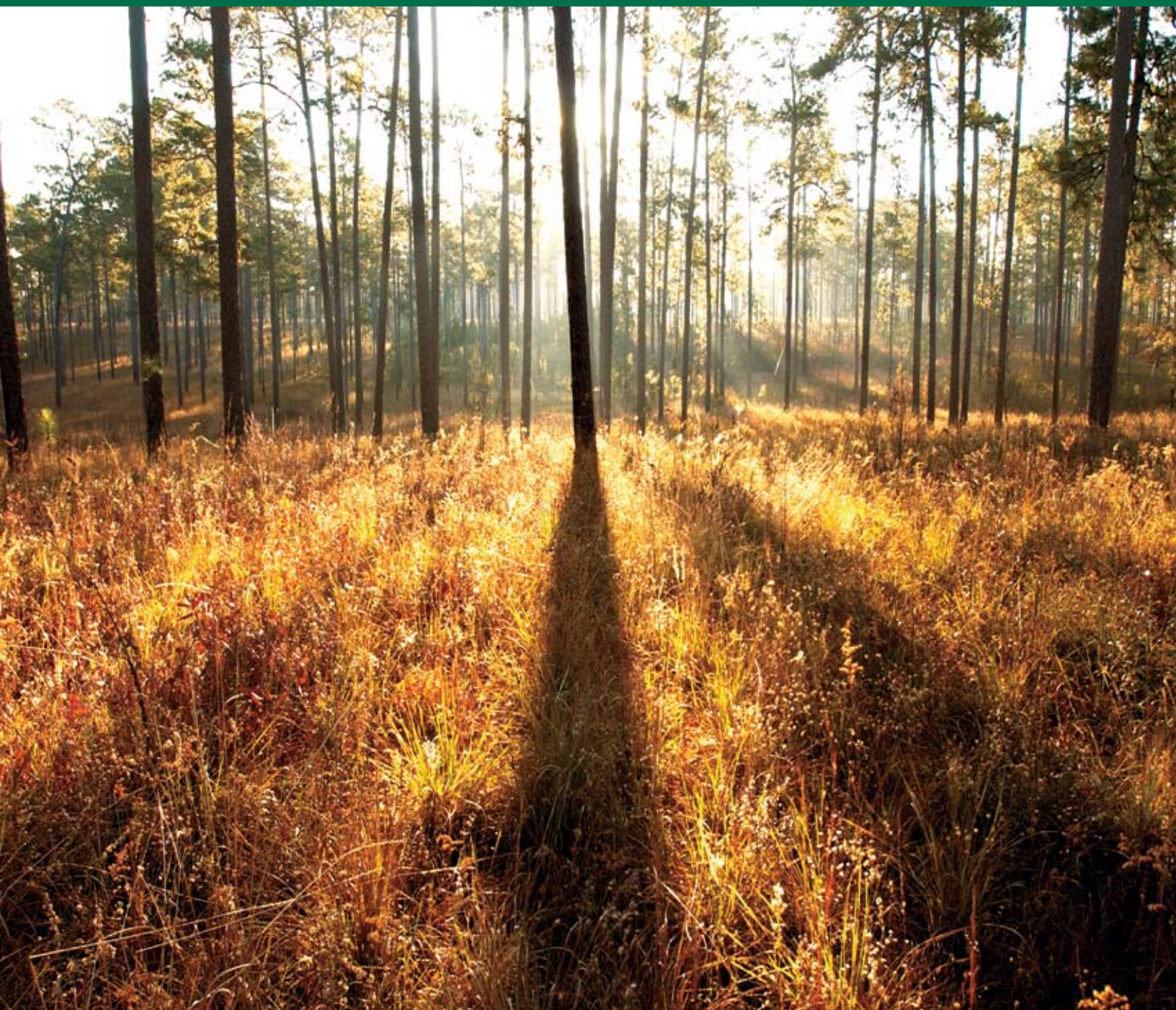
RED HILLS FOREST STEWARDSHIP GUIDE



RED HILLS FOREST STEWARDSHIP GUIDE

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VISION STATEMENT

Our goal is to pass the land on to future generations in as good, if not better, condition than when received. Along with that, we desire to pass along our love of the land and our stewardship ethic. – Red Hills Landowners

ACKNOWLEDGMENTS

The Red Hills Forest Stewardship Guide was funded by a grant from the Turner Foundation. We gratefully acknowledge the Foundation's support and its commitment to conservation and research. We also wish to thank Dr. Lenny Brennan, former director of research at Tall Timbers Research Station, who acquired the grant and conceived of the need for this guide. In addition, our knowledge of the Red Hills was expanded considerably by the work of Dr. Christine Ambrose and Dr. Keith Moser, conducted in partial fulfillment of grant requirements.

This document is the result of the collaboration of a great many people. The process of developing the guide involved considerable interaction between Red Hills landowners, managers and foresters and Tall Timbers' scientists, conservationists and land managers. This guide is dedicated to the landowners, managers and foresters of the Red Hills for without their commitment to hunting and conservation, the beautiful landscape known as the Red Hills would not exist.

We gratefully acknowledge the efforts of Bob McDonald, who facilitated the series of interactive meetings that developed dialogue between the Red Hills landowners and land managers and the Tall Timbers research and conservation staff. We also acknowledge the efforts of Kaye Gainey and Lisa Baggett in assisting with all aspects of the interactive meetings and in organizing participant input. They also produced many of the graphics included in the guidebook and assisted with word processing. We appreciate the diligence and care with which Kathy Marois entered and organized comments from the various sessions. We also acknowledge the helpful reviews of all or selected portions of this publication by Wilson Baker, Earl Bennett, Warren Bicknell, Dr. Bill Boyer, Dr. Lenny Brennan, Dr. Dale Brockway, Dave Brownlee, David Copps, Bruce Davenport, Dr. Todd Engstrom, Kaye Gainey, Ray Gainey, Dr. Jim Guldin, Larry Hedrick, Stuart Jackson, Jessica Masters, Bob McDonald, Leon Neel, Caroline Noble, Paula Seamon, Walter Sedgwick, and Shane Wellendorf. Special thanks is due Dr. Jim Guldin for assistance with developing diameter distribution graphs and Larry Hedrick for insightful discussions on even-aged and uneven-aged management. A special note of thanks is due Leon Neel for his review comments, open discussion of forest managment philosophy and time in the woods illustrating points.

Pictured at the meetings organized to develop this Red Hills Forestry Stewardship Guide are landowners, land managers, Tall Timbers staff and facilitator, Bob McDonald (top left photo at right.) Photos by Ron Masters and Rose Rodriguez.

PREFACE

Tall Timbers Research Station & Land Conservancy is about fire ecology, forests and wildlife in a conservation context. Its mission is to foster exemplary land stewardship through research, conservation and education. This stewardship balances ecological values and economic utility within a framework of long-term conservation.

In keeping with this mission and purpose, Tall Timbers in 1998 applied for and received a grant from the Turner Foundation to study and characterize two important components of the Red Hills landscape. The first component was to determine and map the extent of native ground cover. The second was to evaluate and describe forest management strategies that have perpetuated the open pine woodlands and associated values. Two reports, *Remnants of a Forest: Mapping and Inventory of Ground Cover in the Red Hills Region of South Georgia and North Florida,* by Dr. Christine Ambrose, and *The Stoddard-Neel System of Ecological Forest Management in the Red Hills Region of Florida and Georgia,* by Dr. Keith Moser, accomplished these goals. The *Red Hills Forest Stewardship Guide* is the final product of this grant.

This guide was developed as an outgrowth of three interactive meetings organized by Tall Timbers in Summer 2002. These meetings involved the research and conservation staff of Tall Timbers first with landowners and land managers as separate groups, and, finally, with a joint session involving all participants. The purpose of these meetings was to more clearly define and better understand the landowners' and managers' distinct perspectives in successfully perpetuating the region's rich biodiversity and heritage. Further, we wanted to foster an understanding of the management and research issues that they find important.

In order to develop a useful guide, we needed to identify their specific land management objectives and long-term goals and to understand why they remain so committed to land ownership and management. This continuing dialogue, coupled with education and outreach, engages the owners, managers and Tall Timbers research and conservation staff, making everyone a contributor. It provides feedback to the respective parties to help guide the efforts of researchers and conservationists. The outcome of this process is improved communication and an exceptional educational opportunity.

Magnificent longleaf pine forest with a lush carpet of bracken fern ground cover. Photo by Christine Ambrose.

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INTRODUCTION

Conservationists like Gifford Pinchot and Aldo Leopold today are revered for the legacy of words they left on their personal interactions with the land. Indeed, their words prompt us to renew and rekindle *our* relationship with the land. In *Round River,* Aldo Leopold wrote, "The land is one organism. Its parts, like our own parts, compete with each other and cooperate with each other. The competitions are as much a part of the inner workings as the co-operations. You can regulate them—cautiously—but not abolish them. … To keep every cog and wheel is the first precaution of intelligent tinkering."

"Keeping all the parts" has become increasingly problematic with the continual upward spiral of human populations and ensuing development pressures. So much has been written about this that, at times, the clarion call seems almost trite. A legacy of words is important, but more important, is the legacy actually left on the land.

Designated as one of America's "Last Great Places" by the Nature Conservancy, the Red Hills' park-like pine forests, with their diverse ground cover, predominate between Thomasville, Georgia, and Tallahassee, Florida. The region contains some of the finest remaining examples of old-growth longleaf pine forests and woodlands. The open woodlands provide for wildlife, protect our clean air, provide a sink for carbon sequestration and help to recharge the Floridan aquifer, a source of fresh drinking water for portions of Florida, Georgia and Alabama. *Much of the ecological significance of the Red Hills region is associated with its intact native ground cover.* Even though relatively few species are represented in the canopy of these woodlands, the native ground cover is incredibly diverse and rich. Many areas will average over 50 different plant species per square yard. A key element is wiregrass. Nationally, only about 2 percent of the original extent remains. Some of this is found in the Red Hills.

About 30,000 acres in the Red Hills currently are in the longleaf pine and wiregrass habitat cover type (Figure 1). Longleaf-dominated forests, with attendant native ground cover, have been described as one of the most endangered ecosystems in North America, as they are home to more than 230 rare types of plants and animals. Of these, 27 were federally listed as endangered or threatened and 99 were proposed for listing or were candidates for listing.

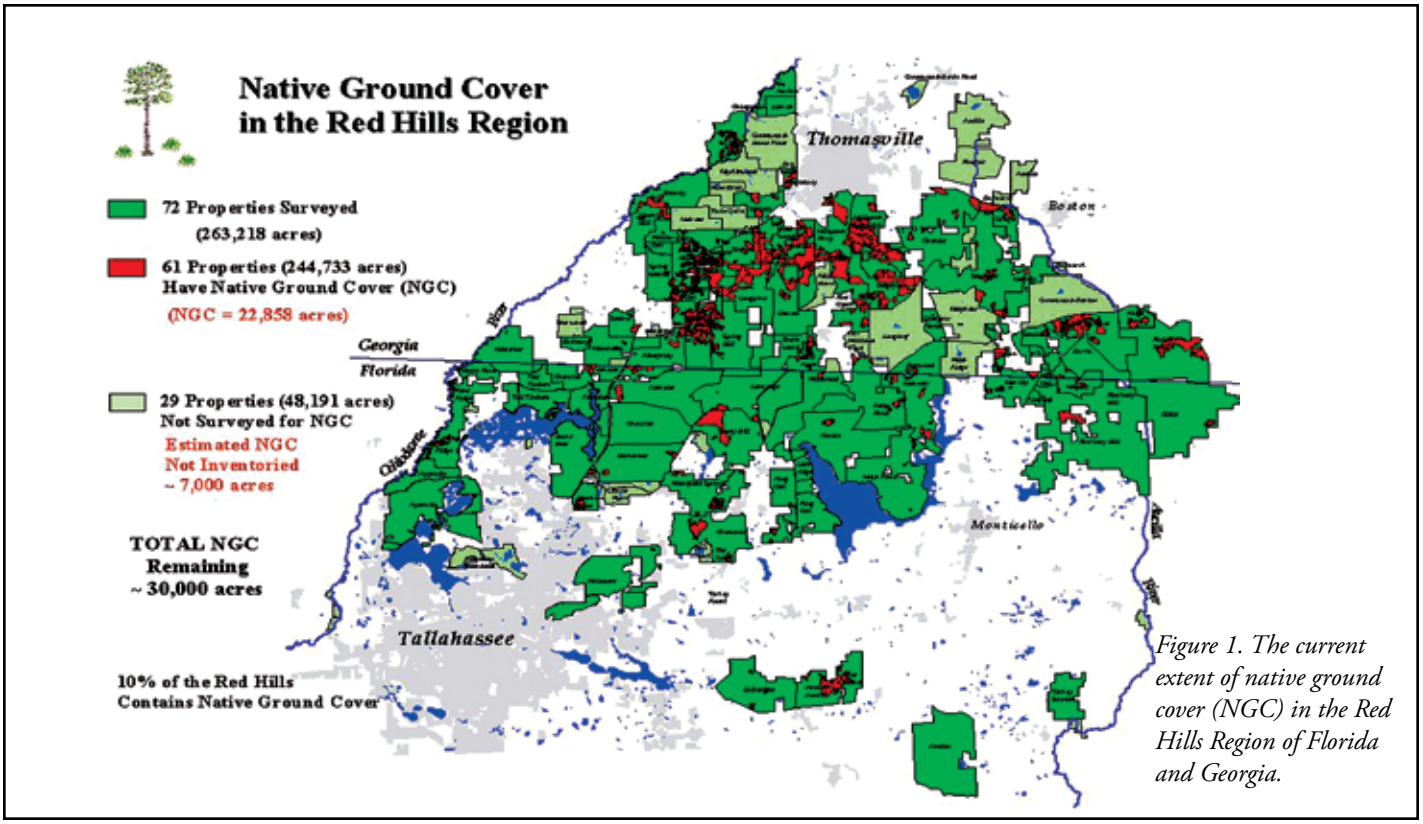


Figure 1. The current extent of native ground cover (NGC) in the Red Hills Region of Florida and Georgia.

Just as other parts of the world, the Red Hills Region has felt the effects of urbanization, forest fragmentation, forest densification, loss of native ground cover, increased water pollution and other related ills that result from poorly planned growth. However, the 300,000-acre central core of the Red Hills remains largely forested and intact, with over half of the land base protected by private and public conservation efforts.

Overall, the Red Hills has maintained its distinct sense of place because many landowners have practiced sensitive land management for over a century. Their ties with the land run deep. Through use of sustainable forestry practices and the use of prescribed burning, they have ensured that the region's natural heritage will be passed on to future generations. Combined objectives of stewardship, wise game management, productive forestry and concern for the region's wildlife and aesthetic character have resulted in a model working landscape. *The Red Hills Region has thrived because of human intervention, not in spite of it.* Understandably, not all landowners' objectives are the same, and, at times, there are inherent conflicts in this multiple-use land management approach. But the fact that this region boasts one of the best, if not *the* best, wild quail hunting environments in the nation—not to mention that it contains high-quality forests and woodlands rich with biological diversity and produces forest products in a sustainable manner—is a tremendous testimony to the compatibility of these traditional land uses combined with a modern conservation ethic. Few private lands can match the abundance of rare and endangered species and rare, functioning, intact environmental communities as the Red Hills. Here, keeping all the parts is our goal.

During our interactive meetings, a guiding philosophy of stewardship was expressed by landowners and mirrored by the land managers. Stewardship as expressed by owners and managers encompasses their relationship with the land. It carries with it the overriding idea of conservation and sustainability rather than total preservation and recognizes that ecological change is an important part of this landscape. This concept of stewardship recognizes our place on the land and our responsibility to the land. The stewardship tradition of the Red Hills has not been static but has evolved through time as science has discovered new knowledge about ecological relationships. It has grown through embracing this new knowledge and allowing it to modify what is put into practice on the land. The landscape continues to change for the better as a result of this interaction.

The purpose of this guide is to describe the range of forest management strategies that have perpetuated the open pine woodlands and resulted in the current level of biodiversity. **The recommendations in this guide do not supercede existing site-specific management plans for conservation easements.** Existing plans are unique to the biological features on a particular ownership. Instead, we describe a range of options that will ensure existence of important biological elements of the Red Hills in the future. It is beyond the scope of this guide to provide a management recommendation for every contingency on the land, as each situation is unique. Rather, we seek to provide concepts for vegetation management, both understory and overstory, in the Red Hills. Vegetation management influences the wildlife species and biodiversity of the region. Whenever possible, however, specifics are given about species of high interest.

Components of Stewardship

- Love of the land
- Sustainability
- Responsibility
- Continuing a tradition of appreciation
- Caretaker
- Wise user
- Integrity
- Ethics in land use
- Professionalism in land management

In developing this resource, we drew upon the current state of research and the current Red Hills conservation easement strategy to protect and conserve the unique ecological communities that compose the Red Hills. We recognize and value the ownership patterns and management philosophy that have perpetuated the ecological integrity of this wonderfully rich and beautiful region. We gratefully acknowledge and share the landowners' and managers' love of the land. We hope our efforts will serve as a model, or, at the very least, a rough template of conservation possibilities in a working landscape.

This guide is a starting point for land management *in the Red Hills Region*. Research and management recommendations should be taken in this context. Occasional exceptions or differences may be experienced outside this region. As research is completed, new information will become available. This is not the final word!

Natural History

A good starting point for examining the natural history of the Red Hills is the time when ice covered much of North America. Then, northern forest elements, like jack pine and red pine, occurred as far south as Atlanta. Further south, elements of the eastern deciduous forest were crowded into a refuge along the southern coastal plain. Pollen from sediment cores indicates that some element of southern pines was present. These forests also included temperate, deciduous trees, many species of which are considered characteristic of more northern climates today.

As the glacial sheets retreated, the eastern forest expanded rapidly and southern pines began their march northward. Different species segregated out according to their respective niches and site-specific conditions. Some scientists suggest that lightning-caused fire was already having an influence on developing plant communities. Concurrent with the movement of temperate forests northward, however, was the arrival of humans on the scene. By 4,000 years ago, the southern pines had reached roughly the current distribution limits for each species.

Some authorities believe that the use of fire by Paleo-Indians had a significant influence on the evolution and development of current forest types in North America, particularly those of the southeastern coastal plain region. Others suggest that the lightning fire regime was the predominant force shaping the assemblage of plants that filled newly created climatic- and soil- related niches. Most likely, some combination of lightning-caused fire and aboriginal use of fire helped to fix fire-adapted characteristics in the genetic makeup of individual species in this vegetation complex.

The importance of lightning and aboriginal fire regimens is very evident in the adaptations of various southern pines to fire. For example, human-caused fire regimes have been credited with fixing the genetic character of cone serotiny or persistence in several pine populations. Cones remain for several years and open in the presence of intense heat. Pond pine is one of these. However, it is impossible to differentiate between the influence of lightning and aboriginal fire, as both were present in developing southern pine ecosystems.

Longleaf pine shows other adaptations and growth patterns that provide protection from frequent ground fires, such as a grass stage with well-insulated terminal buds. Following adequate root collar development and suitable light regimens, grass-stage longleaf bolt into a stage of rapid growth, elevating the terminal bud above ground fires in a short period of time. Shortleaf pine and pond pine illustrate a different adaptation to fire, such as sprouting from the root collar or along the stem following top-kill. The sprouts at the base serve as insulation from the heat of succeeding fires. The plate-like bark on these and less fire-tolerant species, like loblolly and slash pine, also is thought to be an adaptation to frequent fire.

The prevalence of fire-tolerant grasses in the understory of the Red Hills forests also speaks of their fire-derived nature. Chief among these is wiregrass, which generally will not flower and set viable seed except following early growing season fires. Many of the bluestem grasses, like broomsedge bluestem, found in the region also decline if not frequently burned. Frequent fire also promotes flowering and seed set. These fire-tolerant grasses actually help perpetuate this fire system by their combustibility, arrangement and quick drying character.

Without fire, the plant community changes. Hardwoods become more dominant and understory grasses slowly give way to woody development in the understory. Leaves then become the primary fuel for fires following canopy closure. At this juncture, the nature of fire changes to a slow moving, often less intense character. Large grazing mammals, such as bison and elk, are thought to have some influence on plant community and fire regime dynamics, influencing the distribution of some plants. Information about historical large mammal distribution and time of occurrence is hotly debated. Therefore, we are unsure about the possible influence of these species in the development of the current Red Hills landscape.

Human Influences

Carbon dating of artifacts puts humans in the region some 10,000 to 12,000 years ago. Artifacts also indicate that, by 3,000 years ago, the aboriginal people were well transitioned from a hunter-gather society to a more agrarian culture. Panfilo de Navaez (1528) and Hernando de Soto (1539) found numerous extensive agricultural fields in the Tallahassee region, with one account describing a maize field stretching for more than six miles. References to frequent storms, lightning and lightning-struck trees also were recorded in this region by Nunez Cabeca de Vaca, who preceded de Soto. Early accounts by later explorers of the forests of this and neighboring regions give descriptions of the open character of the forests, the grassy ground cover and aboriginal burning and lightning-set fires.

The Spanish influence in the region declined by the late 1700s and native Indian populations declined to lower levels, possibly a result of disease and occupation by the Spanish. Evidently, some rebound in the Native American population was noted as Andrew Jackson campaigned against the Miccosukee Indians in 1818. With the acquisition of Florida in 1821 by the U.S., and the exile of the Seminoles following the first Seminole War, Native American presence was eliminated from the Red Hills. The extent of Native American agriculture at that time is unclear.

1839 lithograph of a plantation by Lake Jackson in Leon County, Florida. Courtesy of the Florida State Archives.

In the 1820s, cotton planters began to move to the region and purchase land. A well-developed plantation culture soon sprouted in the Red Hills. Because there were only a few decades between the first planters and the Civil War, not all of the land in the Red Hills was converted to agriculture. Following the Civil War, many cotton plantations were divided into various holdings, including numerous tenant farms. In the 1890s, entrepreneurs from the north began piecing together many tracts of land to serve as quail hunting plantations and a refuge from the rigors of northern winters. These landowners began the healing process for the land from the agricultural influence of both Native and European Americans. Many of the plantations that exist today have been passed down through several generations.

In the 1920s, a young naturalist named Herbert Stoddard arrived on the scene to examine the bobwhite quail decline. His acumen for natural history, attention to detail and fine observation led to his seminal work on the bobwhite quail. His observations on fire remain relevant today. With his young protégé Leon Neel, Stoddard developed a system of forestry now referred to as the Stoddard-Neel system. This system was unique in its management of a given stand compared to contemporary silvicultural practices. Their goal through time was to perpetuate the ecosystem by retaining continuous overstory, continuous ground cover and continuous diversity. They have left a mark on the land in well-managed forests that stands as a testimony to their wisdom.

Herbert L. Stoddard, Sr. Photo by Wallace B. Grange.

Ed, Roy and Betty Komarek also left their mark through encouraging the development of a fire culture. They preached about the benefits of fire and, along with Stoddard, demonstrated its use at Tall Timbers Research Station and elsewhere in the Red Hills. As a late contemporary of Stoddard, Neel, and the Komareks, Larry Landers in his writings laid the groundwork for a collective conservation strategy. His efforts took conservation efforts to the next level, that of conserving the landscape within the Red Hills Region. His thoughts and philosophy precipitated a strategy for conservation easements to protect the ecological value of the Red Hills. Indeed, part of the Red Hills' heritage is shared by these forward thinking individuals who wrote their names on today's landscape.

At right, 1778 map by Joseph Purcell from a survey by John Stuart, British Superintendant for Indian Affairs, showing the old field lands of the Apalachee. Courtesy of the Florida State Archives.


A MAP
of the
ROAD from PENSACOLA in W. Florida
to
ST. AUGUSTINE in East Florida
from a Survey made by Order of the late Hon. Col.
John Stuart Esq. His Majesty's Superintend.
of Indian Affairs. Southern District
in 1771 By Joseph Purcell
Appalatchi Old Fields
ITINERARY

"Next to the earth itself the forest is the most useful servant of man. Not only does it sustain and regulate streams, moderate the winds, and beautify the land, but it also supplies wood…"

— Gifford Pinchot, A Primer of Forestry

Forest Function and Ecology

When we look at a forest, most of us recognize that it is more than just a large number of trees located in close proximity. A forest is the functioning group of organisms from the tallest trees, understory shrubs and herbaceous plants down to the symbiotic relationship between certain types of fungi with rootlets, called mycorrhizae, that assist a tree in its uptake of nutrients, and the fungi that slowly break down dead plant material. The collective group of plants that make up the forest in a discrete area is a community. The sum of all natural communities, and their physical environments within a specific geographic area, makes an ecosystem. This includes all elements and processes that interact with and influence the surrounding environment.

At the highest level, a forest ecosystem is described in terms of energy flow and cycles of water, carbon, nitrogen and other minerals. Therefore, the health of an ecosystem commonly is described in terms of its "function" as well as its "composition." For example, in the Red Hills region, one function of a healthy ecosystem is the natural process of water filtration as it passes from uplands to wetlands through respective soils and plant communities prior to entering the aquifer. This removes silt, fertilizers, pesticides and other toxics from runoff. This important function can be degraded by development of, or improper disposal of, toxic materials.

A forest is the product of past and present land use, climate, soil type, topography, hydrology or moisture regime, fire or absence of fire and other natural disturbances coupled with plant and animal components. Of these elements, climate exerts the greatest influence on the distribution of a given plant species. In an undisturbed state, the mix of species in a forest is determined by soils, topography and hydrology. The subsoil and parent materials also exert an influence on forest community composition and structure.

The soil-site-moisture relationship helps define a given species' niche or functional role in the environment. For example, longleaf pine is found primarily in uplands and is associated with deep sandy soil. Along ridges and hilltops with shallow, nutrient-poor soils, shortleaf pine may predominate. Pond pine favors wet, finely textured soils. Spruce pine prefers better drained, finely textured soils in the upper portions of flood plains and at the heads of hammocks. Loblolly and slash pine often are more prevalent on moist, loamy soil types, with slash preferring the wetter sites.

As for hardwoods, we most often find white oak on moist, sheltered sites like north-facing slopes. In contrast, post oak and black jack oak are restricted to drier and nutrient-poor ridges. Other species, including water oak, exhibit great elasticity and are found on a range of sites. The numerous broad-leaved herbaceous plants (forbs), grass and shrub species sort out in similar fashion across different sites according to their respective niches and adaptations.

Each plant species exhibits different traits or adaptations thought to help it thrive under a certain set of environmental circumstances. For example, some tree species, such as southern magnolia, are very tolerant of shade. Others, like longleaf pine, are relatively intolerant of shade. Some are adapted to different moisture regimens. The bald cypress will withstand long periods of inundation by water, while the white oak will not grow in standing water. In similar fashion, different species show different adaptations to fire. Some, like southern magnolia, are intolerant of fire, while others, like post oak, are tolerant of frequent fire. Likewise, species vary in their tolerance of high soil pH and soil nutrient concentrations.

Natural disturbances also play an important role in determining where a species will be found. In the Red Hills, these include wind-throw, insect infestations, drought, floods, lightning strikes and fire. A forest's response is

tempered by the magnitude of the disturbance, which may affect an individual tree, a group of trees, a whole stand or even large sections of forestland, as happens with a powerful hurricane.

Following a disturbance, the plant community undergoes an often-predictable sequence of change called *plant succession.* The wildlife community undergoes a similar change. The process of old-field succession provides a familiar example to residents of the Red Hills. Taken from bare ground, such as a fallow field, the first colonizers typically are annual grasses and forbs (sometimes called weeds), followed in predominance by perennial grasses and forbs; pioneer woody shrubs; sapling trees; and, finally, a mature forest. In the Red Hills, the shrub stage is often represented by shortleaf and loblolly pine, which aggressively colonize openings because of their light, wind-disseminated seed. The heavier seeded oaks follow as blue jays, crows and squirrels disperse acorns farther into the opening. One example of plant succession is seen in a research area on Tall Timbers Research Station known as NB66, which provides an example of the change that takes place on an old-field site following fire exclusion for 36 years. (See figure on next page.) NB66 formerly was dominated by shortleaf and loblolly pine with a grassy understory, but currently is dominated by water oak, sweetgum and pine.

The various types and scales of natural disturbance that operate on a forest also structure it as it matures. In the case of small canopy gaps, the forest that develops might be somewhat uneven-aged. If they are young and vigorously growing, adjacent trees may spread their crowns to fill the gap. Depending on what is present beneath the canopy, seedlings or midstory trees may fill the gap if adequate sunlight is available. Periodic fire or absence of fire altogether will determine the species that will be released to fill the gap. Where the gap is larger, through blow-downs or patches of insect-killed trees, the forest may develop in small, even-aged patches. With hurricane-caused blow-downs, the forest that develops is often even-aged.

Other stand structures may develop depending upon whether fire is an influence. In old-growth longleaf stands, and in the presence of frequent fire, a two-tiered stand often will develop, with regeneration occurring in stages. Here, regeneration is found in patches where the canopy has broken down. These stands are noticeably devoid of midstory, and have a rich and diverse ground-level community. Understanding how different forest structures develop, and the processes that influence regeneration over time, is important because our forest management practices are based on mimicking what we see in terms of forest stand dynamics.

RAY STANYARD PHOTOGRAPHY

Old-growth longleaf at the Wade Tract Preserve, Thomas County, Georgia.

NB66 — March 1967

NB66 — February 2003

Above are photographs of NB66, an area on Tall Timbers. The top photo was taken in March 1967, after a prescribed burn, when the area was prime quail habitat. This "old field" land was predominately loblolly and shortleaf pine. The bottom photo was taken at the same place, (note A4 marker at right of both photos) but in February 2003. Prescribed fire has been withheld since 1967. Because of the lack of fire, the pines now compete with water oak and sweetgum. NB66 is an example of forest land that has not been managed using frequent fire and therefore does not support quail or red-cockaded woodpeckers. The top image is a composite of two photos taken by Roy Komarek in 1967. Composite image and bottom photo by Rose Rodriguez.

"At one time I was classed by many as an enemy of these forests because of my written and spoken insistence that the pine forests not only could be burned over frequently enough to maintain their natural vegetation and associated wildlife but indeed should be burned, for the safety and the healthy development of the forests themselves." — Herbert L. Stoddard, Sr., Memoirs of a Naturalist

The Role of Fire

Fire has dramatic implications on plant succession. It favors certain species over others by causing mortality to fire-intolerant competitors or, indirectly, through changes in available light, soil nutrient status and pH. It even may influence moisture regimens. Fire changes the competitive advantage of various species, determining future plant community dominants. It also refines plant community boundaries.

In the developing plant communities of the Red Hills, frequent fire controlled hardwood encroachment in the uplands. It also helped to separate genetically the pine species by fixing certain genetic traits in those subjected to frequent fire. Different species of pines have different responses to a given fire regime. For example, studies of a portion of the Red Hills region known as the Wade Tract show that longleaf pine will successfully regenerate in canopy gaps with a seasonally shifting two-year burn cycle. However, with continuous fuels, regeneration will be limited or altogether nonexistent, with repeated one-year interval dormant season fires.

Research shows that shortleaf pine is slightly less tolerant of frequent fire than longleaf pine. A three-year burn cycle, accompanied by open canopy conditions and continuous fuels, will allow some degree of shortleaf regeneration to be established. On the other hand, loblolly and slash pine, while resilient to fire when older, cannot regenerate successfully in the presence of frequent fire, that occurring at one- to three-year intervals. Pond pine and spruce pine favor more moist sites and are markedly different in their fire tolerance. Spruce pine of any age is intolerant of fire, while pond pine, similar to shortleaf pine, will sprout following a fire. With its persistent or serotinous cones, a crown fire may be necessary to regenerate an aging pond pine stand. The intense heat will open the cones and release seed that one day will form a new stand.

Occasionally shortleaf and loblolly may persist following annual or biennial fire. This may occur in ground cover like that found on old-field lands, or with low-intensity, patchy burns under conditions of high relative humidity. This is particularly true when burning an understory dominated by woody shrubs or weeds, or where soil disturbance creates firebreaks.

Fire often affects the herbaceous plant community in the Red Hills in similar ways. Yet, at times, it yields different results. For many herbaceous species, fire acts as a release from competition for seedlings or as site preparation for seed germination. It accomplishes this by reducing plant litter and by allowing greater light to the understory through top-killing small hardwoods. Fire also interacts with the canopy cover of dominant trees. Frequent fire may cause annual forbs to predominate in the understory, with moderate canopy cover and continued soil disturbance.

CHRISTINE AMBROSE

Horseweed. Photo by Ron Masters

When stands are opened up to near savanna conditions, grasses will begin to predominate. Different species of legumes, like the lespedezas and beggar-lice, are promoted by fire in most any season. On the other hand, fire has been shown to have little effect on some understory herbaceous plant species. In particular, some annual plants, like horseweed, may decline or increase through time irrespective of the fire regime. Ground-level dominance for others, like bracken fern and wiregrass, may be influenced by burn season. Under frequent dormant season fires, bracken will tend to dominate disturbed sites, while wiregrass will dominate if periodic growing season fires are employed and ground cover disturbance is limited. Research to date suggests that wiregrass, in the Red Hills region, will produce viable seed only following mid-April to June burns. In other regions viable seed production has been accomplished under different burning regimes. Currently, the influence of burn season on bluestems, eastern gama grass and panic grasses is poorly understood in the Red Hills.

Wiregrass, other fire-tolerant grasses like bluestems, and highly flammable shrubs tend to perpetuate fire in the system. Historic interaction with large grazing mammals also may have helped promote and extend the distribution of these understory types by providing a disseminating agent for seed—especially in the case of wiregrass—and by reducing competition from palatable species including eastern gama grass and some of the panic grasses. Evidence is far from conclusive about the historic distribution of large native herbivores in the Red Hills. Assuredly, so-called "cracker cattle" brought in by settlers had an influence, due in part to the fact that the settlers burned the woods to "freshen the grass."

Frequency is the fire variable that most influences plant communities. Other important fire variables include season, intensity and severity. On lower coastal plain sites, seasonality of fire becomes more important in its influence on recurrent hardwoods. In the upper coastal plain and other regions, fire season appears to have less of an influence on hardwood encroachment where the understory is dominated by bluestems or is the result of old-field succession. A three-year burn interval is the threshold that tips the balance in favor of either an herbaceous-dominated ground community or a developing woody, midstory plant community. A frequent fire regime with both growing and dormant season fire will help ensure that the entire complex of plant species and communities indigenous to the Red Hills is preserved.

Fire Season in the Red Hills

In both the scientific and popular literature about fire, season of burn is generally referred to as dormant or growing season burns. This becomes confusing because different regions have different lengths of growing seasons. In the Red Hills the growing season is very long and burns early in the growing season have different affects than those late in the growing season. Defining the specific month and the stage of plant growth provides the most useful information. However, this is not always practical; therefore, the seasons and general plant stage of growth are defined here.

DORMANT SEASON FIRE – Fire occurring during the months of most deciduous plants' dormancy, following leaf abscission but before bud break and leaf out of trees and shrubs. This occurs generally from mid-November to early-March in the Red Hills. Warm-season herbaceous plants have ceased active growth and many have died back.

GROWING SEASON FIRE – Fire occuring during the months following bud break and leaf out but before leaf abscission for deciduous trees and shrubs in the fall. This occurs generally from early-March to mid-November in the Red Hills. Warm-season herbaceous plants are actively growing.

"Forest management and conservative lumbering are other names for practical forestry. Under whatever name it may be known, practical forestry means both the use and preservation of the forest." — Gifford Pinchot, A Primer of Forestry

Development of a Plan

Management plans provide guidance in the use of the land. They are the how-to and where for land management. A successful plan communicates the owner's vision, allowing the land manager to easily chart a course for day-to-day activities. A well laid out plan will state both the purpose and mission for land ownership and the landowner's expectations for the land. As such, it is a tool for leadership developed by the owner as a guide for follow-through by the manager.

When reviewed on a periodic basis, plans act as a tool for refining the owner's vision. The most effective plans are not cut in stone, but are dynamic documents that undergo review at least every five years. This review should involve both the landowner and the land manager, with additional input, if possible, from a consulting forester and/or consulting wildlife biologist.

A well written plan contains all of the information necessary to make informed decisions on management. It also serves as a record of what the landowner wants to accomplish and a measure of progress over time. Finally, it serves as a repository for important information about the property that may be passed down to future generations.

Many landowners already have management plans in place as the result of a conservation easement. This guide does not supercede those plans. Conservation easement management plans are site-specific and designed to perpetuate and protect specific natural elements in the landscape. They also meet the Internal Revenue Service (IRS) eligibility standards for tax deductions.

The following sections give a brief explanation about the essential elements of a working management plan and specific items to include.

Establishing objectives

Successful landowners carefully plan and target management activities to accomplish their objectives, minimize expenses and ensure the long-term productivity of their property. Objectives should be specific and measurable, which assists in evaluating the success or failure of land management initiatives.

Landowners that either neglect to identify their management objectives or set priorities are often disappointed, because they never clearly defined what is important to them or what they want to accomplish. It is equally important to prioritize objectives so that managers and consultants have a clear understanding of where and how different land management efforts fit together. For example how should wildlife habitat enhancement efforts fit with timber management? Which is the priority?

Red Hills landowners' long-term objectives

Red Hills landowners identified their long-term objectives during a series of interactive meetings at Tall Timbers in summer 2002. Any one, or a combination of these, is a suitable starting point for developing a set of short-term objectives to personalize a management plan. Long-term goals guide short-term goals and help define objectives to be considered.

- Passing on the land in as good or better condition than when received
- Preservation of biodiversity
- Conservation
- Recreational value
- Aesthetics
- Keeping the property intact and in the family

Red Hills landowners' short-term objectives

- Good quail hunting
- Timber revenue
- Balance of quail and timber revenue
- Good deer, turkey, waterfowl and dove hunting
- Preservation of biodiversity
- Conservation of a diversity of sites and habitats
- Maintaining open woods that are aesthetically pleasing

Of the short-term objectives, landowners identified the following management scenarios for specific discussion in later sections of the guide.

- Optimum quail hunting
- Optimum timber revenue
- Optimum balance between quail and timber over the property

Resource maps and photos

Resource maps and photos are essential in identifying what is on the land and in structuring an organized approach to property management. The number of maps and photos required is determined by the level of detail that landowners and managers desire.

Essential

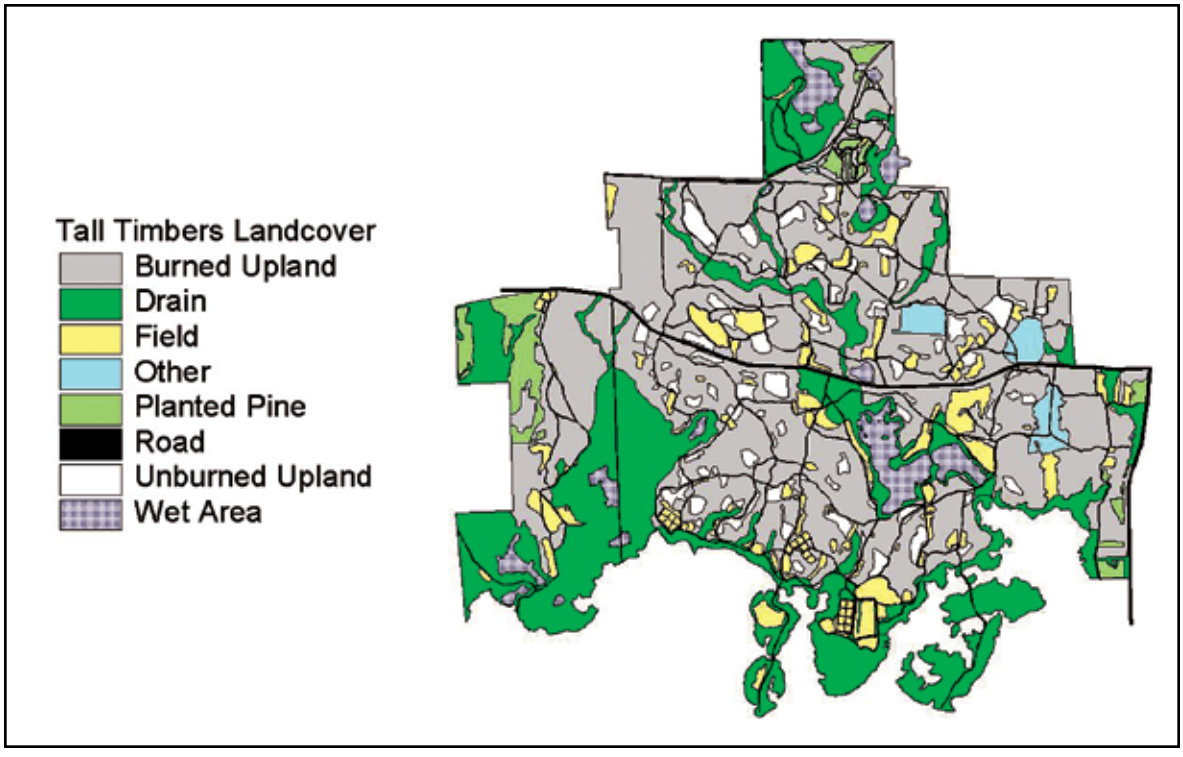
- Soils map, which assists in managing appropriate timber species on appropriate soil types (may be obtained from the Natural Resources Conservation Service office in your county)
- Cover-type map(s), which identifies habitat cover or forest types, special natural areas and important cultural features that the landowner desires to protect
- Management history map(s), which depicts past management, including burn areas and timber harvests
- Recent aerial photography
- Special feature map, which identifies conservation easements and acreage under the Conservation Reserve Program (CRP) or other special programs

Recommended

- Topographic map, which also identifies roads and water features
- Management map(s), which identifies when and where specific practices will occur
- Photos of special features (cultural or natural)

Timber management plan

- Specific goals, such as converting a percentage of old-field land to longleaf, maximizing timber production in specific units, managing for certain product classes in specific areas, identifing desired future condition, mix of pines and hardwoods, hardwood leave areas



A landcover map, like this one of Tall Timbers Research Station, which identifies habitat cover or forest types, special natural areas and important cultural areas, is essential for managing your property.

- Description of resources, such as stand maps, forest cover type, current standing volume by stand and forest cover type, management strategy (even-aged or uneven-aged management), appropriate silvicultural practices and rotation length
- Schedule of planned stand entry periods, such as those for planting, thinning, burning, chemical control of hardwoods and regeneration
- Growth projections for the long-term planning horizon
- Economic analysis of planned activities, such as cutting strategies and product classes
- List of potential impacts on non-target species
- Schedule for plan review (at least every 10 years)

Wildlife management plan

- Specific goals, such as managing quail, deer, turkey or red-cockaded woodpeckers to a specific population density, achieve a balance of late and early succession wildlife species, predator management, identify desired habitat conditions
- Description of wildlife resources, such as species, population and harvest history and current population status
- Schedule of planned stand entry periods, such as those for wildlife thinning, burning, chemical or mechanical control of hardwoods and plantings
- Description of habitat management techniques and associated outcomes such as planting dates, burning dates and conditions, fertilization
- Economic analysis of planned activities, such as management techniques
- Schedule for population and habitat monitoring surveys
- Schedule for plan review

Conservation management plan

- Specific goals, such as those that encourage sustainable forestry that retains the forest's ability to produce all values and products
- Identify and describe the property's conservation values, including special natural areas, historic resources and scenic resources
- Specific management guidelines that protect the property's conservation values

Essential Elements of a Management Plan

- Landowner vision statement
- Statement of mission and purpose
- List of long-term objectives
- Specific short-term objectives
- Identified priorities and options
- Legal description
- Resource maps and photos
- Timber management plan
- Wildlife management plan
- Special considerations
- Financial plan – budget and economic analysis
- Schedule of work and plan review

Special considerations

- Specific identification of goals that may conflict with, or require special coordination with, other resource goals
- Identify tradeoffs
- Communication with neighbors about management of adjacent parcels
- CRP requirements or limitations

Financial plan and budget summary

- Income summary from forestry operations, wildlife leases and other sources, such as CRP
- Cost summary for cultural or habitat management practices, such as prescribed burning, pre-commercial thinning, supplemental feeding, predator management, food plots and herbicide work
- Balance sheet and benefit/cost analysis
- Projected cost for planning horizon (five- or 10-year)

"…silvicultural systems…are based on the nature of the forest itself, and are chiefly imitations of what men have seen happen in the forest without their help."

— Gifford Pinchot, A Primer of Forestry

Timber Management

A range of forest management strategies has perpetuated the ecological, conservation and aesthetic values of forests in the Red Hills landscape. For almost a century, judicious timber harvest has retained these values because emphasis has been placed on retaining some level of overstory canopy cover. The forest sprang up on abandoned old-fields or previously existed on uncleared and unplowed lands. The most prevalent silvicultural technique was single-tree selection, while the most often used model was the Stoddard-Neel system (see later section).

The upland forests of the Red Hills were historically dominated by various pine species. Pine forests are ideal for management because they may be harvested in such a way that habitat needs for a number of wildlife species can be met and economic productivity sustained.

The first step toward development of a timber management plan is to retain a certified and registered consulting forester. This forester should be well-versed in the management of natural stands, wildlife and the use of fire and will offer assistance with details of stand management and conducting timber sales. Studies show that working with a consultant increases revenues from timber sales by between 23 percent and 50 percent, compared to dealing directly with loggers or an individual procurement forester working for a mill or other forest product companies.

Current forest composition may help define management objectives

Forests are composed of numerous "stands" of trees. A stand is the smallest unit of area for which a forester will determine a management strategy. Stands range in size from five acres to well over 100 acres and may be defined by topographic and physical features of the landscape, such as a flood plain, roads or boundaries. Stands often are defined by the current species mix, age and size class distribution, or unique site conditions such as drainage or slope position. The current tree composition of a stand is a reflection of past management history and the ecological site conditions. It is important to keep a significant portion of the stands over 100 acres in size to meet the needs of wildlife species that require large areas. These wildlife species are termed area sensitive species.

To help define management objectives for a given stand, consideration must be given to whether the stand is natural, old-field or planted in origin. Natural stands

Sustainable forest management to retain conservation values should:

- Keep stands open and park-like
- Use frequent fire in different seasons
- Retain a significant element of old trees when using uneven-aged management
- Use long rotations when using even-aged management
- Recognize much of the biodiversity, wildlife and aesthetic values are associated with the diverse groundcover and open stand conditions
- Minimize native groundcover disturbance
- Provide adequate regeneration
- Retain occasional snags and old flat-topped trees to give stands character, additional wildlife value and aesthetic quality
- Protect unique features
- Recognize that maximum timber production or maximum quail production may not retain all conservation values

Table 1. Ecological adaptations of pine species found in the Red Hills region[1].

Species	Seedling fire tolerance	Mature tree fire tolerance	Persistent (serotinous) cones	Minimum cone-bearing age	Shade tolerance	Soil moisture regime	Site soil texture	Soil fertility
Longleaf	High	High	No	20	Very low	Very dry to moist	Coarse to slightly loamy	Low
Shortleaf	Moderate	High	Somewhat	5	Low	Very dry to moist	Slightly coarse to loamy	Moderately Low
Loblolly	Low	Moderate	No	5	Moderate	Moist	Loamy	Moderate
Slash	Low	Moderate	No	7	Moderately high	Moist to wet	Loamy	Moderately high
Spruce	Low	Low	No	10	High	Very moist	Fine	High
Pond	Moderate	Moderate	Yes	4	Very low	Wet	Fine	High

[1] Adapted from Duryea and Dougherty 1990; Harlow and Harrar 1969; and McCune 1988.

develop after disturbance as a result of the ecological site conditions. Typically, the best-adapted species are found there. The current species mix in natural stands often is a direct result of fire regime, moisture and soil characteristics (see Table 1). This mix also can reflect seed production of nearby tree species if a good seed crop occurs immediately after a natural or human-caused disturbance that removes the preceding forest cover. Natural stands, that have been high-graded where only the best timber has been cut, may have a different species composition. Much of the area in the Red Hills is believed to have been dominated by longleaf pine, with lesser amounts of loblolly, shortleaf and slash pine. Pond and spruce pine also occurred naturally, but were restricted in their distribution to moist seepage areas and sandy floodplains, respectively, because of their very specific soil and moisture requirements.

Old-field stands were the result of past agricultural practices in which tree species from nearby areas naturally seeded into abandoned agricultural fields and a stand of timber was allowed to develop. These stands developed in an even-aged manner with most of the trees being of similar size. Old-field stands typically are dominated by loblolly pine or a mixture of loblolly and shortleaf. In fact, one of the early common names for loblolly was "old-field pine." Those stands developing without a fire influence will be of mixed composition with various amounts of sweetgum, water oak and other oak species. Old-field stands often have a ground cover dominated by a variety of disturbance-dependant grasses and forbs. Broomsedge bluestem is a key indicator species of soil disturbance on old-field land.

Until the past decade, either loblolly pine or slash pine was used for planted stands across the southeastern U.S., due in part to the fact that the growth and yield characteristics of these two species make them desirable for short rotations, typically lasting less than 40 years. The goal in using these species was to maximize fiber production for pulpwood or small sawlogs such as the chip-n'-saw log market. Short-term financial returns were emphasized rather than long-term yields. Stands underwent several thinnings before being clearcut at the end of the rotation, and then a new stand is planted. With short rotations, aesthetic and some wildlife values may be sacrificed. In recent years, the planting of longleaf has increased, due to its ecological suitability and demonstrated economic viability under longer rotations. Longer rotations yield larger and higher quality wood products such as saw timber and poles, which have higher value.

Prefer native trees on appropriate sites

In planted pine stands, it is suitable to retain and manage for loblolly or slash if they are found on appropriate sites. If either species is off site, conversion to a more adapted pine species is recommended at the earliest practical time. This is especially true on relatively nutrient-poor, dry sites where longleaf and, less often, shortleaf are more suitable. A preferred option for conversion is to begin under-planting with the desired species in canopy gaps created through periodic harvest. Some foresters may recommend that stand conversion be accomplished by cutting down the entire stand and regenerating it with the desired and best-adapted species. The benefits of overstory cover are lost for a period of time, however.

If slash or loblolly have been planted on droughty, nutrient-poor sites they will perform poorly in longer rotations. Landowners increasingly are switching to longer rotations because of the value of maintaining forest cover through time. Retention of at least some overstory trees is more aesthetically pleasing to many landowners than cutting them. Another consideration is that hunting access may be limited in young, planted pine stands, also known as pine plantations, from just prior to canopy closure (five to eight years) to the first commercial thinning (15-18 years).

On old-field stands dominated by loblolly or a loblolly-shortleaf mixture, it may be entirely appropriate to manage them as natural stands, since both are native species and show some tolerance to a range of ecological sites. Conversion to longleaf also is appropriate on suitable sites with drier, sandier soil. Once again, planting longleaf in canopy gaps is an appropriate strategy. If frequent fire for quail management is part of the plan, favor longleaf or shortleaf in stand management because of their fire tolerance. Another option is to convert a portion of old-field stands to planted pine if timber management is a major objective. On wetter sites with higher soil fertility and a loamy textured soil, conversion to slash pine may be warranted.

Pre-existing natural stands of pine generally should not be converted to another pine species. Natural stands of longleaf and shortleaf can be determined, in part, by the associated hardwood or ground cover species in the stand. Natural longleaf stands may have a runner oak and a wiregrass understory. Depending on the site, natural longleaf stands also may have some element of bluestems and other grasses in the understory. On the other hand, natural shortleaf pine in the Red Hills region is found much less frequently, and often grows in association with post oak and blackjack oak with various bluestem grasses in the understory. Natural shortleaf also is associated with shallow soils along high river bluffs and hilltops. Site conditions should be checked to determine if naturally seeded loblolly or slash stands are on appropriate sites. On sites that have a history of frequent timber harvest, these two species and, often, shortleaf will become established on adjacent but inappropriate sites because of their prolific seeding nature.

Stands dominated by or including pond pine and spruce pine should be managed for these species and not converted to slash or loblolly. These stands generally will be small and are valuable for adding biodiversity and variety in the landscape. Dense stands of spruce pine are subject to bark beetle attacks at any age. Thinning of these type stands at an early age may be necessary for their perpetuation. Insects appear not to attack scattered individual spruce pine trees. Special care should be undertaken in harvesting on sites where these species are found, as these soils often are saturated and prone to rutting and compaction.

When planting pine seedlings on recently cultivated fields, the soil should be tested for residual chemicals. Chemicals that are used to defoliate peanuts or cotton prior to harvest may not readily leach from the soil in a short period of time. During drought stress, these chemicals may actually kill young pine seedlings.

The silvicultural toolbox: regeneration

Strategies for forest management are categorized as either uneven-aged or even-aged (Figure 2). From a pragmatic standpoint, even-aged stands are managed so that an individual stand has a defined beginning and endpoint. This period of time is referred to as the rotation length. On the other hand, uneven-aged stands do not have a rotation length. Regeneration, recruitment and harvest occur on a somewhat continuous basis. The diameter distributions—the number of trees per acre in a given size class—are considerably different for the two at the stand level (Figure 2). Many more trees per acre are found with uneven-aged stands.

In his book, *A Primer of Forestry*, Gifford Pinchot suggested that silvicultural systems were developed to closely mimic what humans have observed in nature. Natural stands develop as a matter of course into either even-aged or uneven-aged stand structures, depending on the nature of the natural disturbance that initiated the stand and the pattern and scale of succeeding disturbances. Early ecological studies have documented natural stands of longleaf and shortleaf with both even- and uneven-aged stand structures.

Uneven-aged pine forest at Melrose Plantation managed by the Stoddard-Neel method. Regeneration, recruitment and harvest of pine trees occur on a continuous basis. Photo by Bill Palmer.

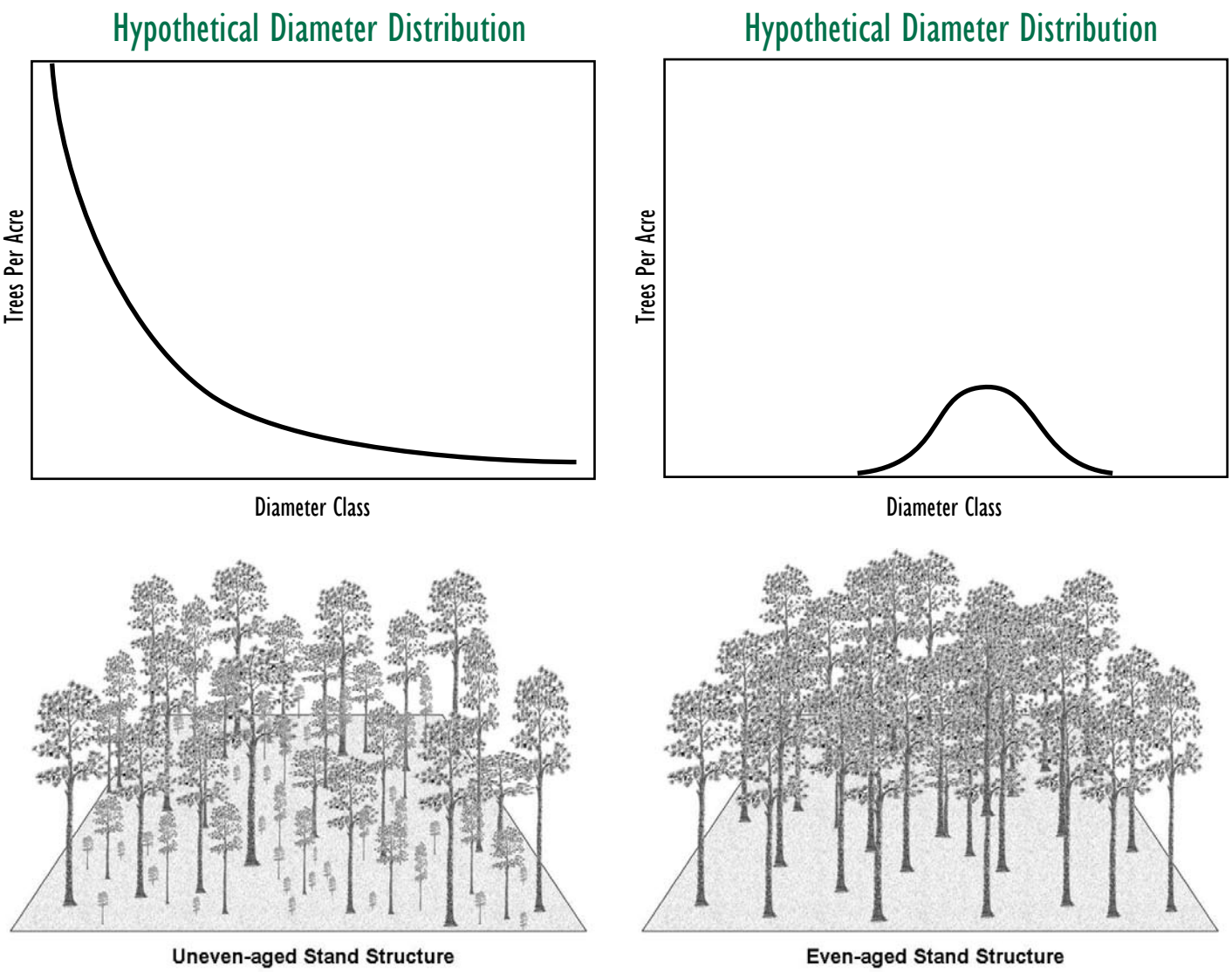


Figure 2. Stand structure of mature stands resulting from ***traditional*** *application of uneven-aged management has a reverse-j-shaped diameter distribution curve. That resulting from even-aged management has a bell-shaped diameter distribution curve.*

Whether the stand develops as even-aged or uneven-aged also is influenced by tree species. For example, tree species that are intolerant of shade, like longleaf pine and white oak, naturally will tend toward development as an even-aged stand or an uneven-aged stand with well-defined but unevenly distributed age or size classes. This occurs because young seedlings cannot grow well or persist in shade. In open stand structures, these species may regenerate and develop a structure with stems in several size or age classes. On the other hand, if the species under consideration is very tolerant of shade, like spruce pine or red maple, the stands they occur in may approximate uneven-aged structure because reproduction and developing stems are not shaded out. Other species are intermediate in their tolerance of shade.

Stands initiated by small- to large-scale catastrophic events, such as disease outbreaks, stand replacement fire, or hurricanes will generally exhibit an even-aged structure. Stands that develop under periodic low-level natural disturbances, such as periodic low-intensity fire, or following disturbance events that cause scattered individual tree mortality may possibly develop an uneven-aged structure, depending on the species' shade tolerance. Because natural disturbance acts on stands at varying scales, from single tree to stand replacement, one forest management strategy is not inherently better than another. Just as financial managers diversify their portfolios to hedge against risk, a forest manager should use some diversity of regeneration techniques and maintain a diversity of stand structures across an ownership.

Which is best?

Appropriate application of *either* system of management will create an average age distribution across the landscape or ownership unit that approximates the reverse-j diameter distribution (Figure 3). For even-aged management, that means

that, at any given point in time, a certain portion of the stands on an ownership will be in regeneration, some at mid-rotation, with fewer in late rotation (Figure 4). The key point is that the age- or size-class distribution approximates the reverse-j diameter distribution in this "cookbook" approach.

A clear understanding of what each method will create in terms of stand structure is essential in determining which will best meet an owner's objectives. The issue of whether a stand is being managed as an uneven- or even-aged stand has been confused to a degree by applying stand level terminology to landscape or ownership-level conditions. Using stand-level terminology for a landscape is not appropriate.

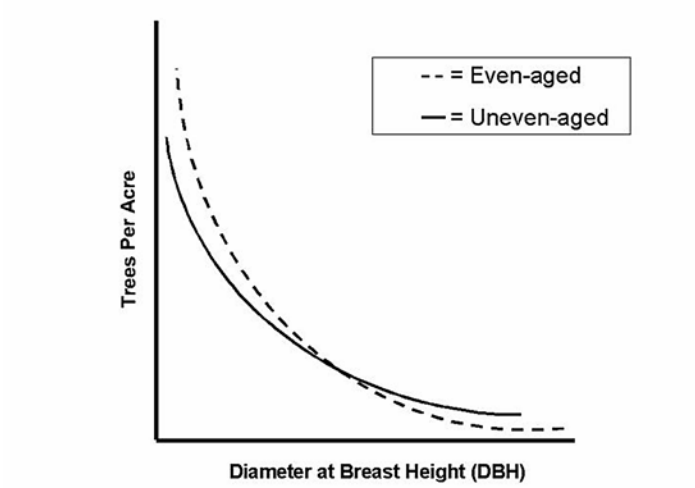


Figure 3. *Across an ownership with timber management objectives, the optimal diameter distribution should approach a reverse-j diameter distribution, regardless of whether an uneven-aged or even-aged management approach is followed (from Farrar 1996).*

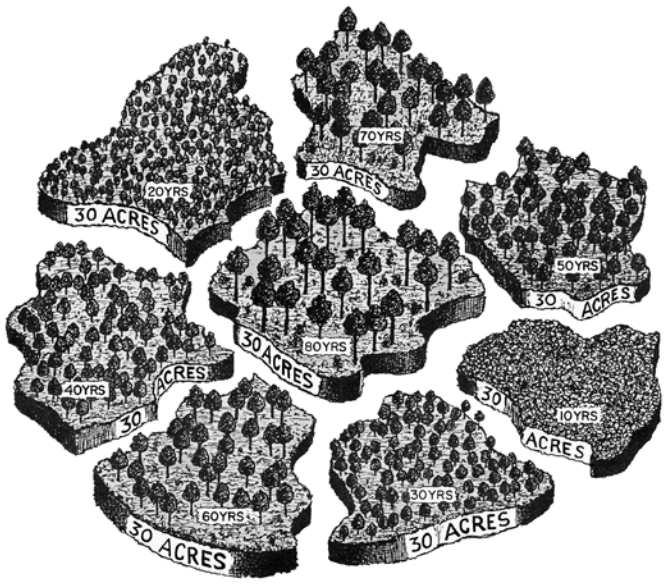


Figure 4. *A small tract under even-aged management that shows an appropriate distribution of age-classes for a moderate length rotation (From U. S. Fish and Wildlife Service 1975).*

Advantages of Traditional Uneven-aged Management

- Benefits late succession wildlife
- Midstory structure benefits some species
- Low cost of regeneration
- Emphasis is on high-value sawtimber; high per-log volume
- Income stream is more constant unless an aggressive thinning regime is used in even-aged stands
- Stand is less vulnerable to destruction
- More aesthetically pleasing to some

Disadvantages of Uneven-aged Management

- Early-succession wildlife habitat needs are not met if adequate amounts of well- distributed regeneration are present
- Frequent entry (disturbance) into the stand for periodic cuts
- Less cost-effective hardwood control methods
- Midstory is a deterrent to some wildlife species
- Harvest operations typically are more expensive
- Lower volume yield for longleaf
- Requires more management skill and time
- Can amount to high grading if applied incorrectly

The issue also is confused by equating single-tree selection cutting with only uneven-aged management. Even-aged stands are selectively cut. These harvest cuttings are commonly referred to as "thinnings." A thinning can structure the stand in many different ways, depending on what is cut and what is left. The Stoddard-Neel system applied to old-field lands is a classic example of how single-tree selection thinnings have been applied to stands that originally developed in an even-aged fashion.

From a wildlife standpoint, each type of stand structure has an associated suite of wildlife species that will use developing stands at different points in time as the structure becomes suitable for their specific needs, regardless of whether it is developing as an uneven- or even-aged structure. Those that use the stand early in its development are termed early-

Advantages of Even-aged Management

- Benefits early-succession wildlife until canopy closure (4-8 years)
- Provides cover to habitat generalist wildlife species such as deer and turkey until just past sapling size
- Provides a succession of habitats through time
- No midstory structure in the latter stages of the rotation, which benefits some species
- Limited stand disturbance over time in the first 10 to 20 years after the initial cut
- Takes less technical expertise
- Maximum yield of wood fiber, especially in pulpwood and small sawlog sizes, for short time period
- Easier to apply management treatments such as fire or chemical control
- More aesthetically pleasing to some

Disadvantages of Even-aged Management

- Displaces late succession wildlife following overstory removal
- Intensive initial disturbance
- High cost of establishment (site prep and planting)
- Income is deferred through most of stand life
- Low structural diversity
- Stand is more vulnerable to destruction (disease, wind, insects)
- May displace early-succession wildlife during and following mid-rotation unless an open structure is maintained throughout the rotation

succession wildlife species, while those that use the stand as it approaches maturity are termed late-succession species.

The habitat needs of the array of plant and animal species run the entire succession gamut. It is impossible to manage individual acres for each animal and plant species, as each has a unique role or niche and unique habitat requirements. Open-stand structures without midstory can meet the needs of both early- and late-succession wildlife. This can be achieved through either even- or uneven-aged approaches. A balanced approach to a variety of stand structures in the landscape is critical; as it will ensure that the needs of all wildlife and plant species are met and will contribute to regional biodiversity.

Uneven-aged management

Uneven-aged regeneration techniques are designed to replicate small-scale disturbances within stands that take out single trees or groups of trees. Common techniques include single-tree selection, group-selection and, under certain circumstances, diameter-limit cuts (Figure 5). In the diameter-limit method, trees above a specified diameter periodically are harvested. Care should be exercised in using diameter-limit and single-tree selection cuts so that the stand is improved, as opposed to high-grading, where only the best is taken. Modifications can be made to the shelterwood method, which is even-aged, so that the stand structure includes several diameter classes, with overstory trees retained indefinitely.

Traditional application of uneven-aged management has focused on maintaining a reverse-j-shaped diameter distribution at the stand level (Figure 2) with many more stems of smaller size than mature ones *within a stand*. Some have argued that uneven-aged management is the most beneficial for managing wildlife. However, in the traditional context of managing the diameter distributions as a reverse-j curve, this is not necessarily true (see Figure 2). Strictly speaking, an uneven-aged stand will have three or more distinct age or size classes and will create stands with multiple levels of canopy through the midstory and overstory. This method favors wildlife species that are adapted to such multiple canopy layers and disfavors those that are not. In particular, pine-grassland obligate birds, those adapted to open pine woodlands with a grass-dominated understory, require open midstory conditions that are not found in the traditional application of uneven-aged management at the stand level. This group of birds includes bobwhite quail, Bachman's sparrow, brown-headed nuthatch, eastern bluebird and others.

Traditional application of uneven-aged management (reverse-j diameter distribution) works well for tree species that are at least somewhat tolerant of shade. But this is problematic for managing shade intolerant species, such as longleaf, as seedling establishment often is poor unless the overstory is dramatically opened up. For some shade-intolerant species, the group selection method or the Stoddard-Neel system (see later in this section) is preferred. For others, such as mixed loblolly-shortleaf stands, the single-tree selection method has

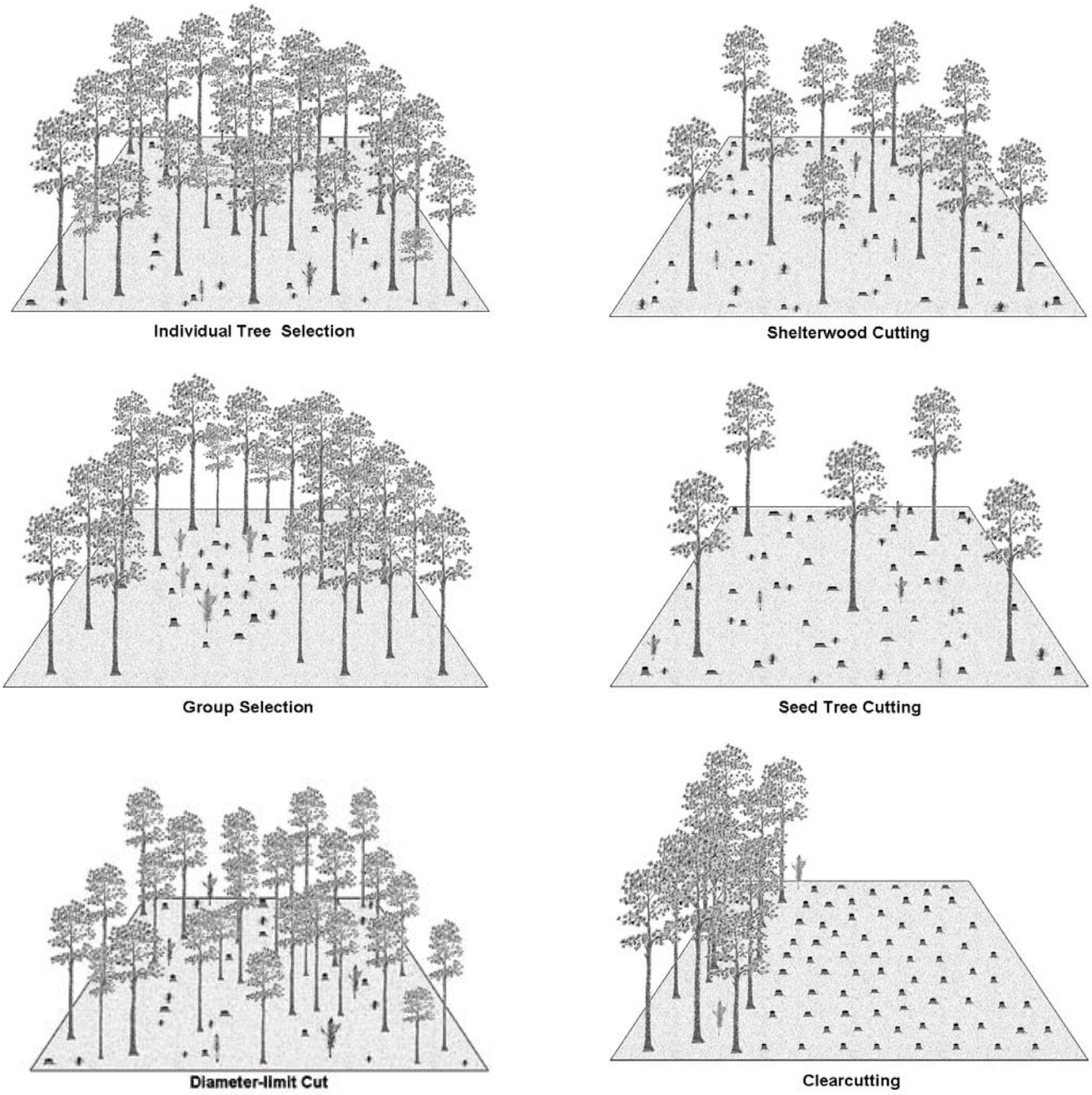


Figure 5. *Various methods of regeneration cutting.*

been shown to work well so long as overstory canopy cover is sparse enough for adequate regeneration.

With respect to longleaf pine in the Red Hills, research on the Wade Tract in Georgia has shown that the group selection method approximates what occurs in old-growth stands over time (Figure 6). In old-growth longleaf, dominant trees periodically succumb to lightning strikes, insect infestations and other forms of mortality. As a result, canopy gaps are formed. Due to the sporadic nature of longleaf seed crops, small clusters of regeneration occur at infrequent intervals, in these gaps. This regeneration may be even-aged or may develop as the result of seed crops from several different years. The use of frequent fire, combined with the effect of shade underneath dominant canopy trees, has resulted in a distinctly open midstory with scattered patches of regeneration.

The spatial distribution of regeneration is important. Because the open woodland structure is retained, native groundcover flourishes on the Wade Tract. In turn, the habitat needs of wildlife species associated with pine-grasslands are provided. Patches of regeneration in various stages of development also contribute to the aesthetic nature of these woodlands.

Application of uneven-aged management requires that some form of stand regulation be imposed to provide a basis on which to regulate timber harvest so that forest canopy

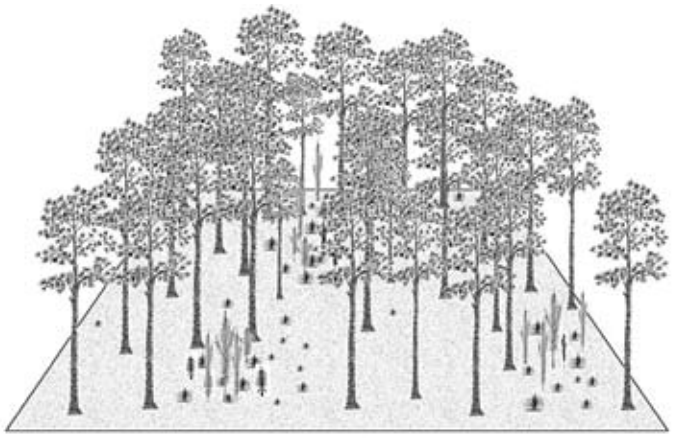


Figure 6. *Old-growth longleaf stand structure on the Wade Tract provides a model for longleaf regeneration using group selection. The uneven distribution of regeneration in canopy gaps retains the open woodland character that is important for biodiversity, yet allows the stand to perpetuate itself.*

cover is retained through time, while reproduction is provided for. Two methods of regulation commonly are used, regulation by volume and regulation by structure. (For more information, see the 1996 Tall Timbers publication *Fundamentals of Uneven-aged Management in Southern Pine* by R. H. Farrar.)

In volume regulation, a stand table is developed prior to the cut to determine the current standing volume by diameter class. If the stand is in suitable condition, in a cutting cycle of 10 years, only the amount of growth that has accrued over that period is cut. Many foresters favor a more conservative approach, and cut from 75 percent to 95 percent of the growth to account for mortality that may occur between cuts. If mortality is limited, the stand will accrue volume through time. A common target of 60 square feet per acre of residual pine is left in stands immediately after the cutting-cycle harvest. Over the succeeding decade, those stands will typically grow about two to three square feet of basal area annually or to 80 to 90 square feet per acre. That growth, or a portion of it, will be cut in the succeeding cutting-cycle harvest during which the poorest trees are cut and the best retained. If the stand becomes too dense to provide adequate quail habitat, adjustments can be made to the stand basal area in succeeding cutting cycles by cutting back to below 60 square feet per acre. This will compromise timber objectives, however.

Another approach that works for moderately shade-tolerant to shade-tolerant species is regulation of the structure or diameter distribution of the stand using a target basal area, taking into consideration the maximum diameter at breast height (DBH) of trees to be retained and a ratio (q) of the number of trees to be left in succeeding diameter classes.

What is basal area?

Basal area is simply the average amount of a given area, usually an acre, occupied by tree stems, usually expressed as square feet per acre. For example, a tree with a 13.5 inch-diameter has a basal area or cross-sectional area of about one square foot, measured at 4.5 feet above ground line, or breast height. In a stand in which all of the trees are 13.5 inches in diameter at breast height (DBH), and basal area is 60 square feet the stand will average about 60 trees per acre. In a stand with a basal area of 60 square feet and an average DBH of 16 inches the stand would average 43 trees per acre.

Why is it important?

The basal area concept is valuable because it is easy to measure in the field and it provides a good index for helping to understand some ecological relationships. Basal area does not equal tree density, but it is highly correlated with tree canopy density. The classic example is provided by the relationship between understory forage production and basal area. As basal area is lowered, overstory crown density also declines, and forage production is predictably increased because more sunlight and nutrients are made available to the understory plants. When qualified by the average tree diameter, it also is a good index to stand structure and suitability for a given species of wildlife. Many species avoid stands in certain basal area ranges. Quail, for example, tend to avoid mature stands above 90 square feet per acre.

BA40-Juvenile

PHOTOS BY RON MASTERS

BA60-Juvenile

BA40-Mature

BA60-Mature

The application of the "q-ratio" is used to determine the cut across age classes. (See Farrar, 1996 for additional information.) As in the volume-control method, the better trees should be left, while only trees with poor form, position and vigor should be taken. If necessary, additional trees may be taken from throughout the stand on a single-tree selection basis. One drawback of this method is that it does not retain the oldest and largest trees in the stand, making the stand structure multi-tiered. This multi-tiered structure has distinct disadvantages for maintaining early-succession wildlife species such as bobwhite quail and those that require open mid-stories such as the eastern wood peewee, a flycatcher, and other pine-grassland obligates.

Regardless of the regulation method that is used, the periodic harvest cuts and burning should be timed to capture regeneration in the stand's openings or canopy gaps. The appropriate size of the canopy gap depends on the shade tolerance of the species in question (Table 1). For shade intolerant species like longleaf, the smallest recommend size gap is an opening with a radius equal to the height of the surrounding trees. For trees that are 80 feet tall, this equates to an opening of about 0.5 acre. However, recent research suggests that gap sizes as small as 0.25 acres may be successful. On more productive longleaf sites, and those with other pine species, the gap size may be as small as 0.25 acre. In open stands of 40 square feet per acre, sufficient canopy gaps already are present. Burning for regeneration should be accomplished prior to seed fall during the late growing season prior to October and then excluded for two to three growing seasons. Seed fall is periodic, so attention should be given to the cone crop.

The Stoddard-Neel system

A hallmark of the Stoddard-Neel system of forest management is the open midstory, patchy regeneration and a fairly continuous canopy dominated by large, old trees. This method retains the scenic beauty of open pine woodlands and facilitates the use of frequent fire. Stands managed in this way have a very diverse ground cover if the basal area is below about 100 square feet per acre, regardless of whether they are old-field or natural in origin. Some of these stands may have a very similar appearance to mature, open, even-aged stands. Forests structured by this management style provide for the habitat needs of early-succession wildlife species such as the bobwhite quail and for late succession wildlife species, such as

BA80-Juvenile

PHOTOS BY RON MASTERS

BA100-Juvenile

BA80-Mature

BA100-Mature

the endangered red-cockaded woodpecker. This management system has been producing sustained forest products for a number of decades. Still, it has retained the value of old-growth while meeting the needs of early-succession plant and wildlife species. Their goal was to perpetuate the ecosystem even if it meant sacrificing immediate timber revenue. They believed that management of the land to produce a maximum return from timber would ultimately destroy the ecosystem.

The late Herbert Stoddard, working with Leon Neel, based this technique on single-tree selection harvest cuts or light thinnings. Leon Neel recently remarked that Herbert Stoddard always said, "timber management is not just cutting timber – what is left is as important as what is cut." Stoddard and Neel continually improved stand conditions by removing poor-quality and poorly spaced trees, with an emphasis on retaining large, old, high-quality trees. Each tree is evaluated in terms of its canopy position, spacing and chances for success, a time-consuming proposition, but one well worth the effort. Using this method, up to about 90 percent of the annual growth over a cutting cycle may be removed through periodic light thinning, assuming an annual growth rate of 4 percent. This is entirely dependent, however, on characteristics of the individual stand and site. Periodic cuts are targeted at thinning the lower overstory. That means thinning from below to achieve proper spacing with developing regeneration in canopy gaps and older overstory trees.

Early on, Stoddard set aside "ring-arounds" in canopy openings to protect advanced regeneration from fire. In addition to managing regeneration, these areas were plowed around and incorporated as a management practice on hunting plantations to provide cover for quail. Ring-arounds are important to capture regeneration where annual burning is practiced. However, when biennial prescribed fire is applied, a fire break around these areas may not be essential for regeneration of longleaf pine. This is based on observations from the Wade Tract, where, after a century of annual dormant-season burning in wiregrass, little regeneration was evidenced in canopy gaps. However, after going to a biennial prescribed fire regime, alternating between dormant-season and early growing season fire, canopy gaps began filling with regeneration.

In old-field stands dominated by loblolly and shortleaf, ring-arounds still may be a practical means of protecting regeneration, because seedlings of these species are less

tolerant of frequent fire. For shortleaf, assuming a two-year burn interval, skipping one burning cycle will allow seedling development, as it is more adapted to fire than loblolly. After adequate regeneration is captured and has developed enough height to become resistant to fire, annual burning may be reinstated where necessary.

Ideally, under the Stoddard-Neel system, small portions of the stand are set aside to allow transition from saplings to the overstory, much like the Wade Tract model in Figure 6. Based on Dr. Moser's report, stands under the Stoddard-Neel system exhibited a distinctly two-tiered stand structure, dominated by high- quality products (Figure 7). The gap that exists in the diameter distribution of sampled stands reflects landowner objectives for maintaining open midstories for quail hunting. At the stand level, this management style is not entirely reflective of a traditional uneven-aged structure. This structure more nearly reflects a transition from even-aged to uneven-aged management. Where an adequate number of trees are allowed to transition to larger diameter classes, this is not a problem. At some point, trees will need

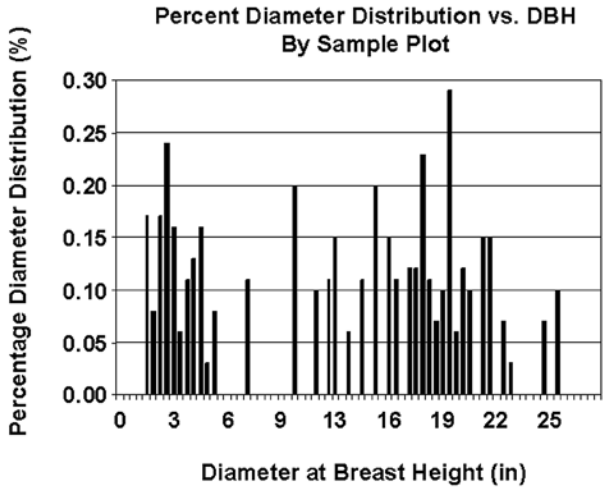


Figure 7. *Percent diameter distribution by sample plot in stands managed by the Stoddard-Neel system. (From Moser 2001)*

to be moved through this part of the diameter distribution in order to replace canopy trees that are aging or have been harvested. If not, the overstory and its associated values will diminish over time.

This is an important phase for retaining overstory canopy cover indefinitely and pursuing a well-regulated uneven-aged management philosophy. The transition phase may be prolonged for long-lived species like longleaf. This transition should take place more rapidly in old-field situations where shorter-lived loblolly and shortleaf dominate the stand composition.

At the hunting plantation level, Dr. Moser found that the diameter distributions were similar to the reverse-j curve

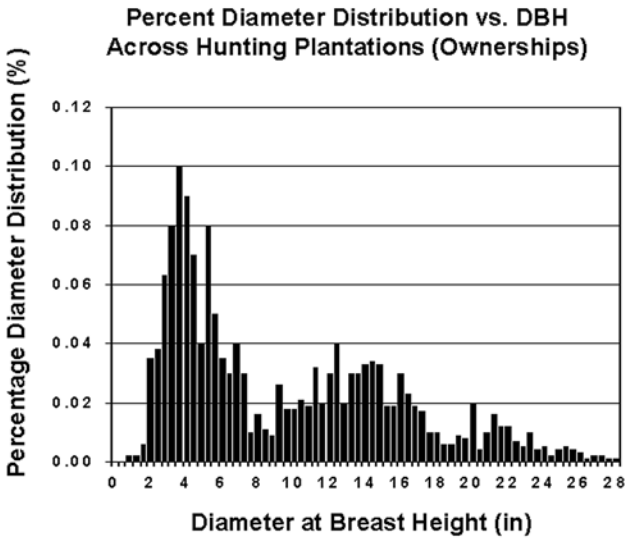


Figure 8. *Percent diameter distribution of forests on hunting plantations managed by the Stoddard-Neel system. (From Moser 2001)*

used as a target for uneven-aged management of shade-tolerant species (Figure 8). Here, too, a depression or gap is seen in the diameter distribution for trees that ordinarily would occupy the midstory. To be sustainable provisions must be made over time to move young trees into and through this part of the diameter distribution, either in selected areas or across the property. As these stands accrue growth, owners may want to reduce to 60 square feet the basal area in stands that are experiencing canopy closure to maintain a density in keeping with goals like quail hunting and maintenance of diverse ground cover. Those emphasizing red-cockaded woodpeckers may want to allow those stands to accrue volume to 90 square feet per acre if dominant trees are over 150 years old.

Using selective cutting techniques one easily can transform an even-aged stand structure to an uneven-aged structure and vice versa. Creation of canopy gaps for uneven-aged management is accomplished by thinning the lower overstory to remove less vigorous trees. Small portions of the stand, or adjacent stands, are set aside for regeneration in canopy gaps. Canopy gaps that are too small may be widened by selective removal of a few adjacent mature trees. The proportion of regeneration that is allowed to develop in a given stand is based on landowner objectives, recognizing that strict adherence to a traditional uneven-aged management approach will result in dense regeneration and a distinct midstory.

Even-aged management

Even-aged management techniques are designed to regenerate stands that will have a simple structure, with most of the trees in a single age or size class that originated at the same time, or

following one broad disturbance event that affected the entire stand. Common techniques used by foresters include shelterwood, seed tree and clear-cut methods (Figure 3).

The first two techniques use natural regeneration from the residual overstory trees. The latter uses planting of bare root or containerized seedlings. For shelterwood and seed tree cuts, the leave trees may be removed following establishment of an adequate number of seedlings. A modification of the shelterwood, called irregular shelterwood, maintains a two-aged structure by retaining partial overstory. This method has shown some potential for longleaf and retains the values associated with overstory canopy cover. Modifications to the shelterwood method may be made so that it approximates an uneven-aged stand condition. Here, overstory trees are reduced in a series of cuts over an extended period of time so that the stand is structured in several size classes with overstory trees retained indefinitely.

Some authorities believe that 4,000 to 6,000 seedlings per acre initially are necessary to naturally regenerate longleaf. For a fully stocked stand, at least 600 seedlings per acre, distributed relatively uniformly across the stand, should be living after the third-year regeneration check. If fewer than 300 seedlings per acre exist after this check, or if the distribution of fewer than 300 seedlings is not relatively uniform across the site, the landowner should consider "banking" the regeneration over several years, by retaining overstory trees until a suitable cone crop produces the desired number of seedlings. If maximum timber production is the goal, the site should be underplanted. If quail hunting is a primary objective, fewer than 150 seedlings is an acceptable goal.

Any of the above techniques can be successfully used to regenerate longleaf, loblolly, slash or shortleaf pine, depending on the landowner's objectives. Published guidelines are available for the appropriate number of "leave" trees, listed by method and tree species. For example, data show that the seed tree method does not maximize seed production in longleaf. If maximum timber production in a longleaf pine stand is the objective, then the seed tree regeneration method may provide less than adequate seed production to develop a fully stocked stand. Conversely, if a major objective is to maximize quail hunting throughout the life of the stand, then the seed tree method of regeneration will be sufficient.

Site preparation is critical for successful natural regeneration. Most often this is accomplished using prescribed fire or chemical control to manage competing vegetation. Introducing dormant season prescribed fire into stands prior to harvest enhances regeneration in several ways. It reduces the fuel bed and suppresses hardwoods so that they are not released after the reproduction cut. A late growing season burn, occurring prior to October, will provide a suitable seedbed if an adequate cone crop—about 780 cones per acre—is available. It also will suppress small hardwoods.

As a regeneration method, clearcutting has limited applicability in the Red Hills and its use should be limited to only a few selected old-field sites with a history of planted pine management. It is not appropriate for natural stands with a native groundcover component because of the disturbance associated with site preparation for planting. High-intensity site preparation techniques that require the use of heavy equipment and entail considerable soil disturbance should be avoided. Remember much of the conservation value of the Red Hills region is found in the ground cover.

When using clearcuts for regeneration, and where wildlife considerations are important, trees should be replanted using the widest recommended spacing for the tree species. This prolongs the benefits to early-succession wildlife. Prescribed fire should be introduced into loblolly, slash and shortleaf stands after they have reached at least 12 feet in height. If prescribed fire figures prominently in a given management scheme, the owner/manager should consider planting longleaf or shortleaf, if they are site-appropriate. Low-intensity prescribed fire also should be introduced into the stand early on, when the trees have attained a height of 12 to 14 feet. This will assist with pruning lower limbs and prolong the benefits to early-succession wildlife. If maximum growth and fiber production is the goal through short rotations, loblolly and slash pine are the species of choice, provided they are site-appropriate. Unique features should be retained and protected in stands that are subject to this method of regeneration.

When using even-aged management techniques, care should be taken to ensure that a diversity of stands of different sizes, shapes and age classes is distributed across the owner's landscape. In this way the income stream is held more constant and the needs of both early and late succession wildlife species can be met. *If maintenance of high value native ground cover or retention of signature live oaks is an issue, intensive methods such as clearcutting should be avoided.*

Recommendations for stand management

It is not possible to produce maximum timber revenue and maintain maximum wildlife production on every acre. A balance between the two requires scaling down expectations. Landowners should consider selecting respective sections of the ownership for maximum timber production, maximum quail production and a balance of timber, quail, other wildlife and aesthetics. Only small areas of old-field stands with a history of intensive management should be allotted

Optimum Timber

- For best survival and stand development, use appropriate species for a given site.
- Use a variety of regeneration and stand management strategies, even-aged and uneven-aged, across a forest to create a multi-aged and structured landscape. This provides a steady income stream and hedges against risk from various mortality agents. Uneven-aged management for longleaf will yield lower volume.
- Manage for a range of forest products from short-rotation pulpwood and posts to long-rotation high quality sawtimber, poles and pilings. Sawlogs bring from five to 10 times the dollar return per unit volume than pulpwood. Higher early stand density will produce a higher percentage of poles at age 35.
- Thinnings typically should not reduce the stand basal area much below 70 square feet per acre, except in the case of longleaf where 60 square feet per acre is acceptable (Figure 9).
- To maximize growth, thinnings should be accomplished when canopy closure occurs or basal areas exceed 90 to 100 square feet per acre.
- Consider fertilization for short-rotation, planted pine.
- Plan prescribed fires for times when burns will be of lower intensity and supplement prescribed fire with chemical methods to control hardwood encroachment. Favor two-year or longer burning intervals.
- Protect the native ground cover component in stands by avoiding piling and burning logging slash, as, over time, disturbance will allow hardwood encroachment. Prescribed burns in native ground cover are more effective at controlling hardwoods than in old-field ground cover.

Guides for When to Thin

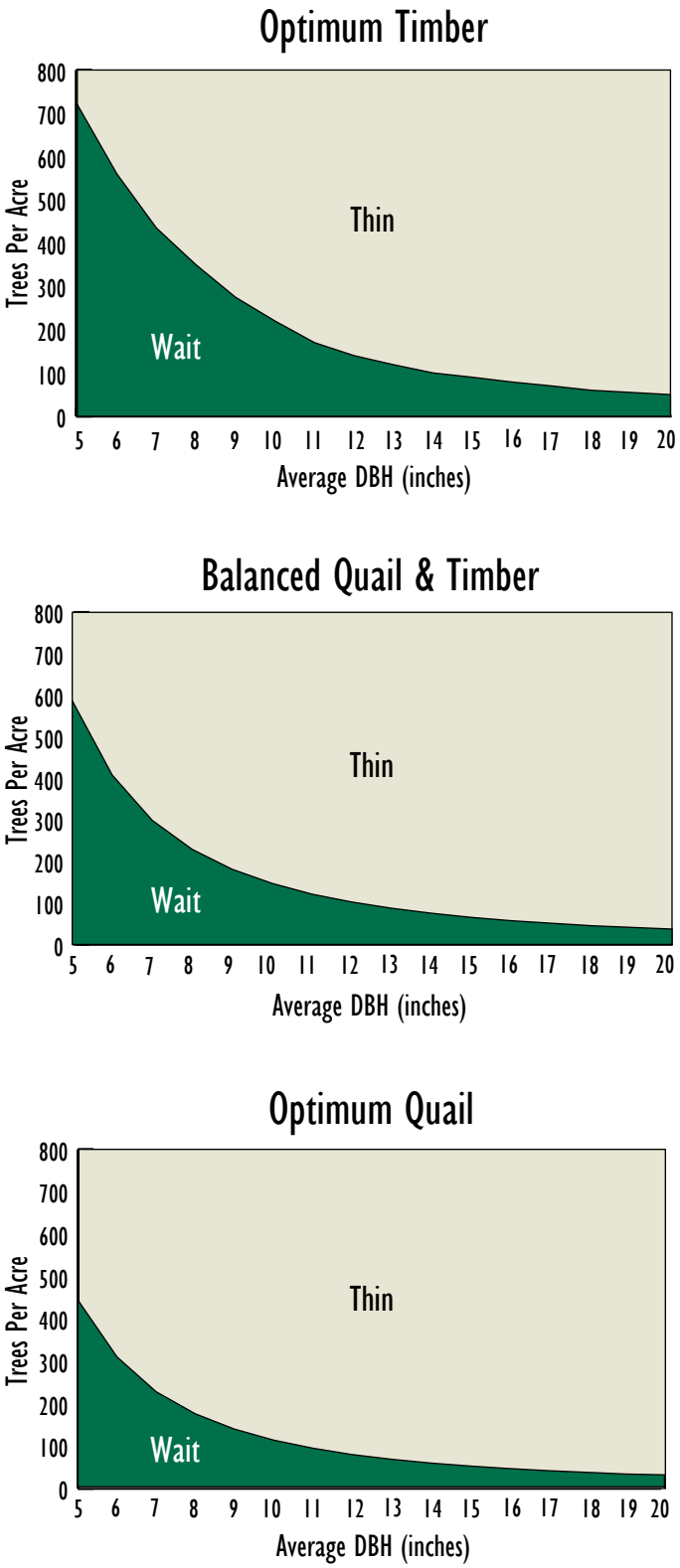


Figure 9. *Guidelines for the thinning of even-aged pine stands given three objectives. Figure current average stand conditions, trees per acre and DBH (inches). If stand conditions are well into the beige, thinning is required.*

Balanced Timber and Quail

- Favor long rotations and more fire-adapted tree species such as longleaf and shortleaf over much of the ownership.
- In planted settings for pine, use the widest practical spacing when planting, and introduce fire at the earliest possible juncture.
- In planted pine settings, thin heavily and at the earliest practical time (Figure 9).
- Use frequent fire, with periodically alternating seasons or, at a minimum, burn in different months. The burn interval should be between one and three years. Less than a three-year interval is recommended if hardwoods are problematic and the herbaceous community is poorly developed, as is the case in some old-field stands.
- Shape individual stands through harvesting so that mature stands are in the basal area range between 40 and 100 square feet per acre. The appropriate basal area on this scale depends on landowner objectives. The herbaceous community deteriorates rapidly above 100 square feet per acre and quail avoid those stands. While the potential for income from forest products begins to decline below 60 square feet per acre, this is at the upper end of the optimal range for quail management, which ranges between 40 and 60 square feet per acre. In stands maintained below 40 square feet per acre, potential for steady income from forest products is severely compromised.
- Ecological values associated with pine-grasslands are retained across the 40 to 100 square foot per acre range of basal area and generally decline if you move 20 or more square feet per acre outside this range. In stands with a site index, or height that trees will attain in 50 years, of 80 or better, the rule of thumb is site index minus 25 for the appropriate basal area.
- Shape stand structure through periodic thinnings over time to a two-tiered (bimodal) diameter structure (see Figures 6 and 7) by selective thinning that removes selected midstory and co-dominant trees and occasional aging or poor-form overstory trees. The level of thinning should not exceed mean annual growth. Regeneration will occur in patches, and provision will need to be made to allow selected patches to transition into the overstory.
- Protect native ground cover in stands; avoid harrowing, piling and burning logging slash, and planting strip food plots, as disturbance will allow for gradual hardwood encroachment. The costs of managing a shooting course with native ground cover is at least 40 percent less than the costs associated with managing old-field ground cover.

to maximum timber production because biodiversity values will suffer. Diameter distributions across the landscape or ownership should approach the reverse-j diameter distribution traditionally associated with uneven-aged management at the stand level.

Odd clusters of hardwoods or other unique features should be retained within stands for diversity. Some standing dead trees, known as snags, should be retained or, if they are not present, provisions should be made for snag development to provide for the needs of cavity-dwelling species. The plowing of firebreaks along drainage features should be avoided and, instead, periodic burns should be allowed to back into these areas as they did historically.

Most landowners in the Red Hills favor management toward natural looking stands because of both the beauty and the financial incentives. In some cases this means converting planted pine stands to more natural looking stands. To a degree, this conversion may be accomplished in two selective thinnings rather than thinning entire rows.

Conversion of old-field stands to longleaf

Landowners and managers increasingly are seeking advice on converting old-field stands dominated by loblolly and shortleaf pine to longleaf pine. Longleaf once was the prevalent species in the Red Hills and is ecologically appropriate on the majority of sites. Longleaf also is a better "fit" for many landowners in terms of an overall

management strategy. Longleaf yields higher value products when grown to sawtimber size. Its wood is denser and is structurally stronger than other pine species. When it comes to quality, sawtimber products are rivaled only by shortleaf. A consulting forester can best assist landowners in receiving the maximum value for these products. Longleaf also is better adapted to frequent fire that is essential for quail management and for retention of the biodiversity values in the Red Hills region. Where *limited* pine straw harvesting is conducted in longleaf stands, longleaf can provide greater financial returns than management for loblolly.

The quickest and most obvious conversion method is to clearcut and replant with longleaf. However, the aesthetic and ecological values associated with retention of overstory canopy cover are lost. Because overstory retention is important, a staggered approach is recommended. If scattered longleaf are present in an old-field stand, longleaf may be favored by opening surrounding canopy gaps and using frequent fire to control regeneration from competing pine species. Recent research at Tall Timbers has shown promise for stand conversion over time by using several underplanting techniques. Containerized seedlings are recommended for underplanting. For open-canopy stands on old-field land, Tall Timbers researchers found that survival was best following the application of herbicide and prescribed fire as site preparation methods. In closed-canopy old-field stands, light disking in the understory improved seedling survival. However, gradual thinning of the overstory and planting in canopy gaps at least 0.5 acres in size (0.25 acres on better sites) is recommended because of the relative intolerance of longleaf to shade.

Economic tradeoffs

Management decisions often are made on the basis of their economic returns. Even-aged management often has been recommended as the most cost-effective way for landowners to manage forests. A study conducted by Tall Timbers looked at moderate- and high-productivity sites from 1961-1993 and compared the economics of uneven-aged management, accomplished by selective cutting, with even-aged management. Patterns of cash flow were decidedly different, with those from even-aged management coming in pulses. Cash flow was more constant, but in lower increments, for the uneven-aged management system. In 1993, the net present value of removals was higher for clearcutting and thinning, while the net present value of residual timber was higher for selective cutting (Figure 10). However, over the entire period, selective cutting had a higher total net present value than did moderately productive sites managed by clearcutting and thinnings (Figure 11).

A study in the Carolina Sandhills compared the economics of longleaf pine plantation management to management for planted loblolly. Longleaf was grown on a 66-year rotation and the loblolly was grown in two successive 33-year rotations.

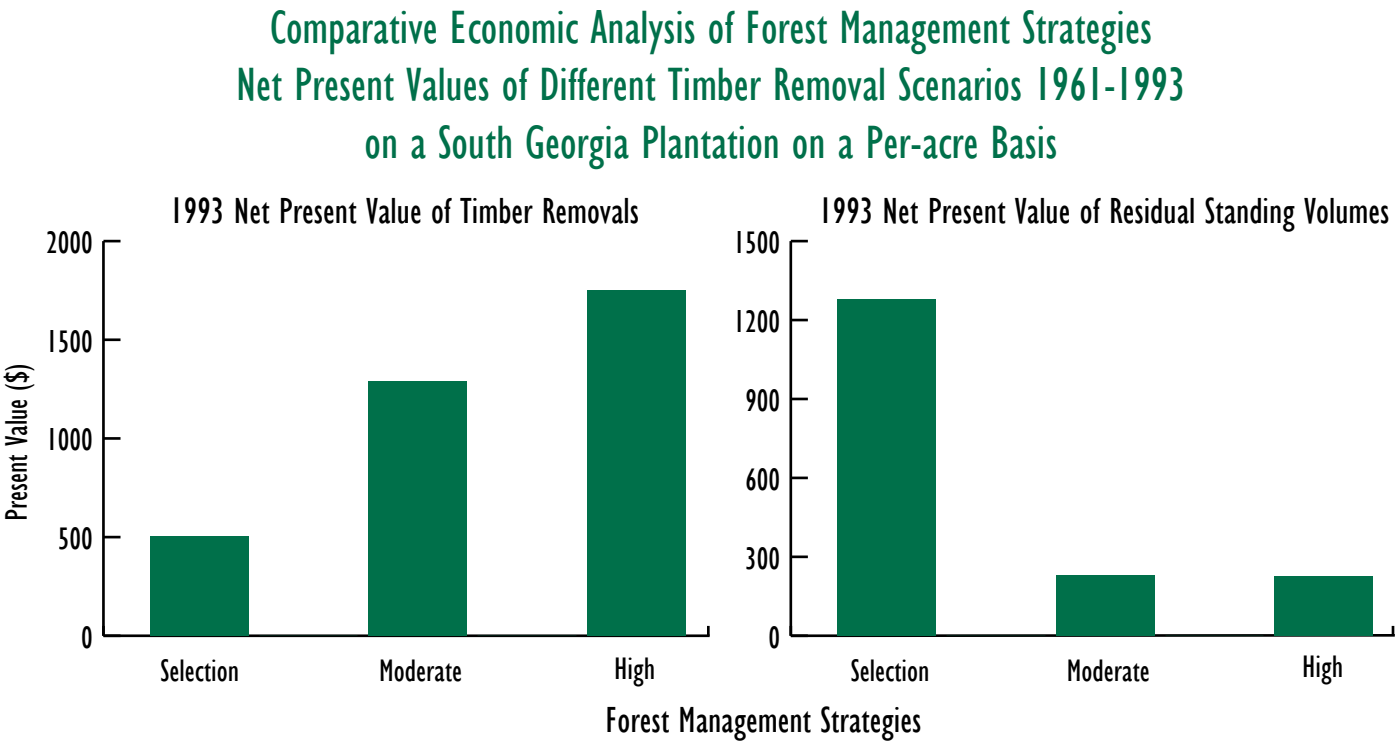


***Figure 10**. A comparison of present value of the cut and residual standing volume of selection cuts based on actual partial cuts from 1961 through 1993, versus clearcutting and thinning on moderate—and high—productivity sites in the Red Hills. (From Moser 2001)*

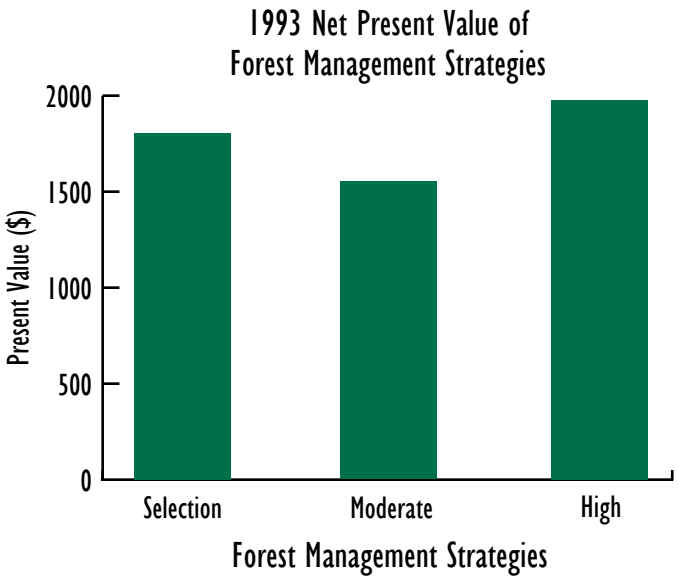


Figure 11. *A comparison of total net present value of selective cuts based on actual partial cuts from 1961 through 1993, versus clearcutting and thinning on moderate—and high—productivity sites in the Red Hills (Moser 2001).*

The longleaf plantation incorporated moderate raking of pine straw at three- to four-year intervals. The benefit/cost ratio was lower for longleaf, with a net present value of $532, compared to $368 for loblolly. Among the reasons for this difference is that the longleaf was sold as high-value, high-quality poles and sawlogs, while the loblolly was sold primarily as pulpwood and small sawtimber, which brought lower returns. The study found that longleaf generated a greater financial return than loblolly over time and had a greater frequency of payments. *Pine straw raking can undermine the value of native ground cover and should therefore be restricted to low levels and only for pine plantation settings.*

The bottom line is that it does pay to convert old-fields to longleaf if they are properly managed. Even-aged management systems are not necessarily more economically efficient for landowners, particularly on low- to moderately productive sites. Landowners should consider a mixture of forest management options and regeneration methods as a hedge against risk. Landowners might consider selecting a few more productive sites for maximum timber production using even-aged management systems and retain the remaining portion of the ownership under an uneven-aged management system.

One of the biggest economic tradeoffs for landowners emphasizing quail is covering the cost of intensive management with timber revenue. Landowners must determine how much timber growth they are willing to sacrifice to maintain high quail densities if quail management is an issue on every acre. Maintenance of mature trees in the 50 to 70 square foot per acre range will sacrifice some quail habitat quality but allow for some income to be generated on a periodic basis. Management costs for quail increase dramatically below a basal area of 60 square feet per acre of mature trees.

Another trade-off is balancing regeneration with the desire for maximum quail habitat and maximum quail hunting opportunity. Regeneration is essential to perpetuate the overstory. The trade-off comes when provisions are not made for adequate regeneration and the overstory begins to age and break down. As the overstory thins, the benefits of partial shade will decrease and the cost of quail management will increase. Potential revenue from timber to offset quail management costs also will be lost. Although longleaf is very long-lived, young trees at some point need to be allowed to move through the midstory and into the overstory.

The option of setting aside a few high productivity sites dedicated to maximizing timber revenue should be considered. Consulting foresters in the Red Hills suggest that intensive management on as little as 200 acres out of 5,000 acres can off-set quail management costs. For example, a recent timber sale in the Red Hills grossed $5,200 per acre for a 200-acre slash pine plantation managed on a long rotation for telephone poles. While this may be the exception rather than the rule for potential timber revenue, it makes the point that sacrificing a few acres of quail habitat may be the most economically feasible option for some landowners, depending on their particular mix of site conditions for growing trees. One land manager indicated that the optimal balance of management for timber and quail, for him, was to manage 60 percent of his stands for the 40 to 60 square foot per acre range of trees 16 inches DBH and up. Timber management in less open stands was emphasized on the remaining area.

Hardwood management in pine stands

Hardwoods naturally occur mixed with pines on many upland sites in the Red Hills. However, based on historical accounts, the distribution and density has increased considerably since the vast longleaf forests were harvested and the historical fire regime changed following settlement and aggressive logging. Hardwoods retained within pine stands do have value both ecologically and monetarily. In recent years, the market for hardwoods has been comparatively good. A few dominant hardwoods, particularly oaks, hickory, ash and black cherry, retained within stands provide benefits to numerous species of wildlife. Retention of shrub and small hardwood tree species is highly recommended. Examples include deerberry, sparkleberry, huckleberry, wax myrtle and dogwood. Small clusters of these shrubs provide excellent cover for quail and other wildlife species.

Hardwoods within pine stands provide benefits to numerous species of wildlife. Photo by Ron Masters

The determination of an acceptable level of hardwoods in upland pine stands is a bit tricky. Research data relative to canopy cover suggest that one square foot per acre of hardwood basal area equals two square feet per acre of pine basal area. This is due primarily to the broader crown of a hardwood relative to a pine with the same DBH. Thus, an average retention of one to five square feet per acre of mature hardwoods in upland pine stands is acceptable and in keeping with the historical dominance of pines and the management emphasis on quail and other wildlife in the Red Hills. This corresponds to roughly a two to 10 square feet per acre equivalent in added basal area affecting the growth of the pines. This will provide variety to the landscape, particularly in the case of signature live oaks. Individual signature live oaks may have a basal area of 8 to 18 square feet. If deer and turkey are a management emphasis, landowners may want to retain 10 to 15 square feet per acre of mature hardwoods. That may come at a higher cost in terms of pine growth and yield, however.

Nonproductive and invasive hardwoods such as sweetgum and water oak should be selectively removed from the uplands. Quality hardwoods that occur on sheltered upland sites without interspersed pines should be retained and managed as unique features. They add diversity in small portions of the landscape, provide habitat structure and have value as a food resource for some wildlife species.

Midstory hardwood encroachment is a major problem for those managing for either maximum timber or maximum quail. This encroachment also places other early succession wildlife species and late succession species like the red-cockaded woodpecker at a disadvantage. Midstory hardwoods siphon nutrients and available moisture from more desirable trees and limits available space. Additionally, it creates unsuitable habitat structure for many types of wildlife. The principal methods of midstory hardwood control are prescribed burning, chemical and mechanical methods. Whenever feasible, landowners should use a hardwood timber sale to reduce overstory hardwoods. In some cases a combination of the following methods will provide the best results for midstory hardwood control.

Fire

Frequent prescribed fire is the preferred method for controlling hardwoods. Although burning in the dormant season will suppress hardwood competition, it actually may promote sprouting from the roots and increase the number of small hardwood stems for a short period of time. Research has shown that appropriately timed annual growing season burns are more effective at root kill. Early growing season following leaf-out is the most appropriate time to burn, because the plant has just expended stored root carbohydrates. By burning at this time, carbohydrate root reserves are lowest and the carbohydrate storage cycle is broken. Burns should be accomplished using the guidelines found in Appendix I. Attention should be paid to relative humidity and fuel moisture, since, at high levels of both, they will lower a burn's intensity to the point that they are unsuccessful. Fire intensity

CHRISTINE AMBROSE

has been shown to be a major factor influencing hardwood control, and only moderately intense fires are necessary.

Fuel continuity is another important consideration, particularly in open old-field-derived stands. In old-field stands, fuels may not be continuous, which lowers the probability of successful hardwood control. Fires in native ground cover appear to be more effective at reducing and controlling hardwoods. Native ground cover, if not disked or harrowed, provides a continuous fuel bed composed of highly flammable fuels that will dry out in a relatively short period of time. It also provides a fuel bed that will readily burn in most seasons. This is another reason that native ground cover should be valued and protected.

Chemical methods

On old-field lands, in particular, the use of chemical methods may be necessary to achieve hardwood control in some areas. Limited, targeted application only where necessary is recommended rather than broad scale application over many acres. Several chemicals are useful in controlling hardwoods. Arsenal® and Garlon® provide promising results. (Others not tested at Tall Timbers may provide equally efficient results.) It is important to recognize that chemical methods will not totally and permanently eliminate hardwoods. Soil type has an influence on the efficacy of hardwood control for some chemicals. Hardwood sprouts often become a problem again within seven to 10 years after treatment. If chemical treatment is aggressively pursued with frequent fire, recurrent hardwoods are less likely to become problematic.

Tall Timbers' Land Manager, Eric Staller, uses a modified leaf blower attached to a backpack sprayer to apply herbicide to hardwood vegetation. This spot spraying method is highly selective and may be more effective than wick or foam brush applications in dense thickets. Photo by Scott Houston.

Selective application of herbicides is favored over broadcast application methods, like aerial application, unless dense sweetgum and water oak are present. Broadcast applications may reduce the forb or grass community in the understory to the point that either habitat quality or fuels are reduced for a short period of time. Broadcast applications also may eliminate desirable understory shrubs. On old-field land in particular, broadcast chemical methods may forestall the ability to burn for a short period of time. In this case, the result may be a rampant increase in pine regeneration, in essence swapping a dense hardwood problem for a dense pine problem. Spot spraying with a backpack sprayer is highly selective and may be more effective than wick or foam brush applications in dense thickets, where not all hardwood stems will be scored and brushed because their sheer density may provide protection for some stems.

Mechanical methods

Mechanical methods for hardwood removal include a range of treatments, from individual tree removal with a chainsaw to mowing and chopping of hardwood sprouts in thickets. Mowing is the preferred method for mechanical control of hardwood thickets. Tall Timbers studies show that mowing will promote grasses and fuel continuity to a greater extent than chopping. Grasses are an important fine fuel for prescribed burning and provide a necessary habitat component for many early-succession species of wildlife. Chopping increases soil disturbance and may damage the roots of crop trees, thus hampering timber production. Chopping in native ground cover also will disrupt fuel continuity and, over time, may seriously damage this important component of the region's biodiversity.

De-limbed oak trees being run through a chipper after a hardwood removal on River Ridge Plantation, Leon County, Florida. Photo by Christine Ambrose.

Wildlife Habitat Management

Few biological arts depend as much on ingenuity and resourcefulness as this one.

— Aldo Leopold, Game Management

Stoddard's talents for applying fire to the land and selectively cutting trees transformed the Red Hills into one of the great wildlife legacies of the 20th century. At the heart of this legacy are large populations of the bobwhite quail and the red-cockaded woodpecker, that once were much more common in southeastern pine forests, in addition to a great diversity of other species. Conservation efforts related to these two bird species serve as a hallmark of the work being done at Tall Timbers.

The challenge for those wanting to perpetuate the Red Hill's wildlife legacy is to carefully evaluate trade-offs associated with individual management decisions. All land-management decisions have either positive or negative effects on quail, woodpeckers and other wildlife. Decisions benefiting the whole, rather than the parts, those framed by long-term goals rather than short-term impulses and those based on a regional perspective rather than a narrow focus ultimately will be more beneficial to wildlife in the Red Hills landscape. Assessing trade-offs using this framework will ensure that the Red Hills' legacy of varied wildlife is passed along to future generations, be they are sport hunting enthusiasts, recreation seekers or conservationists from a different vein.

Each wildlife species falls somewhere along a continuum from habitat specialist to habitat generalist. Both the red-cockaded woodpecker and bobwhite are habitat specialists. However, they function very differently in seemingly overlapping habitat types. Their habitat needs are in contrast to species like the wild turkey or white-tailed deer, which are much more general and elastic in their habitat requirements. Habitat management must create the specific structure needed by a given species to be successful.

Bobwhite quail

Interest in bobwhite hunting and sustaining high bobwhite populations has been a principal reason for land ownership in the Red Hills since the late 1800s. This remains true today. It is because of this regional interest in bobwhite that the Red Hills retains a high degree of natural diversity relative to most other parts of the southeast. Use of frequent prescribed fire and careful timber management has resulted in a natural landscape suitable for wildlife species adapted to the upland southern pine ecosystem.

The density of timber stands should receive constant attention on the well-managed quail preserve.

— Herbert L. Stoddard, The Bobwhite Quail

Tall Timbers research has been inspired by the ideas and practices of the plantation owners and managers in the Red Hills. They have served us as a constant source of experience and information that helps to guide research and test recommendations in the "real world." While Tall Timbers Research Station has existed since 1958, quail management began in the Red Hills more than 100 years ago. Collectively, this information has been used to develop management recommendations for managing quail populations in the Red Hills, which are relevant throughout the Southeastern Coastal Plain.

Most of the Red Hills was agricultural land at the time when it was purchased as private hunting plantations. Today, habitats in the Red Hills range from these widespread old-field habitats to the less abundant longleaf-wiregrass community. How bobwhites are managed in these different plant communities differs in important ways. Because ground cover in the Red Hills is predominately old-field in origin, this section looks at quail management in the context of managing primarily in old-field habitats. However, it also will highlight some of the differences associated with wiregrass plant communities.

Through field experimentation and monitoring of thousands of bobwhites, Tall Timbers has developed an understanding of how and why management influences bobwhite populations. Bobwhite populations only can respond positively following increases in their survival rate, nest production, nest success and chick survival.

How important are these demographics? When management is properly conducted, these demographic parameters work in concert to increase populations and insulate them from dramatic declines. Avoiding large population declines is critical because three to four years are required for a population to recover after a large decline. On managed lands, for example, winter survival of quail can be as high as 80 percent. With high-winter survival of adults, the fall population the following year is less vulnerable to decline from a poor nesting season. Had a low-survival winter been followed by a poor nesting season, quail populations may have declined precipitously. It is the *consistency* of bobwhite populations from year to year that is the hallmark of good management in the Red Hills. Our management prescriptions are designed to increase key demographic rates of quail populations to minimize the variation in population size from year to year.

Prescribed fire

Stoddard proved years ago that prescribed fire is essential to the management of bobwhite. The quality of the forest ecosystems on the quail plantations in the Red Hills stands as a testament to the ecological value of *frequent fire*. The famous Stoddard Fire Plots at Tall Timbers clearly show that annual and biennial fire are needed to maintain a ground cover suitable for quail in upland pine forests. Reducing burning frequency to three or more years had dramatic negative impacts on quail habitat because the ground cover shifted to hardwoods and vines rather than a mixture of grasses, forbs and shrubs. Fire exclusion from southern pine forests has resulted in a near complete loss of bobwhite habitat. There is little doubt that the lost practice of burning the woods throughout the South has been a major reason for the decline of bobwhite populations.

(T)he bobwhite might probably be called the "fire bird," so closely is it linked ecologically with fire in the coastal pinelands.

— Herbert L. Stoddard, Memoirs of a Naturalist

When timber density is appropriate, burning creates the year-round habitats needed by bobwhites by influencing the structure and composition of the ground cover. Maintenance of nesting, brooding and winter habitat for quail depend on fire. Burning 60 percent to 70 percent of a property each March and April has proven to be the best long-term plan for bobwhite habitat in the Red Hills. Burning in patches of 15 to 30 acres produces a mosaic of habitats that benefit bobwhites. In old-field areas, three-year roughs remain good habitat for bobwhites. After that, hardwoods begin to dominate the ground cover and burning should resume. Unlike old-field plant communities, wiregrass-longleaf plant communities should be burned annually to remove two-year roughs, which become too thick for bobwhites if not burned.

On old-field lands, burning later than April provides little benefit to quail, aside from possible hardwood control. Later burns promote undesirable plants such as showy crotalaria, sicklepod and spear grass. In areas dominated by wiregrass, a wider burning window is suggested. Early March burns create a flush of bracken fern that hens use heavily prior to nesting. The trade-off is that wiregrass does not typically flower following a March burn and, therefore develops a lower and matted stature less suitable for bobwhites. Wiregrass assumes an erect and taller stature following an April or May burn, providing a longer window for use by bobwhites. Broods in both habitat types select later burns because of excellent habitat structure for foraging during summer. Therefore, a slightly wider burning window on areas with wiregrass can benefit both the conservation of rare species and quail.

Fire will not always produce the desired top kill of hardwood and pine saplings because of the variation in fuel arrangement and continuity on old-field areas. Higher intensity fires are more successful at top-killing woody stems than low intensity fires. Research clearly shows that annual, early growing season (following bud break and leaf out, around the first week in March) fire for a decade or more is needed to actually kill hardwood rootstocks. On old-field lands, fuels may not be adequate to allow for annual fire.

Research shows that the mowing of hardwood thickets after burning will result in increased grasses and reduced stature of hardwoods, which will improve the efficiency of future fires. In fact, a recent research project that compared mowing, drum chopping and herbicides, combined with fire, showed that only the fire-mowing combination increased grasses. This is significant, since grasses are fine fuels and the primary carrier of fire. There are times, however, when root stocks of hardwoods and vines dominate under ground, and plant diversity and fine fuel loads suffer.

Herbicides can be successfully used to control this vegetation. However, as is the case with burning, cover may not respond adequately for bobwhites the year following treatment, depending on herbicide application and weather conditions. Therefore, on managed quail lands, smaller patches of less than 20 acres should be treated rather than broadcasting broad areas in a single year.

Christine Ambrose mapping native ground cover on Springwood Plantation, Grady County, GA. Early March burns create a flush of bracken fern that hens use heavily prior to nesting. Photo by Joe Noble.

Timber management

Assuming that prescribed burning is used, the direction given in a timber management plan is the most important decision an owner makes relative to the resulting density of bobwhite on a given property. The type and number of trees on a property affects not only bobwhite habitat but also the type and abundance of their competitors and predators. Densities of bobwhites on managed lands in the Red Hills range from about one to six quail per acre during the month of November. The following table (Table 2) can be considered a rough guide to timber density and long-term bobwhite density in November when an overall management program for bobwhites is in place.

The table shows that below a basal area of about 40, the density of bobwhites is not tied to timber abundance. Therefore, unless soil fertility is low, reducing the basal area of mature timber to below 40 square feet per acre likely will not provide significant benefits to quail populations. It also is important to note that management costs rise significantly below a basal area of 40 square feet per acre. At lower basal areas, costs increase because of the additional sunlight at ground level. Some shading can be a benefit in terms of slowing understory growth.

Basal area of mature pine	November density of bobwhite
0 to 40	3 or more birds per acre
40 to 60	2 to 3 birds per acre
60 to 75	1 to 2 birds per acre
75 to 90	About 1 bird per acre
90 to120	Less than 1 bird per acre

Table 2. Timber and quail density on selected plantations that use frequent fire in the Red Hills. The landscape and site index context will also influence bobwhite density.

Overstory trees moderate the type, diversity and structure of ground-level vegetation by reducing the amount of sunlight reaching the forest floor and increasing root competition. For instance, in old-field pines, ground cover height and biomass begin to decline after the basal area of mature timber exceeds 60 square feet per acre and becomes severely inhibited when the basal area exceeds 90 (Figure 12).

As timber density increases, shade-tolerant vines, shrubs and hardwoods replace herbaceous plants. Nutrients are slowly cycled below ground or locked up in plant biomass rather than in seed, forage and insect production. From a quail population standpoint, poor-quality ground cover caused by dense timber can result in increased mortality of quail by predatory birds. Shade created by dense timber and dense overstory also influences the microclimate for bobwhites and, possibly more importantly, their chicks. Densely timbered areas remain shaded during more hours of the day. We may not consider an 85-degree morning in June chilly, but a quail chick's body temperature is over 100 degrees, and temperatures in the 70s and low 80s are not optimal for chick foraging.

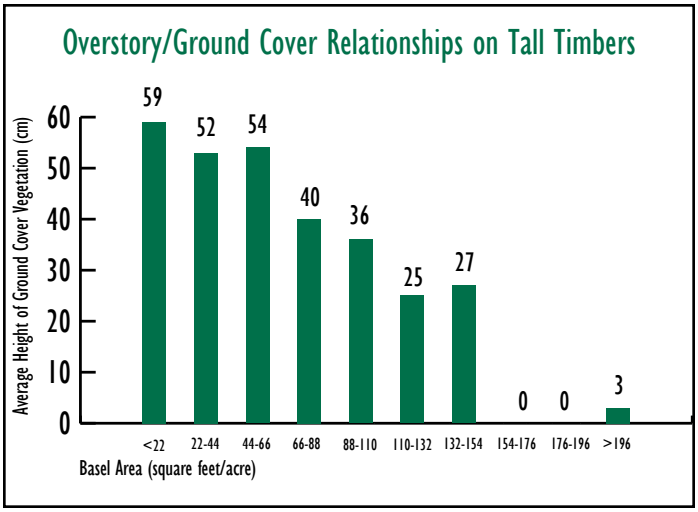


Figure 12. Average height of ground cover vegetation in relation to stand basal area on Tall Timbers Research Station.

Hardwood removal on Tall Timbers. Photo by A. Vince Carver.

Hardwood management

Reducing the abundance of midstory and overstory hardwoods, principally sweet gum, hickories and oaks, is an important component for managing upland landscapes for bobwhites. Hardwoods reduce the efficiency of fire by shading out flammable grasses, casting fire- resistant leaves and moderating moisture and temperature at the ground-level. They also provide habitat for many of the predators of bobwhites.

Reducing the abundance of hardwoods began on the hunting plantations in the early 90s and has now become a widespread practice. The results for bobwhite are impressive, with consistent population increases on areas that already had good-to-excellent habitat. Breeding season (April to September) survival of bobwhites increased from 30 percent to nearly 60 percent after hardwood removal. After a hardwood removal cut on Tall Timbers, the quail population reversed a 15-year decline and has steadily increased due in large part to increased annual survival. Dozens of plantations in the Red Hills and Albany, Georgia area have attained their greatest hunting success two to three years following upland hardwood management.

Maintaining just one mature, mast-producing hardwood tree (primarily oaks) per five acres of upland habitat is sufficient for quail management. Although these are not essential for maintenance of quail populations, they do have aesthetic and conservation value for other wildlife species. Hardwoods that should be retained include black cherry and those adapted to uplands, like Southern red, white, post and turkey oak, hickories and small-stature hardwoods such as dogwood. It is important to protect true drainages in their entirety.

Managing a timber harvest has important consequences for quail populations, the ability to burn and future hunting. By planning ahead, burning areas prior to cutting will help to mark areas that have been set aside for residual cover. Setting aside 10 percent to 20 percent of an area to hold birds until the vegetation recovers is adequate. All stumps should be cut no higher than 12 inches from the ground so as to not impede access. It is important to apply herbicide as soon as possible to fresh cut hardwood stumps to control sprouting.

On old-field sites where erosion is not an issue, quail benefit from the soil disturbance created by dragging trees to an existing opening before limbing and loading. Dragging downed trees lightly disturbs the leaf litter and soil. This disturbance stimulates ground cover resurgence with appropriate habitat structure for quail, reduces the stature of sapling oaks and pines and reduces small mammal populations, which attract predators to the area. After the recovery of vegetation, bobwhites quickly colonize these areas and, that year, have excellent reproductive success. Debris piles created by logging can be burned within two weeks of cutting or, if cover is sparse, after one year of groundcover growth.

In wiregrass areas, however, the soil disturbance associated with logging can be detrimental to sensitive plants and to the quality of the future quail habitat. Plants of less value for quail than the original plant community usually colonize soil disturbance on previously undisturbed areas. In these cases, dragging downed trees along roads or firebreaks is preferred to creating broad soil disturbance. Pines and small hardwoods can be limbed with chainsaws in the woods rather than dragged to a separate location. Downed pine boughs often are chosen by quail as nesting sites so that leaving some of these through the nesting season is beneficial.

L. WES BURGER, JR.

Nesting occurs in most of the habitat types present in the Red Hills.

Nesting and nest habitat

In the Red Hills, quail begin laying in early April and the last nests of the season typically hatch in the first week of October. Typically, the peak hatch for a season occurs around the first two weeks of June, with two additional peaks in either July, August or September. The majority of nests are built in

areas with one to two years of growth, but about 35 percent are located in areas burned in March or April of the same year. About 5 percent of nests are located in "odd" areas, such as fields and gardens. In areas of wiregrass, a higher proportion of nests are located in burned areas. However, since most first nests are placed in one-year roughs, it is best not to burn more than 70 percent of an area in any one year, as they will be crowded into small areas easily searched by predators.

Nesting occurs in most of the habitat types present in the Red Hills. The bottom line is that quail are not particular about choosing a nest site. They use a wide variety of nest building vegetation, including dead grass, moss, needles and leaves, and most nests are placed within 50 feet of an edge or travel lane created by fields, roads or firebreaks.

Quail chicks leaving the nest. Photo by Shane Wellendorf.

Brood habitat

Brood habitat is a critical component of bobwhite habitat management. How it is managed depends on the soils and the type of ground cover. Appropriate structure and availability of insects are managers' main concerns about broods. Our research has found that insect availability to chicks rarely is a concern in natural habitats in the Red Hills, except, perhaps, on very sandy sites. Therefore, structure typically is the main issue that management needs to consider. On typical loamy or clay soils, burned upland pine forests are the preferred habitat type and disked fields are the least-used. In fact, on Tall Timbers, field use remains low until they have been fallowed two or more years. Therefore, a two- to three-year rotational disking of large fields is recommended to improve them for bobwhites.

There are situations in which field use becomes important for both broods and adults. On sandy, droughty soils, where ground cover in the woods is sparse with fewer forbs and grasses, field use by broods increases significantly. This is why fields are an important component of the quail programs on the great plantations in the Albany area, but not as important on the clay-loam lands of the Red Hills. Existing fields also are important for quail management in native wiregrass and longleaf areas. Native wiregrass ground cover provides excellent nesting and year-round habitat for bobwhites. However, these sites often have relatively low soil fertility. Therefore, management of existing fields can improve quail populations by benefiting broods.

Fields smaller than an acre in size receive relatively little attention by bobwhites and their broods, as they simply are not large enough to encompass the birds' daily movement patterns. If feasible, fields two to four acres in size are preferred. New fields should be located on dry, flat areas with low timber stocking. On sites with native wiregrass groundcover, fields should be located where pockets of old-field vegetation, like ragweed, partridge pea, broomsedge and blackberry, already exist. One field per 20 acres is sufficient for managing bobwhites. On very sandy sites, however, up to 40 percent of an area in fields is beneficial.

Partridge pea. Photo by Ron Masters.

An option to creating new fields on old-field lands is to lightly disk patches under the timber canopy. If timber density is at recommended levels, disking will produce results similar to creating a new field. Tall Timbers' research has found that these areas produce excellent brood habitat and stimulate growth of important winter food plants, like the mint blue curl and partridge pea. A word of caution relative to disking wiregrass is necessary. By and large these areas never have been plowed and, therefore, rarely have the appropriate seed bank to respond positively to disturbance. Brood growth and survival are lower on areas of native ground cover that has been repeatedly disturbed, as opposed to recently burned, intact native ground cover.

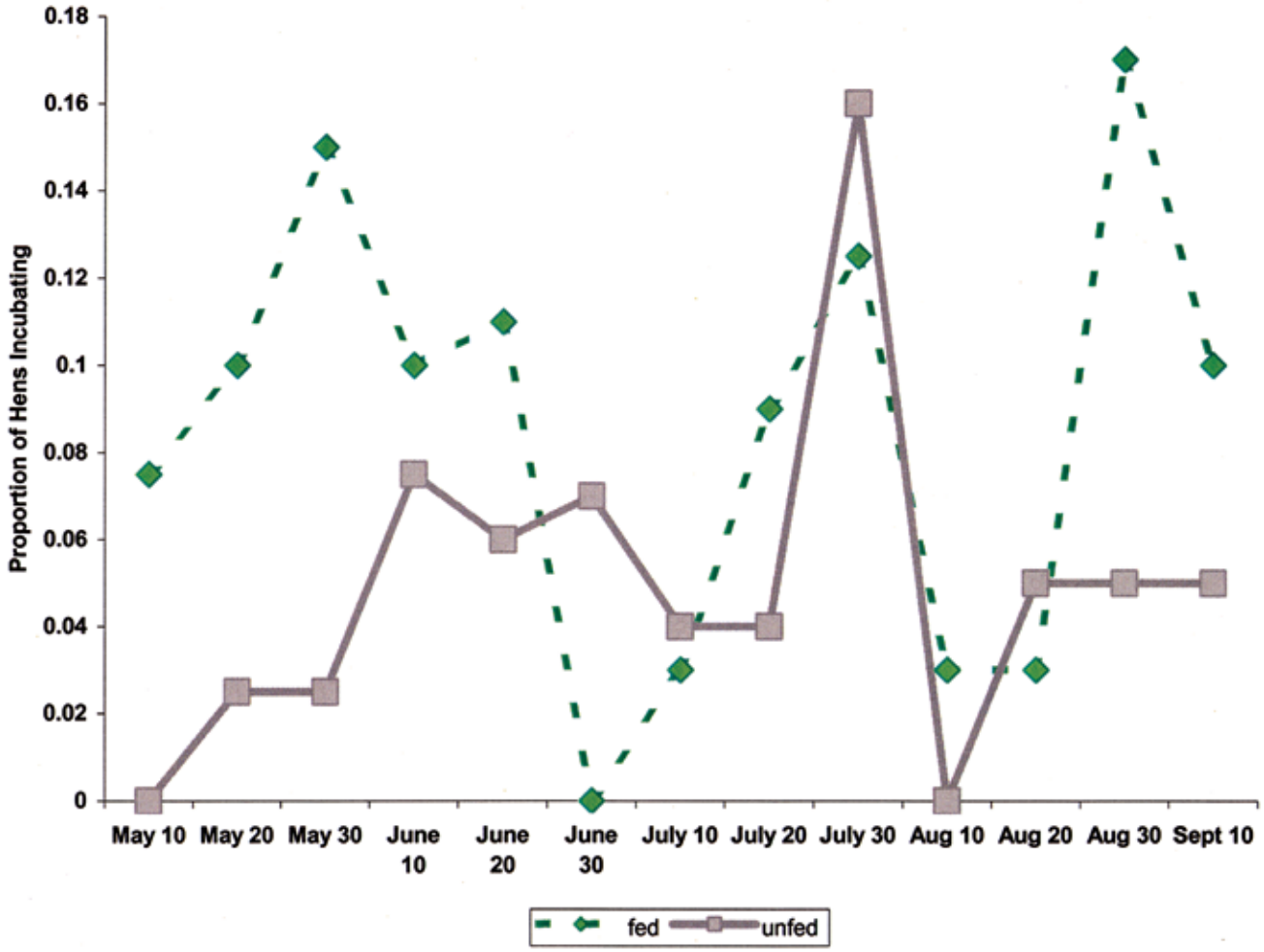


Figure 13. Average timing of incubation for bobwhites on fed versus unfed sites at Tall Timbers Research Station.

Supplemental feeding

Supplemental feeding can benefit bobwhite management programs. Most managers believe in the importance of supplementing natural foods, using grains to maintain higher densities of bobwhites. Tall Timbers' research indicates that food supplementation significantly increases per capita nest production by increasing the length of the nesting season, improving renesting and reducing the interval between nests. For instance, during 1999 and 2000, hens on areas with supplemented food resources produced twice as many successful nests as hens without supplemented food. These benefits in chick production help to offset potential negative factors, such as poor survival over the winter months or lower than average nesting success, to maintain good production and stabilize quail numbers from fall to fall. The goal of management is to reduce the variation in demographic rates caused by natural phenomena like drought. Supplemental feeding appears to help reduce this variation.

Figure 13 shows the schedule of incubation for hens on sites fed throughout the year versus unfed sites. This particular year followed a mast crop failure. On fed sites, nesting began earlier, lasted longer and peaked three times versus once on unfed sites.

On old-field sites with loblolly and shortleaf pine, winter pine mast is an important natural food. Pine mast is a more reliable food source from year to year than oaks, which tend to produce good crops every two to four years, depending on the species. In longleaf-wiregrass areas, however, mast production is lower than on old-field sites. Longleaf pine is not as prolific a seed producer as shortleaf pine, and these upland wiregrass sites tend to have fewer mast- producing oaks. Further, the composition of the native wiregrass plant community produces fewer seeds than old-field plant communities. Therefore, supplemental feeding in longleaf and wiregrass communities is even more important than on old-field sites.

The recommended feeding is one to two bushels per acre per year by spreading every two to three weeks year-round on dedicated feed trails throughout a management area. For example, on 1,000 acres of quail habitat, spreading 40 to 80 bushels of milo every two weeks would suffice. Milo varieties that contain about 17 percent tannins are recommended

Supplemental feeding on Horseshoe Plantation. Photo by Bill Palmer

because they are less attractive to deer, appropriately sized for quail of all ages and resist rot longer than cracked corn. One caveat is that the grain must be safe to feed to poultry with aflatoxin levels below 100 parts per billon. Aflatoxins occur on natural foods items, such as oak mast, and vary annually in abundance. By careful use of supplemented foods, exposure to aflatoxin can be reduced.

Food plots are a traditional management technique for upland game birds, including bobwhites. Managers' plant food plots to provide a unique habitat structure for bobwhites and to create "targets" for hunting. For example, milo planted in large patches can provide a unique habitat structure for coveys in areas with low, grassy ground cover. Also, some people enjoy the appearance of crops planted in patches in the uplands. *Despite these benefits, food plots are rarely the answer to improving bobwhite habitat or populations.*

Even if food plots were beneficial, they tend to fail when other natural foods fail, as occurs during droughts. During dry growing seasons, grains in food plots are more likely to have high aflatoxins. Farmers long ago learned that small-patch farming was not cost-effective. It is cheaper to spread grain that was grown under optimal conditions than to plant and pray you can grow your own!

Predation

The goal of predation management is to maintain a predator population at a level where bobwhite populations can increase when habitat and weather conditions are favorable. Nest predators can reach high enough densities to reduce reproductive output of bobwhites to marginal levels. For instance, we have measured fewer than 20 successful nests per 100 hens on sites with relatively high predator abundance, versus 84 successful nests per 100 hens on sites with low predator abundance. These differences in production of young can have a large impact on population size.

Managing habitat to minimize predation is the first, and most important, step of a successful predation management strategy. Collectively, the actions in Table 3 have the effect of reducing the potential for predation on a managed property by improving the habitat for quail and removing the habitat for key nest- and adult-predators in the uplands.

Management Practice	Habitat Effect	Effect on Predators	Effect on Quail
Mature pine thinning	Improved ground cover by increasing grasses, weeds and overhead cover.	Improved cover reduces search efficiency for some raptors, especially Cooper's hawks.	Increased annual survival, resulting in increased nest production and populations.
Upland hardwood removal	Improved ground cover, as above. Increases grasses, which improve the efficacy of prescribed fire.	Reduces abundance of the most important nest predators on the landscape. Limits perch sites for habitat for bobcats and coyotes. Reduces habitat for for the gray rat snake, while increasing habitat for corn snakes.	Increased adult survival and nesting success. Quail populations increase as a result.
Thinning of planted pines to < 100 trees per acre.	Improved ground cover as above.	Removes roosting site for Cooper's hawks.	Increased useable space for quail. Increased survival of adults.
Clearing debris and piles.	Localized improvement in ground cover.	Removes use areas for important nest and chick predators, such as snakes.	Improves nesting success and chick survival.
Prescribed burning at appropriate scale and season.	Improves structure and composition of ground cover, exposes soil.	Reduces prey items for snakes and hawks.	Provides nesting and brooding habitat with lower predator abundance.

Table 3. Habitat management that influences predation on bobwhites.

Improved cover reduces search efficiency for some raptors, especially Cooper's hawks. Photo by Jim Solomon, Nature Photography of America.

The premier quail hunting properties of the Red Hills and Albany have done an excellent job of managing the landscape to minimize predation of quail. Record abundances are a direct result of these actions.

Putting it all in perspective

At interactive meetings with land managers from the Red Hills, one very successful land manager remarked that 90 percent of his quail population response was from timber management and use of prescribed fire. The other 10 percent came from a combination of the supplemental feeding program, disking and predator control. His statements are borne out by research at Tall Timbers and elsewhere in the South. The first objective for quail management must be creating useable space through appropriate levels of timber harvest. The second is the use of frequent prescribed fire to maintain that useable space. Often those interested in bolstering declining quail populations focus on methods that yield 10 percent rather than 90 percent. Habitat management is the key to sustainable populations.

Red-cockaded woodpecker

Properties in the Red Hills support the largest population of this diminutive species remaining on private lands. The Red Hills population of red-cockaded woodpeckers also has the highest density of territories known anywhere, a reflection of the high quality of our open pine woodland habitats. The distance between territorial groups averages just over 500 yards throughout the region, as compared to an average distance of over 800 yards on some of the best-managed public lands. Territories of red-cockaded woodpeckers in the Red Hills also are among the smallest known, with some woodpecker groups living off a mere 120 acres of high-quality habitat, as compared to groups requiring as much as 250 acres or more on public lands.

Reasons for the large size and high density of the Red Hills population are simple. The red-cockaded woodpecker is well-adapted to a fire-evolved ecosystem, where frequent fire rules and hardwoods have little chance to gain a foothold. Even where timbering is practiced in moderation, the woodpecker can thrive. Those who recommend a hands-off approach to management for this species should take note.

While some private landowners view the woodpeckers' presence as a negative, others are gratified that their land management efforts provide for this species' existence. Increasingly, these landowners also are seeing monetary benefits from this philosophy coming from government programs that provide incentives for the management of endangered species on private lands. This species' presence speaks volumes about the conservation values and land ethic that perpetuate it on the landscape. This species continues to thrive in the Red Hills because of frequent fire and the open nature of these pine woodlands. Most importantly, however, it is present because of the stewardship ethic of many Red Hills landowners.

Management of core areas containing cavity trees

Woodpecker habitat requirements are less flexible in terms of maintenance of breeding and roosting sites. Woodpeckers excavate cavities only in living pine trees that have a large area of heartwood. Appropriate minimum ages for loblolly pine are 70 to 90 years, while minimum ages for longleaf are 90 to 110 years. Although longleaf takes longer to reach a suitable state, longleaf cavities last much longer and, thus, provide greater stability. Providing a sufficient number of trees in these, and even older age classes, is important to maintaining breeding and roosting sites.

A single woodpecker group consisting of breeding adults and young helper birds may use three to six cavities at a time because each bird requires its own cavity. Stable groups

also have several "unused" cavities in the vicinity to provide insurance against calamities that can fell a cavity tree. The insurance provided by extra cavities is important, given the fact that it takes a year or more for birds to excavate new cavities.

In the Red Hills, core areas with cavity trees generally are 15 to 30 acres in size. Special attention given to timber management within these small areas can result in big benefits for woodpeckers. Marking cavity trees is done on many public lands and may help reduce chances of inadvertent damage. Tall Timbers Research Station and Georgia Department of Natural Resources personnel can provide assistance in locating and marking trees in the Red Hills.

Other beneficial management activities conducted within the core area include:

- Protecting cavity trees from fire damage by conduct-ing burns when scorch height is projected to be less than 15 feet. Because of the resin flow associated with cavity trees, woodpecker trees are susceptible to fire.
- Protecting cavity tree roots from heavy machinery, and keeping vehicles 15-plus yards away from cavity trees. Don't establish plow lines within 50 yards of cavity trees.
- Retaining a fairly continuous forest composed of old trees within the core cluster area to reduce risk of damage from high winds.
- Providing for new cavity trees within core areas by using a light hand when marking timber for thinning. Try to retain 10 to15 large trees (16- to 20-plus inches DBH) per acre within core areas. These may be supressed, twisted, flat-topped trees that have larger areas of heartwood and, therefore, potentially lower timber value.

Management of woodpecker foraging habitat

More than 30 years of research have led to detailed guidelines for the management of red-cockaded woodpecker foraging habitat. The recommendations stem from the best available information, but they are just that, *guidelines,* not hard and fast rules. If major deviations from the guidelines are left in place for several years, chances of woodpecker declines are enhanced. Alternatively, slight deviations applied to small areas do not mean that the elimination of woodpeckers is imminent.

Management of woodpecker foraging habitat requires a stand-level perspective because a single territorial group uses 120 to 250 acres of upland pine forests. That means that small populations consisting of only four to 10 neighboring groups may use 500 to 2,500 acres. Within these large areas, woodpeckers show some flexibility in foraging requirements and are not strictly tied to "old-growth" conditions. In fact, woodpeckers have been recorded using an array of pine forest types and stand ages. The specifics that land managers need to bear in mind for adequate foraging habitat are:

- Red-cockaded woodpeckers preferentially forage on older trees. Try to maintain 18 pines per acre that are 14 inches DBH and 70-plus years old. Of these at least one to two trees should be flat-topped.
- Woodpeckers do not use areas with low basal area, less than 30 square feet per acre. They also avoid foraging in areas with high basal area if the basal area is dominated by many young pines ranging from four to 10 inches DBH.
- The basal area of pines should be maintained at four inches DBH at 40 to 90 square feet per acre in second-growth stands, or upwards of 100 square feet per acre in old-growth stands.
- Maintain the basal area of small pines in the 4-10-inch DBH size class at 10 square feet per acre.
- Habitat suitability decreases as hardwood midstory increases. Maintain hardwood midstory below seven feet using frequent prescribed burning and other techniques.

Red-cockaded woodpecker. Photo courtesy U.S. Fish & Wildlife Service.

- Hardwood canopy trees can increase competition from flying squirrels and other species that require an oak component. Keep canopy hardwoods to 15 percent of the total number of canopy trees to help reduce these problems.
- Fragmentation of foraging habitat reduces habitat quality. Avoid making large cuts and openings within forests used by woodpeckers. Keep breaks in the forest less than 60 yards where possible.

Safe Harbor Management Agreements

Because the red-cockaded woodpecker is an endangered species, it is illegal to intentionally harm them or greatly change the habitat they occupy without first obtaining a permit. The threat of government penalty concerns some landowners who have red-cockaded woodpeckers on their property. Fortunately, tools are available to alleviate these concerns. A Safe Harbor Management Agreement is a quick, simple, flexible means of limiting a landowner's legal responsibilities, while also encouraging conservation of red-cockaded woodpecker habitat. Safe Harbor Agreements allow landowners to promote habitat for red-cockaded woodpeckers without fear of additional regulatory restrictions.

Pine with artifical cavity. Photo by Rose Rodriguez.

The first step in a Safe Harbor Agreement is to determine the number of woodpeckers present. A baseline survey paid for by the state or federal government establishes this number. The baseline number equals "zero" on properties where no woodpeckers are found. Otherwise, the number represents the number of territorial woodpecker groups found.

A landowner may back out of the process once the baseline survey is completed. However, if they continue and sign up for safe harbor, any increase in woodpecker numbers that subsequently occurs does not increase the landowner's responsibility under the Endangered Species Act. The landowner is responsible only for the baseline number determined during the initial survey. In addition, once signed, a Safe Harbor Agreement may be cancelled by a landowner with only a 60-day notice.

Also on the list of positives associated with Safe Harbor are financial incentives available from state and federal governments for private landowners who participate in this program. For example, the State of Georgia paid some landowners with Safe Harbor Agreements $7.50 for every acre they burned in 2002. They also paid landowners for construction of new artificial cavities and hardwood removal operations. Such incentives could amount to greater than $15,000 annually on some properties. With these incentives in place, it is little wonder the acreage of private lands under Safe Harbor now totals over 200,000 acres throughout the southeastern U.S.

Other questions and answers regarding Safe Harbor can be found on-line (see resources listed on page 53). Tall Timbers staff also are available to answer more specific questions concerning safe harbor or to put landowners in contact with biologists with the Georgia Department of Natural Resources or the Florida Fish and Wildlife Conservation Commission, which oversee this important program.

Artificial cavities

Lack of suitable cavities is the major impediment to red-cockaded woodpecker population growth and stability. New methods of creating artificial cavities can effectively overcome this obstacle. The procedure that works best in the Red Hills involves drilling artificial cavities in living trees. Drilled cavities last as long as natural cavities and do not damage the tree as much as other techniques. The Georgia Department of Natural Resources provides artificial cavities at no expense to Safe Harbor landowners.

Achieving a balance: bobwhite quail, red-cockaded woodpecker and wiregrass

Habitats suitable for bobwhite quail and red-cockaded woodpecker overlap significantly. Management for both species ultimately is better than management for one and can increase the value of properties over time. For example, both species benefit when management promotes low-to-moderate timber stocking and sparse midstories. The influence of encroaching hardwood midstory for both quail and wood-

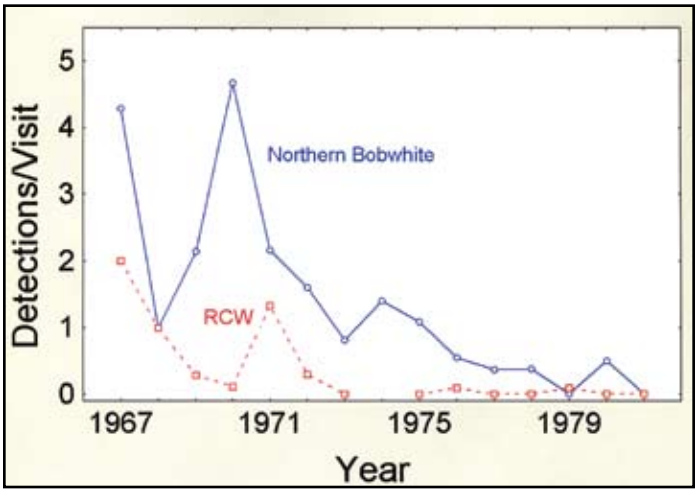


Figure 14. Survey results of average detections of bobwhite quail and red-cockaded woodpeckers as hardwood midstory gradually increases on NB66 at Tall Timbers Research Station.

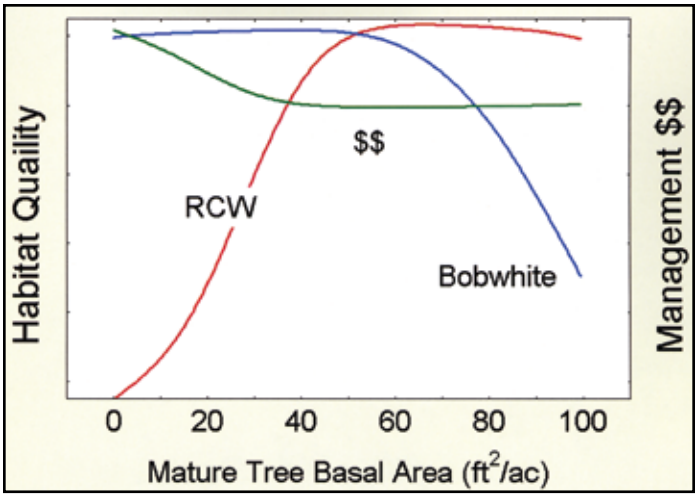


Figure 15. Changing management cost and habitat quality associated with the basal area of mature trees in the Red Hills.

pecker from NB66 on Tall Timbers are shown (Figure 14). This research area has been protected from fire since 1967.

Dense stands of pines near woodpecker populations can be selectively thinned to approximately 40 to 60 square feet basal area and benefit both quail and woodpeckers, while also increasing the growth and dollar-value of remaining trees. Habitat quality and management costs for each of these species are closely associated with the overstory basal area of mature trees, generally more than 14 inches DBH (Figure 15). In addition, quail actually may require more intensive management than red-cockaded woodpeckers when fire is considered for use as a management tool.

Bobwhite management is different in many ways on wiregrass versus areas of old-field. As the proportion of old-field land on an ownership increases across properties in the Red Hills, the associated cost of management rises proportionally (Figure 16).

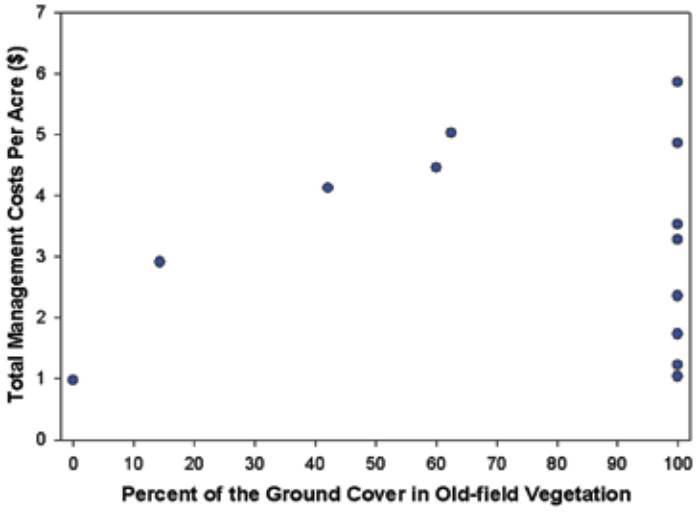


Figure 16. Management costs associated with the proportion of an ownership with ground cover in an old-field condition (Moser 2001).

Nongame wildlife

Birds

Selective timber management that emphasizes an open midstory benefits red-cockaded woodpeckers, bobwhite quail and many other high-priority bird species within Red Hills pine forests. For example, midstory hardwood reduction favoring quail and red-cockaded woodpeckers also favors Bachman's sparrow, brown-headed nuthatch, red-headed woodpecker and many other species considered to be conservation and management priorities in the Southeast (Table 4).

High Priority	Moderate Priority	Lower Priority
Bachman's sparrow	Bobwhite quail	White-eyed vireo
Henslow's sparrow	Common ground-dove	Orchard oriole
Yellow-throated warbler	Eastern towhee	Chuck-will's widow
Southeastern American kestrel	Eastern meadowlark	Summer tanager
Red-cockaded woodpecker		Yellow-throated vireo
Prairie warbler		
Brown-headed nuthatch		

Table 4. Bird species considered a conservation and management priority in the Southeastern U.S. (from Hunter et al. 1993, Pashley et al. 2000).

An additional aspect of pineland management that favors a few priority species of nongame birds is management of patches dominated by wiregrass, bracken fern and runner oak, often referred to as "native ground cover."

Tall Timbers biologist Jim Cox holds a Bachman's Sparrow in the bird's favored open pine woods habitat. Photo by Susan Roth.

Native ground cover can be eliminated with repeated heavy disturbance such as tilling and plowing. Although many species use old-field sites as readily as sites containing native ground cover, a few species appear to be more abundant in the latter, particularly Eastern meadowlark and Henslow's sparrow. For example, surveys conducted in the Red Hills show the Eastern meadowlark typically is found only in areas with more than 200 acres of native ground cover.

Land managers should minimize disturbance to native ground cover. Steps include limiting the width of plow lanes through native ground cover, and, to the extent possible, re-use of old food plots. Over many decades, shifts in the locations of food plots and fire lanes can eliminate native ground cover, which, in turn, can have an impact on the ability of sites to carry fire and support some species.

Snag management

Snags provide essential habitat for a number of species that nest in cavities. Cavity-nesting species make up 30 to 45 percent of the birds found in Red Hills pinelands and can reach a maximum diversity of about 20 species in many settings (Table 5). A diversity of cavity-nesting species, such as woodpeckers, plays a beneficial role in controlling some insects that can be harmful to forests, and cavities excavated by woodpeckers may be used by several species of mammals, amphibians and reptiles.

Primary cavity nesters	Secondary cavity nesters
Brown-headed nuthatch	Wood duck
Red-headed woodpecker	Eastern screech-owl
Red-bellied woodpecker	Chimney swift
Downy woodpecker	Great crested flycatcher
Hairy woodpecker	Purple martin
Red-cockaded woodpecker	Carolina chickadee
Northern flicker	Eastern titmouse
Pileated woodpecker	White-breasted nuthatch
	Carolina wren
	Eastern bluebird
	Belted kingfisher

Table 5. Cavity-nesting species found in the Red Hills. Primary cavity nesters excavate their own cavities and secondary cavity nesters use cavities created by other species or other natural processes.

As a group, cavity-nesting species show steep population declines throughout the Southeast. It is believed that these declines are linked to a decline in snag resources. The relationship between the density of cavity-nesting species and the density of snags is straight forward in southern pine

RAY STANYARD PHOTOGRAPHY

and mixed pine-hardwood forests (Figure 17). An abundance of snags also benefits red-cockaded woodpeckers because the snags provide alternate nesting and roosting locations for cavity-dependent species. Otherwise, these species can compete for the cavities used by red-cockaded woodpeckers. Data for the Red Hills show that snag densities averaged about 130 snags per 100 acres of upland pines. This is on the high side when compared to industrial pine plantations, but it is on the low side when compared to mature pine and mixed-pine hardwood timber stands of the Southeast (Figure 17).

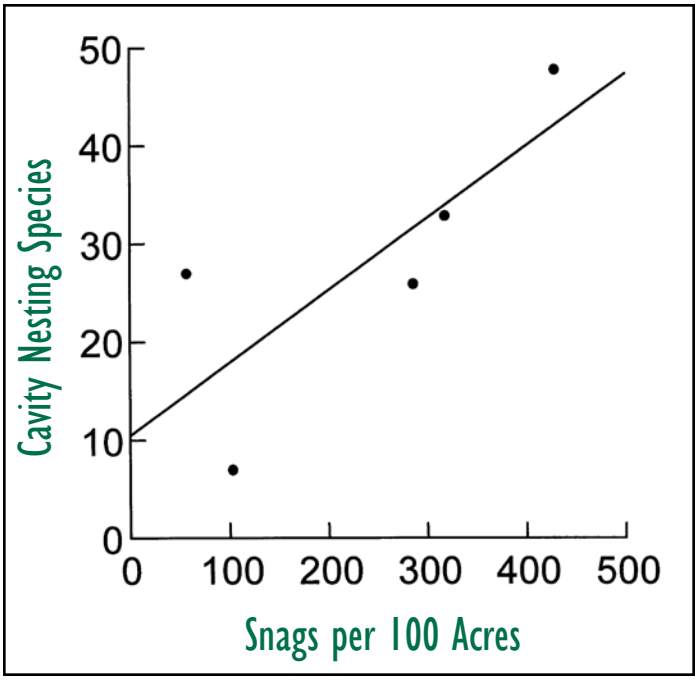


Figure 17. Relationship between snag density and density of cavity-nesting species (taken from McComb et al. 1986).

RESOURCES

Publications

The Land Manager's Guide to the Birds of the South. Paul B. Hamel, The Nature Conservancy. Chapel Hill, North Carolina. 437 pp.

On-line Information

Questions and Answers Concerning Safe Harbor Agreements
http://endangered.fws.gov/recovery/harborqa.pdf

Red-cockaded Woodpecker (information sheet)
http://www.fl.nrcs.usda.gov/infosheet/RCW.pdf

Partners in Flight Bird Conservation Plan for the East Gulf Coastal Plain
http://www.blm.gov/wildlife/plan/pl_04_10.pdf

Partners in Amphibian and Reptile Conservation (PARC)
http://www.parcplace.org/documents/what_is_parc.htm

Reptiles and Amphibians in Longleaf Pine Ecosystems
http://biology.usgs.gov/s+t/frame/d272.htm

Salvage operations are, of course, an important source of income in the Red Hills, but land managers can benefit cavity nesting species if they allow as few as 10 percent to 20 percent of their dead and lightning-struck trees to slowly decay. This also can help wood ducks, which use snags in upland pines up to a mile away from the nearest water. Enlarged red-cockaded woodpecker cavities also are a favorite nesting cavity of wood ducks.

Amphibians, reptiles and other wildlife

Amphibians and reptiles generally have not been extensively studied on plantation lands in the Red Hills. However, general recommendations based on research conducted in the Apalachicola National Forest and other nearby pine forests can be made.

Of the 290 species of amphibians and reptiles found in the Southeast, 170 species (74 amphibians and 96 reptiles) are found within the range of southern pine forests. Many of these are not found elsewhere, particularly several amphibians that require temporary ponds for reproduction and, therefore, are undergoing population declines.

Gopher tortoise burrow. Over 300 invertebrates and 65 vertebrates have been recorded using gopher tortoise burrows.

Several rare species of amphibians appear to be more sensitive to disturbance of native ground cover than non-game birds. Conservation of patches of native ground cover can be important even some distance away from the ponds where amphibians breed. It also is important to consider management of multiple, ephemeral wetlands over large areas. Some species reproduce in enormous quantities every few years, rather than annually. This occurs because variations in rainfall, burning regime and ambient temperature have pronounced effects on the site-specific suitability of individual wetlands. Seeking out specialized conditions, amphibians select only a fraction of available ponds. Therefore, managers should try to keep small, isolated wetlands free of logging debris and slash that can alter their suitability.

The gopher tortoise is an important reptile within southern pinewoods because of its penchant for digging. Over 300 invertebrates and 65 vertebrates have been recorded using gopher tortoise burrows throughout the range of tortoises, so management of gopher tortoise populations can enhance the diversity of Red Hills pinewoods substantially.

Fortunately, management activities for bobwhite quail and red-cockaded woodpecker overlap significantly with habitat requirements for the gopher tortoise. In fact, gopher tortoises can be abundant in areas that support only a few woodpeckers. Tortoises also fare well in areas lacking an overstory, so long as the ground cover and midstory shrubs are kept in check. Gopher tortoises have been shown to grow more slowly on commercial timberlands where soil disturbance has been intensive. Slow growth was attributed to the poor forage quality of sparse ground cover vegetation, especially forbs.

Bats

Bat research in the Red Hills has only recently begun. Snag resources are important for many species of bats, but on-going research is needed to pinpoint management recommendations for this group.

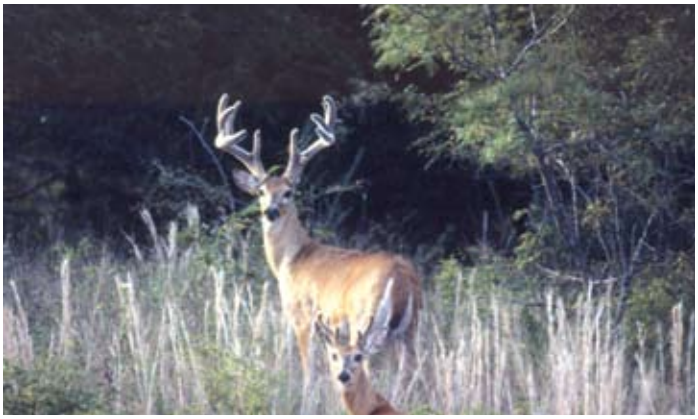
White-tailed deer and wild turkey management

Although the primary hunting interest in the Red Hills is for bobwhite quail, an increasing number of owners and managers have an interest in managing for white-tailed deer and wild turkey. Both of these species have been referred to as "edge species" but actually require several very different habitat structures in close proximity in a given home range. The presence of edge is merely an artifact of their need for more than one type of habitat structure.

Both species often are referred to as habitat generalists because of their association with a variety of different habitats. Indeed, both are very adaptable to a variety of conditions and often can be managed for similarly. There are key differences, however, in habitat requirements. Whereas research in the southeastern U.S. has shown that deer will use dense, woody cover where available for screening, bedding and escape areas, similar areas will be avoided by turkey. To optimize habitat for deer, the "rule of thirds" generally should be applied to the landscape. One-third of the landscape should be in early stages of succession, such as open fields. Open pine woodlands that have been frequently burned, with basal areas in the range of 40 to 60 square feet per acre, will qualify because of the herbaceous ground cover present. In stands with a site index of 80 or better our rule of thumb for site index minus 25 for the appropriate basal area will apply. The next third should be in brushy vegetation or early regeneration. Here, again, open pine woodlands with a distinct understory woody component can meet this requirement. Periodically switching from frequent (one- to two-year intervals) to longer burning rotations (three- to four-year intervals) will allow a shrubby understory to develop on old-field pine lands. The final third should be in mature forests. The composition of this forest is important in optimizing habitat conditions for deer.

Research suggests that 5 percent to 10 percent of the basal area of overstory trees should be in mast-producing hardwoods. Further it is important to keep intact hardwood-dominated drainages and hardwood-dominated patches around sinkholes, hammocks and other unique landscape features. These hardwood features often provide travel corridors that are used extensively by deer.

These guidelines can be similarly applied to wild turkey, with the exception of the dense, brushy component. For optimal turkey habitat, the brushy component should be omitted, with half of the land mature forests and half in early-succession openings, such as fields, or forests having 40 to 60 square feet per acre basal area. Again our rule of thumb on better sites of the site index minus 25 should apply to guide residual basal area. Hens do require some



Bucks in velvet moving from open fields to dense, woody cover. Photo by Ron Masters.

woody understory cover for suitable nest sites, however, and provisions should be made to allow for a scattered, low, woody component in stands.

Periodic lengthening of burning rotations will provide suitable nesting habitat. Brood habitat is important for turkey, and, often, it is recommended that a certain percentage of land remain in fallow fields. However, recent research suggests that open woodlands with a herbaceous understory provides adequate brood rearing habitat in a landscape context like the Red Hills. Hardwoods also are an essential component for turkey habitat management. Similar to deer, they will extensively use hardwood corridors in a pine-dominated landscape. In fact, these hardwood areas may be more important to turkey than deer, because turkey use these hardwood areas as travel corridors for spring dispersal.

A key to management of both species is interspersion of differing age classes of forests and early-succession habitats, and aggressive use of prescribed fire. The target of 40 to 60 square feet per acre basal area will provide adequate early-succession habitat when it is managed using frequent fire with periodically longer intervals. Differing age classes of pines can be easily provided through use of any of the even-aged management techniques or through the use of uneven-aged methods, such as group selection. Some research suggests that wild turkey will avoid individual pine stands managed on an uneven-aged basis. To date, very little research has been published on the management of hardwoods in corridors, hammocks or other unique areas. Therefore, a conservative, approach within these areas seems warranted.

Population management

Another key to management of these species is population management. Over-harvest of specific age-classes of males for either species can be a problem. Often, hunting pressure is placed only on the mature dominant males. If continued over a long period of time, the age structure will become

distinctly weighted to younger animals. Therefore, it is essential to mange hunting pressure on this segment. This is more critical for deer than turkey.

For deer, this means balancing pressure on the bucks and does. This is accomplished by taking an adequate number of does and allowing a proportion of the bucks to reach older age classes. For managers wanting to focus on quality, a buck-to-doe ratio of one buck per two to three does is a reasonable goal. Male white-tails reach the best antler development from 4.5 to 6.5 years of age, with a few becoming trophy animals at 3.5 years of age. Both Georgia and Florida offer deer management assistance programs that will assist with herd management for quality. In Georgia, obtain the DNR, *Wildlife Resources Division's Deer Herd Management for Georgia Hunters* at http://georgiawildlife.dnr.state.ga.us/content/displaycontent.asp?txtDocument=137.

Florida residents visit http://www.wildflorida.org/critters/deer.asp or http://www.floridaconservation.org/ for more information.

Food plots

In the Southeast, most people believe that management for turkey or deer means, "What should I plant in my food plot?" Only in extensive closed canopy forests have food plots been shown to be an essential habitat ingredient.

Where an open forest structure is maintained and fire use is widespread, food plots are unnecessary. However, food plots often are used to attract wildlife and to localize movements. One potential drawback to localizing wildlife is that the chances for disease spread are increased.

Deer and turkey make use of milo patches and will consume a number of cereal grains. Cereal grains, like winter wheat, have the added benefit of providing cool season forage for deer. Chufa is an often used plant that attracts wild turkey. Other recommendations include alternating strips of clover with some type of cereal grain and with cowpeas or soybeans. A soil test should be completed, and fertilizer should be applied at the recommended rate.

During a survey of wild turkey by Tall Timbers' Game Bird Lab, this strutting gobbler and hens were captured on film by a bait station camera.

If an ecosystem is the sum of all of its parts, then "ecosystem management" may be summarized simply as "keeping all the parts". This includes maintaining the processes, such as fire, by which the parts are sustained. Given that humans are part of the ecosystem, ecosystem management does not necessarily suggest maintaining the entire landscape in a pristine, pre-European settlement condition. Rather, it should aim toward maintaining ecosystem functions that support both humans and natural habitats, while minimizing the loss of existing high-quality natural communities. It is important to recognize that ecosystems are not delineated by property boundaries. Management decisions should take into account possible effects beyond the managed property. The following sections provide information and guidelines for the management of upland pine forest communities at the ecosystem, community, and population levels.

Management at the Ecosystem Level

Fire is essential

Frequent fire is a key component in the healthy function of the upland pine forest ecosystem, whether in old-field or more pristine pineland communities. Fire is important to the carbon cycle in that it periodically reduces both standing and dead plant material (biomass) into ash and carbon dioxide. This natural reduction of biomass in turn maintains an essential link in the flow of energy, specifically from the sun to the large number of native plant species that require open habitats for survival and reproduction. These plants transfer energy to specialized herbivores and their predators. Fire also is important to the nitrogen cycle, returning nitrogen to the soil in forms that are available to plants. Additionally fire promotes herbaceous groundcover that reduces leaching and various nitrogen-fixing legumes. Therefore, prescribed and natural fires generally should be allowed to burn in any natural area that will burn under safe conditions. Although prescribed fire has traditionally targeted upland pinelands and herbaceous wetlands, most ecologists agree that periodic, although less frequent, fire also plays a role in keeping at least the fringes of forested wetlands in a naturally open condition.

Water and soils

Ecosystem management should entail the protection of healthy water cycles and, therefore, ecosystem function. One of the most important goals should be to reduce the potential for runoff of sediment and valuable nutrients by water. The best way is to maximize the area of ground covered by vegetation and, conversely, to minimize soil exposure and removal of plants by mechanical means. Trees naturally occurring in wetlands are an important link in the water cycle, slowing the sub-surface flow of water through root absorption and evapotranspiration, allowing water to be better filtered, and creating a humid micro-environment. Artificial drainage in natural areas short-circuits this process and may alter the local plant community. By maintaining wetland forests in their natural locations and natural drainage features, landowners receive the dual benefits of preventing soil and nutrient loss and protecting water quality.

Another water management issue is the artificial impoundment of water. Dams placed on headwaters to create ponds are a traditional local land use that may provide habitat for waterfowl, amphibians and recreational fish. These impoundments should be dispersed and used on a small number of headwaters to minimize the loss of wetland habitat. They also will produce stream flow reduction and stabilization, and the oxygen reduction and warming of water that occurs in reservoirs. Pond banks should be planted with erosion-resistant vegetation, and bank slopes should not exceed a one-foot rise to a four-foot run. Plugging of natural sinkholes to create ponds is discouraged, given that they are important sources of aquifer recharge and represent a unique natural habitat feature. History suggests that sinkhole impoundments may be drained by the formation of new sinks within the basin.

DAVID COPPS

Upland Longleaf Pine Forest. Photo by Kevin Robertson.

Management at the Community Level

Ecosystem management considers the importance of all components and linkages of the system. Proper management of natural communities keeps food chain links intact and, in turn, benefits herbivores, including insects and other microfauna that depend on them for survival. These animals feed other wildlife, including game birds, which, in turn, are eaten by predators. Where fire suppression has allowed an unnatural increase in the hardwood component of the forest, some predator populations expand. Abnormally high predator populations may require control in order to attain management objectives for game birds. Nevertheless, predators play an important role by controlling populations of rodents and other animals that may compete with game species. Predators also can increase the genetic quality of prey populations through selection of less healthy individuals. Therefore, management that seeks to restore the natural ecosystem function of the upland pinelands, while supplementing game populations, is preferable to selective trapping or elimination of high-quality natural communities that may support predators, like bottomland forests.

Finally, ecosystem management should attempt to use land within the bounds of its natural function to the extent possible. During upland hardwood removals, care must be taken not to intrude upon wetland habitats for the purpose of increasing quail habitat and reducing predators. By retaining wetland and other unique special natural areas in the landscape matrix, the proper function and interaction of various natural communities will contribute to the biodiversity and health of the ecosystem as a whole.

Keeping the parts

The Red Hills ecosystem is composed of a variety of natural upland and wetland communities that have unique management needs. Natural communities are particular associations of plant and animal species that are believed to have retained their essential species composition and structure since presettlement times.

Because keeping all of these communities intact is important to ecosystem health, less prevalent communities, natural features or unique areas may be considered as special natural areas meriting particular management practices for their preservation. A major key to protection is early identification. Sensitive areas should be identified and, preferably, mapped. These may include sinks, other depressional wetlands, hammocks, unique trees or groups of trees, slope forests and other components of the landscape that add diversity. Management may be as simple as omitting certain intensive management practices on these parts of the landscape.

Guidelines for identification and management of common natural communities in the upland pine ecosystem

Upland pine forests

When frequently burned, the upland pine forest community is characterized by widely spaced pines, a few understory shrubs and a low, even, dense ground cover of herbaceous plants. The forest canopy typically is dominated by longleaf pine, with lower densities of slash pine and loblolly pine in low areas, although shortleaf pine may naturally dominate the uplands on some sites. Natural stands may have scattered clusters of seedlings and saplings, making the structure appear two-tiered. The herbaceous layer of the natural community, often called native ground cover, is commonly dominated by wiregrass, but also may be dominated by other native bunchgrasses, including little bluestem and plume grasses, which provide a continuous fuel matrix. The Red Hills is thought to be a transition zone between the wiregrass-dominated sand hills of Central Florida and the bluestem-dominated pinelands of the upper Coastal Plain. Therefore, the density and dominance of wiregrass in undisturbed areas may vary from place to place, probably in relation to soil characteristics.

Native ground cover often may be identified by the presence of species that are particularly sensitive to soil disturbance and, therefore, indicate areas that have not been severely disturbed in the past. These species include wiregrass, running oak, bluejack oak, turkey oak, coastal plain angelica, Maryland golden aster, oblong leaf twin flower, Curtis' spurge, summer spurge, pink fuzzybean, eastern silver aster and various species of goat's rue. Bracken fern also typically forms continuous stands in native ground cover that has been burned in early spring. Otherwise, native ground cover may be identified by its high species richness at small spatial scales and the paucity of common agricultural weeds. Healthy native groundcover makes the system more resistant to invasive exotic species.

Fire is a factor in the ecology of this community, because it reduces hardwood encroachment and facilitates reproduction of longleaf pine, wiregrass and many other native herbs. Bunchgrasses and longleaf pine needles provide an ideal fuel matrix for hardwood-suppressing fires. This combination allows burning during the "lightning season" (May to June), when the largest numbers of fires may have naturally occurred. Lightening season fires are most successful at killing hardwood saplings if native ground cover is intact. Many plant species, including wiregrass, regenerate only, or most successfully, when burned at this time. Therefore, at least occasional lightning-season prescribed burns are recommended for this community.

Reducing the impact of logging operations on the herbaceous component

- Trees should be limbed where they fall to avoid dragging whole trees.
- No tops, limbs or butts should be left within six feet of the base of a living tree lest damage occur during a future fire.
- Tops and limbs should be flat-lopped.
- Drag trails should be dispersed to minimize damage to the herbaceous community, avoiding those areas that are flagged for protection, like RCW trees and natural wetland communities.
- Timber should be logged with equipment that will have the least impact on soil and ground cover.
- Equipment maintenance such as oil and lubricant changes should not be conducted in the woods.
- The timber harvest operation should be closed down in the event of rain to prevent excessive damage to the herbaceous community and the soil profile. Logging under wet conditions appears to cause the most damage to native ground cover.

The primary conservation concern related to the herbaceous component of the community is soil disturbance associated with firebreaks, food plots, logging and roller-chopping. Most perennial, native, fire-dependent plant species depend on root storage for survival, and their existence and role in the ecosystem is threatened by plowing. Natural soil profiles are important for supporting the large number of soil fauna and microorganisms, including nitrogen-fixing bacteria and mycorrhizae that make nutrients available to plants and herbivores. Plowed areas usually do not return to native ground cover, although it is unknown whether re-establishment eventually will occur. An alternative to plowing new ring-a-rounds to protect longleaf saplings and wildlife is to rotate burning among permanent fire blocks, using roads, drains and previously used firebreaks as boundaries, whenever possible. Rotating food plots among previously used and old-field areas is highly encouraged, as opposed to installing new food plots in native ground cover areas. Mowing of hunting lanes is preferred over roller chopping so that soil disturbance is minimized.

During logging operations, the site should be inspected daily by the land owner or manager to ensure that sound management practices are being used. Logging practices should follow the Georgia Forestry Commission Best Management Practices, Section 2, Streamside Management Zones www.gfc.state.ga.us/Publications/RuralForestry/GeorgiaBMPManual.pdf), or should maintain existing wetland buffer widths.

Seepage slope

Seepage slope communities are herb-dominated wetlands on the lower part of slopes or in drain heads, typically bound on the upslope side by an upland pine forest community. Soil moisture is maintained by down-slope seepage, such that the ground is usually saturated but rarely inundated because of an impermeable clay layer beneath the soil surface. The community is maintained by fire entering from the adjacent uplands. In the absence of fire, it succeeds to dominance by shrubs and wetland trees. Seepage slopes, known for their spectacular arrays of flowers, are the most species-rich plant communities in the region, with up to 50 species per square yard. Many of the species are rare and occur only in this community type. Seepage slopes have become globally rare because of the high sensitivity of the saturated soil to disturbance by alterations in hydrology from artificial drainage, rutting and fire suppression.

Seepage slopes may be identified in the field by their erect, densely packed, bright-green herbaceous plants and soft, peaty ground, usually carpeted with sphagnum moss. They also may be identified by their "insect-eating" plants, including the hooded pitcher plant. In autumn, they often are marked by the urn-shaped capsules of meadow beauties and the curly-cue seed spikes of toothache grass.

Seepage slope natural community showing hooded pitcher plants and urn-shaped meadow-beauty capsels. Photo by Kevin Robertson.

At right, toothache grass with curly-cue seed spikes in a seepage slope community. Photo by David Copps.

Bay forest community. Photo by Kevin Robertson.

Bay forest

Bay forest communities, also called "baygalls" or "bays," often exist at the base of a drain as part of a pineland-seepage slope-bay forest complex continuum. Bay forests are characterized by densely distributed, tall, straight, evergreen hardwood trees, most having light-colored bark. Typically, there is an open understory of shrubs and ferns and the ground is covered with intertwined roots covered with sphagnum moss, and black, peaty soil that is saturated and pooled in places. Although the community rarely is invaded by fire, it may burn under very dry conditions. This natural community is especially important to the survival of various rare and threatened amphibians.

Floodplain and basin swamps

So-called "swamps" in the Red Hills region usually are associated with abandoned river channels in river floodplains or large basins sunk into the karst (irregular limestone deposits) underlain landscape. These areas originally were dominated by bald cypress and pond cypress, but, following extensive cypress cutting, most have become dominated by black gum and associated hydric or water-loving tree species. Swamp communities are covered with water during at least part of the year, usually resulting in a very sparse herbaceous layer on exposed, mucky soils.

Bottomland and slope forests

Bottomland forest communities in the Red Hills region typically have a continuous, closed canopy of large hardwood trees, an open understory of shrubs and an herbaceous layer of ferns, forbs and grasses. Bottomland forests occur in stream floodplains or in basins that are infrequently flooded. These communities rarely burn, although infrequent burns may be partially responsible for their open subcanopy, especially near the edges. High-quality examples of this habitat within the region are dominated by American beech, southern magnolia, spruce pine, American holly and a large number of oak species. A high-quality, herbaceous layer in this community type often is indicated by the presence of spike grass, cinnamon fern and maiden cane.

The slope forest community type is very similar in species composition to the bottomland forest community, but it occurs on slopes leading from uplands to floodplains and has fewer wetland species in the herbaceous layer. However, seepage of water downslope, and shade from the canopy and slopes, allow many hydric species, including spike grass, to occur. Much of the loss of bottomland forest and slope forest communities has resulted from conversion to open pinelands, pine plantations, fields or reservoirs. If left to recover following logging, the forest initially returns as early-succession tree species, especially water oak, sweet gum and red maple. Late succession canopy species may return after several decades, but viability for many native plant and animal species may be greatly reduced in the interim.

Cinnamon fern and maidencane on perifery of bottomland forest community. Photo by Kevin Robertson.

Depression marsh and dome swamp

Depression marsh, also called "depression pond," and dome swamp, also called "gum swamp" or "cypress dome," natural communities represent late developmental stages of lime sinks. Depression marshes are sinks that have accumulated peat and may be seasonally inundated. Typically these have concentric bands of herbaceous vegetation reflecting

Floodplain swamp community. Photo by Kevin Robertson.

moisture levels and often are surrounded by a ring of trees, especially live oak. Dome swamps demonstrate further accumulation of peaty soils, such that the basin is covered by a stand of trees, usually dominated by black gum, tupelo gum, pond cypress, red maple and evergreen shrubs, as in bay forests. Soils typically are saturated or very close to the water table. Areas that are similar in ecology but more extensive due to the size of the depressional basin may be called basin swamps.

Guidelines for management of natural wetlands

High-quality wetland communities require special care in land management. In general, management of these communities should focus on minimizing soil disturbance and alterations in the natural hydrology and avoiding fire suppression. Wetland communities are highly susceptible to soil disturbance, even under dry conditions, because of the high water table and finely textured soils. The use of roller chopping, disking, and harrowing is discouraged and usually is not necessary. The use of vehicles, in general, and heavy equipment, in particular, typically causes severe rutting in these communities and should be avoided when possible. Salvage cuts of isolated blow-downs in high-quality bottomland forests and swamps should be avoided. Seepage slope and depression marsh natural communities are particularly sensitive to rutting, which disturbs plants, changes the moisture regime of the soil and promotes invasion of weedy species.

Alterations in the hydrology of wetland communities may include draining, impounding, and stabilizing the water levels within the area. The use of artificial drainage, including ditches, pipes and tiles, is discouraged, because it lowers the water table and reduces the soil moisture required by the natural plant and animal species. Impoundment of high-quality habitat has obvious consequences to the plants and animals in the community, and it will alter the hydrology of downstream wetlands. Stabilization of water levels, either at high or low levels, eliminates the natural water fluctuation that is critical to plants and animals in certain natural communities, including depression marshes, cypress domes and basin swamps. Seasonal fluctuations of water level in such isolated wetlands are essential to the breeding cycle of crayfish and amphibians, which provide food for mammals and migratory birds. Also, most wetland tree species, including cypress, require such fluctuations for seedlings to germinate and grow.

The use of fire is critical in the management of most wetland natural communities. Seepage slopes and depression marshes are highly dependent on frequent fire for their persistence, and it is believed that incursions of fire into wetland forests encourage tree regeneration. Therefore, it is recommended that wetland communities not be isolated by firebreaks. Rather, fire should be allowed to creep into the community from the adjacent uplands during burns. Thus, existing firebreaks running through or along the periphery of these communities should be abandoned, unless required to address safety or liability concerns.

Wetland forests, which typically form the down slope boundary of seepage slopes, serve as natural fire breaks under most conditions, such that installing fire breaks generally is not necessary. However, burning should be avoided under drought conditions, especially in bay forests and dome swamps, to avoid peat fires, which are smoky, difficult to extinguish and can kill even large trees. Otherwise, the frequent use of fire should maintain a natural transition from upland to herbaceous and forested wetland communities. If the use of mechanical means to prevent the spread of hardwoods upslope is considered necessary, care should be taken so that the clearing of hardwoods does not infringe upon the natural extent of the bottomland forest or slope forest communities. Although this is a subjective judgment, it should be guided by the presence of wetland soils, as indicated by the characteristic herbaceous species listed in the previous descriptions of high-quality natural communities. The presence of tree species listed in these community descriptions also suggests that the forest is not a result of recent invasion hardwoods and likely is occupying its natural ecological extent.

If logging is conducted in wetland forests, chain skidding is recommended, whenever possible, to reduce the use of heavy vehicles. Tracked vehicles and double-tired skidders have a smaller impact on the soil than single-tired skidders. Plank roads also reduce rutting. A buffer zone of at least 200 feet should be maintained around adjacent streams and other bodies of water to reduce runoff from the impacted area.

Depression pond community. Photo by Kevin Robertson.

Population management

Population management generally may be categorized as either game management or protection of rare species. Management for the most popular game species, as well as certain rare bird and reptile species is presented in previous sections. Numerous other mammals, amphibians, fish, crustaceans, insects and plants have species known to be, or thought to be, threatened. The primary cause of threats to these species is elimination or alteration of their natural habitat. The species that are at least somewhat protected by state laws in Florida or Georgia that are most likely to be encountered in the Red Hills are listed in Appendix II.

In general, the best method of managing rare species is to protect and properly manage the natural community in which they exist. Deciding on appropriate management is more difficult when a rare species is found in an altered environment. In such cases, management should aim toward maintaining the conditions under which the species was found, especially if it is the environment in which it reproduces. For plants, the most important variables determining population survival are sun exposure, fire frequency, fire season in some instances and soil moisture. Descriptions and management recommendations for Georgia state-listed plants and animals are provided in *Protected Plants of Georgia* (Patrick et al. 1995) and *Protected Animals of Georgia* (Ozier et al. 1999), respectively. Descriptions and management recommendations for Florida state-listed animals and plants are given in *Field Guide to the Rare Animals in Florida* (Hipes et al. 2001) and *Field Guide to the Rare Plants of Florida* (Chafin 2000), respectively.

Historic cemetery on Mayhaw Plantation, Thomas County, Georgia. Photo by David Copps.

Historical resources

The hunting plantations of the Red Hills Region have conserved a great abundance and diversity of historic and pre-historic features. Historic sites of special interest include old buildings, roads, tramlines, cemeteries, grain and sawmills, wells, groves and Indian mounds and middens. The identification, appreciation and maintenance of these resources are highly encouraged, as they are an irreplaceable and a continuous source of knowledge regarding the region's cultural history.

Wooden buildings should be protected from fire using firebreaks and, if possible, maintained or restored. Grave stones and other isolated features should be marked to avoid damage by vehicles or equipment. Historic earthworks, such as old road beds, tramlines and Indian mounds should be preserved for historical interest. At the request of the landowner, Tall Timbers will identify and make recommendations for the protection of historic sites.

Managing for Aesthetics

Creating an environment that is beautiful, as well as functional, is among the most important goals of land management in the Red Hills region. The objective of managing for aesthetics is to provide a visually pleasing environment for land owners, residents and guests to better enjoy the experiences of hunting, riding, fishing and other recreation. Protection of the natural beauty of the landscape and natural communities, as well as the maintenance of historical resources and land use traditions, upholds a unique cultural heritage rooted in the century-long history of the Red Hills hunting plantations.

The influence of management for aesthetics extends well-beyond those who directly participate in the local hunting tradition. Roads through the Red Hills plantation region provide viewers with an education as to how most of the landscape of the Southeast once appeared, thus helping them value our remaining natural resources. Visual access from roads and waterways also provides the public with a lesson in the safety, beautifying effects and ecological importance of prescribed burning, garnering support for its continued use in the future. Aesthetically managed landscapes offer the public an alternative to viewing poorly-planned development and encourage people to appreciate the local land owners and hunting traditions that keep the land natural. It also provides welcome relief from the monotonous wall of vegetation that borders most roadways and limits the view. This use of the land for sustainable forestry, while protecting its natural beauty and resources, makes the Red Hills region an important national example of the potential balance between productivity and conservation.

New Hope Road, above, was designated Thomas County, Georgia's first Scenic Road. The designation will insure that any future improvements must protect its scenic character. The lower and middle sections of the road traverse through a canopy of live oaks and upper portions through open vistas of adjoining plantation lands. Photo by Kevin McGorty.

Important Elements that Contribute to Aesthetics in the Red Hills

- Mature trees (i.e. live oaks, longleaf, magnolias)
  - Signature/significant live oaks and other oaks
  - Wiregrass-longleaf ecosystems
- Canopy roads, unpaved roads
- Rolling hills & drains
- Views and vistas of open park-like pines
- Diversity of plant and wildlife species
- Historic sites within Red Hills
- Soil fertility
- Evidence of pride in properly managed land
- Mature hammocks
- Natural appearance (fire, etc.)
  - Post-burn green-up
- Interspersed lakes, rivers, ponds and wetlands
- Clear, clean water in rivers, lakes and pond

Balancing Aesthetics with Other Goals

Balancing the management objective of aesthetics with those of productivity and natural resource conservation can be a challenging, though important, goal. A traditional practice following logging is the "clean up" of the site, usually involving the mechanical piling of logging debris for burning. In native ground cover areas, scraping and gouging of the ground with the front fork or bucket of a skidder can cause extensive damage to the herbaceous plant community. Thus, removal of the lowest-lying and least visible fuels should be avoided. Limbing should be conducted so that

small branches, which will not damage a mower, are left on the ground and only larger limbs are removed. A certain amount of small-diameter slash pine is beneficial for quail cover. Most slash can be cleaned up with prescribed fires in the spring.

Live oaks draped with Spanish moss traditionally have been a symbol of the region's natural beauty. The continuous distribution of live oaks from east Texas to Virginia and southward to the Keys, especially in sandy soils close to the coast, suggest that it is a natural ecological component of the Red Hills. Cutting of live oaks has become increasingly common to reduce roosting habitat for quail predators. While thinning of trees where they are excessively dense may be warranted, it is recommended that local populations not be eliminated. This practice will benefit the large number of native birds and air-plants that they support. The protection of live oaks is especially appropriate where they exist on the edges of natural water bodies and depression marshes where they are a characteristic part of those natural plant communities. In North Florida's Leon County, removal of trees greater than 18 inches in diameter is prohibited unless previously approved through a silvicultural short-form permit or notice of intent from the county ("Leon County Land Development Regulations," *Leon County Code of Laws,* Chapter 10).

Herbicides often are used to control weeds along fence rows, roads and in turf surrounding buildings and ponds. They also kill hardwood saplings and stumps. Label instructions on all chemicals should be closely followed, especially if there is the possibility of contamination of nearby wetlands. Some chemicals are highly toxic to aquatic life. Quickly degrading chemicals such as "Roundup" always are preferable to more persistent chemicals. Fire and mowing always should be used in place of chemicals when possible.

Ecosystem management, or "keeping all the parts," is both a great challenge and a tremendous opportunity to pass on the rich natural and cultural resources that are unique to the Red Hills region. Broad-minded management that considers the large-scale ecological and historical contexts of each property, in addition to the traditional attention to detail characteristic of local managers is the key to successful stewardship of the region as a sustainable ecosystem. The efforts of today will grant an invaluable heritage to future land users as well as the many citizens who will benefit from the sound management of natural landscapes.

Majestic live oaks contribute to the aesthetic beauty of the Red Hills. Photo by Ron Masters.

"Conservation is a state of harmony between men and land.
By land is meant all of the things on, over, or in the earth."

— Aldo Leopold, A Sand County Almanac, and Sketches Here and There

Bringing it Together

From small farms to large hunting plantations, conservation easements are becoming a popular way to conserve land while keeping it in productive rural use and family ownership. Landowners also have discovered that donating easements can provide substantial tax savings for their families and corporations. Today, tens of thousands of acres in the Red Hills are under conservation easement.

What is a conservation easement?

A conservation easement is a voluntary legal agreement between a landowner and an easement holder that permanently limits uses of the land in order to protect ecological, historical, or scenic resources. The owner of a piece of land has the right to subdivide, build structures, harvest trees, mine for minerals, and other rights. A conservation easement allows a landowner to retain ownership, use, and enjoyment of the property while restricting some of those rights for the purpose of protecting the lands' conservation values.

Easements are custom designed to meet the personal and financial needs of each landowner. An easement may cover a portion of a property or the entire parcel. The easement will identify the specific rights the landowner wishes to retain, limit, or forgo. As a legal agreement, a conservation easement is recorded in county records. An easement is granted in perpetuity, and, therefore, all future owners are subject to its conditions.

A typical conservation easement between a Red Hills landowner and Tall Timbers does the following:

- Restricts commercial and residential development of the property;
- Specifies that the land may continue to be used in future years as it is now, for traditional rural uses such as farming, forestry, hunting, wildlife management, etc.;
- Allows timber harvesting and planting in conformance with "best management" practices and a mutually agreeable conservation management plan;
- Specifies the maximum number of buildings that may be located on the property in the future; and
- Conserves special natural areas of animal or plant habitats, wetland features, or historic resources.

Under a conservation easement, the landowner remains responsible for all land management decisions and activities. As the easement holder, Tall Timbers' interest and responsibility is only to ensure protection of the conservation values identified in the easement.

What is a conservation management plan?

For most easements on larger parcels, the landowner, the property manager, the landowner's forestry consultant, and Tall Timbers staff develop a conservation management plan. This plan guides agriculture, forestry, and wildlife management practices on the property in order to protect conservation values identified in the easement. A more fluid document than the legal easement, this plan may be revised over time, as circumstances change if the landowner and Tall Timbers both agree that revision is necessary. The plan recognizes the intrinsic importance of the property's economic sustainability and traditional land uses.

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RAY STANYARD PHOTOGRAPHY

What are the benefits to the landowner?

Landowners donate conservation easements for a variety of reasons. Foremost is a love of their land and a strong desire to protect it for their families and future generations. Conservation easements are powerful estate planning tools that provide families the opportunity to plan together for the future of their land. Neighboring landowners in the Red Hills who donate conservation easements on contiguous properties provide mutual protection against unwanted or unplanned development while sharing the benefits of conserving larger resource areas for hunting and wildlife management, scenic landscapes, privacy and prescribed burning.

What are the tax benefits of donating an easement?

Federal income tax

Federal tax laws allow the donor of a qualified easement to claim its value as a deduction for income, gift and estate tax purposes. Only donated easements qualify for a tax deduction.

As a charitable donation, the easement value generally is based on the difference between the fair market value of the property before and after donation of the easement. The difference between the "before" and "after" value is the amount that can be treated as a charitable donation for income tax purposes.

For example, if the owner of a 1000-acre Red Hills property valued at $6 million placed an easement on his or her land precluding future residential and commercial development, a qualified appraiser would determine the land's fair market value, as reduced by the easement, is $2.4 million, a 60 percent diminution. The charitable donation thus would be valued at $1.2 million. The landowner can deduct the amount of the easement donation up to 30 percent of his or her adjusted gross income, plus a five-year carry-forward for any excess value. Corporations are limited to a 10 percent deduction. As this publication went to press, Congress was considering increasing federal tax benefits for conservation easements. Visit www.talltimbers.org for up-to-date information.

In the Red Hills, easement values vary from a 30 percent to 90 percent diminution of value, based on the size and location of the parcel. The highest easement values are on properties under intense development pressure.

Estate tax

Conservation easements can significantly reduce the value of an estate, making estate taxes more affordable to heirs. Unlike limits it places on deductions for federal income taxes, the Internal Revenue Code allows unlimited charitable contributions for the purpose of reducing estate and gift taxes. Essentially, the value of the property is frozen at the lower "after" value for estate and gift tax purposes. In addition, up to 40 percent of the value of land covered by a conservation easement may be exempted from estate and gift taxation. Heirs can donate post-mortem conservation easements to reduce estate taxes under the above provisions if the easement is completed within nine months. Property owners considering the donation of a conservation easement for estate tax benefits should consult their personal advisors regarding recent tax law changes and implications.

State taxes

The State of Georgia is providing a 25 percent state income tax deduction for conservation easements. See www.gadnr.org/documents/conservation_tax_credit.html.

Local property taxes

As a conservation easement restricts various development rights and diminishes the fair market value of a property, it has the potential to provide ad valorem tax relief. In Florida, the lowest assessed rate is for agricultural land, and this is the category under which most easements fall. Florida law requires property appraisers to recognize the reduced market value of a property under easement. Georgia landowners who donate an easement automatically qualify for the lowest property tax assessment under that state's Conservation Use Covenant program. However, only up to 2,000 acres will qualify. A landowner may put an additional 2,000 acres under the Agricultural Preference Covenant for qualifying lands at a lower tax reduction. The program has resulted in approximately 50 to 70 percent savings in taxes on qualified land. Contact your local county tax assessor office for more information.

Tall Timbers Land Conservancy

In the past decade, our land conservancy has become the leading regional land trust in Georgia and Florida, protecting more acreage through conservation easements than any other organization. For further information and copies of our Model Conservation Easements and Model Conservation Management Plans call (850)893-4153, ext. 238. These items also are available on our website at www.talltimbers.org.

THE FUTURE FOR THE RED HILLS

A land ethic, of course, cannot prevent the alteration, management, and use of … 'resources,' but it does affirm their right to continued existence, and, at least in spots, their continued existence in a natural state. — Aldo Leopold, A Sand County Almanac, and Sketches Here and There

Steeped in tradition, with a distinct sense of place, culture and common goals, the future for the Red Hills looks bright indeed. Strong public, private and corporate partnerships have created an exemplary model of stewardship and conservation that possesses the staying power necessary to transcend the pressures of sprawling urban growth patterns. Commitment by the Red Hills landowners, past, present and future is the glue that binds common goals and values. These include a love of the land, huntable populations of wild bobwhite quail and appreciation of the land's aesthetic beauty. Perhaps the most important goal expressed by landowners is to pass on their love of the land to future generations and to pass that land on in as good or better condition than when received.

The good land stewardship practices of the past, frequent fire and selective timber harvest have maintained the open character of the piney woods that is so important for quail and a host of other plant and animal species. To insure a bright future, though, there are several things that we must be mindful of and work on together. The first is protecting the right to hunt, for it was the love of hunting and the land that initially motivated this group of landowners to manage their properties wisely. Of equal importance is protecting the right to use prescribed fire. Fire is an essential part of the natural processes that forged the Red Hills landscape and has perpetuated its rich flora and fauna. Finally, we cannot forget the potential negative impact of land use changes from misguided public policy. These threats have arisen, and will arise from time to time. Our best defenses always have been, and will continue to be, proactive involvement and a united front.

In order to keep the Red Hills landscape and ownership patterns intact and in the family, proper financial planning is essential. Large land holdings require continuous, large cash outlays for both capital and labor. Alternatives like conservation easements, operation endowments and estate tax planning are essential for keeping the land in a family for multiple generations. Consult your family financial advisors for details.

Tall Timbers remains committed to the Red Hills community and to fostering good land stewardship through research, conservation and education. Together we can maintain a bright future and a favorable forecast for the Red Hills. It takes everyone getting involved. Be a part of conserving the Red Hills landscape and its cultural heritage. I guarantee you it will be worth it.

The historic Beadel House at Tall Timbers Research Station is the former home of Tall Timber's benefactor, Henry Beadel. Mr. Beadel was a sportsman, naturalist and conservationist who bequeathed his hunting plantation to be established as 'a fire type' nature preserve ... [to] conduct ... research on the effects of fire on quail, turkey and other wildlife, as well as on vegetation of value as cover and food for wildlife, and experiments on controlled burning...."
Henry Beadel, 1958

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APPENDIX – TABLE I

Guidelines for Safe Prescribed Burning

From Wright and Bailey (1982), Wade and Lunsford (1989), Bidwell and Masters (1993)

BURNING PARAMETER	LOW	OPTIMUM	HIGH	PREDICTED	ACTUAL
1-HR FUEL MOISTURE[1]	7%	10-20%	>30%		
10-HR FUEL MOISTURE	6%	10-12%	>15%		
SOIL MOISTURE[2]	DRY	DAMP	WET		
RELATIVE HUMIDITY[3]	25%	30-55%	>60%		
TEMPERATURE	20˚F	45-60˚F	80˚F		
WIND SPEED (IN STAND)	0 MPH	1-3 MPH	>10 MPH		
WIND SPEED (@20 FT)	<6 MPH	8-15 MPH	>20 MPH		
MIXING HEIGHT[4]	1500 FT	1700-6500 FT	NA		
TRANSPORT WIND SPEED[4]	<8 MPH	9-20 MPH	NA		
AIRMASS STABILITY[4]	STABLE	SLIGHTLY UNSTABLE OR NEUTRAL	HIGHLY UNSTABLE		
DISPERSION INDEX[4]	<12	60-100	>100 CAUTION INDICATED		
CATEGORY DAY[4]	I	III-V	NA		

[1]Fine fuel moistures presented are actual, not calculated values. Values from National Fire Danger Rating System tables are different than these actual values.

[2]Always check to ensure lower litter layer feels damp to touch.

[3]Relative humidity will drop roughly **half with each 20˚F rise in temperature** and **double with each 20˚F drop in temperature.**

[4]Obtain this information from either the State Division of Forestry, National Weather Service, or U.S. Forest Service fire weather forecasts.

Situations to avoid:

Avoid burning under a thermal inversion.

Avoid burning when a major front is approaching.

Avoid burning during extended drought periods.

Avoid burning when relative humidity is <25%.

Avoid burning when 10-HR fuel moisture is 5% or lower, you **will** have spot fires.

Avoid burning when the dispersion index is <12.

Avoid burning on a Category Day of I, on a Category Day of II don't start until 11 a.m. and be sure the surface inversion has lifted. The burn should be completed before 4 p.m.

APPENDIX–TABLE II

Protected Species in the Red Hills Region

Protected Species			Listed Status		
GROUP	COMMON NAME	SCIENTIFIC NAME	GA	FL	FEDERAL
Reptiles	American alligator	*Alligator mississippiensis*		SSC	LT (S/A)
	Florida pine snake	*Pituophis melanoleucus mugitus*		SSC	
	Gopher tortoise	*Gopherus polyphemus*	T	SSC	
	Suwanee Cooter	*Pseudyms cocinna suwaniensis*		SSC	
	Alligator snapping turtle	*Macromlemys temminckii*	T	SSC	
Amphibians	One-toed amphiuma	*Amphiuma pholeter*	R		
	Striped newt	*Notophthalmus perstriatus*	R		
Mammals	Round-tailed muskrat	*Neofiber alleni*	T		
	Sherman's fox squirrel	*Sciurus niger shermani*		SSC	
Birds	American swallow-tailed kite	*Elanoides forficatus*	R		
	Bachman's sparrow	*Aimophila aestivalis*	R		
	Little blue heron	*Egretta caerulea*		SSC	
	Snowy egret	*Egretta thula*		SSC	
	Tricolored heron	*Egretta tricolor*		SSC	
	Bald eagle	*Haliaeetus leucocephalus*	E	T	LT
	Red-cockaded woodpecker	*Picoides borealis*	E	SSC	LE
	White ibis	*Eudocimus albus*		SSC	
	Wood stork	*Mycteria americana*	E	E	LE
Fish	Spotted bullhead	*Ameiurus serracanti*	R		
	Blackbanded sunfish	*Enneacanthus chaetodon*	R		
	Suwanee bass	*Micropterus notius*	R	SSC	
Plants	Incised groove-bur	*Agrimonia incisa*		E	
	Southern lady fern	*Athyrium filix-femina*		T	
	Flyr's brickell-bush	*Brickellia cordifolia*		E	
	Buckthorn	*Bumelia lycioides*		E	
	Woods poppy-mallow	*Callirhoe papaver*		E	
	Sweet shrub	*Calycanthus floridus*		E	
	Spreading pogonia	*Cleistes devaricata*		T	
	Green-fly orchid	*Epidendrum conopseum*	U		
	Wild ginger	*Hexastylis arifolia*		T	
	Catesby lily	*Lilium catesbaei*		E	
	Turk's cap lily	*Lilium superbum*		E	
	Southern twayblade	*Listera australis*		T	

Protected Species

			Listed Status		
GROUP	COMMON	SCIENTIFIC NAME	GA	FL	FEDERAL
Plants	Hummingbird flower	*Macranthera flammea*		E	
	Pyramid magnolia	*Magnolia pyramidata*		E	
	Green adders-mouth	*Malaxis unifolia*		E	
	Crabapple	*Malus angustifolia*		T	
	Florida spiney-pod	*Matelea floridana*		E	
	Angelpod	*Matelea gonocarpos*		T	
	Indian cucumber-root	*Medeola virginiana*		E	
	Piedmontwater-milfoil	*Myriophyllum laxum*	T		
	Hairy fever-tree	*Pinckneya bracteata*		T	
	Blueflower butterwort	*Pinguicula caerulea*		T	
	Yellow butterwort	*Pinguicula lutea*		T	
	Yellow fringed orchid	*Platanthera ciliaris*		T	
	Crested fringed orchid	*Platanthera cristata*		T	
	Yellow fringeless orchid	*Platanthera integra*		E	
	Snowy orchid	*Platanthera nivea*		T	
	Rose pogonia	*Pogonia ophioglossoides*		T	
	Giant orchid	*Pteroglossaspis ecristata*		T	
	Meisner tearthumb	*Polygonum meisnerianum*		E	
	Florida mountain mint	*Pycnathemum floridanum*		T	
	Miccosukee gooseberry	*Ribes enchinellum*		E	E
	Alabama azalea	*Rhododendron alabamanse*		E	
	Yellow fly-trap	*Sarracenia flava*	U		
	Hooded pitcher plant	*Sarracenia minor*	U	T	
	Bay starvine	*Schisandra coccinea*		E	
	Chaffseed	*Schwalbea americana*	E	E	E
	Little pearl-twist	*Spirantes tuberosa*		T	
	Silky camellia	*Stewartia malacodendron*	R	E	
	Crane-fly orchid	*Tipularia discolor*		T	
	Florida merrybells	*Uvularia floridanum*		E	
	Rain lily	*Zephyranthes atamasco*		T	
	Treat's zephyr lily	*Zephyranthes treatiae*		T	

R. TODD ENGSTROM

Red-cockaded woodpecker

KEVIN MCGORTY

Flyr's brickell-bush

CHRISTINE AMBROSE

Gopher tortoise

TALL TIMBERS FILE PHOTO

Turk's cap lily

Note: This is a working list and is constantly revised. See following page for listing explanations.

Protected Species Listing Explanations

Federal Legal Status (U. S. Fish & Wildlife Service)

LE = Listed endangered. The most critically threatened species. A species that may become extinct or disappear from a significant part of its range is not immediately protected.

LT = Listed threatened. The next most critical level of threatened species. A species that may become endangered if not protected.

C = Candidate Species for addition to the List of Endangered and Threatened Wildlife and Plants. Taxa for which the USFWS currently has substantial information on hand to support the biological appropriateness of proposing to list the species as endangered or threatened.

PE or PT = Candidate species currently proposed for listing as endangered or threatened.

Laws regarding federally protected species are specific according to species as determined by the U.S. Fish and Wildlife Service and by the Endangered Species Act. Penalties for convictions or violations of these laws range up to $50,000 and/or one year imprisonment for criminal violations against the federal Endangered Species Act.

Georgia Legal Status

E = Listed as endangered. Species is in danger of extinction throughout all or a significant portion of its range.

T = Listed as threatened. Species is likely to become endangered throughout all or a significant part of its range.

R = Listed as rare. Species should be protected because of its scarcity.

U = Listed as unusual. Species exhibits special or unique features and thus deserves special consideration in it continued survival in the state.

Any activities which are intended to harass, capture, kill, or otherwise directly cause death of any protected animal species are prohibited, except as specifically authorized by law. The sale or purchase of any protected animal species or parts thereof is prohibited unless authorized by a scientific collecting, wildlife exhibition, or other permit or license issued by the Department of Natural Resources. The destruction of the habitat of any protected animal species on public lands in prohibited. No person within the state shall cut, dig, pull up or otherwise remove any protected plant species from public land unless such person has secured an appropriate permit from the Department. No person within the state shall sell or offer for sale, for any purpose, any protected plant species, unless such species was grown on private land and is being sold by the landowner. No person within the state shall transport, carry, or otherwise convey any protected plant species from the land of another unless each shipment thereof has affixed a tag supplied by the Department.

Florida Legal Status

E = Listed as endangered. Species is in danger of extinction or extirpation in Florida (although it may still exist elsewhere).

T = Listed as threatened. Species is likely to become endangered in the near future.

SSC = Species of Special Concern. A species that faces a moderate risk of extinction in the near future.

It is unlawful for a person to intentionally kill or wound any fish or wildlife of endangered, threatened, or special concern species as determined by the State of Florida or to intentionally destroy the eggs or nest of any such fish or wildlife, except as provided for in the rules of various state agencies. No person shall pursue, molest, harm, harass, capture, possess, or sell any endangered species or parts thereof or their nests or eggs except as authorized by specific permit. Penalties for convictions of violations of these laws range from a maximum of $500 and/or 60 days imprisonment for first offenses of misdemeanor crimes.

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RAY STANYARD PHOTOGRAPHY

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