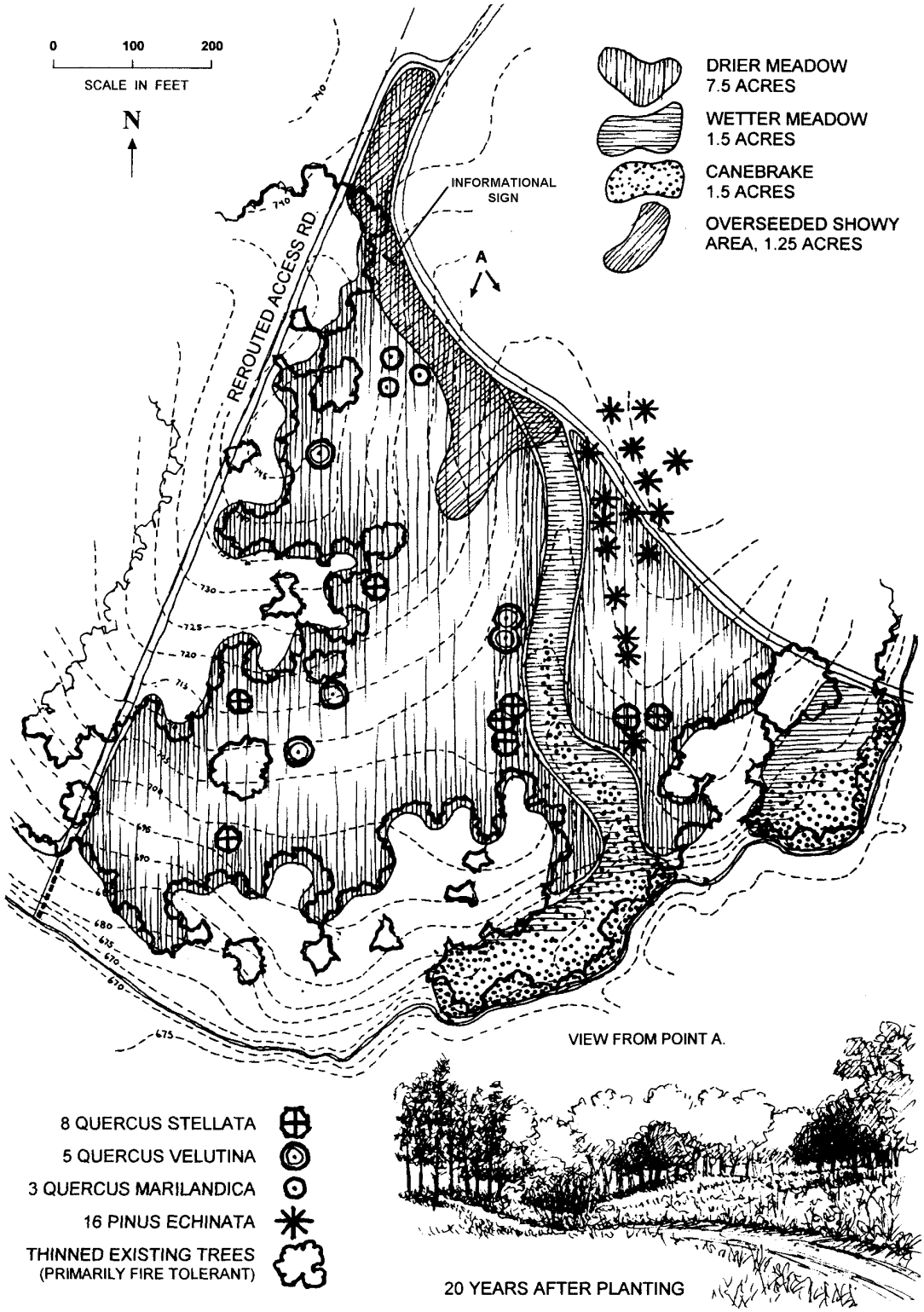


Figure 7.4 Planting Design Plan

americana where soil conditions are favorable. Rare species such as *Echinacea pallida*, usually found on more limiting soil conditions, should be included and identified even though they are not necessarily native to the county. While not shown as native to the county, such species may have been more widely distributed before widespread fire suppression and thus should be considered in species selection.

There are other important factors of restoration design to consider that have important implications on public perception. In his 1994 article "The Urban Savanna: Reuniting Ecological Preference and Function" Gobster points out several elements that are of great importance when considering restoration or design of savanna landscapes. Design cues such as split rail fences, showy forbs, mowed paths, tree framed views, and vegetative screens will improve initial viewer response by demonstrating human stewardship and care rather than a potential appearance of neglect sometimes associated with reinitiating ecological processes. Context of the site will dictate the type of design cues used, whether more or less formal. If design cues are not enough, on-site signage, newsletters, and public notices encouraging volunteer participation can make such sights as a fresh burn more appealing. Burning Meadow application signage, concerned mainly with fire ecology and Indian history, will play a critical role in natural and cultural history education, while framed views, showy forbs and mowed paths will contribute to the aesthetic value.

Site Preparation

Activities involved in installing and maintaining ecological functions in a natural savanna such as tree cutting, soil scarification, and burning, can be perceived negatively by the viewer (Gobster 64-68). Because the Burning Meadow site is based on functions of the presettlement savanna, strategies for its implementation and management may be unsightly at times. Therefore care must be taken to minimize the unsightly effects and to instill an aesthetic based on ecological understanding. Besides design techniques already mentioned, public perception can be influenced by involving people in guided nature walks and restoration activities such as burning, and collecting seed. This can have the effect of instilling greater appreciation for the site in particular and an ecological aesthetic in general. As Gobster puts it: "The beauty of the oak savanna often exhibits itself in subtle ways, and thus is more likely to be discovered with knowledge of the plants and experience of ecological processes over time." (69) Activities conducive to introducing public participation and viewer involvement are mentioned in the implementation and management process.

In order to prepare for implementation of Burning Meadow, sources of propagules must be identified, invasive exotic species must be identified on and around the site, and a management plan to follow up implementation must be made. Unique meadows, roadsides, and native gardens within the tri-county area should be identified as possible noncommercial seed sources. Volunteers should be organized for seed collection of these species using the potential species list. Wild seed collection and seedling propagation should be commenced well in advance of implementation. Seed production could be contracted out in advance or commercially available seeds could be ordered near planting time if funds are available.

Control of invasive exotics should begin as soon as possible since some species need repeated treatments and others may be prevented from going to seed. Possible

treatments for the kudzu and fescue on the site include close mowing, burning, and herbicide treatment. During the growing season before planting, infested areas of the site can be treated with a non-persistent herbicide followed a few weeks later with a combination of closely mowing in fescue areas and burning everywhere else. Herbicide, and/or close mowing might then be repeated to eventually eliminate selected species before the growing season ends. Before burning, kudzu will need to be removed from bordering tree branches so fire won't be conducted into the trees. Fire breaks, including the existing road and creek, will need to be extended around the site. Permission for burning should be obtained from the proper authorities. An annual, non-persistent cover crop should be seeded if soil is excessively exposed while waiting for grasses and forbs seeding. An alternative scenario would involve only herbicide treatments, leaving the dead leaf litter to cover the soil over the winter.

Debris piles on the site not consumed by fire will be removed and rough areas will be smoothed with a tractor. The soil should be left as undisturbed as possible, however, to deter erosion and preserve what soil structure there is.

Creating savanna canopy structure will require, in part, the removal and pruning of selected trees and understory as shown in the section drawing in Figure 7.4. While fire could be used in a controlled though random manner to accomplish this, the context of the site suggests manual selection and removal of woody plants including herbicide application to stumps. Following that, a controlled burn could be conducted if the ground plane needs further cleaning up, though care should be taken if there is abundant slash.

With debris and invasives removed from the ground plane, all open areas can be prepared for seeding. Just before seeding, the soil surface can be prepared by lightly cultivating, dragging or raking the surface to promote seed-soil contact. Deeper soil cultivation may be needed if there are severely compacted soils, especially in visually prominent areas where rapid meadow development is desired.

Site Installation

Following preparation, seeding can occur in the fall or spring. Planting zones should be flagged to guide seed placement. Various methods can be employed for seed dispersal. Grasses will preferably be drill seeded with a seed drill able to handle various sizes of seeds such as a Nesbitt or Truax. 20 lb. p.l.s. (pure live seed) per acre should be distributed 10 lb. in one direction and 10 lb. in a perpendicular direction with seed mixes matched with appropriate zones. Otherwise grasses can be broadcast at 20 lb. per acre into lightly cultivated soil. Because forb seeds can vary greatly in size and costs they should be sown separately from the grasses with attention given to design. Forb seeds will be hand or machine broadcast over the grasses in appropriate zones at about 4 lb. p.l.s. per acre, while showy forb and grass species may be seeded selectively by hand for a designed effect. A medium such as moistened contractor sand will aid in even seed distribution of both grasses and forbs. After seeding, soil should be lightly compacted to ensure seed-soil contact. An alternative method for seeding involves cultipacking the prepared soil in one direction, broadcasting seeds, then cultipacking again in a perpendicular direction. Narrow ridges and valleys created by the cultipacker causes seeding depths to vary randomly up to ¾" in depth. Plugs of visually key species might be incorporated with the seeding effort to produce some "show" in the early phases of the restoration. After planting, a light mulch of native grass hay, pine straw or mulch fiber should be applied over the bare soil to

reduce soil exposure. A cover crop of an inexpensive non-persistent cool season annual might also be used for reducing erosion during the dormant season and/or early spring, and to provide some cover to emerging warm season seedlings.

After a fall planting, cool season "weeds" that emerge over the winter should be mown closely very early in the spring and clippings removed to allow the soil to warm in the sun and promote germination. In the first year the site may need mowing 2-4 times. The need for mowing will be determined by closely monitoring annual weeds to prevent them from going to seed. For instance, in the second month seeded areas might be mowed at 6 inches to prevent annuals from seeding and to allow growing warm season species more solar access. Mowing could be repeated at 8 - 10 inches in the mid-summer and again in the fall or as needed. Watering at the rate of 1"/week may be needed if a spring drought occurs but should be discontinued as plants become established. During the second growing season spot treatments of herbicide to aggressive invasives may be necessary, followed by replanting of the area. Mowing at 6 - 8 inches may be necessary again in the spring to favor warm season species, and possibly again in the summer. If enough fuel is present in the early spring of the third year the site may be burned, or, if not, mowed. From the third year on the site should be burned every other year or so, at different times according to the management plan. No other management of the ground plane should be necessary unless kudzu or other invasives become reestablished, in which case they should be spot treated with herbicide.

Few, if any, of the slow-growing savanna tree species will transplant well as they become more mature. Proposed tree species should be added as young, vigorous saplings to encourage their establishment in a potentially difficult environment. If possible, balled and burlapped or potted specimens should be planted in prepared holes either before or after ground plane seeding, but not before major site preparation activities are completed. The best time might be immediately after seeding. If planted trees are less than three feet in height, they should be flagged to identify them in the event that high grass needs mowing. During the first growing season, new trees should be watered, especially during drought, to ensure their survival. Other fire-tolerant tree species may be allowed to invade by themselves over the years as long as they do not become too numerous. Small planted trees and selected volunteer trees need to be protected with fencing if grazing is introduced.

Cane *(Arundinaria gigantea)*, will be planted as plugs or from pots in loose drifts along the creek and along the wettest drainages. Cane is difficult to establish, so stands may be slow to come to fruition.

Management Considerations

Landscape management is "the act of guiding the direction and rate of landscape change", not the act of maintaining a static landscape (Morrison, *Design* 58). Management activities prescribed to a restoration design should emulate the natural processes of the community being restored and suppress or eliminate species exotic to that community (Morrison, *Design* 5).

Just as in the initial installation, management practices that bring about ecological integrity, such as tree removal and burning can have negative aesthetic effects (Gobster 66). Because this site is a visible feature of a botanical garden where appearance is important, care must be taken to minimize unpopular effects. Of the tools used in

managing the site, fire has the greatest potential for being most problematic in terms of public perception as well as being most effective for management. Public awareness and involvement may be critical in guaranteeing its continued use. Viewers and participants in the project should also be aware that the Piedmont savanna, with its often slow-growing species, is a fire-dependent community that will probably take a long time to mature.

Methods Employed In Management Planning (Morrison, *Design* 74-87)

1. Management goals establishment.
2. Site inventory and analysis. (mainly of vegetation structure and composition)
3. Identification of homogeneous units which are similar in environmental characteristics and botanical composition.
4. Identification of management units based on management need plus homogenous units.
5. Identification of management objectives by management unit.
6. Identification of management strategy by management unit.
7. Identification and selection of methods or tools to accomplish management objectives.
8. Implementation of the management plan based on priorities and resources.
9. Monitoring of changes to evaluate effectiveness.
10. Adjustment of management plan based on monitoring.

Management Goals

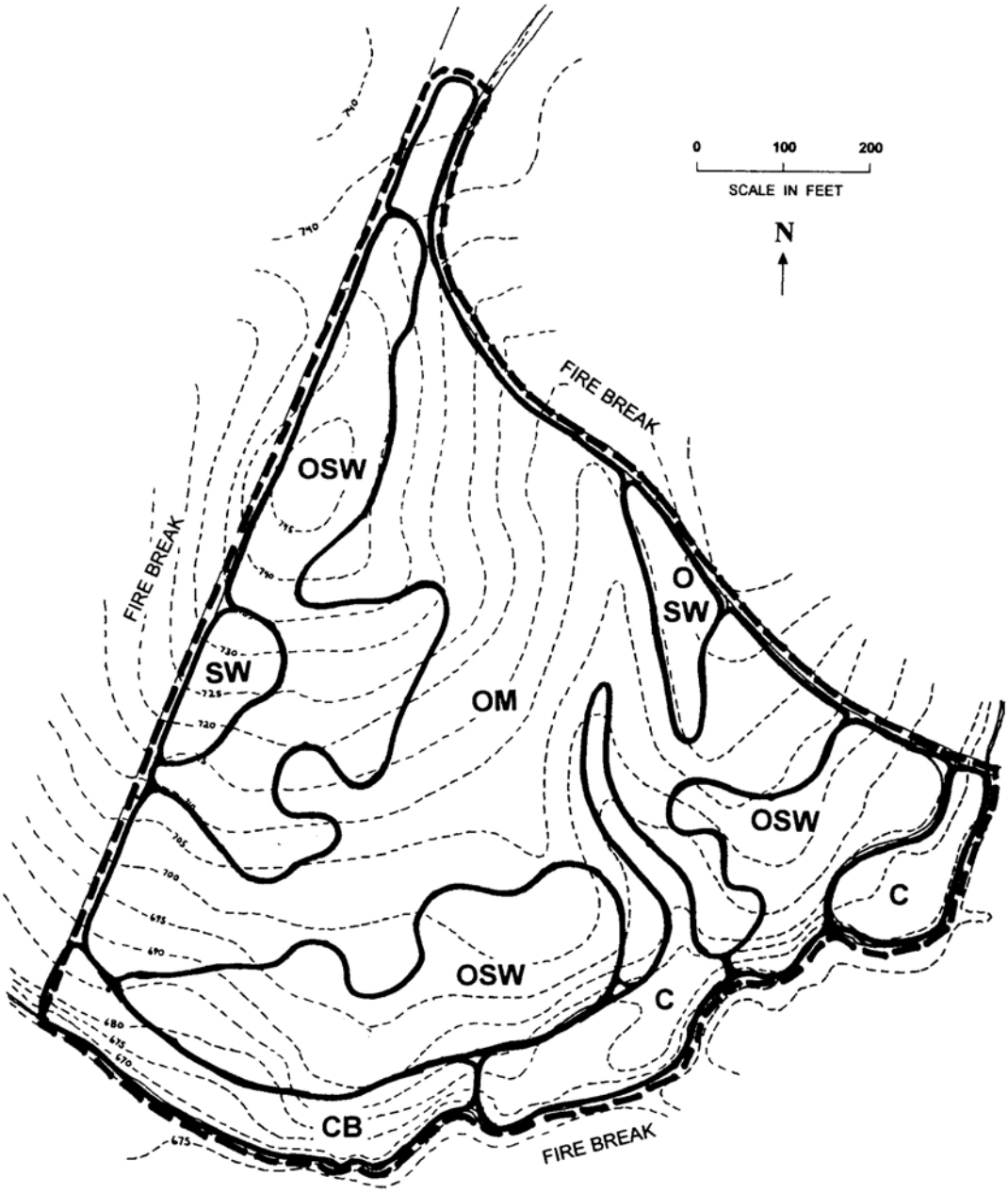
In general, management activities should emulate the natural processes of the Piedmont savanna, while allowing for human needs on the site and suppressing species exotic to the savanna community.

Management Goals

1. The site will be managed to reflect the preferred aesthetic attributes of the Piedmont savanna.
2. Part of the total area will be managed to encourage showy species.
3. A composition of 40 - 70 species per acre in the ground layer will be maintained.
4. Tree species and distribution more typical to the Piedmont savanna will be favored over time, while non-typical trees will gradually be removed.
5. Exotic species will be suppressed or eliminated within the perimeter if possible.
6. The site will host some rare and unusual species appropriate to the community.
7. Management practices will be coordinated with educational programs and volunteer participation.

Management Units, Objectives, Strategies, and Methods

Examination of the site inventory and the site design reveals areas which have similar environmental and floristic characteristics. Management needs, as informed by the



SW	SAVANNA WOODLAND	denser tree canopy open underneath, some understory, sparse ground cover, on drier soil
CB	CREEK BLUFF	dense tree canopy, developed understory, mesic ground layer species along steep bluff

OM	OPEN MEADOW	dense grassy ground cover over wet and dry soils
C	CANEBRAKE	dense cane cover on wet soils
OSW	OPEN SAVANNA WOODLAND	open tree canopy, no understory, grassy ground cover grades into meadow

Figure 7.5 Management Units Plan

goals, are combined with these homogeneous areas to define Management Units (Figure 7.5). These units include the Open Meadow, Open Savanna Woodland, Savanna Woodland, Canebrake, and Creek Bluff. Management objectives, strategies, and methods will be assigned to each of the defined units as shown below. Management strategies to be employed in each unit will at first emphasize modification of existing species followed by the acceleration of the development of the ground layer, then the deceleration or suspension of succession. Management methods for modifying existing vegetation include: plant pulling, digging, cutting, spray application and stump painting of herbicide, and potentially fire. Methods used in accelerating the ground layer include planting and watering. Methods used for suspending succession include fire, mowing, cutting and potentially grazing.

Open Meadow

Objectives:

Vegetative cover of at least 85% consisting of at least 80% grasses should be maintained. 95% of woody vegetation greater than 2-3 feet high should be eliminated unless planted. Exotic species should be eliminated if possible. The designated area for showy species should have a high ratio of showy forbs and 80% grasses.

Strategy:

The meadow will be maintained as a climax prairie type community allowing for species to migrate as they prefer within the site while maintaining an abundance of showy species in the appropriate area.

Methods:

To maintain it as a climax community, burning of the meadow should occur at an average frequency of every 2 years; sometimes in consecutive years and sometimes every 3 years. Burns on those years should occur at different times of the early spring and occasionally in the summer and late fall, so as not to favor any particular species. If woody invasions are persistent in areas, late summer burning of that area may be appropriate. Occasional auto travel of perimeter road should keep kudzu from re-invading. If monitoring after 5 years shows burning to have inappropriate effects such as favoring single species, or allowing woody development, then burning frequencies and timing might be rescheduled. If burning is not possible, then mowing once or twice a year at a height of 6” or greater must become the limiting factor to succession. Selective cutting with stump application of herbicide, and selective wick or spray application of herbicide may be needed if invasives are problematic. Following eradication procedures, seeding and/or transplanting desired species may be necessary if propagules are not already present. Fire frequency should be adjusted to allow establishment of desired species.

Open Savanna Woodland

Objectives:

An open savanna woodland canopy cover grading between 0-50%, sometimes tightly grouped, no woody understory cover other than a few oak grubs, and 30-

85% ground layer cover of mainly grasses should be maintained. Invasive species should be eliminated if possible.

Strategy:

Use controlled burning to maintain a glade-like aspect while allowing planted trees to mature. An open, clean understory up to at least 6 -10 feet, and trunks free of low branches should be maintained. Also allow some successional species and grubs to develop where they do not block views. Encourage modification of species composition, especially in the ground layer to fire- and part-shade-tolerant natives.

Methods:

Low intensity controlled burning should be conducted as an extension of open meadow burning. Lighter fuel loads under trees should keep burned areas patchy; however planted trees should be protected from fire when immature by removing excessive fuel from around them. In some areas summer fires should be used to kill successional saplings while in other places oak grubs should be allowed to develop. Where fire breaks are necessary they can double as visitor paths. Mowing almost annually in the early spring and, if needed, in the late summer may be substituted if burning is not permitted. Kudzu may have to be treated with herbicide if it invades from perimeter areas. If monitoring after 5 years shows burning or mowing to have inadequate effects on modifying species and maintaining an open canopy and understory then other means may be employed, such as selective cutting of woody species, bush hogging, selective cutting with stump application of herbicide, or selective wick or spray application of herbicide. Also browsing animals such as cows might be introduced for a brief period confined by temporary fencing. Following eradication procedures, seeding and/or transplanting desired species into bare patches may be necessary if propagules are not already present. Fire frequency should be adjusted to allow establishment of desired species in such areas.

<u>Savanna Woodland</u>

Objectives:

Canopy cover of 50-85% and understory cover of 5% or less and a sparse ground cover of mainly grasses should be maintained. Invasive species should be eliminated if possible. An open, clean understory up to at least 6 -10 feet, and trunks free of low branches should be maintained.

Strategy:

Maintain and encourage fire tolerant native species in canopy, sub-canopy, understory, and ground layer. Without creating excessively large canopy gaps, gradually reduce inappropriate species, such as water oak and beech, to a minority, especially in drier areas. Allow mainly fire tolerant species such as post oak, red oak and shortleaf pine to mature and fill spaces where inappropriate species have been removed. Encourage the appearance of even agedness if possible.

Methods:

Low intensity burning, as an occasional extension (every 3-7 years) of open meadow burning, that does not harm canopy species should be effective at maintaining a mostly open understory and at modifying ground layer species. If monitoring after 5 years shows burning to have too great an impact on canopy trees, frequency and intensity should be reduced. . If monitoring after 5 years shows inadequate effects on modifying species and opening understory then other means may be employed, such as selective cutting of canopy species and removal of slash, bush hogging, selective cutting with stump application of herbicide, or selective wick or spray application of herbicide. Browsers may be introduced for a brief period to open the understory. Following eradication procedures, seeding and/or transplanting desired species may be necessary if propagules are not already present. Fire frequency should be adjusted to allow establishment of desired species.

Canebrake

Objectives:

Vegetative cover of at least 85% consisting of at least 80% *Arundinaria gigantea* should be maintained over moist areas. Occasional trees and patches of wet meadow may invade.

Strategy:

The Canebrake will be encouraged and maintained by periodic burning. Cane will be allowed to migrate and/or spread as it prefers within the site.

Methods:

Establishment of cane may be slow so care must be taken in judging the success of management activities. If unwanted species outcompete the cane while it is getting established, manual methods such as pulling and cutting should be employed to free up cane plants. To maintain it as a climax community, burning of the canebrake could occur at an average frequency of every 3-7 years or more often especially in areas where it grades into meadow. Burning may be done in concert with the open meadow burning.

Creek bluff

Objectives:

A well developed canopy cover representative of a lower slope mesic forest with its accompaniment of sub-canopy, understory, and ground layer should be maintained. However, the lower layers of vegetation should be more open than usually occurs in such a community. Invasive species should be eliminated if possible.

Strategy:

Encourage some fire tolerant species to invade but maintain essentially as is with fewer exotic invasives.

Methods:

Very infrequent low intensity burning can be combined with manual removal of dense understory and invasive species.

It should be mentioned that once the various management activities have begun to bring about the desired visual and ecological characteristics to the various management units, if possible it would be desirable to treat the whole site as one fire compartment as it might have been in the presettlement landscape. Whether or not this is a viable management option might be determined by experimenting and monitoring.

Implementation Of Management Plan

The state forestry commission may offer controlled burning as a service, or the appropriate department of the University might be contacted. In any case, burning must be supervised by qualified individuals. Volunteers may be needed and should be encouraged as part of the education process. Burning may be most appropriate on weekends when coordinated with educational programs and public involvement. Mowing, if necessary, should be done by informed botanical garden staff according to the management plan. Staff may also be responsible for invasive species management, although this is an area appropriate for volunteer participation. If important or rare plant material becomes available at some point, then, for a time, introducing it to the site may become the priority of management. Once established (after 3 years) the site should require little management; if, however, monitoring for invasives is not done, and the burning/mowing plans are not followed, a second restoration of the site would be required.

Monitoring And Modifying

Botanical garden staff may be involved in monitoring, though this area may be most appropriate for interested scientists or professionals. Volunteers and University students in related studies could also be enlisted to perform quadrat layout, inventory and analysis. If monitoring reveals inadequate performance then modification of management goals, objectives, strategies or methods may be necessary. Monitoring will also be necessary to collect useful information for any research associated with the project.

Chapter VIII
Conclusions

In order to understand the place the presettlement Piedmont savanna has in the modern landscape, I have in this thesis considered visual characteristics, ecology, cultural and natural history and the relationship of human preferences to savanna landscapes. Summarizing these aspects points out the value, and the degree of applicability this landscape has two hundred years after its demise.

Evidence in the cultural environment around us suggests that people prefer savanna-like landscapes. This preference is manifest in landscape types such as suburban yards, parks, campuses, and orchards where vegetation structure reflects the scattered trees and open understory of the savanna. Appleton explains this phenomenon as being a result of our bioevolutionary heritage which gives us the affinity for landscapes high in prospect and refuge. Prospect and refuge were key elements in early human survival as our ancestors progressed from being reclusive tree dwellers to more aggressive ground dwellers in the savannas of Africa. The Kaplans, for similar reasons, propose that landscapes are most preferable when they make sense and offer fulfillment, or, more specifically, coherence, complexity, mystery, and legibility. When savanna landscapes are measured in these terms, their high ranking shows that they are indeed favored by humans.

Part of this work has focused on the ecological history of the Piedmont and people's perception of it. Because few people are aware that Piedmont savannas existed or that they played a role in the region's history, it has been important to show not only evidence of their occurrence, but also reasons for their demise. The existence of the Piedmont savannas has been well documented in the many historical citations from Bartram, Byrd, Lawson, Lederer, Hawkins and Spangenberg and the writings of later historians. Savannas may have come into being due to climatic conditions, but their spatial distribution over time has been modified greatly by humans. Piedmont and southeastern grasslands in general, whether a result primarily of Indian or natural burning, were closely linked with patterns of Indian culture; the migration and presence of presettlement fauna such as bison, elk, and deer; and the direction and rate of European settlement. The immediate disappearance of these landscapes upon European settlement was caused by fire suppression resulting from fire compartment fragmentation.

During the completion of this thesis an important article was published by Barden in *Natural Areas Journal* which further discusses the history of the Piedmont savanna.

Understanding presettlement Piedmont savanna ecology is essential, not only in explaining the existence of savanna communities, but also as a model for any related reconstruction of such an environment. Of all the factors that contributed to the maintenance of savanna landscapes, fire was without a doubt the most important. It is recognized that Indians may have been the major cause of fire, though in some cases fire from lightning may have been responsible for maintaining an open landscape. If one considers that by burning, humans were probably the most important agent in shaping the structure and composition of the presettlement landscape, then it might be appropriate to argue that any restoration of such a landscape would, in fact, be a demonstration of a

cultural landscape, more so than of a "natural" one. In a way, this aspect of the presettlement condition brings the often diametrically opposed views of culture and nature closer together.

Where frequent burning was combined with the more difficult growing conditions found on basic soils high in montmorillonite (shrink-swell soils), the most open and often prairie-like examples of the Piedmont savanna occurred. This type of soil, though not the most common, can be found scattered throughout the Piedmont. In South Carolina, North Carolina, and into Virginia, roughly along the Interstate 85 corridor, these soils are most common, and reflect the probable former distribution of prairie-like landscapes in that region. It is probable that the other upland soils of the region, mainly Ultisols, supported woodland savannas rather than prairie. The exception to this would have been in the case of proximity to Indian settlement. Areas where high Indian populations existed, especially in lowlands where rich soils provided the best nutrients for crops, were sometimes very open, to the extent that they might have resembled today's farmland.

Species composition of the presettlement Piedmont also reflected the presence of fire. The oak-hickory-pine-type woodland of that time was dominated by species more fire tolerant than those dominating today's forests. In savannas, fire would have reduced or eliminated the understory. A grassy stratum would have been common to both the open woodlands and prairie-like areas of the presettlement landscape. This grassy ground layer would have reflected the composition and many of the species of the tall grass prairie.

The degree to which the landscape appeared open was a reflection of the influences of fire frequency, soil moisture, exposure, and soil structure. Depending on fire frequency, the visually dominant tree canopy layer may have varied from patches of low trees over a grassy ground plane in more xeric conditions to patches, peninsulas, or even distribution of taller trees over more mesic conditions. Distribution patterns in tree canopy and ground plane species would have reflected the often drifting patterns common in natural phenomena. Sharp transitions or edges would have occurred in relation to abrupt changes in soil, slope, and moisture conditions, or perhaps where intense Indian activities occurred. Both grassland and woodland would have intermingled and graded into cane brakes, a nearly ubiquitous fire-dependent feature of wet soils along drainages. All of these various gradations and edges abundant in the Piedmont savanna would have supported an especially rich species diversity. Savanna ecotones, or edge environments, though they do not support all grassland and woodland species, support a greater number and variety of creatures than can either the grassland or woodland community alone, by creating habitat for both feeding and nesting.

At times the presettlement Piedmont savanna may have been similar in appearance to the pine flatwoods of the Coastal Plain, while at other times to the oak savannas on the edges of the Midwestern prairies. Savanna landscapes would often have appeared as pleasant scenes of open, sometimes distant views, with accentuated lighting and atmospheric effects not to be seen in the denser forests. It is unfortunate that the landscape painters of the Hudson River School came along a hundred years too late and a few miles too far north to represent these scenes for us.

Designing or restoring Piedmont savanna landscapes presents an opportunity to demonstrate an aesthetically, ecologically and historically rich landscape heritage. It is important to provide a model or demonstration for such a restoration design, first because it allows the public to perceive the aesthetic value of an otherwise unseen landscape.

Second, the public needs to understand that this landscape is part of our natural and cultural Piedmont history. Third, it provides an opportunity for the public to learn about the ecological functions of the savanna. Fourth, there is a need to study the Piedmont savanna to determine its long term value as an ecologically sound model for landscape design. Finally, creating these landscapes can provide habitat for some of the endangered species that were once dependent on open, fire-maintained landscapes.

It should be considered, however, that there are some complicating issues in savanna restoration. These include context, scale, and time. First, it is important to use the appropriate amount of "natural function" to maintain the savanna according to the context in which it is located. For instance, in a small garden-like savanna in a neighborhood, one might need to forgo burning and grazing in favor of mowing and manual weeding. If a large-scale landscape in a rural setting is the application site, then the unsightly effects of the first year's slash and burn may be more acceptable while the characteristic long-term aesthetic qualities are developing. On the other hand, when the intention is to demonstrate these ecological functions, the site should be in a more visible location. In this case, plenty of information must be provided to the public in order that they may develop an ecological aesthetic that will allow them to appreciate the temporary roughness of the savanna's appearance. This is especially important in the early years of the installation, when it may be at a visual low point.

The amount of time needed for a savanna installation to attain a mature appearance can add up. Fire-dependent communities, quick to disappear with fire cessation, are slow to redevelop once fire is restored. Some applications may be able to reach the appearance of a mature savanna sooner than others. For instance, where the appropriate tree canopy already exists, a herbaceous layer can be established in only a few years. If a tree canopy must be installed, then faster-growing pines could allow the savanna to reach a mature appearance in only a decade or two. In the demonstration savanna, viewers should be informed that the slow-growing savanna climax species such as post oak and black jack oak will take many decades to reach their full visual potential.

Perhaps in the end, considerations having been given to history, ecology, aesthetics, and applicability, the most rewarding aspect of demonstrating the Piedmont savanna might be found in the imagination of the viewer, who, as he or she gazes upon a ghost of a landscape long past, may catch a glimmer of salubrious prospects over undulating open woods where buffalo and wolves roamed and humans drank from the clear waters of Piedmont creeks.

Appendix A

PRESETTLEMENT FOREST COMPOSITION

(Cowell 122-127)

Floodplain

Species	% Frequency
white oak	16.12
hickory	13.13
pine	9.05
post oak	7.06
black oak	6.17
n. red oak	5.57
ash	4.78
tulip poplar	4.58
dogwood	4.38
maple	4.38
black gum	3.28
sweet gum	2.89
total	77.01

Lower Slope

Species	% Frequency
pine	22.40
post oak	14.24
hickory	12.48
white oak	12.03
black oak	10.52
n. red oak	8.30
total	79.97

Mid-Slope

Species	% Frequency
pine	27.52
post oak	19.36
red oak	11.31
black oak	10.36
hickory	10.22
white oak	8.02
total	86.79

Upper Slope

pine	28.70
post oak	20.01
black oak	12.02
n. red oak	11.84
hickory	8.91
white oak	4.95
total	86.43

Flat Upland

pine	33.70
post oak	19.05
black oak	12.24
n. red oak	11.50
hickory	8.54
s. red oak	2.75
white oak	2.68
total	90

Appendix B

POTENTIAL PIEDMONT SAVANNA "HERBAGE" NOTED BY BARTRAM

Scientific Nomenclature	Common Name	Bartram's Nomenclature
Actaea pachypoda Ell.	white baneberry	*Actaea*
Actinomeris alternifolia	a composite	*Coreopsis*
Amorpha spp.	lead plant	*Amorpha*
Asclepias spp.,	milkweed	*Asclepias*
Aster spp.	aster	*Aster*
Bidens frondosa	beggars ticks	*Bidens*
Circium sp.	thistle	*Carduus*
Commelina sp.	day flower	*Commelina*
Delphinium spp.	larkspur	*Delphinium*
Eryngium yuccifolium	rattle snake master	*Eryngium*
Eupatorium spp.	eupatorium	*Eupatorium*
Euphorbia spp.	spurge	*Euphorbia*
Helianthus spp.	sunflower	*Helianthus*
Polymnia uvedalia	bears foot	*Polymnia*
Rudbeckia spp.	rudbekia	*Rudbeckia*
Silphium spp.	rosin weed	*Silphium*
Solidago spp.	goldenrod	*Solidago*
Thapsium spp.	meadow parsnip	*Thapsia*
Tradescantia spp.	spiderwort	*Tradescantia*
Tricapsum dactyliodes	gamma grass	*Tricapsum*
Verbesina spp.	crown beard	*Verbesina*

Appendix C

HERB LAYER SPECIES OF A XERIC HARDPAN FOREST

Scattered throughout Piedmont, over clay, (shrink-swell such as Iredell) or shallow rock hardpan. Maintained by harsh soil moisture conditions and formerly fire. (Schafale and Weakley 78,79)

Herbs Common to Community

Aster dumosus
Aster solidagineus
Clematis ochroleuca
Danthonia spicata
Hieraceum gronovii
Hieraceum venosum
Hypericum hypericoides
Lespedeza spp.
Liatris gramnifolia
Oenothera fruticosa
Schizachyrium scoparium
Solidago spp.

Rare Species

Echinacea laevigata
Helianthus laevigatus
Helianthus schweinitzii
Hexalectris spicata
Hexastylis lewisii
Lathyrus venosus
Liatris squarrulosa
Lithospermum canescens
Lotus purshianus var. *helleri*
Parthenium integrifolium var. *auriculatum*
Silphium terebinthinaceum

HERB LAYER SPECIES OF A DIABASE GLADE

Known only in areas of Rock Hill and Durham and Granville counties.
Maintained by shallow dry soils and probably formerly fire. (Schafale and Weakley 113)

Herbs Common to Community

Anemone virginiana
Aquilegia canadensis
Arabis canadensis
Aristida longespica
Asclepias verticillata
Aster depauperatus
Bulbostylis capillaris spp. *capillaris*
Cladina spp.
Clematis ochroleuca
Crotonopsis elliptica
Cyperus granitophilus
Diodia teres
Houstonia tenuifolia
Hypericum denticulatum
Lithospermum canescens
Manfreda (Agave) virginica
Oenothera fruticosa
Opuntia compressa
Panicum flexile
Parthenium integrifolium var. *auriculatum*
Polygonum tenue
Portulaca smallii
Ruellia humilis
Schizachyrium (Andropogon) scoparium
Sisyrinchium mucronatum
Sporobolus clandestinus
Talinum teretifolium
Tragia urticifolia
Trichostema brachiatum
Trichostema dichotomum

Rare Plant Species

Aster depauperatus
Baptisia australis var. *australis*
Berberis canadensis
Echinaea laevigata
Eupatorium incarnatum
Isoetes piedmontana
Lathyrus venosus
Liatris squarrulosa
Linum sulcatum var. *sulcatum*
Lithospermum canescens
Lotus purshianus var. *helleri*
Manfreda virginica
Matelea decipiens
Panicum flexile
Parthenium integrifolium var. *auriculatum*
Polygala senega
Polygonum tenue
Portulaca smallii
Ruellia humilis
Ruellia purshiana
Scutellaria leonardii
Senecio pauperculus
Silphium terebinthinaceum
Solidago ptarmicoides
Trichostema brachiatum
Trichostema setaceum

HERB LAYER SPECIES OF AN ULTRAMAFIC OUTCROP BARREN

Occur on outcrops of dunite, serpentine or related ultramaphic rock, usually on southern or flat exposure. Very rare community, one in mountains of North Carolina, one near Augusta, Georgia. (Schafale and Weakley 115,116)

Herbs Common to Community

Andropogon gerardii
Deschampsia cespitosa
Dichanthelium (Panicum) lanuginosum
Dichanthelium (Panicum) sphaerocarpon
Hexastylis arifolia
Muhlenbergia glomerata
Poa saltuensis (languida)
Schizachyrium scoparium
Senecio plattensis
Solidago nemoralis]
Sporobolus heterolepis
Thalictrum macrostylum

Uncommon or Rare Plant Species

Castilleja coccinea
Deschampsia cespitosa spp. *glauca*
Elymus (Agropyron) trachycaulus
Frasera caroliniensis
Gentianopsis crinita
Muhlenbergia glomerata
Poa saltuensis
Parnassia grandifolia
Polygala paucifolia
Polygala senega
Senecio plattensis
Sporobolus heterolepis

HERB LAYER SPECIES OF A MESIC PINE FLATWOODS

This Coastal Plain community has similarities to former Piedmont Longleaf Pine Forest (Schafale and Weakley 80) once possibly extensive in lower Piedmont, but now gone due mainly to fire supression. (Schafale and Weakley 131-133)

Herbs Common to Community

Andropogon gerardii
Anthaenantia villosa
Aristida stricta
Dalea (Petalostemum) pinnata
Euphorbia corollata
Gymnopogon brevifolius
Lespedeza capitata
Panicum virgatum
Paspalum bifidum
Pteridium aquilinum
Schizachyrium scoparium
Solidago odora
Sorghastrum nutans

Rare Plant Species (Mesic Pine Flatwoods continued)

Agalinis tenella
Agalinis virgata
Anthaenantia villosa
Asclepias longifolia
Buchnera americana
Calamovilfa brevipilis
Coreopsis gladiata
Dalea pinnata
Dionaea muscipula
Gentiana autumnalis
Gratiola aurea
Hypoxis sessilis
Oenothera perennis
Onosmodium virginianum
Parthenium radfordii
Paspalum bifidum
Prunus umbellata
Pteroglassaspis ecristata
Rhus michauxii
Rudbeckia heliopsidis
Schwalbea americana
Scleria minor
Solidago verna
Sphenopholis filiformis
Tofieldia glabra
Tridens carolinianus
Tridens strictus
Xyris difformis var. *curtissii*

TYPICAL HERB LAYER SPECIES OF THE BLACK BELT PRAIRIE

Occurred over calcareous soils in Alabama and Mississippi. (Jones 35,36)

Grasses

Andropogon gerardii
Andropogon virginicus
Bouteloua curtipendula
Sorghastrum nutans
Eragrostis capillaris
Schizachyrium scoparium

Forbs

Silphium laciniatum
Silphium dentatum
Silphium trifoliatum
Echinacea purpurea
Dracopis amplexicaulis
Ratibida pinnata
Cacalia plantaginea
Gaillardia aestivalis
Liatris aspera
Liatris squarrosa
Rudbeckia fulgida
Rudbeckia hirta
Rudbeckia laciniata
Helianthus hirsutus
Helianthus divaricatus
Asclepias viridis
Monarda citriodora
Monarda fistulosa
Dalea candida
Dalea pupurea
Neptunia lutea
Desmanthus illinoensis
Oenothera biennis
Gaura filipes
Verbena simplex
Verbena canadensis
Tragia urticifolia
Pycanthemum flexuosum
Schoenolirion croceum

Appendix D

BURNING MEADOW POTENTIAL HERB LAYER SPECIES LIST

Meadow / roadside native herbaceous species of the Clemson area Compiled from Haywood; Jones and Foote; Radford, Ahles and Bell; Niering and Olmstead; and Batson.

Botanical Name	Common Name	Moisture	Height	Bloom Time	Color	Showy
Grasses						
Agrostis hymenalis	Bentgrass	drier	< 24”	Apr-Nov		
Agrostis perennans	Bentgrass	wetter	< 30”	Aug-Nov		
Andropogon gerardii	Big Bluestem	drier	36-72”	Jul-Oct		
Andropogon virginicus	Broomsedge	wet-dry	36-60”’	Sep-Oct		
Aira elegens	Hair Grass	drier	4-18”	May June		
Aristida oligantha	Three Awn	drier	8-24”	Aug-Oct		
Aristida dichotoma	Three Awn Grass	drier	< 28”	Aug-Oct	yellow-purp	
Arundinaria gigantea	Cane	wetter	20-400”	sporadic		
Danthonia spicata	Northern Oat Grass	drier	4-30”	May-Jul		
Elymus virginicus	Virginia Wild Rye	drier	36-48”	Jun-Oct		
Eragrostis hirsuta	Love Grass	drier	.5-1”	Jul-Oct	reddish	
Eragrostis refracta	Love Grass	wetter	12-40”	Jul-Oct	reddish	
Eragrostis spectabilis	Purple Love Grass	drier	16-32”	Aug-Oct	purplish	
Erianthus alopecuroides	Woolly Plume Grass	drier	120”	Oct-Nov		
Erianthus contortus	Plume Grass	drier	40-80”	Sep-Oct		
Gymnopogon ambiguus	Beard Grass	drier	12-24”	Aug-Oct		
Panicum anceps		drier	12-48”	Jul-Oct		
Panicum dichotomum		wetter	6-48”	Apr-Oct		
Panicum sphaerocarpon		drier	6-24”	Jun-Oct		
Paspalum boscianum		drier	12-36”	Jul-Oct	greyish	
Paspalum floridanum		drier	24-60”	Aug-Oct	dark red	
Paspalum laeve		drier	12-36”	Jun-Aug	yellowish	
Paspalum setaceum		drier	4-32”	Jun-Sep		
Setaria glauca	Foxtail Grass	drier	8-40”	Jul-Oct		
Schizachyrium scoparium	Little Blue Stem	drier	30-60”	Aug-Oct		
Sorghastrum nutans	Indian Grass	wet-dry	96”	Sep-Oct	yellowish	
Sphenopholis obtusata	Wedge Grass	drier	8-30”	Apr-May		
Tridens flavus	Purple Top	drier	32-60”	Jul-Oct	purplish	
Vulpia octoflora	Six Weeks Grass	drier	6-24”	Apr-Jun	red	
Forbs						
Acalphya rhomboidea	Three-seeded Mercury	drier	1.5”	Jun-frost		
Agalinis purpurea	Purple Gerardia	wetter	16-48”	Aug-frost	purple	+
Agalinis tenuifolia	Gerardia	drier	8-24”	Aug-Oct	lavender	
Aletris farinosa	Colicroot	wet-dry	16-48”	Apr-Jun, Jul-Aug	white	+
Allium bivalve	False Garlic	drier	6-18”	Mar-May, Sep-Oct	white	
Amianthium muscaetoxicum	Fly Poison	dry-wet	4-24”	May-Jul, Jul-Sep	white	+
Amorpha herbacea	False Indigo	drier	12-60”	May-Jul, Jul-Oct	blue-white	+
Asclepias amplexicaulis	Milkweed	drier	16-40”	May-Jul, Jun-Aug	rose-purple	
Asclepias tuberosa	Butterfly Weed	drier	8-32”	May-Aug, Aug-Sep	red-yellow	+
Aster concolor	Aster	drier	12-24”	Sep-Oct	violet,yellow	
Aster dumosus	Bushy Aster	wet-dry	24-54”	Aug-Oct	whit-blue-lav	+
Aster lateriflorus	Starred Aster	drier	24-54”	Sep-Nov	white,orange	
Aster patens	Aster	drier	12-48”	Sep-Oct	violet	
Aster pilosus	White-topped Aster	drier	.6-1.5”	Sep-Nov	white,orange	
Aster puniceus	Aster	wetter	36-80”	Sep-Oct	violet	

Baptisia alba	False Indigo	drier	48”	Apr-May	white	+
Cacalia atriphicifolia	Pale Indian Plantain	drier	60-120”	Jun-Oct	white	
Cassia fasciculata	Partridge Pea	drier	24”	Jul-Aug	yellow	
Cassia nicitans	Wild Sensitive Plant	drier	4-20”	Jun-Oct, Jul-Nov	yellow	
Chaerophylhym tainturieri	Wild Chervil	drier	8-36”	Apr-May	white	
Coreopsis major	Greater Tickseed	drier	24-42”	May-Jul	yellow-red	+
Croton glandulosus		drier	4-24”	May-Oct		
Desmodium dillenii (perplexum)	Tick-trefoil	drier	20-60”	Jul-Sep, Aug-Oct	purplish	
Desmodium laevigatum	Tick-trefoil	drier	24-48”	Jun-Sep, Aug-Oct	pink-purple	
Desmodium marilandicum		drier	24-60”	Jun-Sep, Aug-Oct	purplish	
Desmodium paniculatum	Tick-trefoil	drier	24-48”	Jun-Sep, Aug-Oct	purplish	
Diodia teres	Buttonweed	drier	6-24”	Jun-frost	white	
Eclipta alba		wettest	4-40”	Jun-frost	white	
Erigeron philadelphicus	Common Fleabane	drier	8-40”	Apr-Jun	lavender	+
Erigeron strigosus	Daisy Fleabane	drier	18-54”	May-Oct	white-lav	+
Eryngium prostratum		wettest	4-28”	May-Oct	blue	
Eupatorium album		drier	16-32”	Jun-Sep	white	
Eupatorium capillifolium	Dog Fennel	drier	36-78”	Sep-frost	white-purple	
Eupatorium coelestinum	Hardy Ageratum	wetter	12-36”	Jul-Oct	blue-violet	+
Eupatorium fistulosum	Joe-Pye Weed	wettest	18-108”	Jul-Oct	pink-purple	+
Eupatorium hysspifolium		drier	24-42”	Jul-Oct	white	
Eupatorium perfoliatum	Boneset	wettest	24-54”	Aug-Oct	white	+
Eupatorium serotinum		drier	24-78”	Aug-Oct	white	
Euphorbia corollata	Flowering Spurge	drier	4-20”	May-Sep	white	
Geranium carolinianum		drier	4-32”	Mar-Jun	pink	
Gnaphalium helleri		drier	24-36”	Sep-Oct	white	
Gnaphalium obtusifolium	Rabbit Tobacco/Everlasting	drier	24-36”	Aug-Oct	white	
Haplopappus divaricatus		drier	24-66”	Aug-Oct	yellow	
Hedeoma pulegioides	Pennyroyal	drier	4-18”	Jul-Oct	white-lav	
Helenium autumnale	Sneeze Weed	wettest	24-78”	Sep-Oct	yellow	+
Helenium flexulosum	Sneeze Weed	wettest	16-40”	May-Aug	red-yellow	+
Helianthus angustifolius	Narrow-leaved Sunflower	wet-dry	36-78”	Jul-frost	yellow	+
Helianthus atrorubens	Dark-eyed Sunflower	drier	24-60”	Jul-Oct	purplish-red	+
Helianthus hirsutus		drier	36-66”	Jul-Oct	yellow	
Helianthus microcephalus		drier	30-96”	Aug-Oct	yellow	
Helianthus strumosus	Woodland Sunflower	drier	36-114”	Jun-Oct	yellow	+
Helianthus tuberosus	Jerusalem Artichoke	drier	36-120”	Jul-Oct	yellow	+
Heterotheca mariana		drier	8-36”	Jun-Oct		
Heterotheca subaxillaris	Camphorweed	drier	12-60”	Jul-Oct	yellow	
Hieraceum gronovii	Hawkweed	drier	12-36”	Jul-frost	yellow	
Houstonia caerulea	Bluets	drier	2-7”	Apr-May, May-Jun	blue	+
Hypericum gentianoides	Pine Weed	drier	4-20”	Jul-Oct	yellow	+
Hypericum mutilum	Dwarf St. John’s-wort	wettest	6-28”	Jun-Oct	yellow	
Hypoxis hirsuta	Yellow Star Grass	drier	2-8’	Mar-Jun, May-Jul	yellow	+
Krigia virginica	Dwarf Dandelion	drier	6-12”	Mar-Jun	yellow	
Lechea racemulosa	Pine Weed	drier	4-16”	Jun-Jul, Jul-Oct	red-maroon	
Lespedeza hirta	Hairy Bush Clover	drier	48”	Aug-Oct, Sep-Nov	white	+
Lespedeza intermedia	Bush Clover	drier	8-40”	Jul-Sep, Aug-Nov	purplish	
Lespedeza repens	Creeping Bush Clover	drier	12-32”	Jul-Sep, Aug-Nov	purplish	+
Lespedeza virginica	Slender Bush Clover	drier	12-36”	Jul-Sep, Aug-Nov	rose-purple	+
Liatris gramnifolia	Grassleaf Blazing Star	drier	60”	Oct-frost	lavender	+
Liatris microcephela		drier	40”	Jul-Sep, Sep-Oct	lavender	
Liatris spicata	Gay Feather	wetter	12-72”	Jul-Sep	rose-purple	+
Linaria canadensis	Toad-flax	drier	6-28”	Mar-May	blue-purple	+
Lobelia cardinalis	Cardinal Flower	wettest	24-102”	Jul-Oct	scarlet	+
Lobelia inflata	Indian Tobacco	drier	4-40”	Jul-frost	lavender	
Lobelia puberula		wet-dry	24-72”	Jul-Oct	violet	
Lysimachia quadrifolia	Whorled Loosestrife	drier	12-40”	May-Jul, Aug-Oct	red, black	+
Monarda fistulosa	Wild Bergamot	drier	28-36”	Jun-Sep, Aug-Oct	pink	+
Monarda punctata	Dotted monarda	drier	12-36”	Jul-Sep, Sep-Oct	lavender	+
Oenothera biennis	Evening Primrose	drier	60”	Jun-Oct	yellow	+
Parthenium integrifolium	Wild Quinine	drier	24-48”	May-Aug	white	
Penstemon canescens	Grey Beardtongue	drier	12-28”	May-Jul	pink-purple	+

Phlox carolina L.		drier	<30”	May-Jun	pink-purple	
Polygala curtissii	Polygala	wetter	3-16”	Jun-Oct	pink-white	
Polymnia uvedalia	Bear’s Foot	drier	36-78”	Jul-Oct	yellow	
Ptilimnium capillaceum		wetter	4-32”	May-Jul, Jul-Aug	white	
Pycnanthemum incanum	Hoary Mint	drier	36-78”	Jun-Aug, Sept-Oct	white	+
Pycnanthemum teniufolium	Slender-leaved Mint	wetter	16-40”	Jun-Aug, Sep-Oct	white-pinkish	+
Pyrrohappus carolinianus		drier	12-36”	Apr-Jun	yellow	
Rhexia virginica	Virginia Meadow Beauty	wetter	36”	May-Oct	rose-purple	+
Rhyncospora globularis	Beak Rush	drier	4-28”	Jun-Sep	reddish	
Rudbeckia heliopsidis		drier	28-48”	Jul-Sep	yellow	
Rudbeckia hirta	Black-eyed Susan	drier	16-40”	May-Jul	yellow	+
Rudbeckia fulgida	Black-eyed Susan	drier	28-48”	Aug-Oct	yellow	+
Rudbeckia laciniata	Cut-leaf Cone Flower	wetter	36-96”	Jul-Oct	yellow	+
Rumex hastatulus	Sorrel	drier	6-11”	Mar-May, Apr-Jun	pink, yellow	
Sabatia angularis	Rose Pink	wetter	4-32”	Jul-Aug, Sep-Oct	pink	+
Salvia lyrata	Lyre-leaved Sage	drier	12-24”	Apr-May, May-Jul	blue-violet	
Scutellaria integrifolia	Skullcap	drier	6-32”	May-Jul, Jul-Aug	blue-violet	+
Silene antirrhina	Sleepy Catchfly	drier	12-36”	Apr-Jul	purplish	
Silphium compositum	Compass Plant	drier	36-156”	May-Sep	yellow	+
Silphium dentatum		drier	24-102”	May-Aug	yellow	
Sisyrinchium angustifolium	Blue-eyed Grass	wet-dry	6-20”	Mar-Jun, May-Jul	blue	+
Solidago altissima(canadensis)	Tall Goldenrod	drier	36-108”	Sep-Oct	yellow	+
Solidago erecta		drier	32-60”	Aug-Oct	yellow	
Solidago gigantea	Late Goldenrod	drier	24-84”	Aug-Nov	white-yellow	
Solidago nemoralis	Common Goldenrod	drier	16-40”	Sep-frost	yellow	+
Solidago rugosa	Rough-stemmed Goldenrod	wet-dry	12-72”	Sep-Oct	yellow	+
Solidago speciosa	Showy Goldenrod	drier	40-80”	Sep-Oct	yellow	+
Stenanthium gramineum	Feather Bells	drier	24-60”	Jun-Sept, Aug-Oct	white	+
Teucrium canadense	Wood Sage	wetter	24-60”	Jun-Aug, Sep-Oct	pink	+
Thalictrum revolutum	Meadow Rue	drier	24-60”	May-Jul	whitish	+
Trichostema dichotomum	Bastard Pennyroyal	drier	4-32”	Aug-frost	blue-violet	
Verbena urticifolia		wetter	40-100”	May-Nov		
Verbesina alternifolia	Crown Beard	wettest	78-156”	Aug-Sep	yellow	
Verbesina occidentalis		drier	78-120”	Aug-Oct	yellow	
Verbesina virginica		drier	78-120”	Jul-Oct	white	
Vernonia novaboracensis	New York Ironweed	wetter	24-78”	Jul-Sep, Aug-Oct	violet	+

Additional species, native to the Carolinas, that are not shown by Radford to be native to the Clemson area, might be included when considering the need to maximize showy species in some areas. This should include the following showy grasses and forbs. Grasses: *Andropogon ternarius, Aristida purpurascens, Erianthus giganteus, Panicum virgatum, Muhlenburgia capillaris, Setaria geniculata.* Forbs: *Agalinis fasciculata, Aquilegia canadensis, Baptisia australlis, Coreopsis lanceolata, Coreopsis tripteris, Dodecatheon meadia, Echinacea purpurea, Helianthus mollis, Liatris aspera, Liatris pycnostachya, Lilium superbum, Lobelia spicata, Lupinus perennis, Oenothera fruticosa, Oenothera speciosa, Phlox glaberrina, Phlox pilosa, Rhexia mariana, Rudbeckia triloba, Salvia azurea, Tradescantia ohiensis, Verbena hastata, Verbena rigida, Verbena stricta, Vernonia angustifolia.*

Rare species such as *Echinacea pallida, Lotus helleri*, and *Helianthus schweinitzii*, that are found in fire dependent savanna communities, should be included to add additional interest to the meadow. These species and others are shown in Appendix C.

Appendix E

POTENTIAL TREE SPECIES OF THE PIEDMONT SAVANNA

(Little)

Genus, Species	Common Name	Piedmont Distribution	Growing Conditions
Carya			
C. glabra	Pignut Hickory	throughout	dry and moist uplands in hardwood forests with oaks and other hickories
C. pallida	Sand Hickory	southern Piedmont	dry sandy and rocky soils on plains and mountain valleys, in oak hickory forests
C. tomentosa	Mockernut Hickory	throughout	moist uplands and less frequently on floodplains, usually with oaks, also pines
Pinus			
P. echinata	Shortleaf Pine	throughout	from dry rocky mountain ridges to sandy loams of flood plains, old fields, often in pure stands or with other pines and oaks
P. taeda	Loblolly Pine	throughout	from poorly drained flood plains to well-drained slopes of rolling hills, hilly uplands, forms pure stands, often in old fields
P. virginiana	Virginia Pine	from upper SC and north in the Piedmont	clay, loam, and sandy loam on well drained sites, eroded soils, in pure stands and mixed
Quercus			
Q. alba	White Oak	throughout	moist well drained uplands and lowlands
Q. coccinea	Scarlet Oak	throughout	various soils, esp. poor and sandy, upland ridges and slopes mixed with other oaks
Q. falcata	Southern Red Oak	throughout	dry, sandy loam and clay loam soils of uplands in mixed forests
Q. marilandica	Blackjack Oak	throughout	dry sandy and clay soils in upland ridges and slopes with other oaks and pines
Q. muehlenbergii	Chinkapin Oak	mainly in southwestern Pied. esp. GA and AL	on mostly limestone outcrops, alkaline soils including dry bluffs and rocky river banks with other oaks
Q. prinus	Chestnut Oak	mainly in NC Pied., and upper Pied. of SC and GA near Mnts.	sandy gravely, and rocky dry upland soils, often in pure stands on dry rocky ridges
Q. stellata	Post Oak	throughout	sandy, gravely, and rocky ridges, also moist loamy soils of flood plains along streams, sometimes in pure stands
Q. velutina	Black Oak	throughout	dry upland sandy and rocky ridges and slopes, also on clay hillsides, sometimes pure stands
Q. rubra	Northern Red Oak	throughout	moist, loamy, sandy, rocky and clay soils; often in pure stands

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