Stewardship of Longleaf Pine Forests:
A Guide for Landowners

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Introduction:

This book is written in an easy-to-read format for the private landowner in the deep South, the heart of the range of longleaf pine. Longleaf pine was once part of the single largest forest area dominated by a single tree species in North America, covering as much as 90 million acres. Today, about 4 million acres remain and much of the ecosystem associated with the longleaf forest is in poor condition. The future of longleaf as a viable economic and ecological component of our Southern landscape rests in the hands of private landowners. Well-managed longleaf forests can provide high-value forest products, excellent wildlife habitat for game and nongame wildlife and scenic beauty all on the same property with few or no trade-offs. As you read through these pages, you will get some ideas about how longleaf forests can fit into the landscape on your property. It is my hope that this publication will assist you in becoming a better steward of the longleaf forests you now care for and, where conditions permit, help you restore this forest community on your land. If you are a natural resources professional, use this book as an overview of longleaf silviculture and restoration and consider this species in your management recommendations.

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I dedicate this publication in memory of my grandmother, Susie Malana McCants. She spurred my interest in longleaf pine when I was a child by telling me stories of growing up during the early 1900s in the longleaf piney woods sawmill camps of south Georgia and Alabama. Her descriptions of the nature of the longleaf big woods and the animals that lived there spurred an interest in things dealing with the outdoors and developed within me a lifelong interest in longleaf pine communities.

— Robert M. Franklin

A Word About . . . . . .

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The Longleaf Alliance was founded to promote both the ecological and economic benefits of longleaf pine forests. Goals include: (A) Halting the decline of longleaf pine forests on remaining acreages and (B) Restoring longleaf to areas from which it has been removed –where longleaf meets the landowner's objectives and goals.

The Alliance's membership is comprised of private landowners, natural resource consultants, forest industries, state and federal agencies, conservation groups, researchers, outreach personnel, and other parties interested in promoting a regional recovery of longleaf pine forests.

The Longleaf Alliance serves as a clearinghouse of information, producing and distributing newsletters, brochures, books, fliers, conference proceedings, tapes and DVDs about site preparation, seedling quality, planting, herbaceous release, prescribed fire, and many other aspects of longleaf pine restoration and management.

The Alliance maintains The Longleaf Nursery List, a compilation of nursery locations, pricing, seed sources, and contact information for nurseries that produce container-grown and bare-root longleaf pine seedlings for sale.

With its partners, the Longleaf Alliance hosts and participates in workshops, programs, and conferences across the Southeast, where landowners and natural resource managers are connected with their peers and public and private organizations that have successfully addressed similar challenges or goals. The largest of these meetings are the biennial regional conferences in alternating states across the natural range of longleaf pine. Regional conferences include poster sessions, field trips, demonstrations, and presentations with hundreds of longleaf enthusiasts in attendance.

Stewardship of Longleaf Pine Forests: A Guide for Landowners

The early settlers of the Southeast encountered a virgin forest of longleaf pines that occurred on up to 90 million acres of land on the coastal plain and adjacent areas of the piedmont and mountains. The natural range of longleaf extended from southeastern Virginia to central Florida, westward to east Texas, broken only by the bottomlands of the Mississippi River and other streams. Longleaf's range also extended up into the mountains of northeast Alabama and northwest Georgia. Today, longleaf pines occur on about 4 million acres of land in the region. Longleaf has declined because of land clearing for agriculture and development, fire suppression, timber harvesting without reforestation efforts and the replacement of harvested stands with faster-growing loblolly and slash pine.

Oxen logging.

Longleaf pine forests are unique in many ways. The tree owed its pre-colonial widespread dominance to naturally occurring surface fires that were set by lightning. These fires would burn over thousands of acres of longleaf forests annually. Longleaf's natural fire tolerance allowed it to persist where less tolerant species could not. It has been estimated that fires burned over much of the longleaf woods at least once every 3 to 5 years.

When American Indians arrived in the region they used fire to keep the woods open around their villages, to clear land for farming, and to attract and drive game for hunting. This combination of naturally-occurring and Indian-set fires restricted hardwoods and other less fire-resistant southern pines to stream bottoms and other wet areas that burned less frequently. Because of frequent fire, longleaf forests were open and parklike with an overstory of pine, a very scattered mid-story of suppressed, fire-tolerant hardwoods and an understory of grasses, forbs, and other succulent plants.

William Bartram, a naturalist who traveled in the South during the 1770s, described one extensive stretch of longleaf woodlands as: "A level open, airy pine forest, the stately trees scatteringly planted by nature, arising straight and erect from the green carpet, embellished with various grasses and flowering plants."

Old growth longleaf forest.

These open, savannah-like woodlands may contain over 40 different plant species per square meter. This makes longleaf forests some of the most diverse plant communities in the Western Hemisphere.

The longleaf pine has many desirable characteristics for landowners who want to practice multiple-use management. Longleaf yields a higher proportion of pole and piling material than other southern pines, and it is the most insect, disease, windthrow and fire-resistant pine species in the South. The tree's relatively narrow crown and sparse canopy allows sunlight to reach the ground much longer in the life of the stand than either loblolly or slash pine. In addition, longleaf can be safely burned earlier and more often than other pines. Both of these factors allow early successional conditions to be maintained longer in the understory, benefiting many wildlife species. All these factors make longleaf pine more adaptable to multiple-use management for wildlife, timber, and aesthetics.

Table 1. Chronology of Major Events in the Decline of the Longleaf Pine Ecosystem

1565-1732	Land clearing. Introduction of hogs and other feral livestock into the woods. Small scale naval stores production begins.
1714	Introduction of water-powered sawmills and logging along waterways.
1750	Feral hogs reach saturation density on open range in Virginia and northeastern North Carolina, eliminating longleaf seedling establishment.
1815	First steamboat in the Carolinas with ten in use in South Carolina by 1826. Introduction of steam power marks the beginning of the Industrial Revolution in the South.
1833	Construction of the first railroad in the United States, connecting Charleston and Hamburg, South Carolina.
1834	Massive turpentine operations follow the introduction of the copper still for the distillation of turpentine.
1850	Turpentine production peaks in North Carolina, operations spread south as northern longleaf forests are exhausted.
1860	Feral hogs reach saturation density on open range over much of the range of longleaf pine.
1850-1870	Rapid proliferation of steam technology for logging railroads, steam skidders, and steam-powered sawmills.
1880-1890	Beginning of standardization of railroad track sizes and linking together of isolated railroad lines, making overland transport of lumber feasible.
1870-1920	Era of massive logging powered by steam technology. Most remaining virgin forest in the South logged.
1880-1930	Stock Laws (Fence Laws) passed in most of the range of longleaf pine. In many areas, last major stand regeneration occurs in the years between the end of open range and the beginning of modern fire suppression.
1920-1950	Most of the range of longleaf comes under effective fire suppression. Second growth forest succession replaces savannah and woodland diversity.
1943	U.S. Forest Service gives general approval to the use of fire in managing pine forests.
1940-1990	Conversion of woodlands to pine plantation.
1947	Escambia Experimental Forest in south Alabama established by the U.S. Forest Service on land donated in a long-term lease by T.R. Miller Mill Company of Brewton, Alabama. Much of the early research on longleaf pine silviculture began here.
1962-Present	Tall Timbers Fire Ecology Conferences and numerous other meetings on longleaf pine management. Increasing appreciation of the role of fire in natural ecosystems.
1992	The Joseph W. Jones Ecological Research Center established to study the biology and silviculture of longleaf ecosystems.
1995	The Longleaf Alliance organized.
1995-2005	600 million longleaf seedlings planted, regenerating one million acres.

Adapted from Cecil C. Frost, 1993. Four centuries of changing landscape patterns in the longleaf pine ecosystem. Proceedings of the 18th Tall Timbers Fire Ecology Conference.

Habitat Types

Ecologists have classified coastal plain longleaf forests into four major series along a moisture gradient from dry to wet: xeric, subxeric, mesic, and seasonally wet. These series are further subdivided into twenty-three longleaf communities based on geography and topographic position. Many of these longleaf forests are extremely rare, especially those on soils that are well suited for agriculture. The majority of remaining longleaf forests will usually fall into one of these five categories: Sandhills, Flatwoods, Savannahs, Rolling Mesic Hills and Montane or Mountain.

Sandhills longleaf forests are characterized by deep, well-drained soils. Typical plant species include longleaf pine, turkey oak, bluejack oak, wiregrass, pineywoods dropseed, and wild blueberries. Some of the rare, threatened, and endangered species that may occur in Sandhills longleaf forests are dwarf or false poison sumac, pixie moss, red-cockaded woodpecker (RCW), gopher tortoise, gopher frog, black pine snake and Bachman's sparrow.

Flatwoods longleaf sites on the lower coastal plain are characterized by having soils that are wetter than the Sandhills' soil. Plant species associated with this type include gallberry, saw palmetto, waxmyrtle, wiregrass, and bluestem grasses. Rare, threatened, or endangered species that could inhabit longleaf flatwoods include American chaffseed, white wickey, RCW, and Bachman's sparrow.

Pitcher plants and longleaf seedling on a savannah site.

Savannah sites typically are the wettest sites occupied by longleaf pine, especially along the lower coastal plain adjacent to the coast. They are usually the most open, with more of a woodland-like appearance than that of a forest. Plant species associated with longleaf savannahs include wiregrass and an array of other grasses and sedges, orchids, and insectivorous plants such as pitcher plants and bladderworts. Rare, threatened, and endangered species found in longleaf savannahs include American Chaffseed, Venus flytrap, Canby's dropwort, rough-leaved loosestrife, RCW, and Bachman's sparrow.

Loblolly and shortleaf pine are common associates. In the absence of fire, hardwoods and other pine species will dominate and replace longleaf pine in the overstory.

Both loblolly and shortleaf pine can occur in association with this type. These pines and mixed hardwoods will eventually dominate in the absence of fire. The rolling mesic hills contain some of the most diverse herbaceous layers of all the longleaf pine communities. These understory communities contain an array of legumes, forms, and grasses such as: Indian grasses, bluestems, dropseeds, and species in the genus *Tridens*.

Rare, threatened, and endangered species that may inhabit the rolling mesic hills include the RCW, gopher tortoise (federally protected in Mississippi, Louisiana, and in the Alabama counties west of the Mobile and Tombigbee Rivers), indigo snake, Bachman's sparrow, Alabama grape-fern, American chaffseed, Apalachicola Indiangrass, and pine barrens prairie clover.

Mountain longleaf forests are found in the upper Piedmont and adjacent Appalachian Mountains and Blue Ridge of northeast Alabama and northwest Georgia up to 2,000 feet in elevation. Scattered longleaf can also be found throughout the lower Piedmont of Alabama, the Carolinas and Georgia, especially on the isolated mountains or monadnocks of the region. Longleaf will form pure stands, especially on south and southwest facing

slopes. It is most commonly associated with loblolly, shortleaf and Virginia pines, as well as blackjack, post, red, rock chestnut and white oaks. Historically, it grew in association with American chestnut on many of these sites. Common groundcover plants include bluestem grasses, other perennial herbaceous plants and heaths (blueberries and huckleberries). Rare, threatened and endangered species that may inhabit mountain longleaf forests include the RCW, Bachman's sparrow, moccasin flower (pink lady slipper orchid), and white fringeless orchid. While not endangered or threatened, the region's fox squirrels are certainly unique. Fox squirrels in the mountain longleaf area tend to be reddish like those in the Midwest and have a large body size like the more southern subspecies.

Regeneration

Longleaf's sporadic seed production and extended time in the grass stage caused many landowners to reforest their sites with loblolly or slash pine, which were easier and cheaper to plant. Research has shown, however, that with proper care, handling and planting of seedlings, longleaf pine survival and growth is comparable to other pine species on most sites.

Planting

Landowners who wish to plant longleaf pine have two options — planting bare-root seedlings or containerized seedlings.

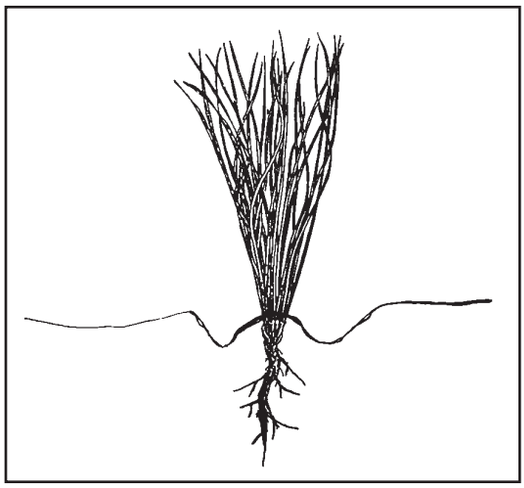
Advantages of planting containerized seedlings are:
(1) Generally higher survival
(2) Lower cost per surviving seedling
(3) Easier to hand plant
(4) Store better and for longer periods than bareroot longleaf seedlings
(5) More widely available in most areas
(6) Containerized seedlings have a longer planting season

Disadvantages of planting containerized longleaf pine are:
(1) Higher cost per seedling
(2) Less tolerant of deep planting than bareroot seedlings
(3) Containerized seedlings are bulky and more difficult to handle and ship

Advantages of planting bareroot seedlings are:
(1) Lower cost per seedling
(2) More tolerant of deep planting than containerized seedlings
(3) May be more available in some areas
(4) Some planters are more familiar with planting bareroot longleaf planting stock

Disadvantages of planting bareroot longleaf pine are:
(1) Frequent lower survival
(2) Do not store as well
(3) Proper planting of long lateral roots and/or taproot slow and complicate planting.
(4) A shorter planting season when compared with containerized seedlings

Planting Containerized Seedlings: Containerized seedlings now comprise more than 85% of longleaf pine seedling production and planting. Container-grown seedlings can be used to extend the planting season or to replant partial regeneration failures in the year in which they occur. Container-grown seedlings typically exhibit higher survival rates than bareroot seedlings, especially with adverse planting conditions such as spring droughts



A machine-planted, bare-root longleaf pine seedling.

When planting containerized longleaf seedlings, keep these factors in mind:

- Minimize competing vegetation for one year after planting. Good site preparation that includes some combination of mechanical, chemical or fire is required. It is much easier to control competition during site preparation than after the seedlings are planted. Given adequate site preparation, a herbaceous release treatment may not be necessary during the first growing season.

- Plant good quality seedlings. Just because the seedlings are containerized doesn't mean they are all good quality. Good quality seedlings have dark green needles, root collar diameters (RCD) of $^{3}/_{8}$ inch or larger, fibrous roots that are light brown in color with numerous white tips and show mycorrhizae (a beneficial root fungus) development.

Containerized longleaf pine seedlings.

- Two tests of quality seedlings are: (1) plugs that remain intact after removal from containers and handling and (2) plugs that remain firm when held horizontally.

- Plant containerized seedlings early. In some parts of the South, container planting stock may be planted as early as September or October, with adequate soil moisture. Some forestry companies try to finish planting their longleaf seedlings by Christmas. Late plantings (February or March) often fail when followed by spring droughts. Seedlings planted early have better developed roots systems, are more drought tolerant, and are better able to handle spring and summer herbaceous competition. In Florida and other areas with high summer precipitation, summer planting may be a viable option.

- Depth of planting is critical. First and foremost, avoid deep-planting. Containerized seedlings need to be planted shallow. In studies conducted by Longleaf Alliance, containerized longleaf seedlings had better survival and early growth when planted with the tops of the plugs exposed, accommodating soil movement on well-prepared sites. Some rules of thumb for various planting situations are:

Proper planting depth for containerized longleaf on:

Cutover sites.

Scalped sites.

Wet sites

Poor quality containerized seedling.

1) Level Sites – Plant with top of plug slightly above the soil surface, about one-fourth to one-half inch.
2) Scalped Sites – The top of the plug should be 1 to 1.5 inches above the soil surface
3) Wet Sites – On wet sites use six-inch plugs and plant them with the top 2 to 3 inches exposed.

Planting Bareroot Seedlings: Longleaf pine seedlings have a stemless "grass stage", similar in appearance to a carrot with a clump of pine needles on top. While in the grass stage, seedlings may grow a huge root system several feet in length. Seedlings remain in the grass stage until the RCD reaches one inch, at which time seedlings begin rapid height growth comparable to loblolly or slash pine. When planting bareroot seedlings, keep these points in mind.

- As with containerized seedlings, minimize competing vegetation near the seedling (at least a 3-foot radius) for the first year after planting. Good site preparation (SP) should include some combination of mechanical SP, chemical SP and/or fire. It is much easier to control competition during site preparation than after the seedlings are planted.

- RCD of bareroot seedlings should be at least 0.4 inches or greater and root systems should have a stout taproot six inches longer with at least six well-developed primary lateral roots.

- A highly fibrous root system, healthy and reddish-brown in color.

- Keep root exposure to an absolute minimum between packaging at the nursery and planting.

- Plant seedlings within two days of pickup from the nursery. Do not put seedlings in cold storage. Keep seedlings out of direct sunlight and as cool as possible without freezing.

- When transporting bundles of seedlings, do not stack the bundles. Seedling survival is improved the shorter the distance the seedlings are transported. Avoid exposing seedlings to rapid air movement when transporting.

- Plant seedlings so the terminal buds will be at ground level or slightly below the settled soil surface 2 to 3 months after planting.

- Bare-root longleaf seedlings may be planted between mid-December and April 1, as long as soil moisture and weather factors are favorable. Planting in the early part of this time frame (December through January)

is better as this allows greater root growth compared to late planted seedlings. Additional root growth allows the seedlings to better tolerate spring droughts. Avoid planting during periods of low soil moisture and dry weather. Also avoid planting during times of low temperature, low relative humidity, and high wind associated with the passage of a strong cold front.

- Control damaging influences such as livestock, brown spot disease, and competition as needed.

- Plant enough seedlings to give 200 to 500 seedlings per acre surviving after one year. Pick a planting spacing that best meets your objectives. Planting for wildlife objectives will usually mean planting at the low end of this range while pine straw objectives may require the high end or greater.

Planting Cutover Sites

Longleaf is easier to establish on previously forested sites as compared to pastures or fields. Cutover sites are typically less fertile and have fewer problems with aggressive weeds, root diseases and root feeding grubs than most agricultural sites.

Planning ahead of time is essential when planting either cutover or agricultural sites with longleaf. First, match the site preparation operation to the site. For most cutover tracts, a chemical site preparation using herbicides followed by fire is a good choice. Chemical site preparation typically does a better job controlling the woody brush competition found on cutover sites. The use of herbicides followed by fire typically causes less soil erosion. Less soil movement through erosion means more consistent and correct planting. Incorrect planting of seedlings is the most frequent cause of planting failures, so the decreased soil movement after chemical site preparation is a major advantage. Chemical site preparation usually keeps more of the native perennial herbaceous community intact. This is important where wildlife and diversity values are high.

Chemical site preparations typically retain more of the native plant community than intensive mechanical site preparations. For example, most native-perennial legumes valued by wildlife are tolerant of two of the most commonly used chemicals, hexazinone (trade names: Velpar L®, DF®, ULW® and Pronone®) and imazapyr (trade names: Arsenal® and Chopper®). Following chemical site preparation, legumes are usually knocked back the growing season after application, but then recover and bloom profusely one to two growing seasons after site preparation. Native warm-season grasses are tolerant to another commonly used chemical, triclopyr (trade names: Garlon 3A® & Garlon 4®).

Match the herbicide to the site. For well-drained, sandy soils with a major oak component, products containing the active ingredient hexazinone are a good choice. On more fertile cutover sites with a hardwood brush component that includes sweetgum and red maple, imazapyr is a good choice. Triclopyr and/or imazapyr (Chopper®) may be needed if the brush component contains waxy-leaved species such as wax myrtle, inkberry, gallberry, yaupon or huckleberry. The point is to match the herbicide with the targeted weed species.

Wait for "brown out" after the chemical site preparation. This may take four to six weeks on many sites. Then, apply a site preparation burn to clean up woody debris and dead vegetation. A good burn will improve access and typically result in a better planting job.

A good site preparation combined with: good quality seedlings, planting early, and planting at the correct depth, will produce high survival rates on most sites.

Planting Agricultural Sites

In recent years, several USDA Farm Bill cost/share programs have emphasized planting longleaf pine on agricultural sites. These fields with their high soil fertility and aggressive weed species can be a challenge to successfully plant. Again, planning is essential. Know what the weed component is on each site and take steps to control the weeds during site preparation. Weed control at this stage is easier than after the seedlings are planted. Included in the appendix are two dichotomous keys: One for site preparation of agricultural fields and another for herbaceous release of planted longleaf on agricultural fields. Consult the keys to find the situation that best meets your site and treat accordingly.

The basic prescription for planting agricultural fields is: (1) Site prepare based on the weeds on the site; (2) Rip or subsoil the site prior to planting. This is needed on most agricultural sites to break through the hardpan that develops on sites that have been under long-term cultivation. Breaking this hardpan is essential to allow deep-rooted seedlings that have better survival and are more resistant to wind-throw in later years; (3) Scalp the rows to be planted. On rolling land, be sure to scalp on contour to avoid soil erosion problems. Do not scalp low spots or flatwoods sites that may hold water for extended periods of time. Do not plant directly over the subsoiled furrow, but offset at least two inches to side of ripped/subsoil furrow; (4) Plant bare-root or containerized seedlings in the scalped row as early in the planting season as practical; (5) Monitor the stand for post-planting herbaceous weed control as needed.

Scalping on old agriculture site.

On most agricultural sites, longleaf seedlings will need some sort of herbaceous weed control the first growing season after planting. In many cases this is usually a one-time, first year application that may dramatically improve early survival and growth. The most commonly applied chemicals for herbaceous weed control over longleaf are hexazinone (trade name: Velpar DF® or L®), imazapyr (trade name: Arsenal®) and sulfometuron (trade name: Oust XP®). Hexazinone and sulfometuron are also premixed and sold as Oustar®. This application can either be banded or broadcast over the entire site.

Subsoiling.

The most common situation for herbaceous weed control is an early season (mid-March to mid-April) application of either (1) Oust®, (2) Oust® and Velpar L® or DF®, or (3) Oustar®. In cases where late germinating weeds such as crabgrass or Texas panicum may be a problem, Oust® is applied in mid-March to mid-April, followed by an application of Arsenal® after mid May. Read current herbicide labels for specific rates.

Before applying soil-active herbicides such as Oust®, check planted seedlings for new root growth. If new-white roots are not in place, delay or avoid application of soil-active herbicides. If the pH is greater than 6.5, do not apply Oust®, Oustar®, or herbicides with the active ingredient sulfometuron, as this can lead to seedling mortality.

Direct Seeding

One option for establishing longleaf regeneration is direct seeding. Direct seeding can be less costly than planting, but is not without problems. Failures may occur from inadequate control of competing vegetation, low seeding rates, using seed not treated with bird or rodent repellent, seeding at the wrong time, or uncooperative weather. If you decide to use direct seeding, here are some tips to follow:

- Pick your sites carefully. Avoid sites that are wet during the late winter and early spring. Newly germinated seedlings are intolerant of standing water. Avoid excessively dry sites and those subject to erosion. The best sites for direct seeding will be soils of medium moisture-holding capacity on gentle slopes.

- Select the best time to plant or sow your seeds. Longleaf germinates naturally just after seed fall during October and November. In most cases, this is the best time to plant or sow longleaf seed. If soils in the area are subject to frost-heaving, seed during late winter.

- Always use the best quality seed that can be purchased from reputable seed dealers. Seeds should come from a known seed or local seed source. Seeds should be treated with bird and rodent repellent.

- Rates for the three main methods of seeding are:
  Broadcast - 3 pounds per acre;
  Row Seeding - $1^{1}/_{2}$ -2 pounds per acre;
  Spot Seeding - $^{3}/_{4}$ of a pound per acre.

Seeds should come in contact with mineral soil. Seeds caught in surface litter, grass, or other debris will germinate, but will not survive because of the exposed root system. Direct seeding is more feasible on large tracts that have been severely disturbed (i.e. mine reclamation sites) and when longleaf seedlings and/or planting crews are not available. The major benefits of direct seeding are speed and cost. The disadvantages are less control over spacing and density and a lengthy grass stage before height growth begins.

Grass-stage longleaf pine seedlings.

Direct seeding is seldom used in regenerating longleaf pine because of the cost and availability of seed. However, it can be a low cost option in years of high seed supplies and in certain situations where extensive areas of disturbed sites need regeneration, as in mine reclamation areas.

Natural Regeneration

For landowners with existing stands of longleaf, natural regeneration is an option to renew their longleaf forests. Advantages and disadvantages include:

Advantages:

- Low establishment costs
- Minimal disturbance to soil and native understory species
- Tree seed is native to site
- Less insect and disease problems
- Minimal labor and equipment needed
- More aesthetically appealing
- Less potential for future wind-throw

Disadvantages:

- Longer rotations typically needed to equal volumes produced in plantations
- Cannot control spacing and initial stocking
- Depends on adequate seed crop and may take several years to obtain adequate stocking
- Prescribed fire or precommercial thinning may be needed to reduce initial stocking
- Value of seed trees may be less due to low volume remaining on site
- Seed trees may be lost to lightning or wind throw
- Requires detailed planning and silvicultural treatments to get the stand and site in proper condition

The Shelterwood Method of Natural Regeneration

For those who wish to use natural regeneration, the shelterwood method has proven successful in regenerating longleaf pine. This method produces an even-aged stand and is low-cost and effective. However, success depends on four conditions: 1) adequate seed supply; 2) receptive seedbed; 3) minimum vegetative competition; and 4) ample soil moisture.

Adequate Seed Supply: Start the development of potential seed trees about ten years before the planned harvest date. Begin by thinning the overstory to 60 to 70 square feet of basal area per acre. Keep the largest, best formed, and most fruitful trees in the residual stand (large crowns and history of cone production). Further reduce stand basal area to 25 to 30 square feet per acre (20 or so 16" DBH trees/acre) with a seed-cut about five years before the final harvest. Monitor cone crops annually in the spring to predict an adequate seed crop. Schedule seedbed preparations such as disking or prescribed burning as needed. The seeds produced by 1,000 or more cones per acre should be adequate to establish a new crop of seedlings. This equates to an average of 34 green cones per tree when checked in the spring before seed fall the following autumn.

Receptive Seedbed: A good percentage of mineral soil must be exposed for seeds to reach the seedbed, germinate, and become well established. A prescribed burn no more than one year before seed fall will usually create a receptive seedbed. A late summer or early fall burn just prior to seed fall may provide a seedbed for two successive crops of seed, however, burning too late will expose seed to excessive predation. Burn early enough to leave time for litter to accumulate to shield the seeds. Mechanical treatments like disking that lightly

scarify the soil surface may be used in lieu of burning. However, these treatments may cost more and damage the seed trees and the groundcover.

Minimum Vegetative Competition: The use of prescribed fire throughout the rotation will prevent excessive encroachment of woody plants in the midstory and understory. However, if competing woody vegetation is present, remove it, preferably before the seed-cut. This may be done by selling and removing merchantable trees, using approved herbicides, prescribed fire, mechanical treatments or combinations of two or more of these operations. Once an average 3,000 to 6,000 longleaf seedlings greater than one year of age are present per acre, the remaining seed trees can be harvested. Generally, once 1,000 to 1,500 seedlings per acre have started height growth and are free from overhead competition, the new stand is considered established.

Newly germinated longleaf seedlings.

Ample Soil Moisture: Removal of competing vegetation is about all that can be done to maximize available soil moisture during the stage from seed germination through the critical first year. The rest is left to chance. After the seed trees have been removed, the stand should be revisited periodically to monitor the presence of brown-spot disease, encroaching competition, and any livestock impacts. Undesirable levels of any one of these conditions should be controlled promptly.

Advantages of using the shelterwood method include: (1) Low cost and (2) The genetic material on site may be the best suited for the area. Disadvantages are the risk factor involved with leaving high-value seed trees on the site for several years as the next crop of seedlings becomes established.

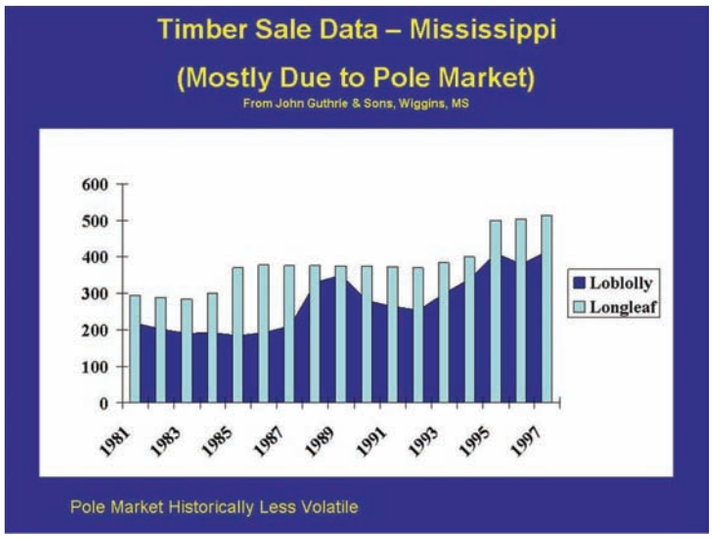
Multiple-Use Management

Longleaf pines can be managed to provide a desirable mix of wood products while providing excellent populations of game and nongame wildlife. A well-managed longleaf forest's open and park-like nature is aesthetically pleasing to many. The open vistas common in longleaf forests are desirable for many outdoor enthusiasts.

Managing for Timber & Pine Straw Production

Longleaf pines can produce quality wood products when grown in a variety of densities. Longleaf pine timberland owners should especially consider growing and marketing poles and pilings. Historically, these products have provided landowners with stumpage prices that range from 30 to 50 percent or more over sawlog prices. Due to the tree's excellent form, longleaf pines can produce a higher percentage of pole and piling material than the other southern pines. Longleaf is the preferred species for poles. Poles and pilings can be produced from well-stocked, even-aged, and uneven-aged stands of longleaf.

On average sites, even-aged stands of longleaf pines can be managed for poles on a 40 to 60 year rotation. Timber thinnings should be frequent and light, concentrating on leaving the best pole candidates and a residual stand basal area averaging 60 to 90 square feet per acre. Pole and piling material is best grown in denser stands in order to reduce the taper of the tree trunks. Growing straight stems with minimal taper is the key to growing quality poles and pilings.



Longleaf pine vs. loblolly pine timber sale comparison.

Another forest product which can be produced concurrently with poles and pilings is pine straw. Highest pine straw yields consistently come from well-stocked longleaf pine stands with little or no understory and midstory development. Straw can be initially raked in longleaf plantations between ages 8 and 12 and afterwards every other year until ages 20-30. (Straw production peaks in planted stands at age 20, and at age 25 in natural stands). Exceptional stands could possibly be raked at younger ages.

Longleaf straw is in high demand as a landscaping material. Retail prices can average from around $3.00 to $7.50 per bale. Landowners typically receive an average of anywhere from $0.35 to $3.00 per bale. The variation in price is due to the method of sale. Most straw is sold either on a negotiated per bale basis or on a competitive sealed bid, lump sum by area raked. The amount of work landowners put into their pine straw businesses directly influences the price they receive. Landowners who rake very clean straw and deliver it to retail stores typically get better prices than those who lease their pine straw raking rights. Long-term pine straw leases usually receive more for the straw than short-term or annual leases.

Actual straw yields will depend on the age and stocking of the pine stand. Annual yields of up to 200 bales per acre are possible. One study in Georgia indicated that in natural stands of longleaf, commercial straw harvest averaged 87 bales and 1,633 pounds of straw per acre. Yields from plantations of longleaf pine should be greater.

If pine straw production is an objective, it should be carefully planned. If care is not taken in monitoring both pine needle and soil nutrient levels when raking straw, it is possible to mine the forest's fertility. Fertility levels can be monitored by periodic soil testing and pine needle nutrient analysis. Nutrient loss can be offset by periodic fertilization based on test results. Take care to avoid over-fertilization. Longleaf pine does not respond to fertilization in the same manner as loblolly pine. Too much fertilizer will make the trees more susceptible to insect and disease problems (see Pests section).

Keeping brush from encroaching into stands managed for straw is a challenge. Fully stocked stands will shade the understory and reduce brush encroachment. Periodic use of selective herbicides is common, but may be expensive. Mowing and prescribed fire can be used, especially before September. Since most needle-fall occurs between September and December, a cool prescribed burn before September followed by harvesting the fresh needles immediately after needle-fall could be the most economical way to control brush.

Also, there is concern that intensive straw management in natural stands of longleaf pine could severely impact the habitat of some rare and threatened plants and animals found only in longleaf pine woodlands and degrade associated wildlife values. Because of this, it is suggested that longleaf plantations be established on old field/marginal croplands with gentle slopes. Advantages to these sites include high residual fertility and little or no competing woody vegetation. In addition, the plantation can be laid out to facilitate mechanized straw raking. In stands with native groundcover, straw can be carefully raked. Some producers use

pitch forks to carefully remove straw from native groundcover. This can be time consuming, but the producers who use this method have productive operations.

Risks

Longleaf pine is relatively insect and disease resistant. The southern pine beetle can attack healthy stands of longleaf if populations reach epidemic proportions, but as a rule, longleaf pine is more resistant to their attack than other pine species. As with the other southern pines, prevention is the best control method. Good timber management using periodic thinnings to remove weaker trees and give the remaining stems room to grow is the best way to reduce losses from this insect.

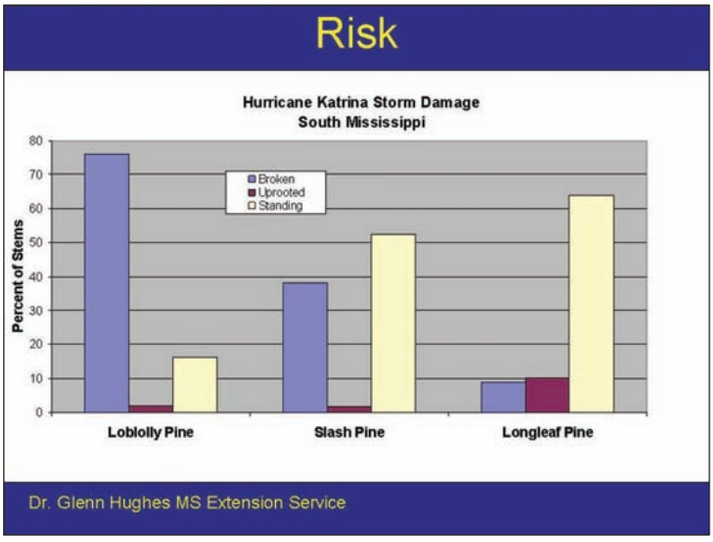
Ips engraver beetles may be a problem at times, but these insects typically attack trees under extreme stress such as trees hit by lightning. Black turpentine beetles also are attracted to stressed trees such as those damaged in logging or a hot fire. Controlling logging damage is the best way to reduce problems with black turpentine beetles.

Seedling infected with brown-spot needle blight of longleaf pine.

Brown-spot needle-blight is a fungal disease that primarily affects longleaf seedlings while they are still in the grass-stage. This disease is more common in the western portion of longleaf's natural range, especially from south-Georgia westward. To minimize risk, control herbaceous competition so that seedlings rapidly exit the grass stage.

The only control option for brownspot needle blight is the use of prescribed fire to remove the diseased needles.

In the western portion of longleaf's range, it is important to monitor plantings and natural regeneration for brown-spot needle blight. Before using prescribed fire, systematically survey the stand. If 20% or more of the cumulative needles on the best seedlings per acre are infected, a burn is needed. If the burn is delayed and 40% or more of the needle surface is infected, seedling mortality from the prescribed burn will often exceed survival.



Storm damage comparison of loblolly pine, longleaf pine and slash pine.

Fusiform rust, annosus root rot, and pitch canker sometimes infect longleaf pine, but longleaf is still more resistant than the other southern pines.

There is concern, however that longleaf pine on high-fertility, old-field sites will have greater problems with insects and disease. Longleaf seedlings and trees are more susceptible to pitch canker on nutrient-rich sites, especially those adjacent to chicken houses, fertilized with chicken manure or with high rates of commercial fertilizer. Some minor insect species such as red-headed pine sawfly and pine colaspis beetles can cause damage and growth reduction to young longleaf, but seldom cause mortality or merit control measures. Both

insects feed on needles and are attracted to the succulent, high-nutrient foliage of longleaf grown under intensive management and high soil fertility.

Longleaf pine is the most fire-resistant of all the southern pines. This species evolved over time in association with periodic, naturally occurring, mild-surface fires. It is not, however, "fire proof." From a risk management perspective, longleaf is a better choice for areas at increased risk for wildfire.

Since most of the range of longleaf pine lies within one-hundred miles of the coast, there is increased risk of wind damage from hurricanes. The entire range of longleaf is subject to thunderstorms and tornados. But, compared to the other Southern pines, longleaf is much more resistant to wind damage. Studies after Hurricane's Hugo in South Carolina (1989) and Katrina in Mississippi (2005) found longleaf to be more resistant to both windthrow (uprooting) and breakage than either loblolly or slash pine.

Managing for Game and Timber

Most landowners with longleaf pine are interested in some combination of game and timber management. Longleaf forests managed as even or uneven-aged stands on rotations ranging from 40 to 100 years or more offer excellent opportunities to accommodate both objectives.

Stand Size: When managing longleaf forests in even-aged units for wildlife, stand size is critical. Forests should be composed of a variety of different aged stands. While it may not be practical to have a stand of timber for each year in the rotation, stands can be managed in age classes varying by 3, 5, 8 or 10 or more years. When using natural regeneration, age classes will be dependent on the frequency of seed crops. In some areas of the South, there may be as many as 20 years or more between seed crops adequate to naturally regenerate even-aged stands.

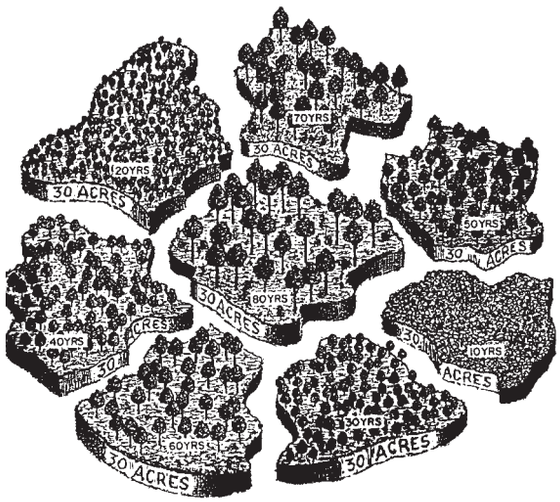
As an example of this style of management, 240 acres of planted longleaf forest grown on a 60-year rotation can be divided up into 12 age classes at 5 year intervals with each age class being approximately 20 acres. An array of other size and age combinations is possible. This is called "all-aged management in even-aged units" and is one of the simplest and best ways to accommodate wildlife values in timber management.

Table 2. All-aged Management in Even-aged Units
240-acre Tract: An Example

Forest Age-class	Acres	Percent
Young growth	60 acres	25%
Intermediate growth	60 acres	25%
Mature growth	120 acres	50%

Illustration of how even-aged pine and hardwood stands can be arranged and age classes distributed to benefit wildlife without significant loss in timber growth and yield.

Timber stand size should be kept as small as practical, but not so small that timber harvests become uneconomical. This size limit



All-aged management in even-aged units.

will generally depend on the local timber market and harvesting systems that are being used in the area. Stands should be irregularly shaped in order to provide more edge for wildlife. Edges are transition zones where two different vegetation types meet. Edges can provide richer habitat for some wildlife species such as white-tailed deer, bobwhite quail, rabbits, and wild turkey than unbroken areas of one habitat type. Keeping streamside management zones (SMZ's) as wide as practical along streams (300 feet on each side, if possible) and leaving small pockets of mast-bearing oaks, persimmons, hickories, and other hardwoods in upland areas are other ways of improving edge.

Timber Thinnings: In longleaf forests with multiple objectives that include timber and wildlife, thinnings should be frequent, at least every 6 to 10 years. One rule of thumb for stands less than 100 years of age where sawtimber is a primary objective is to thin leaving a residual basal area equal to the site index (base age 50) plus the age, minus 40. As an example, a 35 year old stand with a site index of 80 would be thinned to leave a residual basal area of 75 (80+35-40) square feet per acre. Another rule of thumb when managing for sawtimber is to thin to a residual basal area equal to the 50 year site index of the stand.

When adding wildlife objectives, landowners have the option of further reducing basal areas. In general, thinnings for wildlife should occur every 6 to 10 years as practical. Thinnings should favor the very best crop trees and leave residual basal areas in the range of 40 to 80 square feet per acre. This rule of thumb holds true for both even-aged and uneven-aged management. If bobwhite quail management is an important objective, residual basal areas should be in the low end of this range. Deer and turkey will do well at the higher end of this scale.

Uneven-aged Management: The whole purpose of small, even-aged timber stands with irregular boundaries and interspersed age classes is to accommodate various species of wildlife and to improve aesthetics. Another way of accommodating multiple-resource values is by practicing uneven-aged management.

With uneven-aged management, forests are not segregated into even-aged stands of trees. Each unit of forest land will typically have many young, some middle-aged, and a scattering of mature and old trees growing together. Many landowners who do not like the appearance of a final harvest cut will like the concept of uneven-aged management.

Because of longleaf pine's excellent fire-tolerance, the tree is suited for this style of management. Areas with mixtures of older trees and seedlings can be burned with care if the landowner is willing to accept some seedling mortality.

In practicing uneven-aged management managers must have some way of regulating timber harvest to growth while encouraging reproduction. There are several methods of doing this. At the simplest level managers need to know the volume of timber present and the per acre growth rate. Timber harvest removes a certain percentage of the annual growth on a periodic cutting cycle. Individual trees or small groups of trees are typically removed during the periodic harvests. For example, a landowner may decide to harvest 75% of the annual growth on a 10 year cutting cycle. If that is the case, the landowner will have a greater volume in residual timber after harvest than at the start of the cycle.

Two methods often used when practicing uneven-aged management in longleaf pine forests are the Stoddard-Neel method and the "basal area-maximum dbh-q" (BDq) method developed by the U.S. Forest Service.

The Stoddard-Neel (S-N) method of uneven-aged management is a philosophy similar to the German Dauerwald system. Stoddard-Neel was developed in the Red Hills region of southwest Georgia and adjacent northwest Florida by the late Herbert Stoddard and is

implemented today by his associate, Leon Neel. With S-N, longleaf stands are managed by single tree selection, with an emphasis on retaining high quality older trees. Typically, on lands managed by the S-N system up to 90% of the annual growth can be cut on a periodic cutting cycle. Gaps are created in the stand to facilitate natural regeneration. Each tree in the forest is evaluated on its form, age, vigor and quality. Trees to be removed during the cutting cycle are usually poorer in quality in terms of form or vigor. Periodic harvests usually remove or thin the lower canopy. Actual implementation of this method is entirely dependent on the individual stand and forest characteristics. There is no "cookbook recipe." Consequently, it can be challenging for a manager to implement this system due to its subjectivity.

In the BDq method, the timber stand is inventoried and a 'before-cut" stand table is developed. Based on this table, an after-cut target structure is set by the stand basal area (B), maximum dbh of the trees to be left (D) and the fixed ratio of the numbers of trees in succeeding diameter classes (q).

A typical BDq prescription would be to leave 50 sq. ft. of merchantable basal area, assume a maximum dbh of 20 inches and use a 1-inch "q" of 1.2.

When marking timber using BDq, the poorer trees with respect to form, vigor, and position in the canopy are cut and the better trees are left. Regeneration is encouraged by enlarging existing groups of reproduction in openings by harvesting the border trees if they have seedlings growing underneath and/or by cutting trees above the maximum dbh if they need to be cut and have seedlings underneath. Remaining trees that make up the allowable cut are taken on an individual basis throughout the stand.

Essentially, uneven-aged management of longleaf pine means harvesting timber with light thinnings and creating gaps for regeneration on a periodic cutting cycle. Trees selected for harvest are selected and marked on an individual or small group basis. Decisions on which trees to cut and which ones to leave require the land manager to look at each tree in the stand, its relative position, dominance, health, and rate of growth and compare it to the landowner's objectives; i.e., what he/she wants out of their forest.

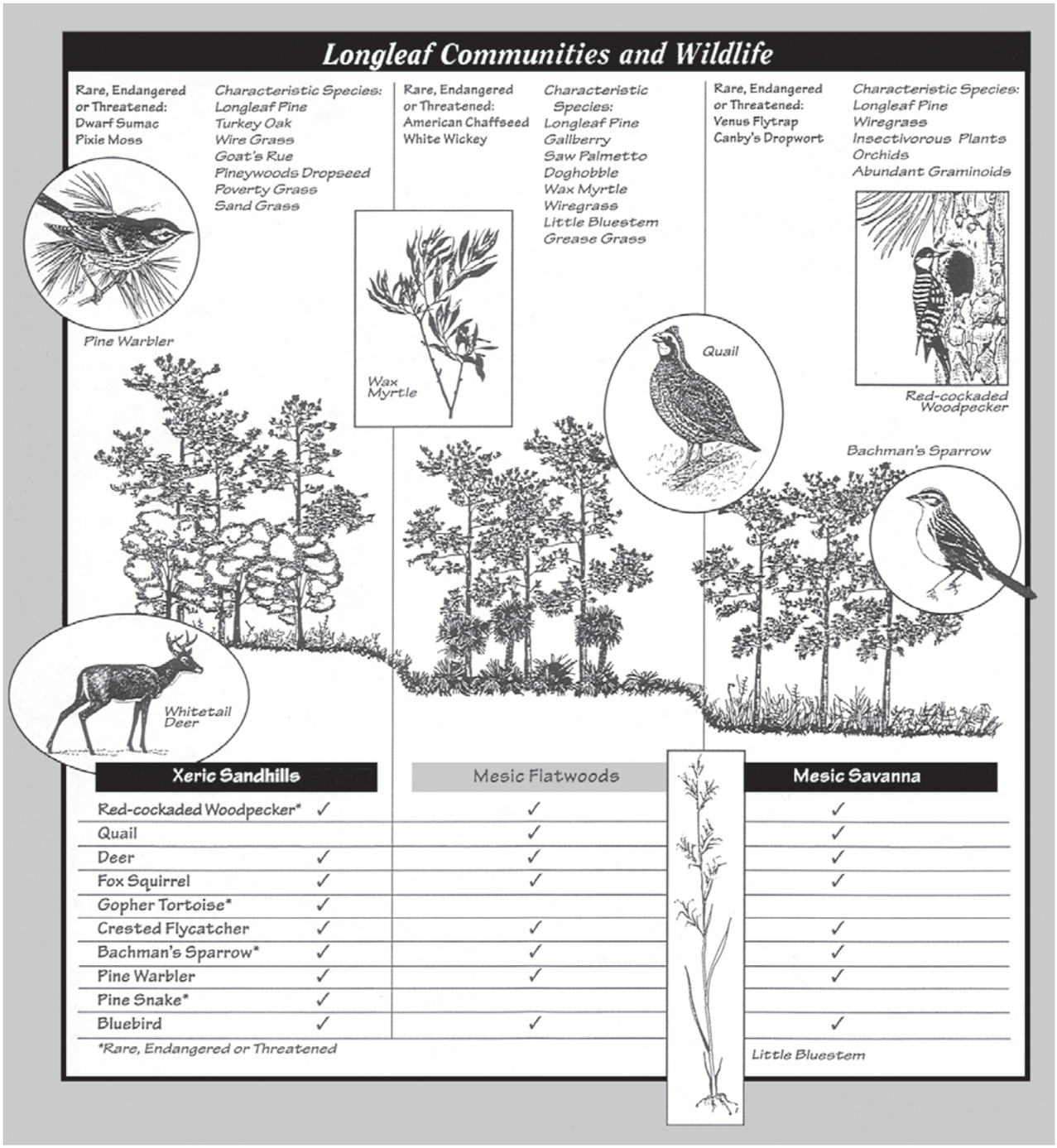
Typically, around 20% of the stems are marked for harvest during each cutting cycle. Regeneration is encouraged in openings made by timber harvesting, and the burning schedule is adjusted to allow the young seedlings time to become fire resistant.

One unique characteristic of longleaf seedlings in openings larger than one-quarter to one-third of an acre is that mild surface fires tend to die out in these patches, allowing seedlings time to reach fire-resistant size. This is one reason you almost always see some scattered longleaf reproduction in annually burned longleaf woods managed for bobwhite quail. On the other hand, if the openings are too large, it is difficult to control competing hardwoods near the centers of the openings with fire, resulting in the establishment of clumps of oaks or other woody competitors.

When it appears that a bumper-crop of longleaf seed will be produced, a growing-season prescribed fire will prepare a good seedbed in longleaf woods accustomed to periodic fire. Next, interrupt the burning cycle in this area for two years or more, giving the seedlings time to become established.

Over the next several cutting cycles, longleaf regeneration is released so it can grow and become part of the continuous stand. By using light periodic harvests that concentrate on leaving the best trees and encourage longleaf regeneration, uneven-aged management can maintain a forest indefinitely.

Table 3. Longleaf Communities and Wildlife



	Xeric Sandhills	Mesic Flatwoods	Mesic Savanna
Red-cockaded Woodpecker*	✓	✓	✓
Quail		✓	✓
Deer	✓	✓	✓
Fox Squirrel	✓	✓	✓
Gopher Tortoise*	✓		
Crested Flycatcher	✓	✓	✓
Bachman's Sparrow*	✓	✓	✓
Pine Warbler	✓	✓	✓
Pine Snake*	✓		
Bluebird	✓	✓	✓

*Rare, Endangered or Threatened

Management in this manner produces a patchy longleaf forest with groves of older trees, interspersed with groups of younger saplings, middle-aged clumps and areas of reproduction. This produces a great deal of diversity on a small scale benefiting many species of wildlife.

It is worth noting that there are trade-offs when practicing uneven-aged management. First, uneven-aged management requires more attention to detail. If care is not taken in planning the harvest, this style of management can quickly "high-grade" the forest. High-grading is a term used to describe a timber harvest where only the best quality trees are harvested. Over time, the average quality of the remaining trees is reduced. Second, studies

have shown that where timber objectives are important, uneven-aged management will likely result in significantly lower volume growth than even-aged stands on the same site with the same residual basal area.

A third disadvantage with uneven-aged management is more frequent entries into the stand for timber harvesting. Logging impacts occur more often and are spread throughout the stand and could increase damage to the residual timber and/or cause reductions of site quality over time.

The major benefit of uneven-aged management for timber production is that when in place, the landowner will have the opportunity to harvest higher-valued forest products such as poles and pilings every cutting cycle. For contrast, even-aged management may require thirty years or longer to produce higher-valued products such as sawtimber and poles.

Nongame species that benefit from uneven-aged management and all-aged management in even-aged units include, bluebirds, ground doves, native sparrows, towhees, woodpeckers, and numerous reptiles and amphibians.

Converting Planted Loblolly Pine (or Slash Pine) to Longleaf Pine: An Opportunity

Many private forest landowners in the South are interested in restoring native longleaf pine forests because of the higher wildlife, recreational and aesthetic values associated with longleaf compared to other southern pine species. The appeal of the open, park-like longleaf woodlands typical of lands managed for bobwhite quail is strong for many landowners. In addition, longleaf has: greater insect, disease and fire resistance; and longleaf yields higher forest product values compared to other pines.

Yet many landowners feel they will lose wildlife habitat and income opportunities for 20 years or more if they clearcut existing loblolly or slash stands and replant with longleaf.

That doesn't have to be the case! There is a simple strategy where landowners can, over time, transition their even-aged loblolly (or slash) pine stands to uneven-aged longleaf while maintaining habitat values and periodic income through the sale of timber. This management system assumes that the landowner is interested in multiple resource management and not maximizing one resource over the other. Recent surveys of Southern forest family owners show that enjoyment, recreation and land appreciation tend to be of greater importance than maximizing timber income. Transitioning timber stands to longleaf can meet the needs of landowners with multiple objectives and conservation interests, while providing solid cash flow from timber management. Modifications of this approach are also described for those with more conservation-oriented interests.

A Basic Example:

The site is a 15 year old 50-acre loblolly pine plantation on a typical Coastal Plain site. The stand was planted with 726 trees per acre after an herbicide application and a site preparation burn. Prescribed fires to reduce fuels and control hardwood sprouts were applied to the plantation at ages 12 and 14 respectively.

The transition begins with the first thinning which in this case is when the loblolly plantation is 15 years old. Existing openings and patch cuts on 20% of the 50 acres (ten acres) create openings ranging from $^1/_4$ acre up to $^2/_3$ acre in size, with the average size being $^1/_2$ acre. Existing openings are enlarged as needed to create the desired patch size.

In the remainder of the loblolly stand, 40% of the volume is selectively thinned and removed. The stocking should be varied to create a "thick and thin" pattern, leaving variable stocking in the residual stand. Another way of achieving this is to set a target residual basal area of 60 square feet per acre with a range of 50 to 75 square feet of basal area per acre across the stand.

In the open patches, after chemical site preparation and as early in the planting season as practical, plant containerized longleaf seedlings at 622 trees per acre (7'X10' spacing). Use prescribed burning on a two-year rotation in the entire plantation to control competing vegetation.

Repeat the thinning process with the same prescription every ten years until all the loblolly is removed and replaced with longleaf. This will carry the last of the loblolly to age 55. At this time the longleaf stand will have trees from one to forty years old.

As the longleaf becomes merchantable, selectively harvest two-thirds of the previous ten-years growth.

Conservation Alternatives:

Other management variations that increase conservation and aesthetic values should be considered. For instance, increasing the frequency of prescribed fire to an annual or biennial basis will generally reduce the number and prevalence of hardwoods in the midstory. Although more frequent fire increases costs, a richer, more attractive herbaceous understory should replace the woody midstory, yielding a more open, park-like stand.

In addition to burning frequency, the timing of the start of longleaf regeneration, and the rate and manner of regeneration can be varied. Most loblolly or slash pine plantations have gone through a significant period of fire suppression while they became established (typically 10 -15 years if they were ever burned). That often allows hardwoods to become established in the understory that will respond to overstory release. A South Georgia land manager, Leon Neel, would often quote Herbert Stoddard, the father of modern day quail management, as saying that to restore land to a frequently burned condition takes the amount of time that the land was removed from frequent fire. Therefore, burning a 15 year-old plantation for 10-15 years before starting the conversion process is not out of the question. This allows time to be factored into the conversion process. A second alternative that would increase the value of time would be to convert at a much slower pace, about 10% at a time, taking advantage of any open patches that result from beetles, wind, or other natural sources of mortality. When a 15 year old stand is periodically thinned until age 35-45, and then 10% is regenerated to longleaf pine every 10 years, the oldest trees being retained will be 135 years old. Some might argue that loblolly or slash are not likely to endure that length of time. However, with thinning practices that continue to increase the vigor of the stand by removing disease infected trees, forked trees, or those of low crown vigor will increase the health of the stand through time and extending the life of the residuals. In addition, thinning and burning the stand regularly to maintain open stand savanna grassland structure reduces the likelihood of beetle infestation.

Size and shape of regeneration areas can be varied considerably. While regeneration gaps $^{1}/_{4}$ to $^{2}/_{3}$ acre in size are sufficient, openings of any size caused by wind, insects, disease, fire or other causes should be taken advantage of in regeneration. Natural gaps often have scattered mature trees. The needle drop from these trees will provide fuels that will help carry fire across the stand. Clean gaps are not required if slower growth of regeneration can be tolerated. In addition, openings in the canopy that allow longleaf to be established

and to survive repeated burning can be considerably smaller than those that allow for establishment and growth. Thinking of regeneration as a process, planting could occur five or more years in advance of a release operation. This allows seedlings to become firmly established on the site and to respond quickly to release.

On some sites it is possible to shorten the time frame for the conversion process. Using the basic plantation as an example, the same prescription would be applied every five years. At the completion of the conversion, the oldest residual trees would be 35 years old and the oldest longleaf would be 20 years old. While this would shorten the time frame for the conversion it would create a brief interruption in timber income until the trees became older.

Hardwood Control:

Regardless of the practice selected hardwoods must be controlled. Hardwood control should be accomplished primarily through repeated, frequent burning. Limiting opening sizes will ensure pine needle fuels are present to sustain frequent fires, and hardwoods are not released from competition with the overstory. However, sometimes burning alone does not achieve the desired results. Mowing above the height of the longleaf seedlings in combination with frequent burning increases fine fuels like grasses. Herbicides can effectively control hardwoods, but the application may have unintended consequences on understory plants. Herbicides are most useful on sites on where hardwood dominance is difficult to control with fire alone and in places where the understory community has been reduced in diversity due to past land use such as intensive agricultural practices. By using herbicides in these cases, frequent fire can be established and the restorative influences of fire can act over time. The selection of herbicides and timing of application are critical to minimize their impact on existing understory communities.

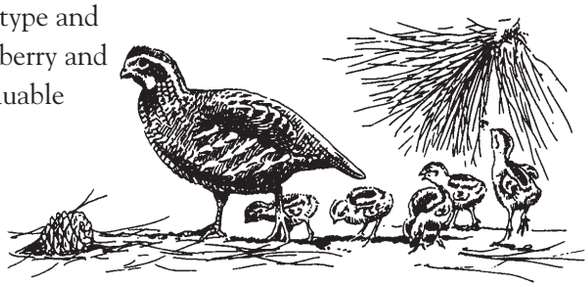
This slow conversion approach is likely to result in considerable natural regeneration opportunities in the latter stages of pine conversion. During years of superior cone production, even scattered, mature longleaf pine can naturally regenerate gaps and/or stands, if the seed-bed is properly prepared. To the extent possible these opportunities should be incorporated into the conversion process. Artificial regeneration through direct seeding longleaf has often been a challenge due to the high levels of seed predation, but at least one project in the sand hills of Florida is experimenting with that approach, and landowners may wish to look into that alternative.

This strategy for converting existing loblolly or slash plantations to longleaf is not for everyone. However, if you are a landowner interested in restoring longleaf to the landscape on your property, this approach should be considered. It will maintain wildlife habitat values, increase recreational value and provide for periodic timber income during the conversion process.

Prescribed Burning

Prescribed fire is an indispensable tool used to accomplish many vegetation management goals in longleaf forests. Longleaf pine is a part of a fire-adapted plant community and tolerates fire much better than other southern pines. It is resistant to fire throughout most of its life cycle. Longleaf may be burned hotter and/or later in the growing season than other pines. These characteristics make fire a very flexible tool in the hands of land managers. Through the careful use of prescribed fire, plant communities in the longleaf forest can be set at desired successional stages to favor selected wildlife species.

Winter or dormant season burns every two or three years are the norm in many forest management plans and provide a compromise for managing most southern game species. This type of fire top-kills woody brush, especially if backing fires or strip-headfires are used. Dormant season burns also stimulate sprouting to provide readily available nutritious and succulent browse for white-tailed deer. Fires of this type and frequency also allow fruit-producing shrubs such as blueberry and huckleberry time to provide good quantities of these valuable wildlife foods between burns.



Prescribed fire later in the dormant season has the advantage of a shorter black period and quicker green-up in the spring. If adequate sunlight filters through the tree canopy, herbaceous growth should result. Legumes, grasses, and other forbs will produce valuable seeds and habitat for insect populations that are important foods in the early lives of turkey poults and quail chicks.

Annual winter fires, as practiced to improve quail habitat, may actually reduce nesting and brood-rearing cover to the point that increased losses from predation outweigh positive effects of the fire regime. Ring-arounds are frequently used to provide cover and can be effective if they are large enough in size. These areas are excluded from burning for several years to provide needed cover. Ring-arounds should be irregularly shaped and greater than one to two acres in size. Smaller areas tend to concentrate quail nests and may attract predators.

Current research suggests that quail will benefit from large unburned blocks of patchy cover rather than depending on smaller ring-arounds. This may mean distributing fire in irregularly shaped blocks and leaving up to half the ground cover unburned in a given year.

Growing season (spring or early summer) burns can eliminate much of the smaller woody vegetation leaving an understory of grasses and forbs and favoring those wildlife species that prefer small seeds, grasses, insects and open spaces. However, growing season burns may decrease fruit-producing shrubs as well as permanent cover. Ground and shrub nesting birds such as quail, wild turkey, chats, towhees, etc. may be adversely affected by late spring and growing season burns, but if burned areas are kept reasonably small in size (25 to 75 acres) and a patchwork of burned and unburned areas is maintained, there should be adequate renesting to offset potential losses. A combination of dormant and growing season prescribed burning might be best for the widest variety of wildlife species.

Growing season prescribed fire.

Many longleaf forests consist of a series of sandy ridges cut by small drains or stringers containing bays and other hardwood wetlands. These stringers can make useful firebreaks. Firelines should not be plowed around these areas to exclude fire. The abrupt edge created by the fireline is unnatural and excludes many of the transitional-zone plants and accompanying wildlife habitat from the forest. If firelines must be placed around these areas, they should be put in by lightly disking, mowing, or using temporary "wet lines" to create a fire barrier. Fire intensity in these transitional areas can be further controlled by starting the fire in these locations.

Game species that thrive in longleaf forests include white-tailed deer, wild turkey, bobwhite quail, cotton-tailed rabbit, and fox squirrels. The open nature of a managed longleaf forest with its intermingling of drains to provide travel corridors, water, escape and resting cover are favored especially by quail, turkeys, and fox squirrels. These species are visually oriented, requiring open conditions with a clear view of their surroundings.

Some of the favorite foods of these species are found in longleaf forests. Soft masts like blueberries, dogwood berries, and persimmon all occur regularly. Hard mast species such as post oak, water oak, blackjack oak, turkey oak, live oak, dwarf live oak, runner oak, southern red oak, and hickory provide valuable food during the fall and early winter. The hard coated seeds of many legumes such as lespedeza, partridge pea, beggar lice, and others survive fires very well and are scarified by fire, improving germination. Ragweed, an important quail food, often reestablishes quickly after fires in open stands.

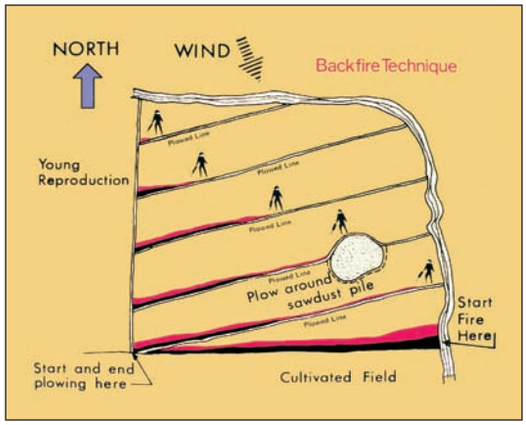


Diagram of back-firing technique.


Back-firing technique.

Burning Young Longleaf: Longleaf pine is the most fire tolerant of all the southern pines. Seedling longleaf may be burned as early as one growing season after germination or planting of seedlings, depending on fuel accumulations and management objectives. Longleaf is at its most fire-susceptible when it first germinates from seed and again when it emerges from the grass stage until it reaches about six feet in height. However an experienced prescribed burner can successfully burn longleaf under six feet in height by selecting the best time of year and weather conditions.

In longleaf plantings adjacent to loblolly pine seed sources, invasive loblolly seedlings will overtop grass stage and small longleaf. Prescribed fire is the only effective method to control the loblolly. Prescribed fire is used in young longleaf to control brownspot needle blight. Fire can also be used to reduce hazardous fuels, improve wildlife habitat, restore the ecosystem and livestock grazing values, just as in older stands. With longleaf pine planted at wider spacings and on agricultural fields, periodic burning is used to help prune the lower branches and improve future stem quality. Young longleaf stands are fire tolerant, not "fire-proof." Care should be taken when using fire at this stage. Prescribed fire should be carefully used to meet specific management objectives when burning young longleaf.

The same caution should be exercised when burning older stands of longleaf that have been fire suppressed for a number of years. The sudden reintroduction of fire into these older stands will cause significant mortality of older trees. In fire-suppressed stands, a litter layer of pine needles, hardwood leaves and herbaceous vegetation builds up over time. The litter layer undergoes decomposition and turns into humus. Over time, pine feeder roots grow into the humus layer to take advantage of the rich organic soil. If prescribed fire isn't carefully reintroduced into these stands, burning may destroy the entire litter layer and humus, killing the pine roots. This is especially true with smoldering fires. If smoldering occurs around the tree trunks, fire intensity doesn't have to be very high to cause mortality. The damage won't

appear to be drastic, but mortality will occur within two or three years after the initial burn. When reintroducing fire into these stands, do it gradually, under cooler, moist conditions to skim off the litter layer in several burns over several years. This reduces the potential for smoldering and forces the feeder roots to grow back into the mineral soil, decreasing the likelihood of fire induced mortality. The lesson is, in fire-suppressed stands, fire should be reintroduced gradually so that fuel loads are carefully reduced and pine mortality is lessened.

Food Plots: Food plantings for wildlife can be an important element in wildlife management in longleaf forests. One problem with establishing food plots in longleaf pine forests is the typically infertile nature of coastal plain soils. The shallow, eroded and rocky soils of most Piedmont and mountain longleaf sites may be problematic as well. Most longleaf grows on well-drained, nutrient-poor, coastal plain soils. Most of these soils are too dry to successfully and consistently grow most of the popular wildlife food plantings. The best areas for food plot establishment will be soils in transition zones between uplands and wetter areas, and even then, success is not guaranteed.

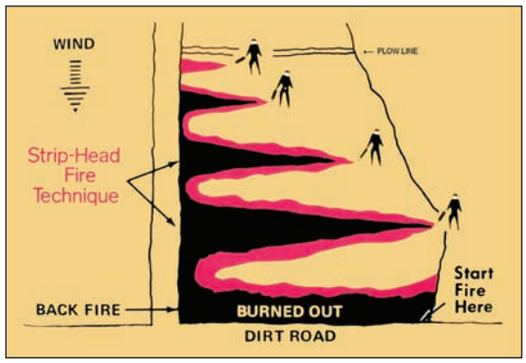


Diagram of strip-head firing.

When establishing food plots for game species, use the following guidelines:

- For bobwhite quail in woodlands, provide one opening up to one acre in size for each 15 to 20 acres. Food plots one-tenth to one-third of an acre in size can be planted in the openings. Openings should be long and narrow to maximize edge. Plots should be planted with both a fall and winter food plant.
- Rabbits will benefit from quail plantings, especially if brush piles are developed adjacent to food plots. Brush piles should be no further than 300 feet from other cover. Rabbit food plots should be one-tenth to one-third of an acre in size and long and narrow to maximize edge. One food patch per 5 acres will improve rabbit habitat or "rabbitat."
- White-tailed deer and wild turkeys will benefit from irregularly-shaped food plots from 1-3 acres in size. Plant at least one plot per 100 acres of forest land up to about 5% of your woodland acreage. Planting more than 5% is usually too expensive.

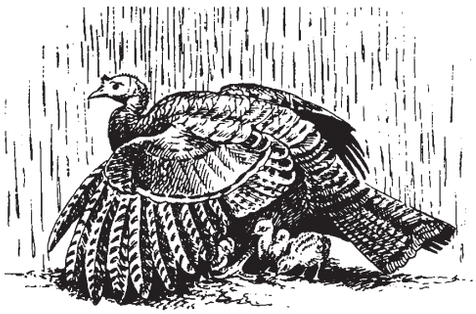

Strip-headfiring technique.

One wildlife planting ideally suited for longleaf lands is chufas. The tubers are favorites of turkeys. Quail, rabbits and squirrels eat them readily if turkeys scratch them up.

Raccoons and feral hogs can be pests on chufa patches. In areas of high raccoon populations, chufas should be planted by broadcasting to make it more difficult for the raccoons to locate and feed on them. Hogs can devastate chufa patches. The best remedy for this problem is to exclude hogs from areas where chufas are planted.

Food plots are an important, attractive, and visible way of improving wildlife habitat and attracting animals. However, don't forget the importance of managing native vegetation. Timber harvesting by selective thinning in conjunction with periodic prescribed burning

may do an excellent job of stimulating desirable native vegetation. In addition, randomized disking, done at different seasons periodically throughout the woods may further stimulate the growth of many desirable native wildlife plants.



Finally, there is much emphasis on restoring native groundcover in longleaf forests, as well as protecting what is left. When developing food plots in longleaf stands, it is suggested that those plots be permanently located and managed accordingly to minimize impact on areas of intact native groundcover. Such areas don't recover well after soil disturbance and food plots in native groundcover may do more harm than good. In addition, care should be taken in selecting species to plant. Some of our commonly used plantings, i.e. Asian Lespedeza and bahiagrass, are invasive. Select species that don't aggressively spread or favor native plants.

Aesthetics

Longleaf forests that are managed by frequent use of prescribed fire and kept open through frequent thinnings are aesthetically pleasing to many outdoor enthusiasts. Keeping stand size as small as practical, varying stand density, and including clumps of native flowering trees and shrubs such as dogwoods and native azaleas will provide scenic vistas that enhance aesthetic values. One way to avoid the artificial appearance of trees planted in rows is to plant pine seedlings on contour or in a coil pattern. Rows will not be evident when using this method, but spacing can still be controlled.

Autumn floral display in longleaf pine flatwoods.

Beggarticks.

Prescribed fire in conjunction with timely, random soil disturbance can enhance native wildflowers on many longleaf forests. If woodlands are kept relatively open, fire will stimulate flowering. Growing season fire will enhance many fall-blooming species such as butterfly weed and blazing star (Liatris spp.) that are important nectar sources for migrating butterflies. Patchy soil disturbance just prior to prescribed fire in March and April will encourage wild sunflowers if they are present in the forest. Light disking before winter burning will encourage blazing stars if present.

In essence, well managed longleaf forests that are carefully burned and managed for wildlife and timber will be aesthetically pleasing. Attention to detail with the timing and scale of land management activities is usually all that is needed to keep these woodlands

Examples of interesting wildlife that live in longleaf forests

Gopher Tortoise

Fox Squirrel

Indigo Snake

Eastern Diamondback Rattlesnake

Woodland Grazing in the Longleaf Pine Forest

The longleaf pine forests of the South have a long history of cattle grazing native forages. Livestock (cattle and hogs) were first brought into the region over 450 years ago by Spanish explorers and settlers. Supplemented from later imports by the colonists who settled Georgia and the Carolinas, these animals formed the nucleus of a subsistence woodland grazing industry that thrived in the South from colonial times up through the first third of the 20th century.

Range management of longleaf pine woodlands in the deep South was minimal. Early settlers adopted the Native American custom of burning off the woods to drive game and to freshen-up the grass to provide early spring grazing for their cattle. Cattle management consisted of year-round grazing in the piney woods, no supplemental feeding, and survival of the fittest. This resulted in calf crops of less than 50 percent and weaning weights of less than 300 pounds. It often took three to five years to grow cattle to marketable size.

After the Civil War, large timber companies moved south and began clearcutting virgin longleaf pine forests. Between 1880 and 1930, most of the virgin piney woods were cut-over, leaving extensive treeless landscapes. As a result, the understory grasses flourished and grazing conditions were at their all-time high for the native range. Cattle production increased dramatically and the Deep South became known as cattle country.

In the 1930's these conditions began to change. Large, stable timber companies and the federal government began buying up much of this cut-over land and replanting pines. This replanting effort along with the anti-cattle and anti-burning bias of foresters working in the region led to the exclusion of all livestock and prescribed burning from the woods.

Interest in woodland grazing began to change with the start of World War II. The war increased demand for beef and research was initiated to develop proper management methods to coordinate cattle and timber production in southern pine forests.

Woodland grazing.

Native Range Management: Most natural longleaf forests in the South today are considered to be either longleaf pine-wiregrass or longleaf pine-bluestem range. The wiregrass range is found primarily on the coastal plain east of south central Alabama. Bluestem grasses generally dominate the range westward into Louisiana and Texas. The wiregrass type is dominated by grasses in the genus Aristida. Other important grasses include Curtis dropseed and native bluestems, as well as many species of paspalums and panic grasses. Forbs in the legume and aster families are common.

Longleaf pine-bluestem range is dominated by bunchgrasses in the genera Andropogon and Schizachyrium. Common grasses are little bluestem, pinehill bluestem, big bluestem, creeping bluestem, pineywoods dropseed, cutover muhly, and Indiangrass. Legumes, asters, *Panicums*, and *Paspulums* are other common components of a healthy understory in the bluestem range.

Cattle grazing beneath longleaf is still a common practice across the south, but hogs should be excluded from longleaf forests. Whether domesticated or feral, hogs are capable of

inflicting severe damage on both the understory community and longleaf pine regeneration.

To improve grazing, thin early and often and use prescribed fire. As pine trees grow, grass yields may decrease from shading. Stands should be thinned as early as practical and as frequently as possible thereafter (6-10 year return interval). Frequent thinning to a residual basal area of 50-75 or less will reduce shading and increase forage production.

Prescribed fire is considered by many range managers to be the most effective tool in maintaining desirable forage beneath pine forests in the South. The use of fire improves the quality of forage and can be used to concentrate and rotate grazing. Ranges burned on a 3-year rotation get their highest use by cattle the first year after fire and correspondingly less use each year until the area is burned again. For longleaf pine-wiregrass ranges, the best schedule for burning uses a late winter or early spring prescribed fire on a two-year rotation. On bluestem range, prescribed burning on a three-year rotation in late winter or early spring is better.

Pineywoods cattle: a heritage breed.

When regenerating or reforesting cut-over pine stands with grazing or wildlife values in mind, use minimal levels of site preparation. This can be a challenge when reestablishing longleaf pine since this species is so competition sensitive. In general, longleaf stands with a history of prescribed fire often need no more site preparation than a good prescribed burn during the growing season prior to seedfall or planting. This will benefit the grazing resource.

Additional site preparation, especially if mechanical methods or broadcast herbicides are used, has the potential to virtually eliminate native grasses. If mechanical and/or chemical site preparation is needed, consider using the least intensive method possible. One pass with a drum-chopper in conjunction with prescribed fire will damage the forage resource less than shearing or root-raking with disking. Using spot applications, individual stem treatments or herbicides applied in bands will be less damaging to herbaceous vegetation than broadcast applications. Also, try to use an herbicide to which grasses are resistant.

Grazing Management: Native forages in the South are most nutritious during the spring and summer. Grazing should be timed to take advantage of this. Wiregrass is most nutritious and palatable for cattle when resprouting after a late winter or early spring burn. Range dominated by wiregrass can be best utilized by cattle from early spring to mid-summer. Cattle should be kept off fresh burns until wiregrass is at least 6 inches tall. Utilization of wiregrass by cattle should be no greater than 50 percent and cattle should be stocked only on the range in relation to the amount of forage available.

Bluestem ranges can best be utilized by cattle from early spring through late summer. Bluestem grasses can be grazed year-round without damaging the resource if supplemental protein and hay are provided during the fall and winter. Regardless of the range type, cattle and the range itself will do better when grazed during spring and summer, supplemented with periods of pasture grazing from mid-summer into autumn and supplemental feeding of hay, protein supplement, or grazing of winter annual grasses during the winter and early spring.

Always remember, stock livestock only in relation to the amount of food available. Do not overgraze.

Wildlife Considerations: The key to compatible management of wildlife and cattle is being able to adjust cattle stocking to available forage while reserving a portion for wildlife. One rule of thumb used on Louisiana ranges for combined deer and cattle management is to reserve 15% of the total livestock carrying capacity for deer. The actual amount reserved will depend on the landowner's objective and must be accounted for when developing grazing plans. Failure to allow for wildlife use when grazing longleaf pine woodlands may lead to overgrazing and soil erosion and/or compaction.

Grazing can also be used to improve wildlife habitat. Research in Florida showed that short-duration grazing on woodland ranges improved forage values for both cattle and wildlife. In this study, wiregrass range was grazed by cattle to a 50 percent utilization and rested for 4 months. As a result, wiregrass, saw palmetto, and brush were reduced while other grasses and legumes increased. This improved habitat for some wildlife species and grazing values for cattle.

Establishing Pines in Pastures: Another option in integrating timber and cattle is the establishment of pines in pastures. This intensive method of range management is called silvopasture and has reached a high level of development in Australia and New Zealand.

In the South, planting longleaf or slash pine in pastures and establishing bahiagrass (usually Pensacola bahia) in pine stands has been successful. Under this style of management, pines are planted under wide-row configurations such as 8x12 feet or 6x8 feet with 24 feet between pairs of rows (both spacings give 454 trees per acre) and the grass is seeded underneath. The bahiagrass is then fertilized for optimal grass production. After the grass is well established and the pines are 3 to 6 feet tall, cattle can be stocked in these pine pastures at rates similar to open pastures. Cattle typically graze these stands for a 7-month grazing season from spring through early fall. In addition, the pines get some benefit from the grass fertilization and respond with increased growth. A disadvantage to fertilization, aside from increased costs, is the increased risk for pitch canker, pine sawfly and pine colaspis beetles.

There is concern, however, about destroying and eliminating native plant communities associated with the longleaf pine if this style of management is used in natural or cut-over stands. Because of this concern, establishment of longleaf pine pastures should be limited to marginal cropland, abandoned open land or establishing pines in existing pastures utilizing scalping and herbicides. Converting these sites will also be more cost-effective than establishing pine pastures in natural longleaf communities.

Red-cockaded Woodpecker: An Endangered Species

A number of rare, threatened, and endangered species of both plants and animals inhabit longleaf pinelands. Most of these species require the open, fire-maintained conditions that are characteristic of this forest type. Many of these species, if they are present on a particular property, can be accommodated by practicing the management strategy outlined in this publication: periodic prescribed burning and frequent timber thinnings. However, some wildlife, like the red-cockaded woodpecker (RCW) also require mature pine forests to complete their habitat needs.

The red-cockaded woodpecker is a bluebird-sized, black and white ladder-backed woodpecker with prominent white cheek-patches. It was once common in the mature pine forests of the South. The bird gets its name from two very small patches of red

feathers located on either side of the male bird's head. These patches or "cockades" are located under the black feathers of the male's black cap and are generally not visible in the field. The RCW is unique among our southern woodpeckers in that it makes its nest-cavity in living southern pines. It is on the federal endangered species list because habitat loss related to mature forest conversion to agriculture, development, and short rotation pine plantations have caused its population to decline throughout the South.

(a) mature red-cockaded woodpecker, (b) a RCW cavity tree.

The red-cockaded woodpecker requires mature, park-like stands of southern pines at least 80 to 100 years of age or older for nesting habitat. Few managed pine forests in the region today attain this age and fire-suppression has degraded many of the acres that remain. When periodic fire is removed from pine forests, a midstory of hardwoods quickly develops. RCW's rarely use pine stands with a hardwood midstory for nesting habitat, possibly because of competition from and predation by other wildlife. While the RCW is the only bird that will excavate a cavity in a living pine, other woodpeckers, birds and squirrels that are more common in mixed pine/hardwood forests will compete with RCWs for use of the finished cavity.

Natural History: The RCW has a unique social organization. The bird lives in family units called "groups". Each group occupies and defends an aggregate of cavity trees, called the "cluster". Groups typically consist of a breeding pair and zero to four helpers. The helpers are usually sons of the breeding male who remain with their parents in subsequent years to assist in incubation, feeding nestlings, defending the territory and cavity excavation. Nesting is usually from April to July. Two to four eggs are laid which hatch in 10 to 12 days. The young leave the nest after 26 days and are fed by the group until they can forage for themselves. With rare exceptions, only one brood is raised each year. The birds forage by flaking off scales of loose pine bark and feeding on the insects and other invertebrates (e.g., spiders) found underneath, rather than drilling into dead trees like other woodpeckers.

Habitat Needs: Two habitat types are critical for red-cockaded woodpeckers — nesting habitat and foraging habitat. The nesting habitat is centered on the cluster which must have mature trees, large enough to contain heartwood and old enough to develop red-heart disease. Red-heart is a fungal disease that will infect older, mature pines. The disease softens the heartwood, making it easier for the birds to excavate nesting and roosting cavities.

Most RCW clusters have one to six "active" cavity trees, one for the nest (typically the breeding male's roost tree) and one roosting cavity for each group member. Not all the cavities in a cluster are necessarily used at the same time and some are constantly being excavated or enlarged. Clusters can vary in size and shape, but most cavity trees used by one group are usually found within 1500 feet of each other.

Foraging habitat consists of pole to sawtimber sized trees in open pine stands. Foraging habitat is normally adjacent to the cluster. The amount of foraging habitat required to

A two-aged longleaf pine stand.

support a group will vary based on habitat quality and quantity.

The U.S. Fish & Wildlife Service is charged with enforcing provisions of the Federal Endangered Species Act and protecting listed species. In working with the red-cockaded woodpecker on private lands, they have emphasized the development of Safe Harbor Agreements (SHA), Memorandums of Agreement (MOA) and Habitat Conservation Plans (HCP). Most notably, MOAs and HCPs have been developed for the lands of several large forest products companies. They have also worked with numerous state wildlife agencies to develop and implement statewide SHAs. Recognizing that some smaller private landowners may have difficulty in managing for the RCW, the U.S. Fish & Wildlife Service has developed a set of private land guidelines for the RCW. These guidelines consist of the following:

Cluster:

- Protect all cavity trees (active & inactive) within the cluster, plus at least a 200 foot buffer around the aggregate of cavity trees.
- If the pine stocking is greater than 50 ft^2 of basal area, the cluster can be thinned to 50 ft^2, favoring the retention of sawtimber sized trees.
- No removal of any active or inactive cavity tree without approval.

Foraging Habitat: Suitable & Available

- Pine and pine/hardwood stands containing 50-80 sqft basal area in 10 inch diameter at breast height (dbh) or larger pines that are at least 30 years of age or older.
- Cluster habitat is included as foraging habitat.

Foraging Habitat: Quantity & Quality

- A minimum of 3,000 ft^2 basal area of pine (10" dbh or larger) must be provided on a minimum of 75 acres for each active cluster.
- The pine basal area per acre may range from 40 to 70 ft^2
- No hardwood midstory should be present, or if it is it must be sparse and less then 7 feet in height.
- Hardwood overstory basal area should not exceed 10 sq.ft./acre
- Stands cannot be considered suitable as foraging acres unless they have open characteristics associated with preferred foraging habitat.
- The separation of the cluster from the nearest foraging stand and distances between foraging stands of unsuitable habitat cannot exceed 200 feet.

One option in the timber management of natural stands that has the potential of maintaining or improving RCW habitat is the irregular shelterwood or two-aged stand. It starts with an even-aged stand being regenerated by the shelterwood system. Once

reproduction has become well established, some of the remaining seed trees in the overstory may be removed, however, a minimum of about 30 basal area should be retained. Because of the competition from the remaining mature trees, the reproduction rapidly breaks into a variety of size classes similar to an uneven-aged stand. After 40 years on an average longleaf site, the largest of the younger trees may approach the size of the smallest of the older trees.

The two-aged approach has several advantages over uneven-aged management. It is easier to maintain area control and a set rotation age. Aesthetically, it has the appearance of an uneven-aged stand. Volume growth is equal to that expected from standard uneven-aged management. In addition, thinning can be done as needed to maintain desired density and appearance without aiming at a target diameter class distribution. At the end of the rotation, the stand is reduced to a shelterwood density once more and the process starts over. Using this method, large residuals are always on site and available as potential nest trees for RCWs. This method is very useful in those areas where good seed crops are too infrequent to provide the regular natural regeneration needed for all-aged management in even or uneven-aged units.

Landowners who have existing active RCW clusters are required by the Endangered Species Act in its current form and interpretation to manage the nesting and foraging habitat in such as way as to prevent harming the species and causing a "take" situation. These guidelines have been developed to prevent take.

These guidelines may change as conditions and new research develops. For additional information on your responsibilities under the Endangered Species Act, contact your state wildlife agency, your state office of the U.S. Fish & Wildlife Service or access the RCW Recovery Plan at: http://rcwrecovery.fws.gov.

Putting it All Together

An array of assistance is available for landowners needing help managing longleaf pine forests. A good start is your local United States Department of Agriculture Farm Service Center and your local State Forestry Commission and State Department of Natural Resources. The biologists, conservationists and foresters from these agencies are available to provide technical advice and limited management assistance to forest owners. If you own at least 10 acres of forestland, you may be eligible to participate in the Forest Stewardship program. This federally sponsored program is administered in most states by the State Forestry Commission or Forestry Service. Landowners who participate in the program have a multiple-use management plan developed for their land based on their objectives.

Once the management plan is completed, landowners may be eligible for cost-sharing for many of the practices they will need to implement through a variety of federal and state funded cost-share programs. Some of the practices that can be cost-shared include prescribed burning, wildlife food plot establishment, forest trail establishment for recreation, control of invasive species and planting

Landowner and forester working together.

longleaf pines. Other sources of help include private consulting natural resource professionals who can assist in developing management plans, implementing management activities and marketing timber and other resources such as hunting leases. Consultants charge a fee for their services. For a list of the natural resource consultants who work in your local area, check with your local county agent or Forestry Commission representative.

Places to see Longleaf Pine Management in Action *

Alabama

Mountain Longleaf National Wildlife Refuge, Calhoun Co., AL; Mountain longleaf pine.

Conecuh National Forest, Covington and Escambia Cos., AL; Sandhill and rolling mesic longleaf woodlands.

Escambia Experimental Forest, Escambia Co., AL; Sandhill and rolling mesic longleaf woodlands.

Solon Dixon Forestry Education Center, Covington & Escambia Cos., AL; Sandhill and rolling mesic longleaf woodlands.

Florida

Blackwater River State Forest, Santa Rosa and Okaloosa, Cos., FL; Sandhill and longleaf pine savannahs.

Eglin Air Force Base, Okaloosa, Santa Rosa and Walton Cos., FL; Sandhill, flatwoods and longleaf pine savannahs.

Georgia

Berry College, Floyd Co., GA; Mountain longleaf pine.

Fort Stewart, Liberty & Bryan Cos., GA; Sandhill longleaf pine & flatwoods.

Okefenokee Swamp National Wildlife Refuge, Charlton and Ware Cos., GA; Longleaf pine savannah.

Louisiana

Kisatchie National Forest, Grant, Natchitoches, Rapides, Vernon and Winn Parrishes, LA; Longleaf pine savannah and rolling mesic woodland.

Mississippi

DeSoto National Forest, Forrest, Greene, Harrison, Jones, Perry, Stone and Wayne Cos., MS; Longleaf pine savannahs and rolling mesic woodlands.

North Carolina

Bladen Lakes State Forest, Bladen Co., NC; Sandhill longleaf pine-scrub oak.

Green Swamp Nature Conservancy Preserve, Brunswick Co., NC; Longleaf pine savannah.

Croatan National Forest, Carteret, Craven & Jones Cos., NC; Longleaf pine flatwoods & savannahs.

South Carolina

Harbison State Forest, Richland Co., SC; Sandhill longleaf pine - scrub oak.

Sandhills State Forest and Sandhills National Wildlife Refuge, Chesterfield Co., SC; Sandhill longleaf pine - scrub oak.

Fort Jackson, Richland Co., SC; Sandhill longleaf pine-scrub oak.

Francis Marion National Forest, Berkeley & Charleston Cos., SC; Longleaf pine flatwoods & savannahs.

Webb Wildlife Center, Hampton Co., SC; Longleaf pine flatwoods.

Texas

Big Thicket National Preserve, Tyler Co., TX; Longleaf pine savannah and rolling mesic woodland.

Sam Houston National Forest, San Jacinto Co., TX; Longleaf pine savannah and rolling mesic woodland.

There are a number of other examples of longleaf management throughout the South. For additional sites, contact your state's conservation agency and forestry commission.

*Adapted from: Goodwin, Carol, and Julie Moore 1995. Longleaf legacies. longleaf pine... the forest that built America. A calendar for 1995. Long Needle Press, Gainesville, FL, 30pp.

Suggested Reading

The following articles and publications were utilized in writing this bulletin. The author gratefully acknowledges both the inspiration and the permission of the authors, agencies and organizations who were involved in writing and publishing these documents. The reader is encouraged to read these for additional information on longleaf pine management and forestry and wildlife management in general. Many of the U.S. Forest Service publications are available free-of-charge from the Southern Region, U.S. Forest Service office in Atlanta. For single copies, call: (404) 347-2385. You can also find many of the U.S. Forest Service publications about longleaf pine on the web. Go to: http://www.srs.fs.usda.gov/pubs/ to access their online publications. Also, go to the Longleaf Alliance's website at: http://www.longleafalliance.org to review an extensive bibliography of longleaf pine related publications.

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Appendix 1

SOURCES OF ASSISTANCE

Federal Agencies:

U.S. Forest Service
Southern Region
1720 Peachtree Road, Suite 760S
Atlanta, GA 30309
(404) 347-4177
http://www.fs.fed.us/r8/

Southern Research Station
P.O. Box 2680
Asheville, NC 28802
(828) 257-4832
http://www.srs.fs.usda.gov

National Forests in Alabama
2946 Chestnut Street
Montgomery, AL 36107
(334) 832-4470
http://www.fs.fed.us/r8/alabama/

National Forests in Florida
Suite F-100
325 John Knox Road
Tallahassee FL 32303
(850) 523-8500
http://www.fs.fed.us/r8/florida/

Kisatchie National Forest
2500 Shreveport Highway
Pineville, LA 71360
(318) 473-7160
http://www.fs.fed.us/r8/kisatchie/

National Forests in Mississippi
100 West Capitol Street
Suite 1141
Jackson, MS 39269
(601) 965-4391
http://www.fs.fed.us/r8/mississippi/

National Forests in North Carolina
P.O. Box 2750
Asheville, NC 28802
(828) 257-4200
http://www.cs.unca.edu/nfsnc/

Francis Marion & Sumter
National Forests
4931 Broad River Road
Columbia, SC 29210-4021
(803) 561-4000
http://www.fs.fed.us/r8/fms/

National Forests in Texas
Homer Garrison Federal Building
701 North First Street
Lufkin, TX 75901
(936) 476-9754
http://www.fs.fed.us/r8/texas/

U.S. Fish & Wildlife Service
Region 4 Office
Richard B. Russell Federal Building
Room 1200
75 Spring Street, SW
Atlanta, GA 30303
(404) 331-0830
http://www.fws.gov/southeast/

State Extension Services:

Southern Region Extension Forester
Forest Resources Building 4-402
The University of Georgia
Athens, GA 30602
(706) 542-7813
http://sref.info/
http://www.forestryindex.net

Alabama Cooperative Extension Service
School of Forestry & Wildlife Sciences
602 Duncan Drive, Room 2349
Auburn University, AL 36849-5418
(334) 844-1044
http://www.sfws.auburn.edu/extension/

Institute of Food & Agricultural Science
Extension Forestry/
Natural Resource Education
P.O. Box 110420
University of Florida
Gainesville, FL 32611
(352) 846-0891
http://www.sfrc.ufl.edu/Extension/ExtInfo.html

Cooperative Extension Service
Extension Forestry
University of Georgia
Athens, GA 30602
(706) 542-2866
http://www.forestry.uga.edu/h/publicservice/

Louisiana Cooperative Extension Service
Extension Forestry
LSU AgCenter
Agriculture Administrative Bldg.
Baton Rouge, LA 70803
(225) 578-2376
http://www.lsuagcenter.com/en/environment/

Mississippi Cooperative Extension Service
Extension Forestry
P.O. Box 9681
Mississippi State, MS 39762
(662) 325-2948
http://www.cfr.msstate.edu/cfr/html/extension.htm

Extension Forestry
P.O. Box 8003
North Carolina State University
Raleigh, NC 27695
(919) 515-5574
http://www.ces.ncsu.edu/nreos/forest/

Clemson University Cooperative
Extension Service
Extension Forest Resources
272 Lehotsky Hall
Clemson, SC 29634-1003
(864) 656-2479
http://www.clemson.edu/extfor/

Extension Forestry
302 Horticulture & Forest Sciences
Texas A & M University
College Station, TX 77843
(979) 845-1351
http://extensionforestry.tamu.edu/

Virginia Cooperative Extension Service
Extension Forestry
324 Cheatham Hall
Virginia Tech
Blacksburg, VA 24061-0324
(540) 231-7679
http://www.ext.vt.edu/resources/

State Forestry Agencies:

Alabama Forestry Commission
P.O. Box 302550
513 Madison Avenue
Montgomery, AL 36130
(334) 240-9300
http://www.forestry.state.al.us

Florida Division of Forestry
3125 Connor Boulevard
Tallahassee, FL 32399-1650
(850) 488-4274
http://www.fl-dof.com

Georgia Forestry Commission
P.O. Box 819
Macon, GA 31202-0819
(478) 751-3500
http://www.gfc.state.ga.us

Louisiana Office of Forestry
Department of Agriculture & Forestry
P.O. Box 1628
Baton Rouge, LA 70821
(225) 925-4500
http://www.ldaf.state.la.us/divisions/forestry/default.asp

Mississippi Forestry Commission
Suite 300, 301 Building
Jackson, MS 39201
(601) 359-1386
http://www.mfc.state.ms.us/

North Carolina Division of Forest Resources
P.O. Box 27687
Raleigh, NC 27611
(919) 733-2162
http://www.dfr.state.nc.us/

South Carolina Forestry Commission
P.O. Box 21707
Columbia, SC 29221
(803) 896-8800
http://www.state.sc.us/forest/index.htm

Texas Forest Service
Texas A & M University System
301 Tarrow, Suite 364
John B. Connally Bldg.
College Station, TX 77843
(979) 458-6600
http://txforestservice.tamu.edu/

Virginia Department of Forestry
900 Natural Resources Drive
Charlottesville, VA 22903
(434) 977-6555
http://www.dof.virginia.gov/

State Conservation Agencies:

Alabama Department of Conservation
and Natural Resources
64 North Union Street, Suite 468
Montgomery, AL 36130
(334) 242-3486
http://www.dcnr.state.al.us/

Florida Fish &
Wildlife Conservation Commission
620 South Meridian Street
Tallahassee, FL 32399-1600
(850) 488-4676
http://floridaconservation.org

Georgia Department of Natural Resources
Wildlife Resources Division
2070 U.S. Hwy. 278, SE
Social Circle, GA 30025
(770) 918-6400
http://georgiawildlife.dnr.state.ga.us

Louisiana Department of Wildlife
and Fisheries
200 Quail Drive
Baton Rouge, LA 70808
(225) 765-2800
http://www.wlf.state.la.us

Mississippi Department of Wildlife,
Fisheries and Parks
1505 Eastover Drive
Jackson, MS 39211-6374
(601) 432-2400
http://www.mdwfp.com

North Carolina Wildlife Resources Department
1722 Mail Service Center
Raleigh, NC 27699
(919) 707-0010
http://www.wildlife.state.nc.us/

South Carolina Department of Natural Resources
P.O. Box 167
Rembert C. Dennis Bldg.
1000 Assembly Street
Columbia, SC 29201
(803) 734-3886
http://www.dnr.sc.gov

Texas Parks and Wildlife Department
4200 Smith School Road
Austin, TX 78744
(512) 389-4800
http://www.tpwd.state.tx.us

Virginia Department of Game and
Inland Fisheries
4010 West Broad Street
Richmond, VA 23230
http://www.dgif.virginia.gov/

Consulting Foresters: Check with your local County Extension or Forestry Commission office for lists of consulting foresters that work in your area or contact:

Association of Consulting Foresters
312 Montgomery Street, Suite 208
Alexandria, VA 22314
(703) 548-0990
http://www.acf-foresters.org

Research, Educational and Conservation Organizations:

Longleaf Alliance
Solon Dixon Forestry Education Center
12130 Dixon Center Road
Andalusia, AL 36420
(334) 427-1029
http://www.longleafalliance.org

Tall Timbers Research Station
13093 Henry Beadel Drive
Tallahassee, FL 32312-0918
(850) 893-4153
http://www.talltimbers.org

The Nature Conservancy
Southeast Regional Office
101 Connor Drive, Suite 302
Chapel Hill, NC 27515
(919) 967-5493 ext. 142

Joseph W. Jones Ecological
Research Center at Ichauway
Route 2, Box 2324
Newton, GA 39870-9651
(229) 734-4706
http://www.jonesctr.org

Sources of Longleaf Pine Seedlings

For up-to-date information about where to purchase both bare-root and containerized longleaf pine seedlings, go to The Longleaf Alliance's "Finding Longleaf Pine Seedlings" link at:

http://www.longleafalliance.org/landowners/seedlings/seedlings.htm

Appendix 2

Before -Planting Dichotomous Key for Site Preparation on Agricultural Lands: Applications to Restoration Ecology

Mark J. Haindś, Research Coordinator, Longleaf Alliance

Artificial regeneration of longleaf pine on agricultural lands has proven to be a particularly challenging endeavor. Frequently, the more fertile the site the better the chance one will incur a planting failure. Agricultural sites tend to have more aggressive herbaceous competitors than cutover areas. Planting failures are common in established bermuda, bahai, and fescue grass pastures. Studies conducted by the Longleaf Alliance indicate seedling survival is more dependent upon a proper site preparation prior to planting, than a correct herbaceous release following planting. Both a proper site preparation and herbaceous release are usually necessary to obtain acceptable survival and growth in the first few growing seasons. Scalping as a site preparation has proven beneficial on agricultural areas. Scalping may; reduce competition, improve moisture relationships, reduce insect predation on seedling roots, and reduce damage from certain pathogenic fungi. For best results, scalping, subsoiling (ripping), and planting should follow the contour of the land. Furthermore, research conducted by the Longleaf Alliance indicates that container-grown seedlings should be planted with the plug protruding 1-2" above the soil surface (in scalped rows) for optimum survival and growth.

As an additional caution, some sites that were once appropriate for longleaf, may be inappropriate owing to changes in soil pH or soil nutrient levels. Sites that have been heavily limed may be basic (>7.0 pH) rather than acidic (< 7.0 pH). Establishing pine trees on basic soils may prove difficult. Additionally, sites that have been repeatedly treated with chicken litter may have toxic concentrations of elements that would normally be beneficial to seedling survival and growth. Have the soils tested for acidity and soil nutrient levels prior to establishing any pine species on old fields or pastures.

Site is a pasture or an old field with grasses present (fescue, bahia, broomsage, bermuda) (go to A).
Site is an old field without a significant component of grasses (go to B).

A Bermuda grass is present. (go to A1)
Bermuda grass is not present. (go to A2)

A1 Recommended site preparation treatments in the order they should be applied:

- #1 Broadcast chemical site prep
- #2 Scalping
- #3 Subsoiling or ripping (optional, strongly recommended if hand-planting, or hardpan is present)

Chemical site preparation is necessary at highest recommended rates of glyphosate (Accord or Roundup) or imazpyr (Arsenal or Chopper) or a tank-mix thereof. Possible chemical site preparation rates are glyphosate at 5 quarts/acre (anytime

grass is actively growing), Arsenal at 20 oz/acre (spring or early summer application), Chopper at 40 oz/acre (spring or summer application), or a tank-mix recommended by licensed herbicide applicators. Scalping should follow the chemical site preparation. Subsoiling should follow the scalping. The subsoiling (ripping) furrow should be to the side of the scalped row rather than in the center of the scalped row. This will allow the seedling to be planted to the side of the rip and in the center of the scalped row. Do not plant seedlings directly in a subsoil/rip furrow. If bareroot seedlings are utilized, both the scalping and the subsoiling should be done at least 2 months prior to planting to allow some settling of the soil. Container seedling may be planted immediately after scalping and subsoiling provided that seedlings are not planted in the rip and the plug protrudes 1-2" above the soil surface. In all cases, subsoiling, scalping, and machine planting should follow the contour of the land.

A2 Recommended site preparation treatments in the order they should be applied:

- #1 Broadcast or banded chemical site prep (optional)
- #2 Scalping
- #3 Subsoiling or ripping (optional, strongly recommended if hand-planting or hardpan is present)

The scalping operation will yield the greatest benefits in seedlings survival. For grasses other than bermuda, herbicides may be applied at reduced rates as a broadcast or banded chemical site preparation. Possible chemical site preparation rates are glyphosate (Accord SP or Roundup) at 3 quarts/acre, 16 oz Arsenal, or a tank-mix of glyphosate and imazapyr applied while grasses are actively growing. Scalping should follow the chemical site preparation. Subsoiling should follow the scalping. The subsoiling (ripping) furrow should be to the side of the scalped row rather than in the center of the scalped row. This will allow the seedling to be planted to the side of the rip and in the center of the scalped row. Never plant seedlings directly in a subsoil/rip furrow. If bareroot seedlings are utilized both the scalping and the subsoiling should be done at least 2 months prior to planting to allow some settling of the soil. Container seedling may be planted immediately after scalping and subsoiling provided that seedlings are not planted in the rip and the plug protrudes 1-2" above the soil surface. In all cases, subsoiling, scalping, and machine planting should follow the contour of the land.

B Patches of bermuda grass or crabgrass are present (go to B1).
No bermuda or crabgrass are present (go to B2)

B1 Bermuda grass is present in patches (go to B3)
Only crabgrass (no bermuda) is/was present (go to B4)

B2 Site was in peanuts or soybeans, or ground was fallow for at least one year (go to B4)
Site was in other crop (cotton, corn, wheat, etc.) (go to B5)

B3 Recommended site preparation treatments in the order they should be applied:

- #1 Spot treat patches of bermuda grass with herbicide.
- #2 Scalping (optional)
- #3 Subsoiling or Ripping (optional, strongly recommended if hand-planting or hardpan is present)

Patches of bermuda grass may be sprayed with a 2% solution of glyphosate (Roundup or Accord). If bermuda grass patches cover more than 10% of the field, scalping is strongly recommended.

B4 Recommended site preparation treatments in the order they should be applied:

- #1 Scalping.
- #2 Subsoiling or Ripping (optional, strongly recommended if hand-planting or hardpan is present)

B5 Recommended site preparation treatments in the order they should be applied:

- #1 Scalping (optional)
- #2 Subsoiling or Ripping (optional, strongly recommended if hand-planting or hardpan is present)

If site was in cotton, plant tree seedling between rows of cotton stubble.

Appendix 3

After-Planting Dichotomous Key for Herbaceous Release: Applications to Restoration Ecology

Mark Hainds, Research Coordinator, Longleaf Alliance

The Longleaf Alliance has conducted four herbicide screening trials over longleaf pine seedlings; two in an old pecan orchard with a full complement of old-field weeds, and two herbicide screening trials on agricultural crop fields in Monroe and Geneva Counties, Alabama. From these and other studies, a good site preparation proved a critical first step. In the absence of a good site preparation herbicides tend to be less effective in promoting good survival and growth of newly planted longleaf pine seedlings. We also recommend that a small number of seedlings be excavated prior to applying any herbicides "over the top" of newly planted longleaf pine seedlings. Insure that new roots have developed since planting. If new roots have not grown from the plug or the original root system, it is inadvisable to apply soil-active herbicides over the newly planted seedlings. If, on the other hand, a vigorous root system in developing (more than 4" of new growth since planting), the seedlings should be able to better tolerate soil active herbicides. Before applying any herbicide over longleaf pine it is important to test the soil pH. One of the most popular herbicides (Oust/sulfometuron) becomes more active as soil pH increases. If the soil has a pH above 6.0, Oust should only be applied at the lowest recommended rate. If the soil is above 6.5 pH, do not apply more than 1 oz of Oust to the acre. If the soil is above 6.7, Oust should probably be avoided on these soils.

Site was a pasture, a cultivated field with a large component of grasses, or a fallow old-field. (go to C)
Site was a clean old field with no significant component of grasses prior to planting. (go to D)

C Area received no site preparation. (go to C1)
Area received site preparation prior to planting. (go to C4)

C1 Site is fertile old field/pasture (go to C2)
Site is infertile sandy soil (go to C3)

C2 Recommended herbaceous release treatments in the order they should be applied:

- #1 Broadcast Oust at 2-4 oz/acre between mid-March and early-April.
- #2 Band spray Arsenal at 4-6 oz/acre as a post-emergent herbaceous release after May 10th.
- #3 Mow between rows (optional).

Two post-planting release treatments will be necessary if the site is a fertile old field and bermuda-grass is present, bahia grass is not killed during the initial herbaceous release, or if crab-grass germinates after the initial chemical treatment. If young crabgrass germinants are present, it is imperative that a post-emergent (second) herbicide be applied.

C3 Recommended herbaceous release treatments in the order they should be applied:

#1 Broadcast one of the following pre-emergent herbaceous releases between mid-March and early-April.

a: Oust 2-4 oz/acre

b: (Tank mix) Velpar L 24-32 oz/acre and Oust 2-4 oz/acre

c: (Tank mix) Velpar DF 10.67 oz/Acre and Oust 2-4 oz/acre

d: Oustar 10-12 oz/acre

#2 Band spray a post-emergent herbaceous release after May 10th (optional).

a: Arsenal 4-6 oz/acre

#3 Mow between rows (optional).

Two post-planting release treatments may be necessary if bermuda-grass is present, bahia grass is not killed during the initial herbaceous release, or if crab-grass germinates after the initial chemical treatment. If young crabgrass germinants are present, it is imperative that a post-emergent (second) herbicide be applied.

C4 Area received chemical site preparation only. (go to C5)
Area received chemical site preparation and scalping, or scalping alone. (go to C6)

C5 Recommended herbaceous release treatments in the order they should be applied:

#1 Broadcast one of the following pre-emergent herbaceous releases between Mid-March and early-April.

a: Oust 2-4 oz/acre

b: (Tank mix) Velpar L 24-32 oz/acre and Oust 2-4 oz/acre

c: (Tank mix) Velpar DF 10.67 oz/Acre and Oust 2-4 oz/acre

d: Oustar 10-12 oz/acre

#2 Band spray Arsenal 4-6 oz/acre as a post-emergent herbaceous release after May 10th (optional).

#3 Mow between rows (optional).

Two post-planting release treatments may be necessary if bermuda is present, bahia grass is not killed during the initial herbaceous release, or if crab-grass germinates after the initial chemical treatment. If young crabgrass germinants are present, it is imperative that a post-emergent (second) herbicide be applied. As an alternative, to steps #1-#3, wait till middle-May and broadcast 4-5 oz Arsenal and 2 oz of Oust to the acre as a tank-mix. Do not use this option unless the site was chemically or mechanically site prepared prior to planting.

C6 Recommended herbaceous release treatments in the order they should be applied:

#1 Broadcast or band-spray one of the following pre-emergent herbaceous releases between mid-March and early-April.

a: Oust 2-4 oz/acre

b: (Tank mix) Velpar L 24-32 oz/acre and Oust 2-4 oz/acre

c: (Tank mix) Velpar DF 10.67 oz/Acre and Oust 2-4 oz/acre

d: Oustar 10-12 oz/acre

#2 Band spray Arsenal at 4-6 oz/acre as a post-emergent herbaceous release after May 10th (optional).

#3 Mow between rows (optional).

Two post-planting release treatments may be necessary if bermuda is present, if bahia grass is not killed during the initial herbaceous release, or if crab-grass germinates after the initial chemical treatment. If young crabgrass germinants are present, it is imperative that a post-emergent (second) herbicide be applied

D Field is fertile soil (go to D1)
Field is unfertile sandy soil (go to D2)

D1 Recommended herbaceous release treatments in the order they should be applied:

- #1 Broadcast one of the following pre-emergent herbaceous releases between mid-March and early-April.
  - a: Oust 2-4 oz/acre
  - b: (Tank mix) Velpar L 24-32 oz/acre and Oust 2-4 oz/acre
  - c: (Tank mix) Velpar DF 10.67 oz/Acre and Oust 2-4 oz/acre
  - d: Oustar 10-12 oz/acre
- #2 Band spray a post-emergent herbaceous release after May 10th.
  - a: Arsenal 4-6 oz/acre
- #3 Mow between rows (optional).

Two post-planting release treatments may be necessary if bermuda is present, if bahia grass is not killed during the initial herbaceous release, or if crab-grass germinates after the initial chemical treatment. If young crabgrass germinants are present, it is imperative that a post-emergent (second) herbicide be applied

D2 Recommended herbaceous release treatments in the order they should be applied:

- #1 Broadcast one of the following pre-emergent herbaceous releases between mid-March and early-April.
  - a: Oust 2-4 oz/acre
  - b: (Tank mix) Velpar L 24-32 oz/acre and Oust 2-4 oz/acre
  - c: (Tank mix) Velpar DF 10.67 oz/Acre and Oust 2-4 oz/acre
  - d: Oustar 10-12 oz/acre
- #2 Mow between rows (optional).

Glossary

The following glossary is included with definitions of terms used in this publication. In addition, many common forestry-related terms not used in this publication are included. For additional information on forestry-related terminology, contact your local county Extension agent or Forestry Commission representative.

All-aged management in even-aged units: The interspersion and management of even-aged units of forest land in such a way as to provide all condition classes of the forest in a relatively small geographic area. The method contains suitable flexibility over forest composition, stand density, and age-class dispersion required to accomplish most multiple-use management objectives.

Agroforestry: Growing and managing agricultural crop such as pasture grass and a forest crop on the same land at the same time. In the South, this is usually a combination of trees and grass in plantations for animal grazing.

Bare-root seedling: A tree grown in nursery beds which will be lifted and packaged at the nursery and out-planted in the field. Seedlings are packaged and planted with little soil around the root system.

Basal area: (a) Of a tree: the cross-sectional area (in square feet) of the trunk at breast height (4-feet above the ground). For example, the basal area of a tree 14 inches in diameter at breast height is about 1 square foot. Basal area = 0.005454 times diameter squared. (b) Of an acre of forest: the sum of the basal areas of the individual tree on the acre. For example, a well-stocked pine stand might contain 80 to 120 square feet of basal area per acre. It is a term that helps describe stocking.

Best management practices: A set of approved land management activities such as road-building standards, streamside management zones and stream crossing requirements that are part of the voluntary program to control non-point source pollution as required by Section 404 of the Federal Clean Water Act.

Board foot: A unit of wood equaling 144 cubic inches. The term is commonly used to measure and express the amount of wood in trees, sawlogs, veneer logs, or lumber. Board feet in a piece of wood is determined by: [length in feet x width in inches x thickness in inches] divided by 12.

Breast height: 4-feet above ground level.

Brownspot needle blight: Disease caused by the fungus *Scirrhia acicola*. This fungus can infect and delay the initiation of height-growth of longleaf pine seedlings. Seedlings are often heavily infected while in the grass stage and often die after repeated defoliations. The disease can be controlled by periodic prescribed burning, fungicide sprays in the nursery or fungicide root dips at planting.

Browse: Leaves, buds, and twigs of shrubs and trees which are eaten by livestock and wildlife.

Buffer: A designated zone or strip of land of a specified width along the border of an area, stream or road. Buffer strips of standing trees may be used to shield an area from view, serve as wildlife travel corridors or filter strips adjacent to streams to protect water quality.

Containerized seedling: Tree seedlings which are grown in containers. When out-planted, the seedlings have a root-ball of soil around the roots.

Clearcut: A harvesting and regeneration method which removes all trees (regardless of size) on an area. Clearcutting is most used with the southern pines which require full sunlight to reproduce and grow well. Clearcutting produces an even-aged forest stand.

Codominant: Term used to describe crown or canopy position in forest stands. Codominant trees have medium-sized crowns which form the general level of the crown cover. They receive full sunlight from above but are crowded on the sides and receive little, if any, side-light.

Competition: The struggle among adjacent trees and plants for growth requirements such as sunlight, nutrients, water, and growing space. Competition goes on among both the roots and the tops of trees and plants in the same stand.

Conservation: The protection, improvement and wise use of our natural resources to provide the greatest social and economic value now and in the future.

Cutting cycle: The planned time interval between major harvesting operations in the same stand, usually in uneven-aged stands. For example, a cutting cycle of 10 years in an uneven-aged longleaf stand means a harvest every 10 years.

DBH: Abbreviation for tree diameter at breast height (4 feet above the ground). DBH is usually measured in inches.

Diameter: The length of a straight line passing through the center of a tree. Tree diameter is usually measured 4 feet above ground level, but log diameter is measured at the small end.

Direct seeding: A method of artificial regeneration where tree seeds are planted or sown on a prepared site.

Dominant tree: A tree having a crown extending above the general level of crown cover and receiving full sunlight from above and partly from the side; a tree that is larger than the average trees in the stand with a full, well-developed crown.

Ecology: The branch of science dealing with the interrelationships of plants and animals to their environment.

Ecotone: The community formed where two other communities meet. Sometimes called an edge, this is an actual, discrete ecological community that will have plants and animals from both adjacent communities and usually some unique residents found only in ectones.

Edge: The area where two different plant communities meet.

Endangered species: A species, subspecies or race that is threatened with extinction throughout all or a major portion of its range.

Even-aged management: Forest management with periodic harvesting of all trees on part of the forest at one time or in several cuttings over a short time to produce stands containing trees all the same age or nearly the same age.

Feral: Reverting to a wild state after being domesticated. For example, feral hogs.

Firebreak: Fire lane – a natural or man-made barrier created by the removal of brush, trees, leaves, other vegetation and natural fuels. Used to prevent the spread of fire.

Forb: Any herbaceous, broad-leaved plant other than grasses, sedges or rushes.

Forests: Any of a variety of vegetation types dominated by trees and usually having a well defined, closed canopy, which shades the understory.

Forestry: The science, art and practice of managing and using trees, forests and their associated resources for human benefit.

Growing stock: All live trees in a forest or stand, including sawtimber, pole timber, saplings and seedlings.

Habitat: The natural environment of a specific plant or animal. An area combining all the necessary resources for the plant or animal to live, grow and reproduce.

Hardwood: Term used for broad-leaved, usually deciduous trees such as the oaks, maples, ashes, hickories, etc.

Harvest: In general, the removal of some, or all of the trees or members of a wildlife population on an area.

Harvest methods: See clearcut, seed tree method, selection method and shelterwood harvest.

Intermediate cut: Removing immature trees from the forest sometime between reproduction and maturity to improve the quality of the remaining forest stand

Intermediate trees: Trees shorter than the dominant or codominant trees but with crowns extending into the general canopy formed by the taller trees. These trees receive little sunlight from above and none from the sides.

Legume: Any plant in the bean family such as partridge pea, lespedeza, soybean, honey locust, etc.

MBF: Abbreviation for thousand board feet. A unit of measure for tree volume or sawn lumber.

Multiple-use management: A concept of land management in which a number of products are produced from the same land base. For example, forests managed for timber, wildlife, recreational areas and water yield.

Natural stand: A stand of trees resulting from natural seedfall or sprouting. The seed tree method, selection harvesting and the shelterwood method all produce natural stands.

Overtopped trees: Suppressed trees. These trees have crowns entirely below the general level of the forest canopy and receive no direct sunlight.

Pilings: Pole-sized timber driven into the ground to bear a load or to support weight. See pole timber.

Plantation: An artificially forested area established by planting or direct seeding. It is usually made up of a single species.

Pole timber: (a) Trees whose diameters range from 4 inches to 8 to 12 inches. (b) A slender column of timber which is usually used to support wiring and cable.

Predation: The act of animals (predators) capturing live food (prey). For example, a Cooper's hawk capturing and eating a cotton rat.

Prescribed burn (or fire): The controlled use of fire to achieve land management objectives. Prescribed fire can be used to reduce hazardous fuel levels, control unwanted vegetation, improve visibility and improve wildlife habitat.

Preservation: Maintaining a natural environment undisturbed by human influence or activities.

Pulpwood: Wood cut primarily to be converted into wood pulp for the manufacture of paper, fiberboard or other wood fiber products. Pulpwood tree sizes are usually a minimum of 4 inches DBH.

Reforestation: Reestablishing a forest by planting or seeding an area where forest vegetation has been removed.

Regeneration: See reproduction.

Regeneration cut: A cutting operation to remove old trees and leave environmental conditions favorable for the establishment of reproduction.

Reproduction: (a) Young trees that will grow and become the older trees of a future forest. (b) The process of forest replacement or renewal. This may be done artificially by planting seedlings or seed or naturally by sprouting or natural seeding.

Rotation: The number of years required to establish and grow trees to a specified size, product or condition of maturity.

Sapling: A small tree, usually between 2 and 4 inches in diameter.

Sawlog: A log large enough to be sawed into lumber, usually at least 10 to 12 inches in diameter.

Sawtimber stand: A group of trees with individual trees large enough to be sawed into lumber.

Seed tree method: Removing all trees from the harvest area at one time except for a few scattered trees left to provide seed to establish a new forest stand.

Seedling: (a) A tree, usually less than 2 inches in DBH, which has grown from a seed. (b) A tree, grown from seed in a bed or container in a nursery.

Selection cut: Harvesting individual trees or small groups of trees at periodic intervals (usually 5 to 15 years) based on their physical condition or degree of maturity. This produces an uneven-aged stand.

Shelterwood harvest: Removing trees on the harvest area in a series of two or more cuttings so new seedlings can become established from the seed of older trees. This method produces an even-aged forest.

Shrub: A low growing perennial plant with a woody stem and a low branching habit.

Silviculture: The art, science and practice of establishing, tending and reproducing forest stands of desired characteristics. It is based on knowledge of species characteristics and environmental requirements.

Site: (a) A tract of land with reasonably uniform soil and climatic factors. (b) An area with the capacity to produce a particular forest or other vegetation because of biological, climatic and soil factors.

Site index: A measure of forest site quality based on the height (in feet) of the dominant trees at a specified age (usually 50 years for natural stands and 25 for planted stands). A site index of 85 means that the expected height of the dominate trees at an index age of 50 years would be 85 feet on that particular area of land.

Site preparation: Preparing an area of land for planting, direct seeding or natural reproduction by clearing, chemical vegetation control, burning, disking, bedding, windrowing or raking.

Species: A population or group of related plants or animals capable of interbreeding and biologically classified into the same category.

Stumpage: The value of a tree or group of trees as they stand in the woods uncut (on-the-stump).

Succession: The replacement of one plant community by another over time until ecological stability (climax forest) is achieved. For example, an abandoned farm, if left to nature, would gradually go through different stages of vegetative cover and finally reach the climax forest stage after 100 or more years.

Thinning: A cutting in an immature stand to reduce the number of trees per acre. Thinnings are done in timber management to improve the growth rate and quality of the remaining trees, while in wildlife management thinnings are used to improve wildlife habitat for specific species.

Threatened species: Species that could become endangered over all, or part of their range in the near future.

Timber: Growing trees capable of being used for wood products.

TSI (Timber stand improvement): Improving the quality of a forest stand by removing cull trees and brush, leaving a stand of good quality trees. Cull trees may be removed by chemicals, fire, girdling or cutting.

Understory: Vegetation, consisting of seedlings, shrubs, grasses and forbs that grow on the ground level and are shaded by a canopy of taller plants.

Uneven-aged forest: A forest with many ages of trees present and with considerable differences in ages, usually within close association.

Uneven-aged or all-aged management: Managing a forest by periodically removing individual trees or groups of trees from the stand while preserving its natural appearance.

Wildlife management: The art and science of changing the characteristics and interactions of habitats, wild animal populations, and humans in order to achieve specific human goals by means of the wildlife resources.

Woodland: Any of a variety of vegetation types consisting of widely spaced trees with a well developed understory.

Table 4. Quick Reference Guide to Wildlife Planting

Crop	Lbs/ Std. Bu Seed/lb (1000)	Seeding Rate	Planting Dates	Planting Depth	Comments
Cool-Season Legumes					
Alfalfa (p)	60 (227)	B: 20-25 lb/ac D: 15-20 lb/ac	Spring and Fall	B or D 1/4-1/2	Use cultipacker and inoculate. Provides browsing and bugging. March–November.
Austrian Winter Peas (a)	60	B or D: 30- 40 lb/ac	Sept. - Nov.	1 in	Provides browsing and seed October–April.
Clover, Arrowleaf (a)	60 (400)	B: 10 lb/ac	Sept. - Nov. 15	1/4 - 1/2 in	Best on fertile well-drained soils. Provides browse in late spring into summer. Inoculate seed.
Clover, Ball (a)	60 (1000)	B: 2-3 lb/ac	Sept. - Oct.	1/8 - 1/4 in	Tolerates poor drainage/low fertility. Provides browse March–April. Heavy re-seeder.
Clover, Berseem (a)	60 (207)	B: 20 lb/ac D: 10-15 lb/ac	Sept. - Oct. 15	1/4 in	Good on wet soils. Provides browse in early winter and spring into summer. Shred and lightly disk to reseed. May lack winter hardiness in some areas.
Clover, Crimson (a)	60 (150)	B: 20-30 lb/ac	Sept. 15 - Oct. 15	1/4 in	Inoculate at planting. Provides browse in early winter and from late winter to spring. Mow to promote reseeding.
Clover, Red (p)	60 (272)	B: 15 lb/ac	Sept. 15 - Oct. 15	1/4 in	Inoculate at planting. Provides winter browse.
Clover, Subterranean (a)	60 (54)	B: 15-20 lb/ac	Sept. 15 - Nov. 15	1/2 in	Inoculate at planting. Provides early winter and early spring browse.
Clover, Ladino White (p)	60 (800)	8-10 lb/ac	Sept. - Nov. 15	1/4 in	Use inoculated seed. Provides late spring-early summer browse. Fertilize annually. Many new varieties available.
Clover, White Dutch (p)	60	6-8 lb/ac	Sept. - Nov. 15	1/4 in	Use inoculated seed. Provides late spring-early summer browse. Fertilize annually.
Cool-Season Grasses					
Oats (a)	32	B or D: 2- 4 bu/ac	Sept. - Nov. 15	1 in	Provides grazing, bugging and seed from fall to early summer.
Rye (a)	56	B or D: 1- 2 bu/ac	Sept. - Nov. 15	1 in	Provides grazing, bugging, and seed. Tolerates early planting better than other small grains. More cold hardy than other small grains.
Ryegrass (a)	24	B: 40 lb/ac for grazing.	Sept. - Oct.	1 in	Best on fertile soils. Provides grazing and bugging through winter.

Crop	Lbs/ Std. Bu Seed/lb (1000)	Seeding Rate	Planting Dates	Planting Depth	Comments
Triticale (a)	48	2 bu/ac	Sept. - Nov. 15	1 in	Provides grazing, bugging and seed from fall to early summer.
Wheat (a)	60	B or D: 1 1/2 - 2 bu/ac.	Sept. - Nov. 15	1 in	Provides grazing, bugging and seed from fall to early summer.
Warm-Season Legumes					
American Jointvetch (Aeschynomene) (a)	~	15-20 lb/ac	April 15 - July	1/2 in	Provides high quality browse from June until frost. Tolerates deer browsing.
Alyceclover (a)	60 (301)	15- 20 lb/ac	May - July	1 in	Inoculate, cultipack. Provides browse and bugging June until frost. May re-seed.
Cowpea (a)	60	B: 1-2 bu/ac. Plant 30- 40 lb/ac in 36" rows w/ plants 3-4" apart.	April - Sept.	1/2 - 1 in	Prefers well-drained soils. Provides browse, bugging, and seed in late summer.
Lablab (a)	60	B or D: 15-20 lb/ac	May - June 15	1-2 in	Prefers well-drained, fertile soils. Provides high-quality browse June–September.
Soybean (a)	60	B or D: 1-2 bu/ac Plant 45 lb/ac in 36” rows	May - July 15	1 in	Inoculate seed sites not previously planted in soybeans.
Reseeding Soybeans (a)		B or D: 40-50 lb/ac	May - July 15	1/2 - 1 in	Prefers well-drained soils. Provides browse, bugging, and seed from early fall through winter. In high deer population areas plant late-maturing variety.
Partridge Pea (a)	~	B or D: 10-15 lb/ac	March - April 15	1/2 in	Moist sites preferred but will produce on all soils. Provides seed through early winter. Will reseed if disked or burned in winter or early spring.
Warm-Season Grasses					
Corn (a)	56	Plant seed 9-11 in apart in 36” rows	March - May 15	1-2 in	Best on fertile, well-drained soils. Provides seed in fall. Use a variety that resists worms and has ears close to the ground.
Grain Sorghum (Milo) (a)	56	Plant 4-8 lb/ac in 36" rows w/ 3- 5 plants/ft.	May - July 15	1 in	Provides seed in fall and early winter. Sensitive to low ph and low phosphorus soils.

Crop	Lbs/ Std. Bu Seed/lb (1000)	Seeding Rate	Planting Dates	Planting Depth	Comments
Egyptian Wheat	~	Plant 5-8 lb/ac in 36" rows w/ 3- 5 plants/ft.	May - July	1/2 in	All soils. Used primarily in strips or patches for quail. Provides seed in fall and early winter.
Browntop Millet (a)	14	B or D: 25 lb/ac Plant 8-10 lb/ac in 36" rows.	April - Aug. 15	1/8 - 1/4 in	Prefers well-drained soils. Can be planted in dewatered ponds for ducks. Provides seed in late summer to mid fall. Plant in rows or disk strips for dove.
German (Foxtail) Millet (a)	50	B: 20 lb/ac. Plant 6-8 lb/ac in 36" rows	April - June	1/8 - 1/4 in	Good on all soils. Provides seed in late summer.
Japanese Millet (a)	35	B or D: 20-25 lb/ac Plant 8-10 lb/ac in 36" rows.	July - Aug. 15	1/4 - 1/2 in	Will tolerate wet soils. Good in dewatered ponds. Provides seed in fall to early winter. Keep water off until 10 in. high.
Pearl Millet (a)	48	B or D: 25-30 lb/ac	May - July	1/4 - 1/2 in	Well-drained soils. Cover for ground nesting birds
Dove Proso Millet (a)	35	B or D: 20 lb/ac.	April - July 15	1/4 - 1/2 in	Prefers well-drained soils. Provides seed from midsummer to fall.
White Proso Millet (a)	35	8- 10 lb/ac in 36" rows. D: 20 lb/ac	April - July 15	1/4-1/2 in	Provides seed from midsummer to fall.
Native Warm-season Grasses					
(Native Bunch Grasses)		Indiangrass, big and little bluestem need specialized planting procedures. There are several varieties of native grasses available. Contact your local NRCS or Extension office for detailed planting recommendations.			Nest cover for quail and turkeys. Cover for rabbits. Burn in winter to maintain.
Switchgrass (p)	~	B or D: 2 lbPLS/ac	March - May	1/4-1/2 in	Always use lbs of pure live seed (PLS) when calculating planting rates for native grasses. Use a cultipacker to establish a firm seedbed for all bunch grasses. Specialized planting procedures call for using special drills or adding inert matter to facilitate broadcasting fluffy seed.
Indiangrass (p)	~	B or D: 3lbPLS/ac	March - May	1/4-1/2 in	
Eastern Gamagrass (p)	~	B or D: 7 lbPLS/ac	March - May	1/2 in	
Big Bluestem (p)	~	B or D: 3lbPLS/ac	March - May	1/4-1/2 in	
Little Bluestem (p)	~	B or D: 3lbPLS/ac	March - May	1/4-1/2 in	
Brassicas					
					Use specialized browse varieties. High protein browse.
Kale (a)	~	D or B:3-4 lb/ac	April - June	1/4-1/2	Browse for fall and winter.
Rape (a)	~	D or B: 2-5 lb/ac	April - June	1/4-1/2	Browse for fall and winter.
Turnip(a)	~	D or B: 1-3 lb/ac	April - June	1/4-1/2	Browse for fall and winter.

Crop	Lbs/ Std. Bu Seed/lb (1000)	Seeding Rate	Planting Dates	Planting Depth	Comments
Other Plantings					
Buckwheat (a) (warm-season)	~	B or D: 30 lb/ac	April - August	1/2- 1	Provides browse seed and some bugging May–November.
Chicory (p) (cool-season)	~	B or D: 10 lb/ac	Sept. - Oct.	1/4-1/2	Browse from March to October.
Chufa (a) (warm-season)	~	B or D: 25 lb/ac Plant 6 to 12 plants/ft in 36" rows.	May - July	1-1 1/2	Tubers preferred by turkeys and water fowl. Rotate every 2-3 years. Prefers "new" soils.
Rice (a)	45	B or D: 90-125 lb/ac	April - June	1	Blackbirds can be a problem. Provides fall seed for waterfowl. Flooding preferred.
Sesame (Benne) (a) (warm-season)	~	5-6 lb/ac in 36" rows	May 15 - July 15		Prepare a clean, smooth seedbed, cultivate for clean rows. Provides seed in late summer. Do not plant on same site 2 years in a row because of disease.
Sunflower (a) (warm-season)	32	Plant 8-12" apart 36" rows	April - July	1	Prefers well drained soils. Provides seed from late summer through fall.

Key:

a) annual p) perennial
B) Broadcast D) Drill

Notes:

Most plantings prefer a soil pH range from 5.8 to 6.2.
Clovers and alfalfa prefer a soil pH range from 6.2 to 6.5.
Clemson Extension recommends a soil test before planting any crop.
Refer to *EC 711 Weed Management Guide*.

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Recommended Legume/Clover Varieties:

Alfalfa: Upstate: Alfagraze, Ameristand 403, Bulldog 505
Low Country: Bulldog 805, Amerigraze 702
Arrowleaf Clover: Apache is highly preferred for virus resistance, but Yuchi is acceptable.
Ball Clover: Ball
Berseem Clover: Bigbee
Cowpea: Iron and Clay
Crimson Clover: Dixie is widely available and remains a good variety.
AU Sunrise and AU Robin give earlier forage production, but seed are in short supply and difficult to find.
Lab Lab: Rio Verde, Rongai
Lespedeza: Marion
Red Clover: Upstate: Bulldog, Cimarron Plus, Redlan Max
Low Country: Cherokee, Southern Belle
Soybean: Hinson, Tyson (both non RR and forage types)
Subterranean Clover: Mt. Barker
White Clover, Ladino: Osceola, Regal, RegalGraze, Will
White Clover, Intermediate: Durana, Patriot, Resolute