MANAGING THE FAMILY FOREST IN MISSISSIPPI

DEPARTMENT OF FORESTRY, MISSISSIPPI STATE UNIVERSITY
MISSISSIPPI STATE EXTENSION SERVICE, U.S. FOREST SERVICE
MISSISSIPPI FORESTRY COMMISSION

Managing the Family Forest in Mississippi

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Introduction

Mississippi is blessed with some of the most productive and diverse forestland to be found anywhere in the United States. These lands range from the bluff hills surrounding the Delta Region, to stream and river bottoms and floodplains, to clay hill uplands. Mississippi has about 19 million forested acres, approximately 66 percent of the state's total acreage. These forests play a very important role in the ecology and economy of Mississippi.

About two-thirds of these 19 million acres of forestland in Mississippi are owned by more than 300,000 nonindustrial private forest (NIPF) landowners. There are as many different management goals and levels of activity on these acres as there are forest landowners. To some of these landowners, forest management means only management for timber production. However, in its broadest sense, forest management means management of forestland for the continuous production of goods and services. This can include timber, but it also includes aesthetic values, wildlife protection, water quality, and the pure enjoyment of owning timberland. It is important that you manage your land for those values that are most important to you.

This publication is a collaboration of the U.S. Forest Service, Mississippi Forestry Commission, Mississippi State Extension Service, and the Departments of Forestry and Plant Pathology and Entomology at Mississippi State University. It will serve as a primer for forest management for private forest landowners statewide and contains information on various topics, including the importance of having a management plan, pine and hardwood regeneration and management, management practices for multiple uses, best-management practices for water quality, forestry economics, taxes, and forest health. For more detailed information on any of these topics, feel free to contact your county office of the Mississippi Forestry Commission, consulting forester, or Mississippi State University Extension Forester.

1 The Management Plan

Britton Hatcher, Extension Associate II
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What

What would you think of someone starting an automobile trip in an unfamiliar area without a roadmap or an unidentified destination?

Adventurous? Unwise? Forest landowners who operate without a management plan are very much like that person driving without a roadmap. Many of us would not dare attempt to travel across our country without the aid of a map or GPS to help us navigate from point A to point B. It would be a long uncertain trip with no guarantee of reaching our destination. Many people, however, are willing to do this with their forestland. A well-prepared forest management plan serves as a roadmap (a series of scheduled activities) showing how to reach a predetermined destination (your management objectives). A management plan can save money, increase profits, and decrease taxes.

Do I Need a Forest Management Plan?

Timber and timberland are valuable assets, and landowners cannot afford to ignore the importance of proper management. A forest-management plan will provide you, as a landowner, the direction you need to successfully reach your goals and objectives in a precise and efficient manner. A plan can also reduce your chances of making costly mistakes that may take years to overcome.

In addition to providing direction for forestry-related activities on the property, a plan may also provide an opportunity for you as a landowner to obtain assistance through state and federal cost-share programs. These programs can provide financial assistance for responsible management practices. Limited funding under such programs is available on a first-come, first-serve basis.

Of course, if your objectives change, you may need to modify your management plan. In summary, an approved forest-management plan is necessary for you as a forest landowner to have your forestland certified, such as with the American Tree Farm System, Forest Stewardship Council, or any number of the certification programs world-wide.

Determine Goals and Objectives

When determining goals and objectives, you must start with forest-management planning. A plan will help you determine where you want your property to be at some point in the future. This process helps identify opportunities and resources available on your property. Remember that opportunities and resources may vary depending on your goals and objectives. A plan can help you concentrate on enhancing the aspects and values of your forestland that are most important to you. These aspects and values can be aesthetics, immediate financial returns, long-term financial gains, inheritance values, recreational opportunities, improvement of wildlife habitat, and possibly others.

Once you have determined where you want to go, you need to determine where you are based on your goals and objectives. Inventory and evaluate your property's resources to help determine where you are. A detailed inventory can tell you a lot about your property, such as stand types, landscape features, and wildlife information. Remember that if your goals and objectives change over time, additional data collection will be necessary.

Once you have determined where you are, the next step is to take the necessary actions to get where you want to be. Specific activity tables listed in the management plan detail how, when, and where to implement scheduled management activities to help obtain your goals and objectives.

Obtain a Written Forest Management Plan

Obtaining a written plan is easy; however, there are several things to consider. As noted above, the first step is to determine your goals and objectives. The next step is to seek the help of a professional. Most often, landowners seek the help of a private consulting forester. Private consulting foresters charge a fee for their services, but once they are hired, they are obligated to represent your best interest while working for you. They can take your goals and objectives and turn them into a proactive plan that will help you reach your goals. In addition, the Mississippi Forest Commission, through the Forest Stewardship Program, can produce management plans for landowners for a small fee. If you are interested in this program, contact your MFC County Service Forester.

A good forest-management plan has many components; however, not all plans are the same and can vary from simple to complex. Some of the components that should be included in the plan include these: ownership goals and objectives, a detailed property boundary description, inventory data, management recommendations, activity schedules, and maps of the property.

At the end of this chapter is a sample management plan you can use as a guide in developing a plan of your own. A forest-management plan is one of the most important tools landowners can have when making important decisions concerning the future of their forestland. A plan needs to be flexible so that it can be changed as key decision-making factors change.

References

Florida Forest Stewardship – Forest Management Plans.
www.sfrc.ufl.edu/extension/florida_forestry_information/forest_management/plan.html

Mississippi Forest Stewardship Program. www.mfc.state.ms.us/landownerassistance/la5.htm

FOREST MANAGEMENT PLAN

for
John Doe

222 Acorn Road
Pine Valley, Mississippi 39341
Property located in
Your County, America

Field data collected and prepared by
Joe Q. Consultant
Trees R Us, Inc.
P.O. Drawer 1645
Big Town, America 39759
662-333-9199

Time period covered by this plan
2008 – 2018

Date prepared
April 9, 2008

INTRODUCTION

This management plan was prepared for John Doe to serve as a guideline for the management practices undertaken in order to satisfy his stated landowner objectives. The plan covers activities utilized to improve the quality of timber and wildlife resources available on the property and includes recommendations for maintaining the soil, water, and aesthetic quality of the site.

In addition to providing direction for forestry-related activities on the property, this plan may also qualify the landowner for various state and federal cost share programs such as the Forest Resource Development Program (FRDP), which provide financial assistance for responsible management practices. Limited funding under these programs is available on a first-come first-serve basis and this plan does not guarantee that assistance will be awarded.

LANDOWNER OBJECTIVES

The landowner's primary objective is to maximize timber income with some consideration for wildlife while making the property aesthetically pleasing. Would like to leave enough timber to sell at death in order for one son to buy out other siblings' share of estate without debt.

TRACT DESCRIPTION

Tract Location

This property is located in Sections 10, 11, 14, and 15, Township 14N, Range 15E in Your County, America, approximately 11 miles west of nowhere.

Tract Acreage

The Sample property consists of approximately 460 acres, which can be divided into

124 acres of pine plantation, established 2000

220 acres of pine plantation, established 2007

65 acres of bottomland hardwoods, and

51 acres of other/open land.

Accessibility of Tract

Accessibility to the tract is excellent in all areas.

Hydrology

Special protection must be given on this property to maintain the water quality. This protection will be done through the use of streamside management zones (SMZ's) and other precautions identified in the Best Management Practices (BMP's) guidelines. Intermittent streams and a pond are the only water sources that will need protection on this site.

Historical, Cultural, or Archeological Features
These areas can range from old cemeteries or Indian mounds to old home sites or other areas of historical significance. There were no such areas of historical, cultural, or archeological value identified on the property.

Soil Series Present
The USDA Soil Survey of Your County shows the following soil series present on the site:

Cahaba Series – Cahaba soils are well-drained soils found on uplands. They are usually associated with Lexington, Luverne, Providence, and Susquehanna soils. These soils are well suited to both pines and hardwoods. The erosion hazard for these slopes is severe due to the slope.

Ruston Series – Ruston soils are well-drained sandy soils found mostly in the eastern part of the county on hilly uplands with side slopes of 12 to 50%. These soils are best suited for pine production.

Stough Series – Stough soils are somewhat poorly drained sandy loam soils located on upland flats and nearly level stream terraces. These soils have a slight erosion hazard and are best suited for loblolly pine production.

Soil Types Present
(CaA) Cahaba fine sandy loam, 0 – 2% slopes – This well drained soil occurs on terraces and is low in natural fertility and organic matter. These soils have a slight to moderate equipment limitation and erosion hazard. Loblolly pine is the best-suited timber species for this soil type with a site index of 75 – 85.

(RuB2) Ruston fine sandy loam, 2 –5% slopes – This a well-drained soil type found on upland ridgetops. RuB2 soils are best suited for loblolly pine production and have a site index of 84 for this species. Both the erosion hazard and equipment limitations are considered slight, so there are no significant restrictions for properly conducted forest management activities.

(StA) Stough fine sandy loam, 0 – 2% slopes – This somewhat poorly drained soil is found on nearly level stream terraces and upland flats. Although sites containing this soil type are moderately suited for cherrybark and water oak production (site indices are 85 and 80, respectively), they are best suited for loblolly pines and have a site index of 90 for this species. The erosion hazard is slight and equipment limitations are considered moderate due to potential wetness, so forest management activities involving heavy equipment use should be restricted to dry periods.

STAND DESCRIPTIONS AND RECOMMENDATIONS

For management purposes, it is common practice to break property down into different stands that are similar in age class distribution, species composition, and structure. Each stand identified in this document will contain all areas on the property that should be managed under the same management regime. The following stand(s) are present on this property:

Stand 1 – Pine plantation, established 2000

This area contains approximately 124 acres of 8-year-old pine plantation. Deer and turkey habitat is considered good to fair for this stand. Soil types present on the stand are as follows: CaA, and RuB2 (See "Soil Types Present").

There is currently no evidence of any existing erosion problems or any threats to water quality in this stand. Care should be taken in any management activities to ensure that no such problems occur in the future. This can be accomplished by using Best Management Practices (BMP's) in forestry operations, which are discussed in a separate section of this management plan. A Streamside Management Zone (SMZ) will be needed around the stream if any logging operations are carried out on the property.

Prescription

This stand is currently in good condition. Let it grow until age 14 –16 and check for a first thinning. A prescribed burn is needed prior to thinning.

Stand 2 – Pine plantation, established 2007

This area contains approximately 221 acres of pine plantation. Deer or turkey habitat is considered good to fair for this stand type. Soil types present on the stand are as follows: CaA, (See "Soil Types Present").

There is currently no evidence of any existing erosion problems or any threats to water quality in this stand type. Care should be taken in any management activities to ensure that no such problems occur in the future. This can be accomplished by utilizing Best Management Practices (BMP's) in forestry operations, which are discussed in a separate section of this management plan.

Prescription

This stand is in good condition and should be left to grow.

Stand 3 – Bottomland hardwood

This area contains approximately 65 acres of bottomland hardwoods. The average age is 60 years. The average basal area is 80 square feet/acre. The stand is 75% sawtimber and the rest is pulpwood. The major hardwood species present are these: white oak, hickory, water oak, and cherrybark oak. Deer and turkey habitat is considered good for this stand type. Soil types present on the stand are as follows: StA (See "Soil Types Present").

There is currently no evidence of any existing erosion problems or any threats to water quality in this stand type. Care should be taken in any management activities to ensure that no such problems occur in the future. This can be accomplished by using Best Management Practices (BMP's) in forestry operations, which are discussed in a separate section of this management plan.

Prescription
Maintain this stand as a hardwood stand. Thin periodically to promote establishment of desired hardwood regeneration. An alternative to thinning would be to make small clearcuts for regeneration.

WILDLIFE CONSIDERATIONS

Habitat Assessment and Recommendations
Overall, this tract currently offers good habitat for deer and turkey. Keep in mind that most silvicultural practices recommended for timber management also enhance wildlife habitat.

Threatened and Endangered Species
There wasn't evidence of any threatened or endangered species noted on this property while conducting the field visit.

TENTATIVE 10-YEAR ACTIVITY SCHEDULE

Year	Stand #	Activity
2009		
2010		
2011	3	Check for timber stand improvement or clearcut
2012		
2013	1	Check for first thinning
2014		
2015		
2016		
2017		
2018		

This schedule is a timetable of suggested timber management practices that will assist you in meeting the stated objectives for your property. It is highly recommended that you seek professional assistance before performing any of these activities.

2 Site Preparation

Andrew Londo, Professor and Extension Forestry Coordinator
Department of Forestry, Mississippi State University

Introduction

Site preparation includes any number of treatments used to prepare a site for regeneration. Proper site preparation will increase early survival and long-term productivity of regeneration.

The choice of which site-preparation technique you use should be based upon which site-limiting factors are present. These site-limiting factors include drainage, competing vegetation, debris on site, and soil compaction.

Drainage

Drainage is a common problem found in many areas of Mississippi. Floodplains and other areas inundated with water for significant parts of the year can cause problems for regeneration. Mechanical methods are the only effective ways to alter site-drainage problems. All of the commercially important pine species, as well as most hardwood species, perform better on well-drained sites.

The common way to reduce the impacts of a high water table found in saturated soils is to "bed" the site. Bedding is the use of a bedding plow, or disks, to create aerated beds in which to plant trees. Thousands of acres in Mississippi have been planted using bedding. The key is to get the trees established in the well-aerated soil of the beds.

Competing Vegetation

Competing vegetation can significantly reduce the early survival and growth rates of your new stand of trees and will result in longer rotation ages with less volume and value harvested in the future. Many species of plants will compete with your newly regenerated forest, but they can be broken down into the broad general categories of grasses, broadleaf herbaceous weeds, vines, and woody plants. The single best method for reducing competing vegetation is through the use of herbicides.

A number of herbicides can be used in managing your forestland. Since chemicals and formulations change frequently, you should obtain a copy of the current Mississippi State University Extension Publication 1532 *Mississippi Weed Control Guidelines*. These guidelines are updated annually to reflect changes in chemicals, formulations, and application methods. This publication is available from your county Extension Service office, and can be found online at: msucares.com/pubs/publications/p1532.html. Additional help is available from MSU Extension foresters, MFC Service foresters, and any

number of consulting foresters and herbicide company representatives and applicators across Mississippi.

It is important to use the right chemicals for the vegetation found on your site. The chemicals your neighbor used on his property may not work on the vegetation found on your property. Also, follow all label directions for proper handling, preparing, applying, and storage of all herbicides. More information on herbicide safety and use can be found at: www.MSUCares.com/forestry.

Debris on Site

One of the single biggest limitations on many sites is the presence of slash and other logging debris. Slash makes it more difficult for trees to be planted, and makes natural regeneration difficult. In addition, the slash left behind can be a fire hazard. A number of treatments are available to remove this slash:

• Years ago, crushing and roller chopping were used to reduce debris on the site. This involves either a large self-powered machine or a chopper towed behind a bulldozer, breaking up the debris and incorporating it into the soil. This method works reasonably well for reducing slash on site; however, it can compact the soil and is very expensive, especially when compared to other site-preparation treatments. In addition, this process does nothing for controlling competing vegetation. The high costs and lack of vegetative control resulting from these treatments have resulted in a dramatic reduction in the use of crushing and roller chopping across the southern United States.

• A common way to remove slash and debris from a site is to create windrows. A bulldozer with a plow or a rake moves across the site, pushing the debris into piles. These piles can then be burned in place or left to decompose naturally. This method makes nice, clean planting sites, but it also removes topsoil when the windrows are made. The burning of these piles is problematic because of the heavy amounts of smoke produced and the long burning times associated with burning windrows.

• Prescribed burning is another treatment for reducing the amount of debris on site. Prescribed burning for site preparation is normally done in the fall while the weather is still hot and dry. This is to ensure that the large debris left on site is sufficiently dry enough to burn. Before conducting any forestry burns, the guidelines spelled out in the Mississippi Prescribed Burning Act of 1992 should be followed. A full description of these regulations can be found in Chapter 10.

Soil Compaction

Most soil compaction problems in Mississippi come from the presence of "plow pans" in old agricultural fields. Over time, the movement of a plow over the same site at the same depth creates a dense, semi-impervious layer of soil called a "plow pan." Some soils also have what's called a "fragipan." These pan layers are dense and restrict the flow of water and the roots' ability to grow through them. Breaking, or fracturing, these pan layers is key to the early growth and survival of planted seedlings.

Pans are fractured by the use of a sub-soiling shank pulled by a tractor or a bulldozer. Typically, the shank is pulled at a depth of 12-18 inches, which is usually deep enough to fracture plow pans. Fragipans that are deeper than that cannot be easily fractured.

Disking is often used to loosen the top few inches of the soil. While this makes the site look nice for planting or making food plots, it does very little to improve overall soil compaction and does even less for vegetation control. Care must be taken on slopes to avoid erosion.

Site-Preparation Costs

All of these site-preparation methods have a cost associated with them which must be considered during planning for regeneration. Many landowners want the "Cadillac" treatment when a "Chevy" treatment would work just fine. It's important to remember that you should pick the treatment you need based on your site, goals, and finances.

While costs fluctuate and change over time, some generalities can be made. Mechanical treatments tend to be the most expensive. It costs a lot of money to haul in a bulldozer and to drive it across a site. It is common to combine multiple treatments into a single-pass operation. For example, many operators today have a bedding plow, subsoiling shank, and shearer all attached to the same bulldozer. This "three-in-one" plow dramatically reduces the cost of using the three treatments individually. Still, this is the most expensive of all site preparation treatments.

Most forestry herbicides are applied with a helicopter. The costs for herbicide site-preparation treatments are typically around $80-100/acre, depending on the acreage being treated, the chemicals being used, and the application rate. Some applicators use skidders or tractors for ground applications instead of a helicopter. Individual stem injection can also be used in certain situations. The costs are typically comparable across all methods.

Prescribed burning is the least expensive of all the site-preparation treatments, costing about $20 per acre. Again, it's important to remember with prescribed burning that all guidelines spelled out in the Mississippi Prescribed Burning Act must be followed.

Summary

Many site preparation options are available to landowners, ranging from disking and bedding, to prescribed burning, to herbicides. In many cases, these methods are combined to provide the best possible conditions for favorable regeneration. For example, prescribed burning in the fall is often used following a summer herbicide treatment to remove slash, as well as recently killed competing vegetation.

It is important to remember that these treatments all have costs associated with them. It may be more cost effective to have your property treated in combination with others in your area. This reduces the fixed costs for the operator involved with moving equipment, thus reducing the cost to the landowner. Also, herbicide application companies prefer to treat a large number of tracts while they are in a given area. Talk to a consulting forester or applicator for information.

Site-preparation treatments should be tailored to your site. What was needed on your neighbor's property, or on other property you own, may not be needed on another property. All of the site-preparation practices discussed create costs up front, which will ultimately reduce total earnings. You might want to follow the rule-of-thumb concerning site-preparation activities: do as much as necessary to get your stand regenerated, but as little as possible as far as costs are concerned.

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3 Natural Regeneration of Southern Pines

Jon Kushla, Assistant Professor
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The use of pine plantation forestry has increased across this country since the middle of the 20th century. Industrial ownership of large tracts of land favored the systematic approach of clearcutting, followed by tree planting.

Such artificial regeneration methods permitted these owners to use tree-breeding methods to create seedlings with highly desirable characteristics, helping them to achieve their management objectives. Many nonindustrial private forest landowners followed with this type of forest management. While artificial regeneration is scientifically acceptable and highly successful, foresters know that it is not the only way to grow southern pines.

The first and second forests of this country were not plantations. The southern pines are pioneer species and are adapted to establishment in open areas. The South has mild winters with warm, humid summers and frequent thunderstorms. Lightning regularly sets fires to the southern forests, creating open areas. Most all of the southern pines have adapted to fire ecosystems by necessity. These adaptations might include thick bark, such as on longleaf pine (Figure 1), or serotinous cones which disperse seeds after a fire, such as with sand or Virginia pines.

Figure 1. Naturally regenerated stand of longleaf pine in southern Georgia. (Photo courtesy of J. D. Kushla)

Figure 2. Naturally regenerated stand of shortleaf pine near Counce, Tennessee. (Photo courtesy of J. D. Kushla)

Indeed, the archaeological, geological, and paleobotanical records shed clues as to the nature of our forests over the past eons. The vast primeval forests of pre-Columbian America developed in response to environmental pressures. In the southern United States, these environmental pressures included global warming, fire, and man. As the climate warmed, glaciers since the last ice age, 10-12 thousand years ago, receded northward. In response to this warming, the forests of the southern United States also changed from beech-hemlock-white pine to the oak-hickory-southern pines that we see today. Meanwhile, Native Americans observed the effects of fire on the forest. They regularly used fire to clear areas for agriculture, and to create wildlife habitat for hunting. Consequently, pre-Columbian forests were a mosaic of settlements, farmed fields, and open woodland savannas.

Natural regeneration succeeds with the forester using an appropriate method that matches the ecological requirements of the tree species desired (Figure 2). There are many advantages to using natural regeneration. Costs are less because seedlings are not bought and planted. Moreover, since trees remain on the site during the entire process, the system is more aesthetically pleasing. This is particularly important to many nonindustrial private forest landowners. However, natural regeneration often involves a longer time from growing the trees until final harvest. Managing for solid-wood products such as sawtimber, which commands much higher prices, can offset the greater cost of a longer rotation length.

Several silvicultural techniques are used for natural pine regeneration. These techniques can be examined in two broad categories: even-aged or uneven-aged methods. Even-aged natural regeneration allows the seed to fall and germinate over a short period of time (about 5 years) creating a growing stand of trees that are of similar age.

On the other hand, uneven-aged regeneration involves managing multiple-age classes (three or more) of a forest in the same time and space. The result is the perpetual appearance of a forest with trees of many sizes and ages across the entire area.

Even-Aged Natural Regeneration of Pines

All the even-aged natural regeneration systems involve three phases during the life of the stand or crop rotation. The initial phase, which may take a few years, is the regeneration phase. This is followed by a phase of intermediate treatments to manage the stand while it is growing. These treatments may include prescribed fire, thinning, and/or competition control with herbicides. The intermediate treatment phase is very important to accomplishing the landowner objectives, and to achieving success of natural regeneration at final harvest. Prescribed fire enhances wildlife habitat. Thinning improves the quality of timber for final harvest and ensures that high-quality trees remain for seed production. Competition control of undesirable hardwoods with herbicides ensures that pines will dominate the site. The final phase occurs toward the end of the rotation when cutting is done in the harvest stage to encourage a good seed crop, and subsequent removal of those crop trees.

There are four even-aged regeneration techniques. They vary by how many trees are left on the site, and how much light/shade is present for the new stand of pines. Even-aged methods include strip clear-cutting, seed-in-place, seed tree, or shelterwood. The technique appropriate to use depends on site conditions and the tree species desired for the final stand. Each method is examined in the following sections.

Strip Clear-cut Method

The technique of strip clear-cutting involves using complete harvests that are long, but narrow (Figure 3). Seed must fall from adjacent stands. Therefore, the strips gen-

Figure 3. Example of strip clear-cutting on loblolly-shortleaf stand. (Photo courtesy of J. M. Guldin).

erally do not exceed 200 feet in width, and are often narrower. Once a stand has matured and is producing seed, strip clear-cutting starts on the leeward (predominant direction of the wind) edge and proceeds across the stand in a perpendicular direction to prevailing winds. Large areas of forestland can be regenerated using several interspersed strips.

This method of natural regeneration is particularly well suited to pines that are intolerant to shade and consistently produce good seed crops. These pines would include Virginia, loblolly, and shortleaf pines. This is the recommended method of naturally regenerating Virginia pine, which is very shade intolerant and tends to invade denuded landscapes such as clear-cuts, retired farmland, or mining spoils.

Adequate site preparation for the seedbed is necessary to ensure sufficient seed germination and initial stocking. If logging does not sufficiently expose the mineral soil on the site, chopping or herbicide application with prescribed burning may be necessary. As such, strip clear-cutting is not recommended on steep terrain because it increases the soil-erosion hazard.

Seed-in-Place Method

This method is a variation to clear-cutting, but the harvesting is not necessarily done in strips. Regeneration comes from mature cones left on the ground after harvesting operations. To be successful, logging slash must be dispersed across the site, since the cones with the slash provide the seed source. Logging should be timed before seed fall. If the site is brushy, a prescribed burn before logging may be necessary for seedbed preparation. This technique is suited to species that consistently produce good seed crops such as shortleaf or Virginia pines. Heat from fire opens the cone and releases the seed. Logging slash from these stands has a ready seed supply that could be released by a winter prescribed burn. If logged during the summer, heat reflected from the soil surface may also be sufficient to open the cones (Figure 4).

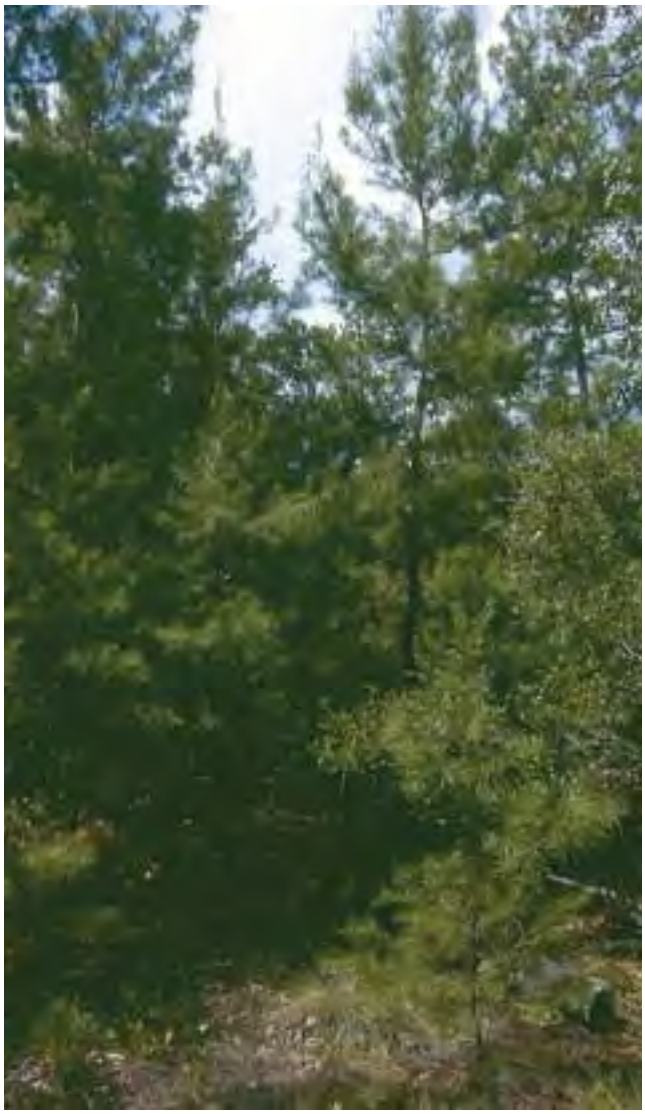

Figure 4. Natural regeneration of Ocala sand pine from seed-in-place, Volusia County, Florida. (Photo courtesy of J. D. Kushla).

Seed Tree Method

This cutting method leaves a few trees on the site to provide seed fall from mature cones. The reproduction cutting occurs twice. The first harvest, or seed cut, removes most of the trees, leaving as few as possible to provide seed for regeneration. Usually, 4-15 trees per acre between 14-18 inches in diameter are retained. The selected seed trees should be scattered as uniformly as possible across the site and should be prolific seeders with good form and disease free.

Once adequate reproduction is established, the second harvest removes the seed trees. Logging operations serve to thin the often profuse regeneration of pine seedlings. The time between harvest cuts may vary with seed crops, but is generally about 5 years.

Again, seedbed preparation is necessary to ensure adequate success of seed germination and initial stocking. If logging operations were not adequate to scarify the site, additional treatments such as burning, chopping, or disking may be necessary.

The seed tree method of natural regeneration is suited to those species having good seed crops on a frequent basis, such as 3 to 5 years. Examples include loblolly, shortleaf, and slash pines (Figure 5).

Shelterwood Method

This technique for even-aged pine regeneration is a variation of the seed tree method, but with more trees left on the site to provide seed. The shelterwood method is highly flexible and provides greater assurance of regeneration success. This technique allows sufficient sunlight to reach the ground, making it suitable for intolerant species, including all of the southern yellow pines: loblolly, longleaf, shortleaf, and slash pine (Figure 6).

Generally, 15-30 trees between 14-18 inches in diameter per acre are left for seed production. Since more trees are left than with the seed-tree method, harvesting takes place in three cuts. The first is the preparatory cut, usually made 5 years before the seed cut. This is similar to a final thinning because it removes inferior or weakened individual trees so that remaining trees can expand their crowns for cone production. The second cut is the seed cut for the final crop of trees to provide seed. Again, the final trees selected should be prolific seeders, straight, and of overall good form. After 5-10 years, the removal cut is made to take out the seed source. A longer time may be permitted to allow for adequate seeding.

Figure 5. Seed tree cut for shortleaf pine in the central Ouachita Mountains. (Photo courtesy of J. M. Guldin)

Figure 6. Shelterwood cut for loblolly-shortleaf pine in the Piedmont National Wildlife Refuge, Georgia. (Photo courtesy of J. D. Kushla)

Indeed, this approach is most useful for longleaf pine, which produces an erratic seed crop (Figure 7). The preparatory cut should leave 40-50 trees per acre that are at least 16 inches in diameter and well spaced. Vegetation control is essential at this time to encourage crown expansion and cone production. The seed cut should favor the most prolific seed-producing trees (those averaging 65 cones per tree). Given the erratic nature of long- leaf seed production, it is best to monitor the cone crop before executing the seed cut. Prescribed burning before seed fall will encourage germination. Minimal damage during the removal cut is done when seedlings are about 2 years old. Longleaf regeneration should be followed by prescribed fire which controls brown spot needle blight and helps promote expansion from the grass stage.

Figure 7. Longleaf Shelterwood in the Escambia Experimental Forest, southern Alabama. (Photo courtesy of J. M Guldin).

Uneven-Aged Regeneration Systems

These systems of managing pine forests are challenging to the forester, requiring constant attention. Continuous forest cover is maintained across the entire landscape, with regeneration cuts mimicking small scale disturbance. The rotation age is generally longer than with plantation forestry, but high quality sawtimber is produced.

In an ideal situation, the uneven-aged forest has a continuous range of tree ages. The forester uses diameter-size classes as a proxy for tree age. So, there are a few large trees, more medium size trees, many small trees, and countless seedlings. While the abundance of trees is inversely related to their size, the ratio of a given size class to the next larger class should remain constant. The forester uses this ratio, along with periodic inventories, to plan removals of growing stock in each size class of trees.

Since a distribution of age or size classes is maintained across the entire forest, cutting is done periodically in all sizes, rather than simply harvesting at the end of a rotation. Each cutting cycle would involve removal of trees for final harvest and regeneration, as well as thinning the smaller size classes to improve timber quality and control the amount and distribution of growing stock. So every cutting cycle includes harvesting, intermediate cuttings, and reproduction. Thus, in a regulated uneven-aged forest, every cutting cycle would produce similar amounts of pulpwood, chip-n-saw, and sawtimber products.

This system of management is very flexible, since the forester controls the amount of removals in each cutting cycle across the entire forest. Consequently, if conditions are far from ideal in the distribution of size classes, the forester can adjust cutting levels in each cycle to eventually achieve a more even flow of forest products over time. In these situations, removals in each cutting cycle are guided by other means than stand structure.

Besides the even flow of the different forest products, several objectives must be achieved during every cutting cycle. The most important among these is the establishment of pine reproduction, which is essential for sustaining the forest. In addition, the intensity of the cutting must be precisely planned, and must match the site conditions. Cutting allows a steady and healthy growth rate for all pines. Too much removal of growing stock reduces the volume production, whereas too little hurts regeneration. Finally, most southern pines are pioneer species. As such, hardwood encroachment must be controlled with periodic use of herbicides or frequent prescribed burning to maintain pine dominance.

There are two approaches to uneven-aged silvicultural systems. One involves single-tree removal for regeneration; the other approach uses group selection of small patches to accomplish stand establishment.

Single Tree Selection

Single Tree Selection occurs in very small areas by the removal of one or two mature trees. These openings typically do not exceed one-tenth of an acre in size. Maintaining the proper amount of removals in subsequent cutting cycles is essential for the health and sustainability of regenerating trees. Removals regulate the amount of light/shade, affecting volume growth of the overstory and vigor of the reproduction.

Single tree selection has been used successfully on the loblolly-shortleaf type at the Crossett Experimental Forest of southern Arkansas for more than 50 years (Figure 8). The USDA Forest Service acquired the property in 1934 as abandoned forestland that was cutover in 1915. Pine stocking was variable, and the entire area was over- grown with hardwoods. Regeneration had been occurring from residual pines since the last harvest. Therefore, the forest had an uneven-aged structure, although the size class distribution was not regulated. Uneven-aged silviculture restored even the poorest stocked areas within about 20 years.

Both the loblolly and shortleaf pines respond well when released from nearby competing trees. Individual trees must have a good leader, a crown length at least 20 percent of the total tree height, and a diameter at the crown base of at least 2 inches. Proper cutting produces a uniform diameter growth. Because regeneration is present throughout the stand, prescribed burning is difficult to use. Consequently, periodic herbicide application is necessary to control hardwood encroachment.

Group Selection

This approach to uneven-aged management uses larger patch clear-cuts than the single-tree system. Patches are still small, generally between one-half and two acres. There are some advantages to this approach. Reproduction is generally easier to obtain since more light reaches the ground. The clear-cuts are also large enough for use as log decks and allow for site-preparation activities such as burning, chopping, or disking.

This system has been used successfully with longleaf pine (Figure 9) which is well adapted to fire, which historically created a mosaic of uneven-aged forest structure with even-aged patches. Most regeneration will survive in canopy gaps, since the buildup of straw around mature trees burns hotter, killing reproduction.

Summary

Natural regeneration methods are suitable for all the southern pines. These techniques are often appealing to nonindustrial private forest landowners since they are more aesthetically pleasing and have lower regeneration costs. Pines can be managed as even-aged or uneven-aged. The longer rotations associated with natural regeneration are offset by the production of high quality saw timber. Periodic tree removals through harvests, thinning, or cutting cycles will permit a more steady income. The control of unwanted hardwoods and herbaceous species is essential to ensure regeneration of desired species.

Figure 8. Pine regeneration with uneven-aged silviculture on the Crossett Experimental Forest, southern Arkansas. (Photo courtesy of J. D. Kushla)

Figure 9. Longleaf regeneration in patch using group selection for uneven-aged silviculture. (Photo courtesy of J. M. Guldin).

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4 Artificial Pine Regeneration

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Artificial regeneration can be defined as the planting of trees or broadcasting of seeds for the regeneration of forest land.

The most common and successful method for artificially regenerating pine trees is through planting. It is important to note, however, that planting in and of itself does not guarantee success. The overall success of your planting operation depends on a number of factors including these: matching the species to the site, seedling quality, proper handling and planting of seedlings, and in some cases, the proper use of direct seeding. We will discuss all of these factors in this chapter.

Matching the Species to the Site

Four commercially important southern pines are planted each year in Mississippi. These include loblolly pine, shortleaf pine, slash pine, and longleaf pine. The choice of the species to plant is the decision of the landowner because on many sites more than one of these species will grow.

- **Loblolly Pine**

The most widely planted species is loblolly pine. Loblolly pine naturally grows well throughout most of Mississippi and currently produces more than half the total timber volume harvested across Mississippi annually. The landowner needs to be aware of several insects and diseases that are pests of Loblolly pine (see Chapter 13). Also, Loblolly pine is susceptible to damage from ice and wind storms that periodically strike Mississippi.

- **Shortleaf Pine**

Another commercially important pine is shortleaf pine. Shortleaf pine grows naturally throughout Mississippi; however, it is rarely planted. Loblolly pine is favored for its rapid growth rates. However, shortleaf pine is a viable alternative on well-drained and drought-prone sites in north Mississippi and where damage from ice is severe. Shortleaf pine is resistant to fusiform rust but is very susceptible to southern pine beetles.

- **Slash Pine**

The natural range of slash pine includes the lower gulf coastal plain, which includes the southernmost counties in Mississippi. Slash pine is sometimes planted in the lower coastal plain for pulpwood, saw log, and pole production. Natural stands tend to grow very slowly if not thinned early to maintain sufficient room for the crowns to mature. Slash pine has been planted further north in recent years, only to suffer from ice damage and severe fusiform rust in-

fections. In many cases, sites suitable for slash pine in the lower coastal plain have been planted to loblolly pine, which is faster growing and is more resistant to fusiform rust. Slash pine is, however, better suited for the strong winds associated with hurricanes along the coast. On suitable sites in the lower coastal plain, it may be advantageous to plant slash pine to help reduce the damage inflicted by future hurricanes.

• **Longleaf Pine**

Longleaf pine once dominated the lower coastal plain forests of Mississippi. The natural range of longleaf extends from the coast to Claiborne County on the west and Kemper County to the east. The longleaf forests have declined because of extensive logging in the 19th and 20th centuries, changes in land use, and a reduction in fire frequency. Across its range, longleaf pine has been replaced by loblolly pine and mixed hardwoods. Periodic fires once kept competing vegetation at bay, which enabled the more fire-resistant Longleaf pine to dominate the landscape.

An issue many landowners have with longleaf pine is the grass stage. Longleaf pine is unique among the southern pines and is only one of three pines in North America that have a grass stage. During this grass stage, very little height growth occurs. This grass stage may last for up to 8 years or more, but it can be shortened by using high-quality seedlings in containers, proper planting techniques, and adequate site preparation with herbaceous weed control, especially during the first growing season.

Longleaf pine is less susceptible than the other southern pines to fusiform rust, southern pine beetles, and other insect pests. It can be planted on appropriate lower coastal plain sites. Planting longleaf pine too far north will leave it susceptible to ice damage. Also, in some areas, seedlings are susceptible to the brown spot needle blight fungus. When brown spot infestations are severe and prolonged, seedlings will die. Table 1 compares many traits of the four southern pine species discussed above:

Table 1: A comparison of traits found in commercially important southern pine species in Mississippi.

	PINE SPECIES			
TRAIT	**Loblolly**	**Slash**	**Longleaf**	**Shortleaf**
Fusiform Rust Resistance	2**	3	1	1
Susceptibility to Southern Pine Beetle	2	3	4	1
Drought Resistance	3	4	2	3
Cold Tolerance	2	4	3	1
Resistance to Ice Damage	2	4	3	1
Tolerance to Poor Drainage	2	1	3	3
Fertility Requirements	2	1	3	3
Resistance to Stand Stagnation	3	4	3	2
Resistance to Wind Damage	4	2	2	3

** Adapted from Ezell, et al 2001.*
***Ranking: High =1, Low = 4*

Comparing Species

Species selection in Mississippi is normally easy since loblolly pine is preferred on most sites. Landowners in the southern coastal plain are faced with several alternatives and must compare species to determine which is best for their sites and their long-term goals. The common problem is deciding between loblolly pine and slash pine. Slash pine has historically been favored along the lower coastal plain, not only for timber production, but also for the production of resin and turpentine. However, the rapid growth and flexible site-requirements for loblolly pine have resulted in an increase in acres planted to loblolly pine.

The following comparisons should clarify slash-loblolly pine selection in the lower coastal plain. It is critical to match the species to the site. Soil properties and drainage are often used to decide between planting slash pine or loblolly pine on a particular site. Some generalizations have been made to compare loblolly, slash, longleaf, and shortleaf pines in the coastal plain:

- Slash pine is usually preferred on poorly drained lower coastal plain flat wood sites; loblolly is better suited on well-drained sites.

- Slash pine grows better than loblolly on poorly drained sites where phosphorus is limited if the site is not fertilized. (A soil test can determine if your site is deficient in phosphorus.)

- On well-drained sites with a moderate occurrence of fusiform rust, both loblolly and slash pine perform about the same.

- Longleaf and slash pines are well suited for resin and turpentine production.

- Slash pines have been genetically improved for fusiform rust resistance. Loblolly pine has been genetically improved for faster growth.

- Loblolly pine is more susceptible to attack by southern pine beetles than slash or longleaf pines.

- In areas prone to high winds from tropical storms and hurricanes, slash pine and longleaf pine are better able to withstand damage than loblolly pine or shortleaf pine.

One last thing to keep in mind is the level of genetic improvement that you want your seedlings to have. Landowners have a choice of getting seedlings from either state or private nurseries that offer a selection of genetically improved seedlings, first generation, low density, containerized, 1.5 generation, etc. The choice of what to plant often depends upon your own resources and goals. However, understanding how these genetically improved seedlings are made, and what it all means, will allow you to make a better informed decision on which seedlings you plant.

What Is a Genetically Improved Seedling?

Forest-tree improvement is the process of selectively breeding trees under controlled conditions to produce genetically superior trees and seed. For southern pines, this process began by selecting superior trees in natural stands in the 1960's. Superior trees were selected based on such factors as good form and fast growth. After several of these superior trees were selected in the field, scions, or branch tips, were collected and grafted onto seedlings in an orchard. An orchard is a type of nursery where seed will ultimately be collected from trees of known parents.

The grafted seedling takes on the characteristics of the grafted tip and is grown in the orchard. These grafted seedlings are planted in combination with other grafted and nongrafted seedlings. After about 10 to 15 years, these seedlings begin to flower and produce seed. These seeds are first-generation seeds.

The first-generation seeds are planted and become first-generation seedlings. These seedlings are said to be "improved." Some of these seedlings are subsequently planted in a progeny test. A progeny test allows for the seed orchard manager to take periodic measurements of the seedlings. The ultimate goal of this is to determine which of the first-generation seedlings have the best traits. The seed orchard manager then selectively breeds the best of these first-generation seedlings to create a second- generation seedling. Second-generation seedlings are said to be "advanced generation." Third-generation seedlings would be made in the same manner by selectively breeding the best of the second-generation seedlings.

In addition to the first, second, and third generation seedlings already discussed, there are also 1.5-generation seedlings. A 1.5-generation seedling is a first-generation seedling that comes from a parent first-generation tree that has proven to have very good characteristics, such as rapid height or diameter growth over a longer time period.

Other Seedling Terms

There are other terms used in describing seedlings. The following list contains several commonly used terms that you may encounter when ordering seedlings:

Containerized Seedlings: These are seedlings grown in a greenhouse in plastic tubes rather than in a nursery bed. They have a fully intact, well-developed root system and are more expensive than traditional nursery bed seedlings.

Low Density: Seedlings typically grown in nursery beds at 25 seedlings per square foot. Low-density seedlings are grown at 18 seedlings per square foot, or at a "lower density" in the nursery bed. These low-density seedlings typically have better developed stems and roots.

Morphologically Improved: Seedlings that have been selected for good form and quality in the nursery. They are often called low-density seedlings .

Why Plant Genetically Improved Seedlings?

Because of the time involved with growing and creating improved seedlings, they cost more than unimproved seedlings. Also, costs increase with each generational increase, usually by about a penny per seedling. However, genetically improved seedlings will, on average, generate greater volumes and provide a larger return on your regeneration investment. A rule of thumb concerning genetically improved seedlings is that each generation increase in improvement (for example, from first generation to second generation) will result in a 10 percent increase in growth. The increase in growth has three benefits for the landowner. First, there is an increase in volume over a given period of time. Second, faster growth results in earlier thinnings and shorter rotation lengths. Third, because of increased growth, there are potential early changes in product class. In other words, you may be able to get higher value chip-n-saw wood at a second thinning than lower value pulpwood.

Seed Source and Planting Zones

Seedlings are now available for private landowners from more sources than ever before. It is important to remember that seedlings produced out of state may or may not be appropriate for planting in certain areas of Mississippi. When ordering seedlings, especially from out-of-state nurseries, make sure you ask about the geographic origin of the seed source. Most nurseries will not knowingly sell you seedlings that will be unsuccessful in the area you are planting.

Ordering Seedlings

Once you have selected the species you want to plant, it's time to order your seedlings. Planning ahead is crucial to ensure that you get the seedlings you want. Most state and private nurseries start taking seedling orders in mid-summer. You should place your seedling order early to ensure that you get enough of the seedlings you want to meet your planting needs.

A number of decisions should be made before ordering your seedlings. These decisions include the species, the number of seedlings you need, and when and how they will be delivered. In many cases, your consultant, or the tree-planting company contracted to plant your trees, will have already taken these issues into account. Make sure that you, your consultant, and tree planter understand exactly what it is you want.

To determine the number of seedlings to order, consider the following items:

- How many acres do you want to plant? Acreage can be determined by actual field measurements, or it can be estimated from maps, aerial photos, or other records.

- What is the spacing you will use? Most pine plantations today are established with about 600 trees per acre. This number is flexible and is based on landowner objectives and seedling availability.

Seedlings are planted at different spacings to achieve the desired density, or number of trees per acre (Table 2). The general trend is to increase the space between rows. This improves access for harvesting equipment during thinning operations and for fire-fighting equipment in the event of a wildfire.

- When ordering seedlings, make an allowance for cull seedlings. In the past, this cull factor was as high as 10 percent. Today, with improved nursery practices, equipment, and seedling quality, a cull factor of 1-2 percent should be more than sufficient.

A minimum number of seedlings planted per acre may be required for state or federal cost-share programs. Make sure you know what those requirements are. For questions about the Forest Resources Development Program (FRDP), contact your county office of the Mississippi Forestry Commission. For information about the Conservation Reservation Program (CRP), or Wetlands Reserve Program (WRP), contact your local USDA Service Center.

Table 2: Spacing and the resulting seedlings per acre.*

Spacing (Feet)	Number of Seedlings Per Acre	Spacing (Feet)	Number of Seedlings Per Acre
6x8	907	9 x 9	537
6x9	806	9 x 10	484
6x10	726	9 x 11	436
6x11	660	9 x 12	403
6x12	605		
		10 x 10	435
7x7	888	10 x 11	396
7x8	777	10 x 12	363
7x9	691		
7x10**	**622**	12 x 11	330
7x11	565	12 x 12	302
7x12	518	12 x 15	242
8x8	**680**	15 x 7	414
8x9	**605**	15 x 8	363
8x10	**544**	15 x 9	322
8x11	495	15 x 10	290
8x12	453	15 x 15	193

**** Adapted from Ezell, et al.***
*****Values in bold type represent common planting densities***

For example, the number of seedlings you need to order for planting 35 acres at 7-feet x 10-feet spacing:

1. 7-feet x10-feet spacing = 622 seedlings per acre (Table 2)

2. 35 acres x 622 seedlings per acre = 21,770 seedlings

3. 1% cull factor: 21,770 x .01=218 seedlings

4. 21,770 + 218 = 21,988 total seedlings needed.

5. Round up to the next thousand = 22,000 seedlings needed*

****Pine seedlings are sold by the thousand, so always round up to the nearest thousand to ensure you have enough seedlings.***

Delivery Dates

Planting season typically begins in December and runs through mid-March. These dates can be extended somewhat based on weather conditions. However, the most successful planting comes from seedlings lifted from the nursery beds in January and February.

Planting too early can result in seedlings not being dormant when lifted, creating more "transplant" shock. Hard frosts can kill seedlings that have not gone dormant. This dormant period is also called hardening off. Hardening off occurs when the seedling is fully dormant and is no longer growing. Fully hardened-off seedlings can be kept in cold storage for up to 8 weeks.

If large acreages are to be planted, or if you expect delays during the planting, arrange with the nursery to ship seedlings at different times to accommodate the planting schedule and to get the seedlings planted as soon as possible after lifting.

Seedling Storage and Care

Pine seedlings are typically packed and shipped in open-ended bales, wax-coated cardboard boxes, or bags. These packages are specially designed to protect the seedlings during shipping and storage.

Proper storage conditions must be present before planting to ensure the seedlings will be suitable to plant. It is best to plant seedlings as soon as possible. Never store seedlings that were lifted early or late during the planting season because they may not be totally dormant.

When you receive the seedlings from the nursery, ensure that they are protected from high temperatures, freezing temperatures, direct sunlight, and wind. If you pick up the seedlings from the nursery or from some other distribution point, make sure you can keep the seedlings cool and damp for the trip home. Arrange to pick up seedlings in the afternoon and schedule long-distance hauling so that it's done during the night when it's coldest outside. If an open truck or trailer is used, cover the seedlings with some kind of tarp or canvas to protect them from wind. Make sure air can circulate around the seedling boxes/bags/bundles to ensure that heat doesn't build up.

To prevent water loss from open-ended bales, avoid exposing the bales to wind and sun during transport. Avoid stacking bundles more than two bundles high because the weight will damage seedlings on the bottom of the stack as well as reduce air flow, thereby, increasing the potential for heat buildup on the bottom.

If possible, place your seedlings in a cold-storage facility. Dormant seedlings can be kept for several weeks at temperatures of 33-36ºF and high relative humidity. Baled seedlings may require watering to keep the roots and tops wet. Always allow excess water to drain from the bales to prevent mold from forming on the seedlings. Damage from a lack of water drainage is evidenced by a sour smell and discolored seedlings.

Most landowners do not have access to cold-storage facilities, which makes it even more important to plant seedlings as soon as possible after receiving them. When seedlings can't be planted immediately, a landowner may have to rely on storing them in a garage or shed where the temperature cannot be controlled, but where the seedlings can be kept out of the wind and sun. Warm weather will severely limit the amount of time seedlings can be stored in this manner.

If seedlings freeze, let them thaw out before separating or planting them. Immersing them in cool water for up to an hour can help them thaw out more quickly. Freeze-damaged root systems will appear to be limp and discolored. These roots will slough off very easily during handling. Discard all seedlings that have freeze damage.

Preparing Seedlings for Planting

Seedlings of various sizes and qualities may be present in your order. Nurseries typically do a good job of selling consistently high-quality seedlings, and some nurseries even grade them to a uniform size before packaging. Others try to grow uniform seedlings in the nursery beds to reduce handling when they are lifted. In either case, it is important to grade the seedlings before planting. Remove the ones that are too small or too large. Discard seedlings with poor root systems, broken stems, missing bark, missing needles, or that are otherwise damaged.

Before seedlings are taken to the field and given to the planters, they should be graded in a cool, high humidity area that is protected from wind and sun. As seedlings are removed from their packages, dip the roots in water or some other medium to keep them moist. Do not allow seedlings to sit in water for more than an hour. Allowing planters to grade seedlings in the field slows down the planting and can result in cull- seedlings being planted.

One or two people should be able to handle the grading and any root pruning that needs to be done. Grading guidelines are provided in Table 3:

Table 3: Grading guideline for southern pines.*

Species	Height (Inches)	Root Collar (Inches)	Condition of Stem	Needles/ Fascicle	Winter Bud
Lobolly & Slash Pine	6-12	1/8+	Stiff, Woody	2's and 3's	Usually Present
Longleaf Pine	8 Clipped, 12 unclipped	1/2+	Not Present	Large, 2's and 3's and free of brown spot	Thickly Scaled
Shortleaf Pine	6-10	1/8+	Stiff, Woody	2's and 3's	Usually Present

**** Adapted from Ezell, et al 2001.***

An optimum root system is 6 to 8 inches long with at least 5 or more strong first-order lateral roots that are at least 3 inches long. Use seedlings with root systems that are 5 to 6 inches long with good lateral root development. If root systems are more than 8 inches long, the seedlings will be difficult to plant correctly without special care and supervision during planting.

Any root pruning that takes place should be done by the graders, never by the planters in the field. Pruning in the field results in roots being torn off, ultimately leading to poor survival. Prune roots with scissors, shears, hatchets, or machetes by making a single clean cut and removing as few of the roots as possible. It is important to keep the root system proportional with the stem. Prune roots to no less than 8 inches for seedlings with 8-12 inches in tops.

Seedling Care in the Field

In addition to proper storage, you must also take care of seedlings in the field if your tree planting is to be successful. Take only as many seedlings to the field as you will need that day. If possible, have them delivered to the planting site twice a day to keep seedlings as fresh as possible.

The quality of your seedlings will decline quickly if they are handled poorly in the field. Keep the seedlings out of the wind and sun to so that they will stay cool, damp, and fresh. Ensure that there is good ventilation around the seedling packages to keep heat from building up. To keep heat from building up, do not place seedlings under a tarp during the day in the field. At night, a tarp can be used to keep the seedlings from freezing.

When giving seedlings to planters, open and empty one container/package at a time. Planters should carry the seedlings in bags or buckets with some water in the bottom to keep the roots cool and moist. Never allow seedlings to be carried by hand with the roots exposed while planting.

Planting

The key to the survival of your planted seedlings is the ability of their roots to quickly begin taking up nutrients and water. Seedlings should be planted in moist mineral soil where water can be readily taken up by the roots.

Depending on the site, both hand and machine planting can be used successfully. Large, clear, and open tracts may be more easily planted by machine than by hand. Small tracts of land or irregularly-shaped tracts with fair amounts of debris on site may be better suited for hand planting.

When machine planting, it is critical that the planting depth be properly set. Planting too deeply will cause the seedling roots to dry out, and planting at too shallow a depth will result in u-rooted seedlings. Both will result in high mortality. Regardless of the planting method, plant seedlings at the correct spacing and depth so that the roots are not deformed and the soil is properly packed around the roots. This will eliminate air pockets that will cause the seedlings to die.

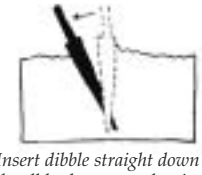
It is very important to have a written contract with the planter, specifying all planting details. This includes transportation and handling of seedlings, planting dates, number of seedlings and spacing, conditions when planting is to be suspended (the site is too wet or dry, freezing or summer-like temperatures). The contract should also specify guidelines for inspections during planting to insure that seedlings are properly planted before payment is made.

Hand Planting

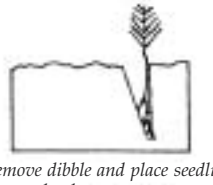
A good hand-planting crew can average about 1,000 seedlings per man-day, depending on the site, weather, etc. Most hand-planting crews in Mississippi use a tool called a "dibble bar" for planting. A dibble bar has a blade that is at least 4 inches wide and 10 inches long. Planters should carry seedlings in a bag, never in their hands as they walk across your site. Remember, it only takes a couple of minutes for a seedling that is exposed to wind and sun to dry out and die.

For successful planting, proper dibble bar technique is just as important as proper seedling handling (Figure 1):

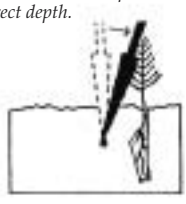
Figure 1. Proper Dibble Bar Technique



1. Insert dibble straight down in soil and pull back to open planting slit.

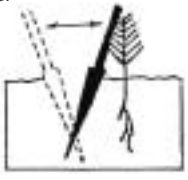


2. Remove dibble and place seedling at correct depth.

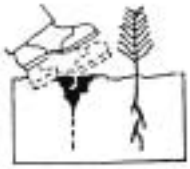


3. Insert dibble part way, push and twist forward closing top of planting slit.

4. Push dibble straight down to depth of blade.



5. Rock dibble back and forth to pack soil firmly against root.



6. Fill in last hole by stamping with heel.

It is important that there be a crew foreman or supervisor on site. It is the crew foreman's job to ensure that seedlings are being properly handled and planted. Any concerns you have should be brought to his attention first. The following items should be checked during the planting job:

• Check the distances between planted seedlings frequently both within and between rows to insure proper spacing.

• Use a shovel to check for air pockets around the roots of planted seedlings as well as the presence of any J-rooted seedlings (Figure 2)

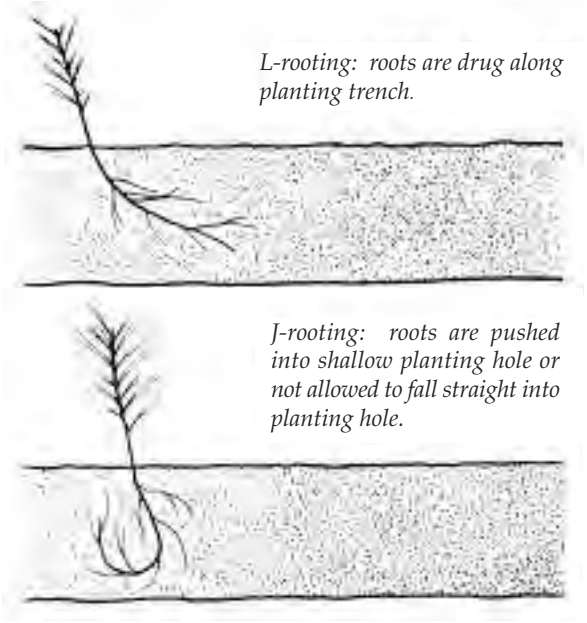
Be sure to report any inconsistencies with planting or concerns you may have with the crew foreman.

Machine Planting

Using the right machine on the right site can result in many thousands more seedlings planted per day. Just as with hand planting, frequently check planting performance to insure proper planting, especially when soils or the amount of debris on the site changes.

The planters should make sure that the packing wheels are set properly, to insure that there are no air pockets around the roots of your newly planted seedlings. Also, seedlings should be planted straight and at the proper depth. Planting them too quickly or not deep enough can result in L rooting (Figure 2) which will likely cause your seedling roots to dry out and die.

Figure 2. "L" and "J" Rooting



Planting Conditions

The reason the planting season extends from December through March is that it is the coldest and, typically, the wettest time of year. The best planting conditions occur when the temperature is between 33 and 60 degrees fahrenheit, relative humidity is greater than 40 percent, and the wind speed is low. Also, the soil should be good and moist. Dry soils are not only difficult to plant in, but they also provide unsuitable conditions for early root growth and survival. Do not plant in freezing weather or summer-like conditions.

Container-Grown Seedlings

An increasing number of nurseries are producing containerized seedlings. These are seedlings that are grown in containers in a nursery greenhouse. These seedlings are often called "plugs." Containerized seedlings offer many advantages over traditional bare-root seedlings:

• The seedling roots are protected by the container they are in, making them less likely to be damaged during transport and planting.

• The planting season can be lengthened by planting earlier in October or later into April.

• Seedlings can be machine or hand planted—but whichever method is used, make sure that the planting hole is large enough to accommodate the entire "plug."

Evaluating Planted Stands

A simple method to determine trees per acre is to measure 100th acre plots throughout the plantation. A 100th acre plot has a radius of 11 feet, 9.3 inches. A center stake and a piece of string, twine, or bamboo pole cut to this length can be used to determine a plot. All seedlings within the plot are counted. For each plot, record in Table 2 the number of seedlings that are free to grow, the number of seedlings that are live but growing under weeds, and those that are dead. If the seedlings are dead, it is important to dig them up to determine why they died.

An adequate sample is about one plot per acre, with usually no more than 30 plots evenly distributed throughout the plantation. Each plot is recorded separately on the tally sheet (Table 4). Count the number of living seedlings with little weed competition (called "free-to-grow"), the number of live seedlings under heavy weed competition, and the number of dead seedlings. If the plantation has just been planted, assume all seedlings are free to grow. (Note that if the planting was in a grass pasture, it should not be con-

sidered free-to-grow unless scalping or adequate chemical site prep was done.) From these data, calculate free-to-grow, living and total seedlings per acre. Formulas can be found in Table 4. Percent survival can also be determined.

If competing vegetation is too thick to collect data on plots, row counts can be used instead. You can go down a row and count where 10 trees are supposed to be, based on the spacing. This will give you percent survival. A number of rows from across the plantation should be counted in this way to get an accurate estimate of survival for the entire plantation. Reasons for mortality could be accounted for in the same way as plots. Record data in Table 4.

Table 4: Pine plantation evaluation form. Measure one plot per acre up to 30 plots.

Determine stocking – Count number of trees in 100th Acre Plot = 11ft. 9.3 in. radius				Planting Quality: Evaluate seedling near plot center (also dead)	
Plot	**Number of Live Seedlings Free-To-Grow**	**Number of Live Seedlings Under Weeds**	**Number of Dead Seedlings**	**√ if Planting Quality Fails**	**Reason: L or U root, not packed, too shallow, root pruned,too deep-longleaf**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
Total	A=	B=	C=	D= # Plots Failing =	

** Adapted from Londo and Dicke, 2006.*

Evaluating the Data

Trees per acre. Plantation density is a personal decision based on your management objectives as well any requirements associated with a cost-share program. For most plantation spacing, plots should average 500 to 700 live seedlings per acre (Table 2). If the average seedling count is low, you should re-evaluate the site and decide on whether to re-establish the plantation. No plot should have less than 3 live seedlings (300 seedlings per acre).

New plantings. Replant if planting quality fails. Once a planting job passes inspection, the vendor should be paid.

First growing season. By late spring, the number of live free-to-grow seedlings should be well over 300 per acre. If weed competition is severe, herbicide release applications are warranted to release seedlings from competition. If the number of free-to-grow seedlings drops below 300 per acre, landowners have three viable options:

1. Do nothing. Look forward to having a mixed pine-hardwood stand (about half the value of a mature pine plantation).

2. Rehabilitate plantation. Apply release herbicide over the seedlings. A viable option only if release herbicide can control weeds. (Note that many herbicide rates sufficient to control woody competition may injure slash and longleaf seedlings in the first growing season. Always follow current herbicide label instructions.)

3. Start over. Apply herbicides at site-preparation rates and replant. Good option when weeds are too tough for release. (Be sure that all of the existing pines are also destroyed.)

Direct Seeding

Direct seeding is when seed from a desirable species are sown on an area, by hand or from the air. Direct seeding is overlooked by many private landowners as a reforestation option.

There are many advantages to using direct seeding over planting for regeneration:

- Lower initial costs compared to planting.
- Easier to use in remote areas.
- Root systems of trees are natural, no issues with J or L rooting.
- You can treat large areas quickly, with a larger window in which to get it done.

There are also a number of disadvantages to using direct seeding over planting for regeneration:

- As with natural regeneration (Chapter 3), you have no control over spacing and stocking of seedlings.
- Droughty soils will result in high mortality.
- It will take your stand longer to become established; thereby increasing rotation lengths while lowering yields.

Site Selection for Direct Seeding

Any site you can plant, you can also regenerate using direct seeding. The only exception would be on very droughty sites. In general, there are three types of sites that are ideally suited to direct seeding:

- Remote or inaccessible sites
- Sites with low or poor productivity where growth of trees would not make cost of planting economically feasible.
- Any area of land where a minimum investment is essential.

Species Selection for Direct Seeding

Any species can be grown by direct seeding on the right site. For more guidance on species selection, refer back to the species selection for planting.

Site Preparation

Site preparation for direct seeding of pines must accomplish two things. First, mineral soil must be exposed. This can be done by disking or burning. Forest floor and other material can be moved by hand using a rake if necessary. Seeds should be sown directly onto the soil surface.

Some degree of competition control would be highly desirable. Burning and disking will reduce competing vegetation in the short term, but they will not control vegetation in the long term. Not only will controlling competing vegetation help improve the survival and growth of your seedlings, it will reduce the amount of predation by animals on the seed.

Sowing the Seed

Sowing rates are affected by a number of factors, including site condition, seed quality, method of seed distribution, and number of trees desired. There are a number of methods for sowing seed, including from a helicopter, broadcasting from the ground with a cyclone spreader, row seedling, and spot seeding.

With a cyclone spreader, one person can cover 12-15 acres a day. Spreaders can be adjusted to accommodate various seed sizes and can provide uniform seed distribution across the area.

Row seeding seeds are dropped 1-2 feet apart along parallel lines across the area. This is slower than broadcasting since rows are usually 8-10 feet apart. Rows can be placed closer together to ensure better stocking if the site demands it. Spot seeding uses a rake or other tool to clear individual spots which are then seeded. Table 5 provides recommended sowing rates for southern pines.

Where To Purchase Seed

Many of the nurseries that sell seedlings also sell seed. Contact the nursery and ask for prices and species availability.

Table 5: Recommended sowing rates for southern pines.*

Species	Seeds/Pound	Sowing Method	Number of Seeds Per Acre	Pounds of Seed Per Acre
Longleaf	4,700	Broadcast Rows Spots	15,000 2,900 4,350	3.24 0.63 0.94
Slash	14,500	Broadcast Rows Spots	14,000 2,900 4,350	1.11 0.23 0.35
Loblolly	18,400	Broadcast Rows Spots	12,000 2,150 3,650	0.75 0.14 0.23
Shortleaf	48,000	Broadcast Rows Spots	20,000 4,350 5,800	0.48 0.10 0.14

** Adapted from Ezell, 1998.*

Summary

Forest regeneration has long-term implications on the environment, your finances, and the Mississippi economy. You have many options for reforesting your land. The choice of what you do is based upon your own objectives, your finances, and the site in question. Above all else, planning ahead is critical to making your reforestation a success, because forest regeneration is a process, not just an event. If you plan carefully, the chances that your reforestation efforts will be successful will increase dramatically.

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5 Regenerating Hardwoods In Mississippi

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Introduction

The southern hardwood forest has long been managed for a variety of products, ranging from chips for pulp and paper to veneer for high-quality furniture.

Hardwoods are now being used in new technologies, such as bio-energy, phytoremediation (removal of heavy metals and other toxins from the soil), and carbon credits (the selling of carbon stored in the soil and vegetation to offset additions of carbon entering the atmosphere).

Several governmental programs, such as the Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), and the Wetlands Reserve Program (WRP) have also promoted or assisted in the planting of hardwoods throughout the South.

Much of Mississippi's forestland was once owned by large industrial organizations. Today, new landowners are more interested in using their land in a combination of ways, such as recreation, wildlife, and aesthetics. These changes could quite possibly result in reduced harvests and longer rotations where hardwoods are allowed to grow to higher valued products.

It is important to understand that hardwoods, unlike conifers, are very "site demanding." This means that a greater understanding is needed of soil and site conditions before a landowner makes a decision on regeneration. Relatively few commercially valuable hardwood species grow well on very wet or very dry sites. Willows, water tupelo, and cypress are found on sites that are inundated by water most of the year, if not year round. On the other hand, there are extremely droughty upland sites that support blackjack and post oak. In both cases, these two extreme types of sites are difficult to regenerate to highly desirable hardwood species. As a result, the economic returns from these sites will be minimal.

A number of sites between these two extremes, however, will support good hardwood growth of commercially valuable species. A complete understanding of the soil and site condition of these types of sites will allow you to pick the best species to manage on that site. Unlike today's pine in

the southeastern United States, the great majority of hardwood stands are naturally regenerated. The reason for this is that pine, especially loblolly pine, will grow well on a large number of sites and soils throughout the southeast. In addition, the market for pine is much better because pine can be used for chips, structural lumber, veneer, plywood, oriented strand board (OSB), and poles.

A great deal of research has been done on the cost of establishing and growing pine. This research has resulted in an artificial regeneration system that is much more financially viable than similar regeneration systems for hardwoods. This pine system has been aided by research in genetics, silviculture, competition control, physiology, harvesting, and biometrics.

On the other hand, hardwoods have not been researched as much; therefore, natural regeneration of desirable hardwoods is much more cost effective than artificial regeneration. This is the main reason that natural regeneration is a viable option for a hardwood regeneration system. In most cases, this type of system is more difficult and must be approached in a different manner than that of an artificial regeneration system.

Site Selection

Since hardwoods are more site-sensitive than pine, it is critical to match the species to the site. A rule-of-thumb that has been used for a long time was to examine the species make-up of the existing stand and to use that as a guide to determine which species might perform best. However, a great majority of hardwood stands have been high graded. High-graded stands have had all the best stems removed consistently over time, leaving low quality and undesirable stems behind.

A better method would be to use the Baker-Broadfoot Method developed by the USFS Southern Hardwood Laboratory at Stoneville, Mississippi, in 1977. This method can be found in a publication titled "A Practical Field Method of Site Evaluation for Commercially Important Southern Hardwoods," and is available from the U.S. Forest Service, Southern Forest Experiment Station. This method uses the physical condition of the soil, moisture availability during the growing season, nutrient availability, and soil aeration. If followed correctly, this method will provide information on 14 hardwood species, of which 5 are oak species.

To evaluate a site fully for hardwood potential, you must have an understanding of a wide variety of hardwood species, their flood and shade tolerances, their growth habits, ideal soil conditions, and the topographical positions where these species are frequently found. An optimal hardwood site will have deep silty-loam to sandy-loam soil that is fertile with good moisture availability, good soil aeration, neutral to slightly acidic pH, and free of soil pans or other barriers that would restrict root growth. This type of site would produce excellent growth of a variety of hardwood species. However, in most situations, you will not find this type of site but rather sites similar to those shown in Table 1.

County soil surveys will also provide you with valuable information that can be used in the proper site selection. These publications are available from your county Natural Resources Conservation Service (NRCS) office. The key is to examine the site closely by using a soil borer or auger. You should also evaluate the site under various environmental conditions, such as after heavy rains or during different seasons of the year. The importance of selecting or matching the correct hardwood species to a specific site cannot be overstated.

Natural Regeneration

Natural regeneration of desirable hardwood species is not fast, not simple, and is usually one of the greater challenges in hardwood management. It is important to remember that hardwood species can (and will) regenerate naturally. For that reason, many landowners have done little or no actual management. The basic assumption was that "hardwoods had been there before, and they will be there again." That assumption is true, but the regeneration that came back naturally was typically from undesirable species. This partially explains why the high-grading mentioned earlier has resulted in millions of acres of hardwood forests that are covered with hardwoods that are not valuable commercially.

To be successful, the land manager must identify the desirable species best suited for the site and then try to create the conditions that will encourage the establishment and growth of seedlings of those species. To be sure of success with most desirable species, this must be done before the existing stand is removed. Seedlings that are at least 2 feet tall are called advanced regeneration. Advanced regeneration is necessary for successful natural regeneration for most of the desirable hardwood species….especially oaks.

Table 1. Physiographic site position, site characteristics, soil characteristics and possible species commonly found on bottomland and upland sites in Mississippi.

Floodplain			
Front	Good surface and internal drainage	Loam to sandy loam soils - pH will limit species	Cottonwood, sycamore, sweet gum, pecan, water oak, and green ash
Ridge	Moderate surface and internal drainage	Not as fertile as fronts because of age	Sweet gum, willow oak, water oak, green ash, pin oak, and cherrybark oak
Flats	Poor internal and surface drainage	Higher clay content	Nuttall and overcup oak, green ash, sugarberry, water hickory, and persimmon
Slough	Poor drainage, easily inundated	High clay content	Black willow, overcup oak, and water hickory
Stream Terrace	Very good hardwood site but generally very narrow	Good nutrient and moisture availability	Yellow poplar, northern and southern red oaks, black cherry, sweet pecan, black walnut
Upland (Generalized)			
North Slopes	Good site for hardwoods, with slower organic matter decomposition allowing for deeper soil surface layers	High amount of organic matter, better moisture availability	Northern red oak, southern red oak, yellow poplar, black cherry
South Slopes	Droughty site, pan may greatly affect growth, usually poor hardwood site, chert or gravel may be near the surface	Little organic matter, poor moisture availability	White oak, post oak, hickory
Broad Ridges	Usually better than South-facing slopes but depth to pan may determine hardwood potential	Fertility and moisture availability determined by the depth of loess over parent material	Southern red oak, hickory, sweetgum, blackgum, white oak
Coves	Grows some of the best hardwoods, usually deep soils	Excellent moisture availability, fertility above average	Yellow poplar, sugar maple, American beech, white oak, northern red oak, and black cherry
Terrace	Characterized as old floodplains of ancient or current streams, may have fragipans that restrict growth	Fertility varies but lower than floodplain soils as well as typically lower moisture availability	Sweet gum, cherrybark oak, Shumard oak, sweet pecan, black walnut, southern red oak, water oak, and willow oak

Factors To Consider

When naturally regenerating your hardwood forest, the primary factors to consider are species availability (seed sources), seed crop, soil nutrients, available moisture, and light. Soil nutrients and moisture are rarely a problem on good hardwood sites in Mississippi. However, the other factors should be examined.

Seed Source: For best results, the desirable species not only have to be present, but also need to be well distributed across the site. A few desirable species, such as yellow poplar, green ash, and cottonwood are all light-seeded species. Their seeds can be carried a long distance by wind. However, most desirable species, such as the oaks, have heavy seeds that will not travel far from the parent tree. If a species could grow well on a site but is not present, you will have to use artificial regeneration if you want to grow that species.

Seed Crop: All desirable species do not produce a "bumper crop" of seeds every year. For that reason, it is necessary to monitor the seed crop and time the natural regeneration activities in conjunction with a good seed crop. Keep these points in mind:

- Light-seeded species have good seed crops more consistently than heavy-seeded species.
- White oak acorns form and mature in one year.
- Red oak acorns require 2 years to form and mature.

Generally, this means you can depend on the light-seeded species most years. You have to check the white oaks every year, and you can plan a year ahead with red oak species.

Light: Light is the key in regenerating most desirable hardwood species. Generally, these desired species (such as oaks) do not grow well in the shade. However, full sunlight is not necessary. Most oaks actually grow better in partial (33-50%) sunlight as seedlings. However, once established, they generally grow better in full sunlight. It is important for you as a landowner to know the seedling light requirements of the various species.

Regeneration from Sprouts: The previous discussion has focused on seeds and seedlings. This section focuses on sprouts from roots or stumps. We know that hardwoods can and will sprout. The problem is that most of the sprouting that follows harvesting in mature hardwood stands is not desirable. Some species seem to sprout regardless of size or age. A good example of this is the sweetgum tree. Unfortunately, most of the desirable hardwood species do not produce viable sprouts as they age and become larger. If they did, all we would ever have to do is cut large trees, and they would be replaced by one or more sprouts. If sprouts from desirable hardwood species appear following a harvest, they are a welcome addition to the new stand.

Depending on the species, natural regeneration includes the following steps:

- Stand Assessment
- Pre-Harvest Preparation
- Partial Over-Story Removal
- Final Over-Story Removal

Stand Assessment: This procedure is used to determine the presence and distribution of desirable species on the site. It is the essential first step before making decisions about any pre-harvest work and the timing of any operations. If you don't have the sufficient numbers of desirable species on the site, the site will likely need to be artificially regenerated.

Pre-Harvest Preparation: If the stand assessment reveals an abundance of advanced regeneration of desirable species, no pre-harvest preparation may be necessary. Unfortunately, desirable advanced regeneration is rarely present. In addition, mature hardwood stands are usually occupied by stems of undesirable species. These trees may range in height from 8 - 50 feet and in diameter from one-inch or more. They are very effective at intercepting any sunlight that makes its way through the canopy before it reaches the forest floor. This is the reason you may find many small oak seedlings (less than 6 inches tall) from time to time in a hardwood stand, but very few of these seedlings will have enough sunlight to grow to be advanced regeneration or saplings. This is a good example of a situation where the desirable species are present, a good seed crop occurred, moisture and nutrients were adequate, but light was the limiting factor.

If the understory or midstory contains these undesirable stems, they must be controlled before harvest. Again, it is best to do this when a good seed crop is expected so the desirable seeds can take advantage of the conditions. The best way to control the undesirable understory/midstory is to inject the trees with an herbicide solution. The injected trees will die, which will allow light to reach the forest floor and will also decrease the demand for water and nutrients, which the desired seedlings can use.

Injection is best for many reasons: it is selective, meaning that you can leave desirable stems; it costs less than most mechanical options; it controls sprouting, which often happens following mechanical work or fire; it will not damage the desirable trees when done properly; it requires no specialized equipment, can be done by anyone; and it is very effective. If there are stems in the overstory that have no commercial or wildlife value, they should also be injected. A number of chemicals can be used for stem injection. For more information, please refer to Mississippi State University Extension Service Publication 343, *Mississippi Weed Control Guidelines*.

Partial Overstory Removal: The harvesting of overstory trees should be tailored to the species being regenerated. If the desired species are all light-seeded and very intolerant of shade (yellow poplar, sweet gum, cottonwood), you should remove most of the overstory. Seed will disseminate by wind across the area, and the resulting seedlings need all the sunlight they can get.

However, if oaks are preferred, the seedlings will do best in 30-50 percent full sunlight. It is possible that the preharvest injection will allow enough light to reach the forest floor if wind, disease, or past harvests have left sufficient gaps in the overstory canopy. However, if these gaps are not present, or are not sufficient, you should harvest a portion of the overstory. Research demonstrates that harvests that leave 50 square feet of basal area per acre evenly distributed across the site provide optimum conditions for oak regeneration. Basal area is the surface area of a tree measured at 4.5 feet above the ground (diameter at breast height or DBH). The surface area of the tree at DBH is projected onto the ground. This projected area is the basal area for that tree. With enough measurements, basal area can be accurately estimated on a per acre basis.

A professional consulting forester can assist with marking trees that should either be removed or left to achieve the desired species mix and density. A partial removal is also an opportunity to remove any undesirable stems from the overstory. You should time the partial removal to coincide with a good seed crop to ensure that the seeds can germinate and become established while conditions are best. This illustrates how the process can be challenging. Once the decision to regenerate the stand is made and the assessment completed, the timing of operations becomes critical. Seed crops must be monitored and the injection and/or partial removal must be completed in a timely manner for best results.

Final Overstory Removal: It normally takes a few years for desirable regeneration to be classified as "advanced" or "established." For the rapidly growing species such as cottonwood or yellow poplar, this could be only 1 or 2 years. Most oaks and other desirable hardwoods may require 3-5 years. Of course, freezing temperatures, flooding, or other unforeseen events can damage or destroy the seed crop or the smaller seedlings. If this happens, the residual overstory offers an opportunity to capture the conditions created if it is not too long before another good seed crop.

When the desired regeneration is established, the overstory can be removed in one or more harvests, depending on the landowner's objectives. Some owners dislike the appearance of a total clearcut and may prefer to retain scattered overstory trees across the site. Retaining overstory trees indefinitely is acceptable, but the owner must recognize that the residual overstory trees will interfere with the development of the new stand. In addition, these residual trees are often more valuable because of their size and species. These "leave" trees will continue to grow, of course, but they are more susceptible to damaging agents, such as insects, wind, and disease. Leaving the trees behind can result in lost monetary value to the landowner. Overstory removal will damage some of the regeneration present, but unless the root system is pulled out of the ground, the seedlings should recover.

Enhancement Plantings

In some cases, the landowner may want to use natural regeneration, but if the desirable species is not plentiful enough in the overstory to serve as a seed source, or a more diverse species mixture is desired, then enhancement plantings are needed.

In most cases, seedlings being used for enhancement plantings should be larger and possess large root systems. These seedlings will have to be planted with a shovel. Transplanting 100 to 200 trees per acre of this type and quality of seedling will add the needed aspect to your stand. However, care and planting of these types of seedlings are just as important as with any planting operation.

Artificial Hardwood Regeneration

Seedling Quality

A number of variables are important in the production of a quality hardwood seedling. Among these variables are the genetic quality of the seed, nursery and soil characteristics, nursery fertilization and water regimes, seed-

bed density, weed control, shoot and root modification, and insect and disease control. If these variables are correctly addressed, the resulting seedlings will be well suited for survival and growth, even under unfavorable field conditions.

An ideal bare-root hardwood seedling has the following characteristics:

- Between ⅜-inch and ½-inch root collar diameter
- 5 to 8 major lateral roots
- Tap root of about 8 inches
- Shoot with numerous branches

These key characteristics provide the seedling with the best chances of survival and growth, even under stressful establishment conditions. Unfortunately, this ideal hardwood seedling is rarely found in many commercial nurseries. As a landowner, resource manager, or forester, you should recognize this problem and take the appropriate steps to get high-quality hardwood seedlings.

The first step to take is to locate a nursery that has a history of producing quality hardwood seedlings. Talk with others who have purchased seedlings from that specific nursery. If possible, visit the nursery during the growing season and determine the seed-bed density and weed control. Inquire about the geographic and genetic origin of the seed before you purchase it. Never move seedlings of northern geographic sources to southern planting sites. The seedlings need to be graded to ensure that they have the desired characteristics. Grading is the process of sorting the seedlings, removing those that are too small, poorly formed, too small of a root system, etc. This grading should be done before planting, thus eliminating sub-par seedlings and resulting in a higher probability of survival and increased growth rates.

Do not allow root systems to dry during any grading process. It is best to grade the seedlings in a closed building where water is accessible so that the roots can be periodically moistened during the grading process and before bagging. Close planting bags as tightly as possible without injuring the shoots of the seedlings, and then place them in a cooler at 35 °F until planting. Hardwood seedlings can be held for several months in cold storage, but you should periodically inspect the bags and root systems to ensure that no problems have arisen. It is best, however, to plant the seedlings as soon as possible following delivery.

Eastern Cottonwood or Hybrid Poplars. If eastern cottonwood or hybrid poplars are being used, much of the previously stated information is applicable. However, the planting stock with these species will most likely be unrooted cuttings. The size of the cutting will vary. Cottonwood is usually longer in diameter and length as compared to hybrid poplars. A typical cottonwood cutting will be between 14 and 24 inches long with a diameter ranging from ½-inch to 1-inch. In comparison, hybrid poplar cuttings will be about 9 to 12 inches in length with diameters ranging between ⅜-inch to ½-inch.

Cuttings should also be graded before planting so that damaged and poorly formed cuttings are eliminated. Once grading is completed, the cuttings are soaked from 12 to 24 hours to ensure that the maximum moisture levels of the cuttings are attained before storage. They can then be bagged and stored in various ways, but optimally, the cuttings should be placed in thick plastic bags and stored at 28 °F until they are planted.

Below-freezing storage allows much longer storage duration and improves survival. If the cuttings are stored under more typical conditions (such as 35 °F) storage time should not exceed 4 months.

Genetic Quality

Outside of eastern cottonwood, there are few truly genetically superior hardwood seedlings or cuttings currently being produced. Generally, hardwood seed are collected from a variety of geographic areas by various means, including trees from urban areas. Throughout the South, state and private nurseries are growing millions of hardwood seedlings annually, with the vast majority of these seedlings having no genetic superiority and in many cases little or no information of origin. Therefore, the majority of hardwood seedlings are unimproved. While the governmental programs (CRP, CREP, and WRP) previously mentioned have accounted for a great majority of hardwood planting, these programs have focused on water quality, soil erosion, and wildlife habitat, and they have had few instructions on seedling quality.

Information suggests that the use of seed from sources north of the planting site not only results in less growth but could even lead to disease problems and mortality as the stand matures. Hardwood species such as cottonwood and sycamore are exceptionally vulnerable to diseases from northern sources. Therefore, it is always best when purchasing hardwood seedlings to make sure the seedlings are at least from a southern seed source.

As genetic improvement programs for hardwoods progress, improved seedlings may be available in the future. Be sure to ask the nursery if they have any genetically improved seedlings available.

Site Preparation

Hardwood plantations have historically focused primarily on rapidly growing species such as eastern cottonwood, American sycamore, sweet gum, and green ash. Because these species have high demands for light, water, and nutrients, most plantations were established on fertile floodplain or bottomland soils. Successful plantations combine excellent site preparation with intensive herbaceous competition control on the proper sites during the early stages of establishment. Without proper site preparation, intensive mechanical competition control will be greatly hindered, if not impossible. Unlike pine, very few chemicals can be used over-the-top of hardwoods during the growing season. An important point to remember is that there are a number of ways to ensure an excellent stand of hardwoods through artificial regeneration. The amount of money spent can vary greatly and will depend on the amount of mechanical and cultural treatments involved. Growth and survival of rapid-growth hardwoods, such as cottonwood, sycamore, and sweet gum, will improve greatly from intensive mechanical and chemical treatments. However, in most cases these treatments are too costly for private landowners. Other hardwoods, such as oaks, do not demand the extreme measures used for fast-growth hardwoods, and these treatments can be modified, which will reduce costs while producing a quality hardwood stand.

Landowners must carefully consider the cost of site preparation for hardwood plantations. The primary reason is the length of time required for hardwood management. Rotations of 50-60 years (and compound interest) force landowners to be cautious with site-preparation and planting expenses if the operation is to be cost effective.

Most of the land currently being planted is in retired agricultural fields. A relatively small number of natural hardwood stands are being replanted since most of these stands are naturally regenerated. Site-preparation methods that are cost effective for each type of site are discussed in the following sections.

Agricultural Field Sites – You should subsoil all old fields. Decades of mechanical and/or animal traffic result in a restrictive layer in the soil that will reduce planting quality and seedling growth. In most cases, the vast majority of the vegetation on the site will be herbaceous species (grasses or broadleaf weeds). These do not require any chemical site preparation. However, extensive coverage by aggressive vines, such as pepper vines, trumpet creeper, or red vine, will require treatment before planting. The appropriate herbicide treatment will vary with the vines involved. Extensive coverage by aggressive and invasive woody species such as tallow tree will also require chemical site preparation.

Subsoil treatments should be done on either 10-foot or 12-foot centers (based on the desired number of seedlings per acre). The site should be dry and should be timed well in advance of planting so that rain will settle the soil in the trench. September or October before planting is usually the best time. The subsoil trenches will improve planting quality and promote seedling growth and establishment. In summary, subsoil every field. Do not disk or bed because these treatments will not provide any marked control of competing vegetative weeds.

In most cases, the vast majority of the vegetation on the site will be herbaceous species (grasses or broadleaf weeds). These typically require some chemical site preparation to ensure survival of your planted hardwoods. The appropriate herbicide treatment will vary with the herbaceous species, present and the hardwood species being planted. Be sure to apply the appropriate herbicides at the right time for your site conditions.

Natural Stand Sites – Use natural regeneration in these areas if at all possible because site preparation and planting are expensive. If desirable species are not present, many stands should be converted to pine stands. You can under-plant desired species, but the same conditions are required that must be met for natural regeneration (available light, right species on the right site, control of competing herbaceous and tree species).

Establishment

Once you have chosen the site and have matched the correct species to the site, have acquired high-quality seedlings, and have prepared the site to an optimal level during the correct time, the next step of establishment seems to be the simplest. However, when dealing with hardwoods, any of the steps, including the handling and planting of seedlings, are critical to making your hardwood planting efforts a success.

Store the seedlings properly to ensure that they will be in good condition at the time of transplant. Once the seedlings are removed from the cooler, transport them to

the site in a covered vehicle. At the site, keep the seedlings out of the sun and the wind. Once a bag has been opened, the seedling should be planted as quickly as possible. Keep all the seedlings in their planting bags until they are ready to be placed in the ground. Do not prune the root systems. Plant the seedlings well below the root collar. Seal the transplant hole as tightly as possible to promote survival and early growth.

Later in the planting season, it is best, if possible, to machine plant. This will eliminate air pockets and will provide increased contact between the seedlings' roots and the soil, even when the soil is dry. When planting late in the planting season, consider weather conditions, and plant just before rains.

Competition control is important for both natural and artificial regeneration efforts. Control of the midstory and understory is a critical component for all regeneration efforts. In artificial regeneration, chemical site preparation may be required, but it should be used only when asolutely necessary. Another important aspect of competition control is herbaceous weed control in planting areas of old fields. While chemical site preparation in old fields may or may not be necessary, herbaceous weed control (HWC) during the first growing season after planting is critical. It is absolutely essential for cottonwood or sycamore plantings. In years of average rainfall, survival of oak seedlings will be increased by 20 percent. During dry years, survival will increase by 40 percent. Mowing and disking between rows will help keep vegetation down, but it should be done several times during the year, making it very costly. Best control will be achieved if herbicides are applied over the top of the seedlings before bud break and before the weeds break dormancy (pre-emergent). The herbicides used depend on the hardwood species as well as the weed species present.

Direct Seeding

Another method of regenerating hardwood stands, especially the heavier seeded species such as oaks, is to collect the seed and sow them directly. Collect the seed fresh, soak them in water for about 2 hours, float the seed to determine if they are viable, and store them at 35 °F in a sealed plastic bag until they are planted. Plant the seed at a depth of about 2 inches. Plant a large number of seed (700 to 1,000/acre) to ensure a good survival rate. This method has been used primarily on agricultural fields where the primary competition is grass. More information on collecting acorns for regeneration can be found in MSU Extension Service Publication 2421.

High-Graded Stands

High-graded hardwood stands have resulted from an absence of markets for poor quality hardwoods and from decades of removing the biggest and best trees, leaving the rest behind. Viable pulpwood and other markets for small, otherwise commercially undesirable species help to relieve this problem.

Site quality is critical to the possible improvement of degraded stands. Where site quality is poor and not capable of supporting growth of valuable hardwood species, it is best to harvest and plant pines or to accept a pine-hardwood mixed stand. However, if site quality is good but the stand is in a degraded state, you can make treatments to improve the quality of the stand, thus reflecting the potential of the site. You have four options in deciding what to do with degraded hardwood stands:

- Naturally regenerate the stand if there are sufficient high quality desirable trees to serve as the seed trees.
- Artificially regenerate the stand.
- Rehabilitate the stand.
- Leave the stand alone.

There is a simple evaluation of six criteria that will help you decide what should be done. These criteria are stand age, site quality, manageability of trees, number of cull trees, number of desired trees, and advanced regeneration.

Manageability of trees refers to the species, stem form, and the ability of the tree to respond to silvicultural treatments. The target is 30 to 50 square feet of basal area per acre or about 40 to 50 small saw-log sized trees per acre. The silvicultural treatments that will help rehabilitate degraded stands include the following:

- site-preparation techniques of clearcuts
- deferment cuts to favor regeneration of desired species
- control of undesirable species in the mid- and understory
- crop-tree release of the acceptable growing stock
- adjustment of harvest openings to take advantage of regeneration and site quality.

If regeneration is the decided course, the regeneration methods already discussed can be used, along with the appropriate site-preparation and vegetation-control

activities. The use of chemicals to control more shade-tolerant species will be necessary so that the more desired species will have sufficient growing space.

Conclusion

Hardwoods can be regenerated naturally or through the use of seed, seedlings, and cuttings. Natural regeneration is the most economical, and in many cases, the best way to provide sustainable hardwood stands. However, there are times when plantations can be used effectively.

Natural regeneration is effective when adequate advanced regeneration of the desirable species is present at the rates needed to regenerate the site. Artificial regeneration can also be very effective, but there are a number of factors that must be met. These include proper site selection, matching the species to the site, site preparation, and seedling quality. Although these previously stated factors are critical, other factors such as proper handling and planting of seedlings, as well as competition control are also critical to the success of a hardwood plantation.

Other options for establishing hardwood stands are direct seeding and enhancement planting. Direct seeding of a variety of oaks has been successful on a number of sites, especially agricultural fields that have been placed in one of the governmental conservation programs. Many of these direct seeding efforts, however, have failed. Enhancement plantings can also be used on these conservation programs, especially on the Wetlands Reserve Program or Wildlife Habitat Improvement Program land where wildlife is critical to the success of the planting.

Enhancement plantings can also be used in natural systems where the desired species is absent, increased genetic quality is wanted, or a greater diversity of species is needed. Typically, planting seedlings is more dependable than direct seeding and is used more extensively across Mississippi.

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6 Harvesting and Best Management Practices

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A forest-management plan will include some type of harvesting. You may want to grow pine trees as a crop, or you may want to concentrate on wildlife management. Whatever you choose, there is an appropriate harvesting method for managing your property.

Harvesting Methods

Clear Cutting. Clear cutting is an even-aged stand technique that removes all of the merchantable timber from a stand at one time. Trees that are not merchantable are sometimes left standing and may need to be removed before planting. One alternative is called a clean-cut. This is a clear cut, but during the course of the harvesting operation, all of the stems are dropped regardless of merchantability. This also enhances the aesthetic appeal of the logging site.

Seed Tree or Shelterwood Cuts. These types of cuts are also even-aged stand techniques. These cuts are made to ensure natural regeneration on the tract of land. Trees of desirable species and quality are left standing and spaced as evenly as possible to promote seed production and dispersal. Seed tree cuts are commonly used with pines. This cut requires fewer trees to remain as the seed source, typically between 7 and 10 trees per acre, since pine seeds are dispersed by wind. Shelterwood cuts leave about 30% stand basal area per acre to ensure regeneration. This method is used with trees that produce heavy seeds. Once the new stand is established, the seed trees are removed.

Diameter-Limit Cutting. This is an uneven-aged management technique that only removes trees of a predetermined diameter and larger. It is supposed to result in a high quality uneven-aged stand. Unfortunately, this technique has been used in the past as a method of high-grading, or taking just the good trees and leaving poor quality trees. It typically results in a poor quality stand that has little future timber value and is, therefore, rarely used.

Selection Cutting. The selection-cutting method of harvest is also for uneven-aged stands. Trees are selected singly or in small groups to promote regeneration in those areas where the trees are removed. The goal is to maintain a well stocked stand while realizing periodic financial returns from harvesting.

Best Management Practices

Best Management Practices (BMPs) are designed to minimize or prevent non-point source (NPS) pollution that is created either from harvesting operations or from other silvicultural practices. NPS pollution from forestry operations occur after the land is cleared and exposed soil washes into a stream or other water body. This sediment can carry herbicides, pesticides, fossil fuels, and other contaminants, to name just a few. Increased sediment is the main pollutant from harvesting operations.

Forest Roads. Harvesting does not typically expose soils. Forest roads and skid trails do, and are the major source of sediment, especially where the roads or trails cross streams. Roads should be crowned and water diversion structures should be used to allow water to run off the road and into vegetation. Approaches to streams should be stabilized and protected to ensure sediment does not enter the stream.

Streamside Management Zones. StreamsideManagement Zones (SMZs) are areas of limited management along streams and other water bodies. They serve as vegetative buffers to slow water down before it reaches the stream, allowing any sediment to settle out before the water enters the stream. The width of the SMZ depends on the slope of the land. The steeper the terrain, the wider the SMZ needs to be. Harvesting is allowed within the SMZ, but only half of the crown cover should be removed and only if doing so will not expose the soil within the SMZ. The remaining trees and ground cover will filter the water.

Specific guidelines and recommendations on topics covered in this chapter can be found in *Mississippi's Best Management Practices Handbook*. This guidebook is available from your county office of the Mississippi Forestry Commission or your county Extension Service Office.

Communication. The best management tool you can use is your involvement. Communicate with the foresters and the loggers who are working on your property. Let them know what your expectations are. They can help with specific decisions and offer alternatives if needed. Loggers can and should explain to the landowner what to expect from any harvesting operation.

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7 Financial Considerations

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Owning forestland can have many benefits, including economical and recreational. Some benefits, however, are non-monetary. As with any investment, forestry has risks as well as benefits.

Benefits over other investments include a wider range of markets, multiple products, recreational opportunities, and intangible items. Risks include the long amount of time before revenues are realized and natural disasters such as hurricanes, tornadoes, ice storms, or pest and disease outbreaks. Other items to consider are taxes which are covered in Chapter 12.

Timber production requires a long-term approach to investing. Therefore, many landowners may not be able to evaluate their timber's financial opportunity and then compare it with other financial investments. Time and interest rates play a very important role in evaluating the financial alternatives. Money has a time value, and we can account for differences in this value by using compound interest techniques (Bullard and Straka 1998).

Sources of income you can expect from your forestry investment include revenues from thinning and final harvest, as well as annual lease payments for recreational activities such as hunting, fishing, and wildlife watching. Other income sources can include harvesting of pine straw and other non-timber products.

Potential costs you should expect include regeneration costs, timber stand improvements, and taxes. Of course, depending on your amount of forest management and your desired objectives, you may have more or less sources of income and cost.

One important consideration for evaluating forestry investments is the interest rate to use in the calculations. The interest rate should consider and reflect the risk factors associated with the various forestry investments. The rate of return should be comparable to landowners' alternative investments. Research has shown that forestry investments have similar risks and returns to those of common stocks. So, what interest rate should you use as a landowner? It varies for each individual landowner. You should consider alternative uses for your money, or the rates you would expect to earn on similar investments. A study by Bullard et al. (2002) indicated

that Mississippi forest landowners desired nominal (includes inflation) interest rates varying from 8% (for investments lasting five years) to 13.1% (for investments lasting 25 years). Of course, your desired interest rate may differ from these, depending on your current situation.

Five investment terms often used in evaluating forestry investments are Net Present Value, Benefit Cost Ratio, Equivalent Annual Income, Rate of Return, and Land Expectation Value. Using your sources of income and cost, you can perform the following calculations to evaluate your forestry investment. Your forestry investment can then be compared with alternative investments. A brief description of each investment term follows.

As an example of how to apply the forestry investment terms presented in this chapter, consider the following forestry investment scenario:

A landowner wants to know if planting a pine plantation to be harvested in 30 years is a good investment. The pine plantation will have some initial costs and will require a mid-rotation thinning.

The landowner has estimated the following costs and revenues for the 30-year pine plantation investment. Costs include $120/acre for site preparation and $38/acre for pine seedlings and planting, which are both incurred at the beginning of the investment, and an annual management cost of $5/acre, which will accrue each year.

Revenues include $500/acre for the mid-rotation thinning at age 16 and $2,800/acre for the final harvest at age 30. The landowner wishes to evaluate this forestry investment at a 6% interest rate, which is a comparable rate of return with other investments the landowner is considering. There are some basic compounding formulas needed to understand and use the forestry investment terms discussed in this chapter:

$$\text{Future value} = \text{Present value} * (1 + \text{interest rate})^n$$

$$\text{Present value} = \frac{\text{Future value at age n}}{(1 + \text{interest rate})^n}$$

$$\text{Present value of annual costs} = \text{annual cost} \left[\frac{(1 + \text{interest rate})^n - 1}{\text{interest rate } (1 + \text{interest rate})^n} \right]$$

where: n = the number of periods or years

In the pine plantation investment example, the establishment costs are examples of present values, and the thinning and final harvest are examples of future values. These three formulas will be necessary to understand the five forestry investment terms presented.

Net Present Value (NPV) is the difference between the present value of all costs (present and future) and income at a given interest rate. A positive NPV indicates that the investment furnishes a higher return than the selected interest rate, and is, therefore, an acceptable investment. An NPV of zero indicates an investment that equals the selected rate. The selected interest rate usually indicates the investor's minimum objective or alternative investment opportunity. The NPV is the correct financial measurement to use to compare two or more mutually exclusive choices (i.e., when only one investment choice is possible). NPV is used to evaluate capital investments and is also commonly called Net Present Worth, Present Net Value, and Present Net Worth. The NPV formula is:

NPV = [Present value of all revenues] – [Present value of all costs]

All revenues and costs must be discounted to present values to calculate NPV. The following example demonstrates how to calculate NPV. From our example, the present value of all costs is $226.82. That includes $120 for site preparation and $38 for planting, which are both already expressed as present values, and $68.82 as the present value of the annual management cost. The present value of annual management costs is calculated as:

$$\text{Present value of annual costs} = \text{annual cost} \left[\frac{(1 + \text{interest rate})^n - 1}{\text{interest rate } (1 + \text{interest rate})^n} \right]$$

$$\text{Present value of annual costs} = \$5 \left[\frac{(1 + .06)^{30} - 1}{.06 (1 + .06)^{30}} \right]$$

Present value of annual costs = $68.82

Present value of all costs = $68.82 + $120 + $38 = $226.82

The present value of the revenues is $684.33, which includes the present value of $196.82 from the thinning at age 16 and the present value of $487.51 from the final

harvest at age 30. The present value of revenues is calculated as:

$$\text{Present value} = \frac{\text{Future value at age n}}{(1 + \text{interest rate})^n}$$

$$\text{Present value of thinning} = \frac{\$500}{(1 + .06)^{16}} = \$196.82$$

$$\text{Present value of final harvest} = \frac{\$2800}{(1 + .06)^{30}} = \$487.51$$

Present value of all revenues = $196.82 + $487.51 = $684.33

Now that all costs and revenues are expressed as present values, the net present value (NPV) for the pine plantation investment can be calculated.

NPV = [Present value of all revenues] – [Present value of all costs]

NPV = $684.33 – $226.82 = $457.51

The estimated NPV for this forestry investment is $457.51 per acre.

Benefit Cost Ratio (B/C) is the present value of revenues divided by the present value of costs. A ratio greater than one indicates the investment should be undertaken. This investment criterion is used for a group of investments that are not mutually exclusive (i.e., more than one investment may be chosen). The investment is acceptable if the ratio is greater than one. The B/C ratio is often referred to as the profitability index of a project. The B/C ratio formula is explained below:

B/C = [Present value of all revenues] ÷ [Present value of all costs]

For our example, the present value of all revenues was calculated to be $684.33, and the present value of all costs is $226.82. Thus, the benefit cost ratio for this investment is 3.02.

B/C = $684.33 ÷ $226.82 = 3.02

This investment is financially attractive at a 6% interest rate, since the B/C is greater than 1.

Equivalent Annual Income (EAI) is the NPV of an investment at a given interest rate that has been annualized. Annualizing the NPV of an investment is useful in investment analysis to compare or rank investments of different lengths. It can be used to compare a forestry investment with other land uses (e.g., agriculture crops) that generate income each year. An investment is acceptable if the EAI is greater than zero. EAI is also known as Annual Equivalent, Annual Income Equivalent, Equal Annual Income, and Net Annual Equivalent.

$$\text{EAI} = \text{NPV}\ [\{i\ (1+i)^n\} \div \{(1+i)^n - 1\}]$$

Where: i = interest rate in decimal percent
n = the number of periods

Using our example, we know the NPV at a 6% interest rate is $457.51. Using this information, we can calculate the EAI.

$$\text{EAI} = \text{NPV}\ [\{i\ (1+i)^n\} \div \{(1+i)^n - 1\}]$$
$$\text{EAI} = \$457.51\ [\{.06\ (1+.06)^{30}\} \div \{(1+.06)^{30} - 1\}]$$
EAI = $33.24/acre/year

If the landowner incurs the costs and revenues during the 30- year rotation, the pine plantation investment will produce returns equivalent to an annual income of $33.24 per acre.

Rate or Return (ROR) is the rate of compound interest that is earned by the funds invested, or the average rate of capital appreciation over the life of the investment. It is the compound interest rate used where the NPV is zero. In other words, the rate of return is the compound interest rate that equates the present value of all future incomes with the present value of all future costs. All incomes are assumed to be reinvested at the same rate of return. ROR is also called Internal Rate of Return and Return on Investment. Investments with only one cost and one revenue can be calculated directly. However, for investments with more than one cost and revenue, an iterative process must be used to estimate the interest rate that equates the present value of revenues with the present value of costs. ROR is useful in accept/reject decisions; however, it is not recommended for ranking investments.

From our example, we know that the NPV at 6% is $457.51. Therefore, the ROR must be greater than 6% since ROR is the interest rate where NPV is zero. ROR can only be solved using an iterative process to determine the interest rate that results in a NPV of zero. An interest rate of 12% results in a NPV of -$23.26, and a rate

of 11% produces an NPV of $14.99. So the ROR is between 11% and 12%. Continuing this iterative process until NPV equals zero results in a ROR of 11.36%. Thus, the 30- year pine plantation investment would earn the landowner a rate of return (ROR) of 11.36% .

Land Expectation Value (LEV) estimates the value of bare land used for growing timber. The LEV formula is a special case of NPV that considers all revenues and costs involved with timber production for an infinite series of identical rotations (even aged management) or cutting cycles (uneven aged management). LEV is the maximum amount an investor would be willing to pay for bare land and still earn an acceptable rate of return that would be equal to the discount rate used in the LEV calculation. Since LEV assumes an infinite series of rotations, it considers the value of future timber growth, allowing for a meaningful comparison of management regimes of unequal time periods. Thus, LEV can be used to rank investments when evaluating alternative rotation ages or management regimes. LEV is also commonly called Bare Land Value, Soil Expectation Value, and Faustmann's formula after Martin Faustmann who first published the formula in 1849. The LEV formula is:

$$\textbf{LEV} = [\textbf{Net Value in Year n}] \div [(1+i)^n - 1]$$

Where: i = interest rate in decimal percent
n = the rotation age in years

To use the LEV formula, compound all of the costs and revenues associated with timber production to the end of the first rotation or cutting cycle and subtract costs from revenues to determine the net value in year n.

Using the 30-year rotation pine plantation example values, the net value in year 30 is $2,627.69, which is calculated as follows:

The final harvest value of $2,800 at year 30 is already expressed as a future value. The revenue from the thinning at year 16 has to be compounded 14 years into the future.

$$\textbf{Future value} = \textbf{Present value} * (1 + \text{interest rate})^n$$

Future value of thinning revenue at year 30 =
$500 (1 + .06)14 = $1,130.45

Future value of site preparation cost at year 30 =
$120 $(1 + .06)^{30}$ = $689.22

Future value of seedlings and planting costs at year 30 =
$38 $(1 + .06)^{30}$ = $218.25

Future value of annual management costs at year 30 = $395.29

$$\textbf{Future value of annual costs} = \textbf{annual cost} \left[\frac{(1 + \text{interest rate})^n - 1}{\text{interest rate}} \right]$$

$$\$5 \left[\frac{(1 + .06)^{30} - 1}{.06} \right] = \$395.29$$

Thus, the net value in year 30 is

Net value in year 30 =
$2,800 + $1,130.45 – $689.22 – $218.25 – 395.29

Net value in year 30 = $2, 627.69

$$\textbf{LEV} = [\textbf{Net Value in Year n}] \div [(1+i)^n - 1]$$
$$\textbf{LEV} = \$2{,}627.69 \div [(1+.06)^{30} - 1]$$
$$\textbf{LEV} = \$553.96$$

The most a landowner should be willing to pay for bare land that could be used for a 30- year pine plantation investment, given the assumptions about costs and revenues used in the calculation, would be $553.96 per acre.

The book *Basic Concepts in Forest Valuation and Investment Analysis* by Bullard and Straka (1998) is a good reference book. It covers all of the above- mentioned terms and provides detailed examples for forestry investments. Another useful application for forestry investment analysis is FORVAL Online – Timberland Investment Calculator, developed at Mississippi State University. This online program will allow you to input your revenues and incomes and also set your desired interest rate. FORVAL will then calculate your NPV, B/C ratio, ROR, and EAI among other financial calculations. You may access FORVAL Online at http://www.cfr.msstate.edu/forval/.

Another useful online application for forestland investment analysis is Timberland Decision Support System (TDSS), developed by the Texas Forest Service. Like FORVAL, TDSS will allow you to use the above financial criteria. It also includes a loblolly pine growth and yield model which will allow you to simulate the potential growth of your loblolly pine forests and include this in your financial investment analysis. You may access TDSS online at http://tfsfrd.tamu.edu/tdss/default.htm.

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8 Marketing the Forest Crop

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A timber crop that is ready for harvest is the realization of much work over many years. The landowner finally reaps the financial benefits of faithfully following the correct forest-management practices.

It is imperative, at this time, that landowners understand how to market their timber so that they can realize the maximum in financial returns. Unfortunately, many landowners do not understand the dynamics of forest marketing.

Selling timber is easy. By simply contacting a few timber buyers, you can quickly receive an offer on your timber. Unfortunately, this offer may not be what your timber is actually worth. Marketing timber requires planning and pre-sale work before you actually advertise for competitive bids. Your goal is to get the best price possible for your timber. To accomplish this goal, you should follow a step-by-step marketing procedure before selling your timber.

Know What You Have to Sell

You cannot determine the value of your timber if you do not know how much you have and where it is located. Therefore, the first step in successful timber marketing is to determine how many acres of timber you have to sell and the quantity of timber to be sold. You must also know the kinds of trees, products, sizes, quality, value, or other characteristics. You can get this information by having your timber inventoried by a professional forester. An inventory is a true estimate of the total number, species, sizes, and quality of trees on a timbered area. Information from this inventory can be used to estimate the value of merchantable timber. An inventory usually provides volumes in cords, board feet, or other products such as poles. It also provides a location map, age and growth information, and a description of the stand of timber.

Most people would not sell a house without first having it appraised to determine its value. As a landowner, you should do no less with your timber. The costs for timber inventories vary, depending on the number of acres involved and how much merchantable timber is on the land. In general, the greater the value of the timber, the

higher degree of accuracy required in the timber inventory. This is because statistical errors of the estimated value of timber are more costly in valuable timber.

Timber inventories should not be viewed as an expense, but as an investment. An investment in a timber inventory before you actually market your timber can result in a substantial increase in financial returns. Conversely, marketing timber without an inventory (not knowing what you have or its value) can result in substantial monetary losses.

Conduct Pre-Timber Sale Preparations

As a landowner, you should have all the details pertaining to your timber sale worked out before you put your timber on the market. Potential buyers will usually make higher bids if they feel comfortable about a timber sale. If all their concerns are addressed and answered before bidding, it can lead to higher bids and a more successful timber sale.

It is important to have all details of the sale worked out in advance. Clearly mark all boundary lines on the ground so buyers know exactly what is being sold. Provide a clear logging access route to the buyers to assure them that they can get the timber out of the woods and to their markets. Also, before the sale, be sure to resolve any legal issues concerning the sale, such as a title dispute. Also, address any liens against the property or timber before the sale.

Selling Methods

Use the proper selling method when marketing your timber. Two of the commonly used methods are "Negotiation" and "Sealed Bids." Each method has advantages and disadvantages, depending on the type of timber being sold.

Negotiation

The most common method used in selling timber is when a buyer and seller consummate a sale by establishing the price through face-to-face negotiations. Unfortunately, if the landowner is unfamiliar with local timber markets, does not know the timber's value, or is not knowledgeable about different forest products, he or she is usually at a disadvantage in this situation.

This selling method, however, does have advantages in certain types of timber sales. A good example is the first thinning in pine plantations. A negotiated sale works very well for a first thinning because it is difficult to inventory the volume of pine pulpwood to be selectively harvested in a first thinning. Also, it is very costly to have the low-valued pulpwood trees marked and inventoried. For example, a seller and buyer can negotiate a priceper ton for pine pulpwood to be cut. This type of sale is called a "pay-as-cut" sale and is usually a negotiated sale.

Negotiated sales for higher value timber products, such as saw timber, high-value hardwoods, or poles can also be conducted, but landowners should know the estimated volume and value of their timber before entering into this type of sale.

Sealed Bid

Many landowners choose a sealed-bid timber sale. Prospective buyers are allowed to submit confidential written offers for timber. These sealed bids will be opened at a specific time and place. Prospective buyers are allowed to make only one bid. This type of sale often results in higher offers for timber for the landowner, but the sale must be conducted properly. A sealed-bid timber sale requires prior planning and preparation by the seller. The services of a professional forester are usually required in preparing and administering a sealed-bid sale. Many landowners view this as an extra expense, but it is very important to have professional help.

Sealed-bid timber sales require a forest inventory of your timber to determine the volume and value of timber being sold. You should have timber-sale boundaries clearly marked and have road access to the property. A timber sale prospectus or bid invitation can then be prepared. The invitation to bid is a letter with supporting information that describes the sale conditions and the timber to be sold. The bid invitation should realistically answer any and all questions potential buyers may have about your timber sale. This will increase your chances of attracting more and higher bids for your timber. Every timber sale is different and, therefore, bid invitations will vary depending on the type and size of the sale. However, all bid invitations should contain the following items:

- Identification of the Seller/Seller's Agent
- Location and Size of the Sale Area
- Type of Sale
- Volume Information
- Duration of Sale Agreement
- Harvesting Restrictions and Conditions
- Bid Opening Procedure

- Conditions for Bid Acceptance
- Payment Provisions
- Attachments to Bid Invitation (maps, volume tables, etc.)

Where To Go for Help

Professional assistance is virtually required to market timber properly. This help is available, but all too frequently, only the best-informed landowners use it. The following people and agencies are available to assist you in marketing your forest products:

- The Mississippi Forestry Commission employs professional foresters to serve as county or service foresters. These men and women can provide expertise in forest management, insect and disease management, and marketing assistance to landowners. In some states, vendor services, tree planting, and timber-stand improvement are provided for the landowner at cost. Generally, a limit is put on the amount of time, timber-marking help, or size of timber sale involved in any service given by the agency.

- The Mississippi State University Extension Service employs foresters to provide information to landowners about forest management, use of wood products, stumpage prices, taxes, etc. These forestry specialists closely follow research and help to get practical research applications into use in the field as soon as possible.

- Industrial foresters are often available to work with landowners who may be prospective suppliers of wood to the companies who employ these foresters. They often provide free timber marking and management plans. All that most of them ask in return is to have the "right of first refusal" when you are ready to sell your timber.

- Consulting foresters are self-employed forestry professionals offering a wide variety of services to anyone who owns timberland. Fees are based on the kinds of services provided. Timber-marketing assistance is usually offered on a commission basis. The consulting forester is able to determine which trees should be cut, their volumes, and total value. He can advertise the sale, obtain bids or negotiate with a buyer, evaluate bids, prepare a contract and logging plan, and supervise the harvesting operation. It is his/her responsibility to protect the interests of the client - the landowner. Consulting foresters are very adept in handling timber sales. Forest landowners, particularly absentee owners, may find that consultant foresters are very often their best source of help.

Many landowners are disappointed with their timber-selling experience because they fail to obtain professional assistance. Timber marketing expertise is only a phone call away, but many landowners fail to take advantage of this assistance. A good marketing procedure will help you conduct timber sales that will meet your goals and objectives. You will also have the satisfaction of knowing that you received the highest possible price for your timber and that the timber sale was handled professionally.

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9 Pine Plantation Thinning

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Thinning

Thinning is a necessary step in the management of your forestland. Both natural and planted pine stands should be thinned.

The three goals of thinning are to promote growth of the residual trees, to promote health of the residual stand, and to provide an economic return to the landowner. Thinning operations should be planned practices that meet your management objectives. It is recommended that landowners use a forestry consultant to assist with all aspects of a thinning operation.

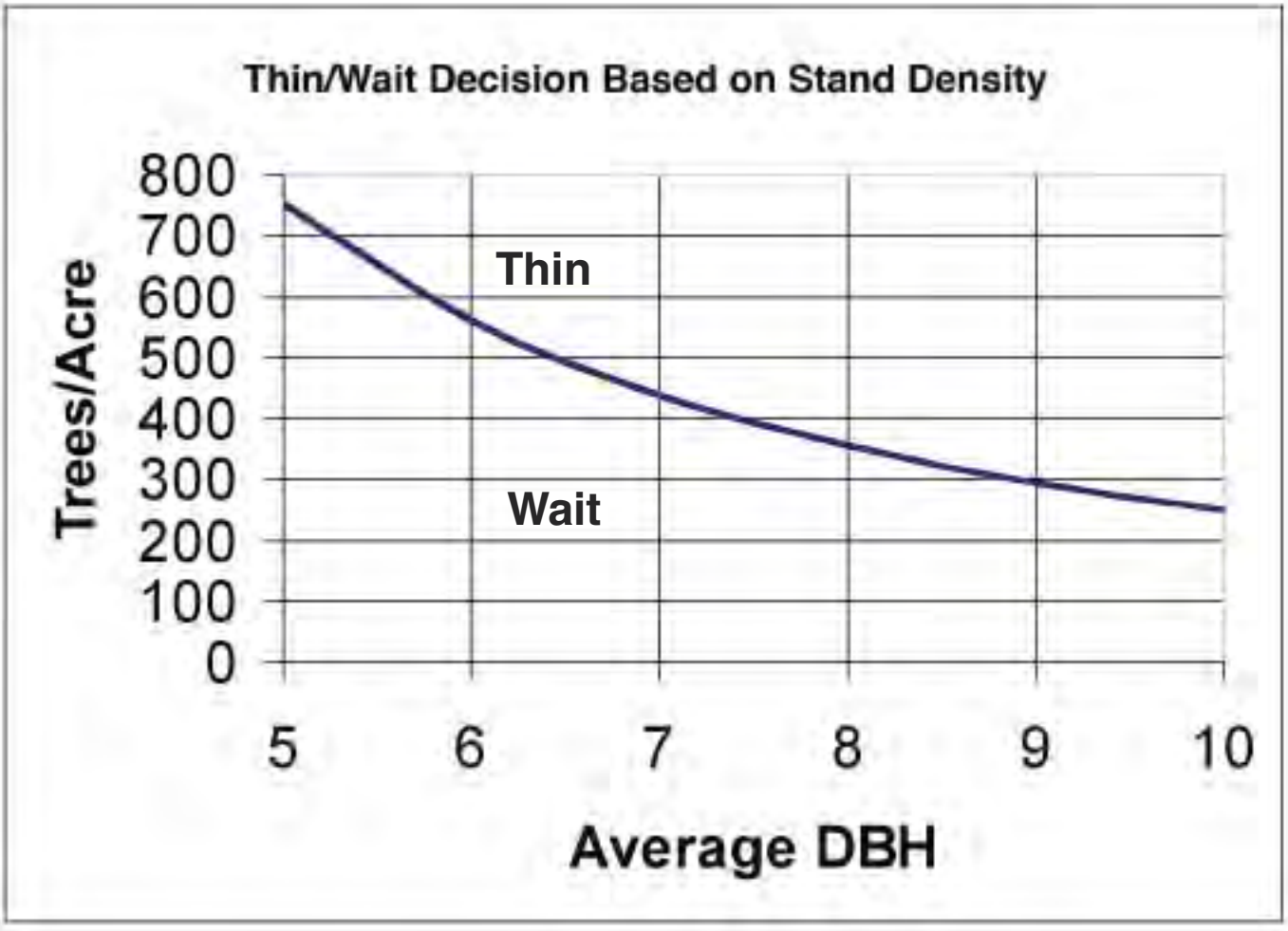
When, how, and how much to thin are commonly asked questions. To answer these questions, you must have an onsite inspection of the forest in question. Several guidelines will help you know when it's about time to thin. All thinning practices should be conducted in accordance with the management objectives of the landowner. Stand density, average stand diameter, tree heights, and growth rates are all important factors that indicate when a stand is ready to be thinned.

Stand density. Stand density is the most important factor in determining when to thin a pine stand. As trees grow larger, the number of trees that a stand can support declines. At the time of planting, a site might be capable of supporting 600 – 700 trees per acre (TPA). However, as the diameter at breast height (DBH) and crowns increase in size, so do the amounts of nutrients, soil moisture, and sunlight required for adequate growth rates.

Figure 1 is a Loblolly Pine Stand Density Index Graph. This graph shows the relationship between TPA and DBH. In order to increase tree size, the number of TPA needs to be reduced, providing space for trees to grow. Anywhere the number of TPA and DBH intersect above the Thin-Wait Line (Figure 1), the stand needs to be thinned.

Once stand density indicates a stand is ready to be thinned, average stand diameter, tree heights, natural pruning, and growth rates should be considered. For a stand to be merchantable it must have an average DBH of 6 inches. Because the majority of logging operations use tree-length log trucks, trees should be at least 40 feet tall before they are thinned. This will ensure that log trucks can be fully loaded (25 tons) and avoid higher hauling costs associated with "double bunking."

Figure 1: Stand Density Index.



(Adapted from Traugott and Dicke, 2006)

Natural pruning occurs because pine trees are shade intolerant. Therefore, lower limbs die and fall off over time, producing a clear stem. The trees should be naturally pruned to at least 18 feet, ensuring a high quality stem. To ensure health and vigor, thinning should be done when growth rates begin to decline.

Thinning operations are typically conducted at several points during the length of the rotation. However, the first thinning operation is the most critical for growth and development of the residual stand. Second and subsequent thinning operations promote the health of the stand and provide economic return to the landowner before final harvest.

First Thinning

The first thinning operation is an important milestone in the life of a pine stand. It is one of the first major decisions landowners have to make and sets the stage for the future quality of the stand. It is essential that this thinning be timed properly--too early, and the residual trees might not be naturally pruned high enough; too late, and growth could have stagnated on the stand.

The goal of the first thinning operation is to create growing room in the stand. Remember that as the trees grow in size, the site can support fewer of them. In order to maintain growth rates, about 40 percent of the trees should be removed. A row thinning in pine plantations is the most cost-effective method. During a row thinning, every tree on the row is removed. Third-, fourth-, and fifth-row thinnings are common and should be decided by site quality, stand health, or landowner objectives. To create additional growing room, trees may be selectively harvested in the "leave" rows. Forked, weak, diseased, or suppressed trees should be removed from the leave row. This will leave the best trees to carry forward in the rotation.

In natural stands, lanes are typically cleared, creating room to operate. Depending on the stand density, it is common to create lanes that are about 8 – 10 feet wide. These lanes should run parallel with the topography of the land. The leave lanes should be about 5 - 8 feet wide. Selectively thin any inferior trees between the lanes. The main purpose of thinning is to provide room for these trees to continue to grow at an acceptable rate. Thinning a natural stand is much the same as in plantation management.

"Are my pine trees ready to thin?" is one of the most frequently asked questions by private landowners. The answer to this question is based on the size, growth rate, natural pruning, height of the trees, as well as stand density, and is not based on the age of the trees. The first thinning should be done when the stand meets these criteria: trees have an average DBH of 6 inches; trees are 40 feet tall and are naturally pruned to 18 feet from the ground; and the growth rate has begun to decline.

For a detailed, step-by-step process of determining if the stand is ready to thin, get a copy of *Are My Pine Trees Ready to Thin*? from your local Mississippi State University Extension office or the Mississippi State University Extension webpage at http://msucares.com/pubs/publications/p2260.pdf.

Second Thinnings

The objectives of a second and subsequent thinnings are to promote stand health, set the stage for final harvest, and provide economic return for the landowner. These thinnings should remove the smaller, forked, damaged, and diseased trees from the stand, leaving the best trees as crop trees. The goal is to create growing space for the remaining crop trees, thereby, ensuring healthy trees.

The second thinning can be conducted as a marked thinning, in which all trees to be harvested, or all trees to be left, are marked with a specified paint color. In this type of operation, it should be clearly stated to the operators which trees are to be harvested and which are to be left. About 40 percent of the trees in the stand will be removed during this thinning operation. Row thinning should only be used for the first thinning. All subsequent thinning should be marked.

Another common method of thinning a pine stand is to leave a basal area equal to the site index of the stand. Site index is the height of dominant and codominant trees at a given base age, usually 50 years. The higher the site index, the higher quality the site is. Foresters often use the rule of site index ± 10 to allow adjustments for certain stand conditions and management objectives. When selecting trees to be removed in this thinning, the very best trees should be left, and the basal area of the leave trees should equal the target basal area. If the stand is thinned to a basal area of 10 square feet less than site index, it will take about 10 years before that stand needs to be thinned again.

Another basic way to selectively thin a pine stand is the "leave tree method." In this method, all trees to be left in the stand are marked. To determine which trees to keep, measure the diameter of the dominant trees that will remain as the crop trees. The 1.75 X DBH (diameter x breast height) rule will dictate (in feet) the spacing of the residual crop trees. For example, if the average DBH is 12 inches, then residual trees should be spaced about 21 feet apart.

Pre-Commercial Thinning

One of the problems with pine regeneration is overcrowding of seedlings. This occurs many times during natural regeneration as well as overseeding from adjacent stands in planted pines. These stands can have thousands of trees per acre; whereas, on the typical planting site only about 600 trees per acre are planted. Referring back to Figure 1, stands with more than 800 trees per acre will take a long time to reach a merchantable diameter. These overcrowded stands will stagnate and never become a merchantable stand. To reduce this overcrowding, these stands should be thinned pre-commercially.

Because of the long time until merchantable harvest, landowners should give preference to the lowest cost method for reducing the number of trees per acre. The goal should be to reduce the number of trees per acre to 400 – 600. A combination of hand and mechanical thinning can be used to remove these trees. Chopping or bush-hogging parallel strips 8 feet wide through the stand while leaving a row of standing trees about 3 feet wide is the best method for pre-commercial thinning. The trees in the leave rows may be thinned by hand, creating more growing room and further reducing the number of trees per acre. The goal of this operation is to remove as many trees as possible with as little cost as possible. Prescribed burning can also be used for pre-commercial thinning. A backing fire during the spring will remove most trees that are 1.5 inches or less in ground line diameter. For more information, please see chapter 10.

Conclusion

Thinning is a necessary management practice that will produce income for the landowner while increasing the quality of the stand for final harvest. Thinning at the proper time will allow trees to continue growing at acceptable rates. Remember the goal of thinning operations is to "leave the best and cut the rest." Anything else will result in reducing the quality of the stand. It is recommended that landowners use the assistance of a professional forester in all aspects of conducting a thinning operation.

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10 Prescribed Burning

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Fire can be a great tool that benefits a number of natural resources. Prescribed burning is defined as the intentional use of fire, under prescribed conditions and with adequate supervision and preparations, to accomplish one or more specific objectives.

The prescribed conditions include a number of weather and fuel conditions that can affect the success of the burn. Some of the more common uses for prescribed burning in Mississippi are listed below:

- Site preparation in advance of planting
- Hazard reduction by removing fuel that could endanger property if ignited
- Reduce above-ground vegetation, generally hardwoods, in pine stands by burning in spring
- Obtain a "root kill" of competing vegetation, generally by conducting a burn in late spring or summer
- Promote or retain diverse herbaceous plants by killing woody plants
- When managing for longleaf pine, fire kills young loblolly pine trees that are competing with the desired longleaf and reduces the occurrence of brown spot disease.
- Improve wildlife habitat by shifting species composition and by removing the forest floor layer so that wildlife can more easily find seeds.
- Burn some types of fruit-producing vegetation, such as blueberries and blackberries, to stimulate berry production.

As you can see, prescribed burning has many positive benefits. In addition, it can be a relatively inexpensive tool since in many cases, burning only costs $25 to $30 per acre. There are some negative aspects about prescribed burning, however. It can be unpredictable if the weather abruptly changes; it can be difficult for the untrained person to control; and it can require unanticipated down-time or the need for special equipment. It also does not respect property lines if fire lines are inadequate or nonexistent.

Smoke is the greatest problem with prescribed burning. Smoke released into the atmosphere and settling onto a major highway or interstate has caused traffic accidents. These accidents have led to lawsuits, which is the main reason fewer people use prescribed burning today than in the past. Insurance rates to cover potential damage from prescribed burns have increased considerably, causing many people to choose other methods of control.

If you plan to use prescribed fire, you must understand the "fire triangle." For any fire to burn, it needs three things: fuel, oxygen, and heat. If you remove any of

these three items, or if you "break" the triangle, the fire will go out. In a forest situation, we can often do little about removing oxygen. However, we can put water on a fire to reduce its temperature. With enough water, at some point, the fire will go out. You can also remove fuels. This is often done by plowing a fire line down to mineral soil.

Legal Issues in Mississippi

The 1992 Mississippi Prescribed Burning Act provides the legal framework for prescribed burns in Mississippi. The Act has four mandatory requirements that must be met for a prescribed burner to have the liability protection afforded by the act. These four requirements are listed below:

- A Mississippi Certified Prescribed Burn Manager must be on site on the day of the burn.

- A permit must be obtained from the Mississippi Forestry Commission for the day of the burn.

- The burn plan must be written and notarized at least one day before the burn.

- The burn must be in the public interest.

There are three ways to become a certified prescribed burn manager in Mississippi:

- Complete and pass the prescribed burning short course offered through the Office of Academic Outreach and Continuing Education at Mississippi State University. The short course is normally offered twice a year, once in the spring, and again in the fall. For more information, contact the Mississippi State University Department of Academic Outreach and Continuing Education.

- Enroll in Forest Fire Laboratory and Lecture (FO 3201 and 3202) in the Department of Forestry at Mississippi State University and pass both accordingly.

- The Mississippi Forestry Commission may recognize certification from other states.

The Mississippi Forestry Commission will issue a permit to conduct prescribed burns when environmental conditions provide adequate smoke dispersal. Two conditions must be met:

- A transport wind speed of 3.5 m/s (approximately 8 miles per hour)
- A mixing height of 500m (approximately 1,750 feet)

When preparing your burn plan, it is important to remember to use these values as the minimum in their respective categories. When calling for a permit, you will be asked to provide your name and the location of your property, including the county. You will also be asked to provide (to the best of your ability) a legal description of the property being burned.

The burn plan must be notarized at least one day before the burn to ensure that you have done some planning for the burn. This is primarily to ensure the public safety as well as make you aware of any special conditions on the property being burned.

Liability

Liability for damages under the Mississippi Prescribed Burning Act falls upon the burner. If the four mandatory requirements listed above are followed, and someone is hurt by your fire or the smoke it produces, the burner can be found guilty of simple negligence. This means that the burner can be held liable for actual damages and up to $150 in punitive damages.

If the four mandatory requirements listed in the previous section are not followed, and someone is hurt by your fire or the smoke it produces, the burner can be found guilty of gross negligence. This means that the burner can be held liable for actual damages, punitive damages up to $500, as well as being guilty of a misdemeanor. The misdemeanor carries a maximum 3-month sentence in county jail. It is important to remember that negligence, either simple or gross, can be determined by a jury.

Burn Plan Preparation

The first step to a successful prescribed burn is advance planning. It is very important to determine the conditions of the area you want to burn, the reason for the burn, and the proper actions to take to meet your goals. You will need a written prescribed burn plan for each area to be burned. Some plans may be short and simple. Others are long and complex. In either case, it is essential that the plans are concise and that they include all necessary information.

Plan Components

Many different forms can be used for a prescribed burn plan. The form provided here is an example of the minimum information necessary to conduct a prescribed burn legally in Mississippi (adapted from Londo, et al. 2005):

- **Legal Description of Property**

The complete legal description of the property must be on the form, including the section, township, and range. Also include the county and state.

- **Name of Owner**

The name and address of the property owner, as well as the name of the person who prepared the plan, should be included. Mississippi requires that a burn plan be notarized, at least one day before the day of the burn. The notary's signature and number should be on the prescribed burn plan. In addition, Mississippi requires that a burn permit be obtained. The permit number should be recorded on the burn plan as well as the date the burn is conducted.

- **Stand Description**

Describe the stand characteristics, including a description of the overstory and understory. Also describe fuels. Fuels are typically considered to be those on the soil surface. Fuel loadings and models can be easily determined by using the fuel model and loading descriptions found in National Interagency Fire Center (NIFC) Publication 1981- S 390 Fire Behavior Field Guide.

These publications are available through the National Interagency Fire Center in Boise, Idaho (www.nife.gov). You should also include the topography of the site because it can have a significant effect on fire behavior, microclimatic conditions, and fuel loading. It is important to note what soils are present on the site. This is especially true if there are organic soils present. Take special precautions to keep fire away from organic soils.

- **Purpose of the Burn**

There are many reasons for conducting a prescribed burn, including timber management, wildlife habitat management, and hazardous fuel reduction. These topics, as well as other reasons, were discussed earlier in this chapter.

- **Pre-Burn Information**

Maps: You need at least three maps: a large scale area map; a site-specific map outlining the burn area; and another site-specific map of the burn area with burning methods and escape routes marked. Highlight the burn area on the large scale area map, along with evidence of smoke-management screening. The site-specific maps focus on the area being burned. These two maps will be used exclusively for the rest of the pre-burn information section.

Fire lanes: On the site-specific map, the corners of the area to be burned should be labeled, usually with capital letters. When installing fire lanes, label the fire lane placement based on the letters. This is done for simplicity and safety. Everyone can see where the fire lanes are based on the map. If the crews are using radios for communication, it is easy to let everyone know where they are, or where the jump in the fire lane has occurred, etc. Interior fire lanes may be needed. These can be installed and labeled in the same way as those on the exterior. It is also useful to put in the burn plan any natural or other man-made fire breaks present. These can include streams, ponds, roads, skid trails, etc.

Acres to be burned, crew size, equipment needed: It is important to document how many acres are to be burned, as well as the crew size and equipment needed. In Mississippi, once the burn plan is notarized, it becomes a legally binding document. Therefore, if you are conducting the burn with a smaller crew size than you initially specified, your liability could increase if something goes wrong.

Special precautions: There will usually be something in the vicinity where you are burning that you don't want damaged by your fire. It could be a streamside management zone (SMZ) around a stream, a hunting cabin, etc. You should note anything of this nature on the burn plan and the site-specific maps.

Notify if needed: Emergency contacts must be listed on your burn plan because you won't have the time to look up numbers if something goes wrong with your fire. You can notify these contacts before starting the burn to alert

them that you will be burning that day. Also, it is good to include the names of people who live in the vicinity of the area you are burning. Some may have health concerns or other issues that would make fire and smoke hazardous for them. Notifying them in advance can save you and them a lot of time and trouble later on.

Smoke management: One of the most important things you can do when planning for a prescribed burn is to determine if there are any smoke-sensitive or smoke-critical areas present. This is important for safety and liability concerns. You should take the following steps, adapted from Wade and Lunsford (1989), as part of a smoke management plan for any prescribed burn:

Step 1: Plot the direction of the smoke plume

Using the regional scale map, plot the anticipated downwind smoke movement. Assume the distance the smoke travels based on the following information:

Grass fuels (regardless of burning method)……5 miles

Palmetto/gallberry fuels using backing or spot fires……..10 miles

Palmetto/gallberry fuels using heading fires……..20 miles

All logging debris fires……30 miles

Backing fires in all other fuel types……5 miles

Line heading fires in all other fuel types……10 miles

Burns of 250 acres or more…….10 miles

Smoke does not travel in straight lines; it disperses horizontally as it moves. To account for this, draw a line starting at the center of your proposed fire, following the prescribed wind direction. Draw two additional lines at 30^{o} from each side of your centerline.

Lastly, follow any drainage for one half the distance determined above. This will account for smoke movement after sundown. It is important to keep in mind the scale of the map you are working with to determine accurate distances. A key concept of smoke management is that if you put smoke in the air, wherever it goes, it is the responsibility of the burner.

Step 2: Identify smoke-sensitive areas

Smoke-sensitive areas are areas where your smoke could have a negative impact. Such places include, but are not limited to the following:

Towns and Cities
Airports
Roads and Highways
Hospitals
Nursing Homes
Schools
Chicken Houses

It is important to note that you will not necessarily be able to find all the smoke-sensitive areas just from the map. You should do a reconnaissance around the area first to determine if there are any elderly residents, residents with respiratory problems, or farms present. You may need to go door-to-door in some cases to ensure that you have all possibilities covered.

Step 3: Identify smoke-critical areas

Smoke-critical areas are locations that already have an air quality problem or smoke sensitive areas in the path of your smoke. An area identified in step 2 is smoke critical if it is within 1/10 the smoke travel distance listed in step 1. For example:

Fuel Type	**Smoke Travels**	**Critical if within**
Grass fuels (regardless of fuel type)	5 miles	0.5 mile
Palmetto/gallberry fuels using backing or spot fires	10 miles	1 mile
Palmetto/gallberry fuels using heading fires	20 miles	2 miles
All logging debris fires	30 miles	3 miles
Backing fires in all other fuel types	5 miles	0.5 mile
Line heading fires in all other fuel types	10 miles	1 mile
Burns of 250 acres or more	10 miles	1 mile

Step 4: What to do if smoke-critical areas are present

If smoke-critical areas are present, you cannot burn under the current prescription. However, you do have the following options:

- Don't burn at all.

- Change the prescription and go through the smoke-management system again.

- Do something other than burning. Use mechanical operations to remove slash, hazardous fuels, and other vegetation. Herbicides can also be used.

- If you are burning windrowed logging debris, and smoke-sensitive or critical areas are present, then don't burn. Windrows produce copious amounts of smoke and take longer than one day to burn.

Firing Techniques

There is more than one way to start a burn. How you start a burn is called the "firing technique," and this can influence your flame characteristics. One of the safest and most widely used firing techniques is a backfire. A backfire is a line of fire set along a firebreak perpendicular to the wind. Because of this, the fire burns slowly back into the wind.

Because the fire is moving into the wind, the flames are low and slowly spreading. Controlling such a fire is relatively easy. However, people often do not realize that this technique generates more heat than most other firing methods. This is because the fire remains in one place longer, burning deeper into the forest floor, and can more easily result in lethal temperatures than other firing techniques. The chief disadvantage of a backfire, however, is the slow rate of spread. It is difficult to use a backfire only to cover even moderate acreage in most of Mississippi, so it is often used in combination with other firing techniques.

The opposite of a backfire is a headfire. With this technique, the fire is set and carried with the wind, stopping once it reaches the far firebreak because you have removed fuel and broken the fire triangle. The flames generated by a headfire are generally higher and travel much faster than a backfire. Hopefully, you will have no "spotting" once the fire reaches the fire break. Spotting is where hot embers are lifted up and over a firebreak, coming back to ground and starting another fire on the wrong side of the firebreak. Because of this danger, it is important to have people looking out for spotting.

A strip headfire is a modified and somewhat safer version of a headfire. With the strip headfire, you have multiple people setting fire. The first one starts nearest a plowed or burned out fireline and puts in a line of flame perpendicular to the wind. After the first firing line is set, a second line is started some distance upwind of the first line. Once the first set line burns up to where the second fire line was started, it goes out. The second fire line has already burned the available fuel. A third and subsequent lines are set in similar order. This technique allows the burner to burn relatively large acreages quickly and safely.

Range of Desired Weather

The desired weather conditions under which you want to conduct the burn needs to be documented here. This includes surface and transport wind speeds, mixing heights, stagnation indices, relative humidity, temperature, and time of day to start the fire.

Summary of Burn

Once the burn is completed, you should conduct a summary of the burn. The number of acres actually burned, and the techniques used should be the same as what you said you were going to do. Additional information needed includes the time the fire was set, time period for which your permit was valid, and the weather conditions on the day of the burn. Depending on the objectives of the burn, you can include the number of acres burned, number of jump-overs, measures of crown scorch, etc. The following is a sample Prescribed Burning Plan form:

BLANK PRESCRIBED BURNING PLAN*

Legal Description of Property

40:_____ Section:_____ Township:_____ Range:_____

County_____ State_____

Name of Owner

Name:_____ Plan prepared by:_____

Address:_____Date plan written:_____

Approved by (Notary):_____ Date burn executed:_____

Burn Permit Number: _____

Stand Description

1. Overstory:_____
2. Understory:_____
3. Fuels: _____
4. Topography and soils:_____

Purpose of the Burn

Pre-Burn Information: (See attached maps)

1. Fire Lanes:_____ Exterior:_____ Interior:_____
2. Other Barriers: Natural:_____

   Man Made:_____
3. Acres to be Burned:_____ 4. Crew Size:_____ 5. Fire Units:_____
6. Special Precautions:_____
7. Notify (if needed): _____
8. Smoke Management

   a. Smoke Sensitive Areas: _____

   b. Smoke Critical Areas:_____
9. Firing Techniques: _____

   _____

   _____

Range of Desired Weather

1. Surface wind speed:_____ 5. Relative Humidity:_____
2. Transport wind speed: >_____ 6. Temperature: High_____ Low _____
3. Mixing Height: > _____ 7. Time of day to start: _____
4. Stagnation Index: 0-2

Summary of Burn

1. Acres burned_____ 2. Firing techniques_____ 3.Date burned _____
4. Time set_____ 5. Time permit in effect _____
6. Actual weather conditions:

   Surface wind (Dir and Speed)_____ Transport Wind_____

   Mixing Height_____ Stagnation Index_____

   Temperature (High)_____ (Low)_____ Relative Humidity_____

   Remarks_____

** Adapted from Londo et al. 2005. Living on the Edge. Wildland Fire Management: A Laboratory Manual. Interactive Training Media, Tallahassee FL. 212p.*

What Weather Characteristics Are Most Critical?

A number of weather measurements are important to consider when determining whether to start or maintain a burn. Generally, for winter burns, you will have a pretty good idea what the weather will be like for a 3-day period. Fronts move in from the north or west in winter, and the weather patterns are predictable. Because of wind instability, never burn when a front is moving through. Once a front blows through, you might be looking for a series of weather characteristics, including the following:

• **Relative Humidity (RH**)—Relative humidity is the amount of water vapor in the air, compared to the maximum amount of water vapor it can hold, and is expressed as a percent. High relative humidity indicates a lot of moisture in the air, and also in the fine fuels that are used to carry the fire. The upper end of RH is 60 to 75 percent, depending on fuel type. A high RH will result in a spotty burn. However, if the temperature is supposed to increase, you can be assured that the RH will drop as the temperature increases, and your patience will be rewarded. A relative humidity below 25 percent is too low to burn because the fuel becomes too flammable, and you could lose control of the fire.

• **Wind Direction**—If your property is on the south side of a major highway, do not burn when the wind is from the south. Wait for a north or northwest wind that will push smoke away from the highway.

• **Wind Speed**—This will vary depending on the firing technique you use. With a backfire, you burn at higher wind speeds than with a headfire. However, you need some wind. Suitable wind speeds may be from 2-20 mph, depending on firing technique.

Other weather variables might be important with your burn: current and projected temperatures, fuel moisture, or other variables.

You should conduct a "test burn" on a small area to make sure the fire will behave as anticipated. If the fire burns as expected and the smoke behaves as anticipated, you have a good test burn and are ready to start your burn.

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11 Managing for Multiple Use

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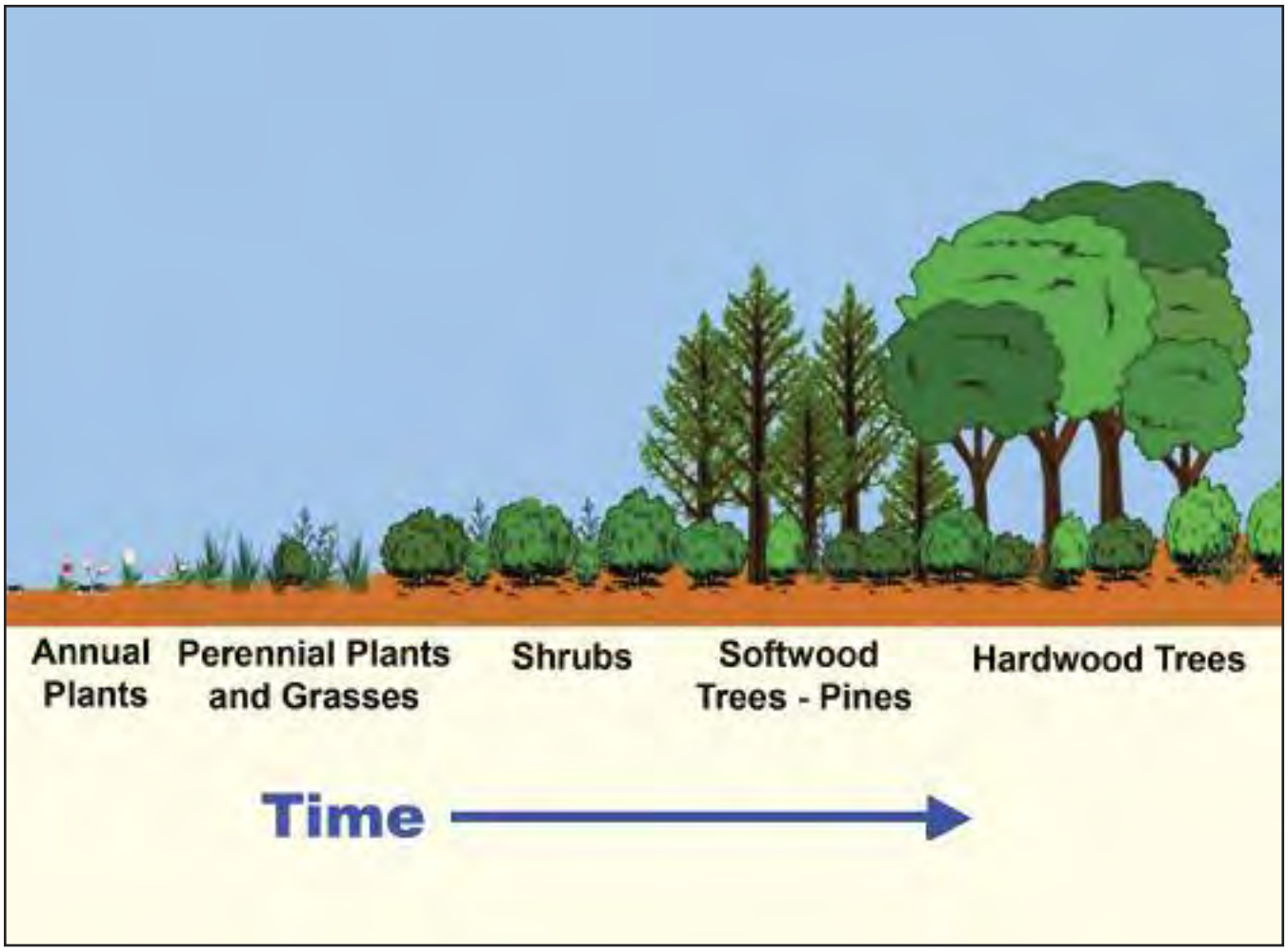
Several surveys indicate that nonindustrial private forest landowners own land for reasons other than timber production. These reasons include aesthetics, recreation, and wildlife management.

The concept of multiple use management was embraced by the U. S. Forest Service in the 1960's after the Multiple Use Sustained Yield Act of 1960 was passed. This act directed the Forest Service to manage forests for a variety of uses, including timber, clean water, wildlife habitat, and recreation.

Private landowners in Mississippi also embrace the multiple use concept on their lands, and many are extremely interested in managing for a sustained yield of timber as well as for enjoyment of their property through recreational use.

Managing for good wildlife habitat is not difficult and can easily be incorporated into the forest-management plan. Landowners should be aware that any actions taken in the forest, including no action, will have an immediate and long-term effect on wildlife habitat.

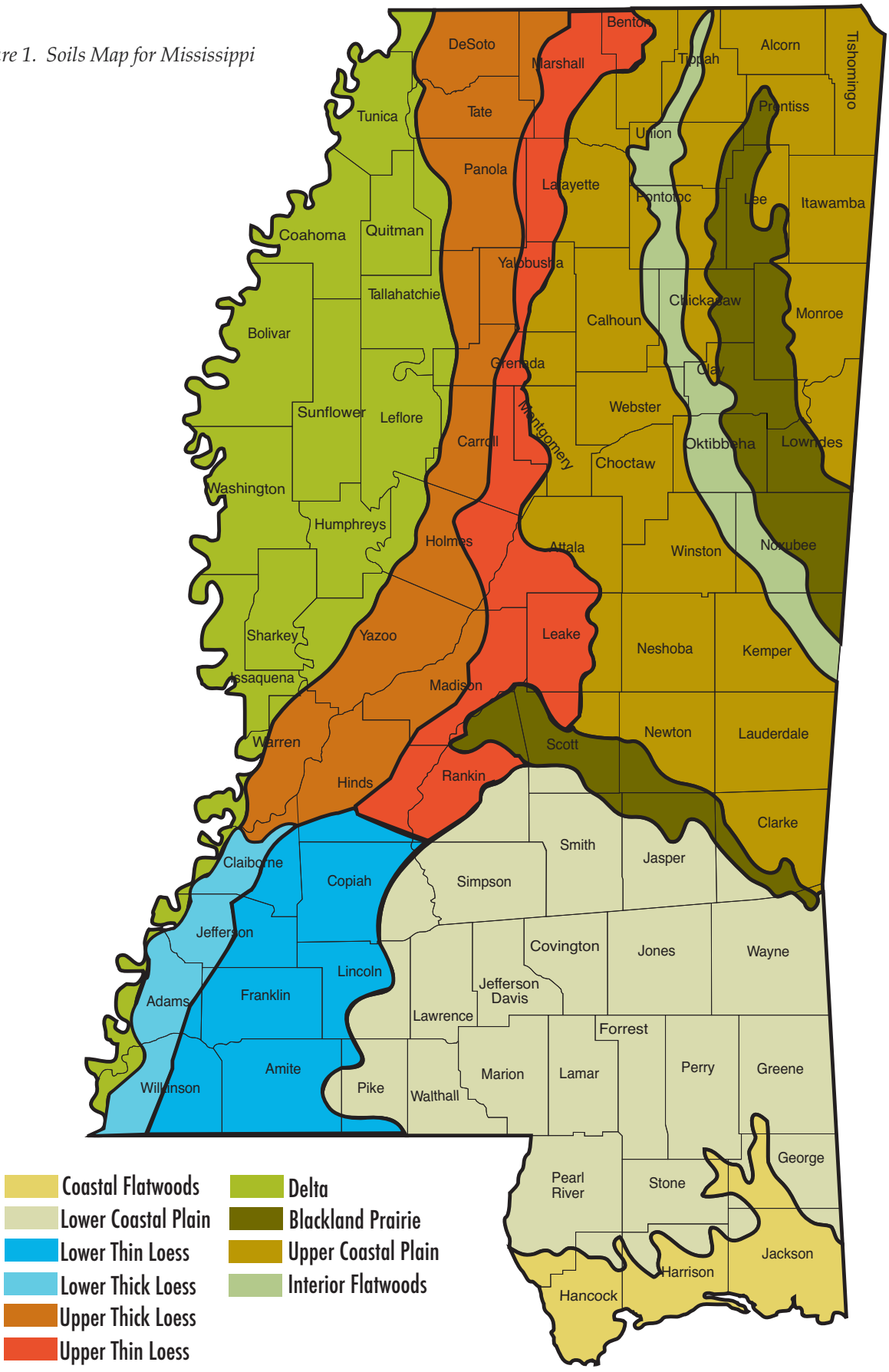
The concept of "plant succession" is important to understanding how different forest management practices alter wildlife habitat. It is also important to understand that not one forest, or forest type, is the ideal habitat for all wildlife species. All disturbances in the forest are followed by a logical and predictable chain of events known as "plant succession." Plant communities do change over time. Disturbances that eliminate all mature trees and greatly disturb the soil and reduce it to bare ground can occur naturally or can be caused by man.



In any event, the simplest plant succession model (as shown above) can help us to understand what will occur in the years following a disturbance. Bare ground will quickly change to annual broadleaf weeds and grasses, and then to annuals and perennial weeds and grasses as light-seeded trees invade the site. Later, the tree seedlings mature first into saplings, then into pole-sized trees, and then into mature forests. In most of Mississippi's uplands (outside the major river bottoms and the coastal flat woods), the ultimate or "climax" forest is oak, beech, and magnolia. Climax forests within the major river bottoms will depend upon soil type and the position of the site within the floodplain. In addition, sites within these major bottoms are altered by changes in stream flow and as sediments are deposited within the floodplain.

The species composition of the annual weeds and grasses that germinate and grow on a site depends upon past land use and what is present in the "seed bank." The seed bank consists of seeds that are already on site, or in the soil. These seeds are there as a result of the vegetation growing on that site, as well as wildlife use of a particular area. Plant succession for old-field sites that were once in agriculture will have a different seed bank than areas that have never been farmed. Pastures that are allowed to revert to forests will have a somewhat different pattern of plant succession because of the dense grass sod and its ability to suppress seeds in the seed bank. Generally, the more you disturb the soil, the more diversity you will have in plant species in the early years of plant succession.

Figure 1. Soils Map for Mississippi



Plant succession behaves quite differently on soils with high fertility and a favorable moisture profile as compared to soils with poor fertility and low moisture capacity and/or poor drainage. The land-management plan must consider all of these things when integrating wildlife habitat management concerns. The most fertile soils grow a higher biomass of plant materials, and those plants have a higher nutrient content for white-tailed deer, for example.

Understanding these basic ecological concepts will allow the land manager to predict and plan for the type of plant community that will result from a particular forest management practice.

Plant species' richness and diversity are the major components of wildlife habitat. While all wildlife species share the common need for food, cover, and water, their specific needs can vary greatly. Therefore, the prudent manager will want to manage his or her forest for a diversity of plant communities that will include the required habitat components for the wildlife species preferred.

Wildlife Management Principles

Diversity – Greater diversity will relate directly to greater habitat quality for a broader range of wildlife species. Diversity includes differences in a number of components. More species of plants, different ages of timber stands, and different types of timber stands are included in this definition of diversity.

Also important are the terms *horizontal* and *vertical diversity*. *Vertical diversity* relates to the presence of different layers, or the absence of those layers, in the forest canopy. Mature hardwood forests normally have good vertical diversity because of the presence of an understory, a mid-story, and an upper canopy layer of vegetation.

Horizontal diversity relates to the change in the plant community across the landscape, particularly at ground level. Horizontal diversity is extremely important as the manager considers the relationship of openings in the forest and the relationship of when and where timber-management practices are located to create different ages and types of ground and canopy cover.

Edge Effect - Edges are the transition between one type of plant community and another. Edges are important since two types of plant communities are present in close proximity to each other, and animals can use both communities quite easily. Increased edge equals greater plant diversity. For example, the edges of a mature hardwood stand and an old field that is growing up in shrubs and grasses provide food for deer in the form of hard and soft mast in the hardwood stand. The old field provides bedding cover and forages such as broadleaf weeds, vines, and soft mast as well.

Edges can be abrupt or feathered. Feathered edges are preferred as there will be greater diversity in plants across the edge rather than a definite boundary such as a fence with an agricultural field on one side and a pine plantation on the other side. A feathered edge would include an area in between the agricultural field and the pine stand that could be managed for early succession plant communities, valuable to quail and rabbits and to many other species. Strip disking is a common way to create a feathered edge where none presently exists. Strip disking is especially valuable to ground-nesting birds such as bobwhite quail and wild turkey. For instance, the newly hatched quail chicks can forage for insects among the one-year-old broadleaf weeds and can easily travel through them on the almost bare ground. Two- and three-year old areas that have been disked also provide benefits to turkey and various other species as the area gradually produces a greater variety of plants and insects that are a required food for turkey poults (turkey young).

Openings – Openings are important for several reasons. Every opening will have an edge, and these edges are valuable to many wildlife species. Openings are used extensively by many species for food and for social interaction. These openings also serve as hunting areas and can be managed in a variety of ways. Annual and perennial wildlife food plantings, strip disking, clipping, fertilization of native plants, and herbicide use are all management practices that will produce good results in managing an opening. Several small openings should be located throughout the property as opposed to one large opening.

Landowners with smaller parcels of land will face limitations on how they can manage for a broad diversity of wildlife species. Quite often, the choices are limited, and a decision is made to favor a certain species. For example, a landowner with 80 acres of pine timber planted under the Conservation Reserve Program (CRP) cannot

really manage for squirrels in the short term. The landowner could, however, manage for white-tailed deer and for greater diversity. He could do this by conducting his management practices, such as thinning and burning, on various portions of the 80 acres in different years to produce a broader range of plant communities across the entire 80-acre forest.

The following section addresses habitat needs for several wildlife species and management practices that will favor those species.

Wildlife Habitat Management for Selected Key Species

White-Tailed Deer

White-tailed deer thrive in a variety of habitat types. They are present in all soil resource regions of Mississippi. Usually, deer are larger and population densities are greater on the most fertile soils. Deer in Mississippi use all habitat types but are more dependent on forage than on hard mast. While hard mast in the form of acorns is an important energy food consumed in fall and winter, excellent populations of deer do exist in areas with very little hard mast.

Because deer are most dependent on forages in the form of annual and perennial broadleaf weeds, vines, and twigs of hardwood seedlings and shrubs, they make great use of plant communities in the early stages of plant succession. These areas also serve as good bedding cover for the deer while they make trips into more open timber areas to forage on hard and soft mast as well as to browse on available plants in the understory.

Deer eat a wide variety of plant materials throughout the year. A good way to categorize plants for deer use is to classify them as preferred, staple, and delicacy. While managers will want to provide as much preferred food plant material as possible, they should make certain that "staple" foods are present in large amounts as well. Preferred foods are those either high in protein and or energy. Staple foods are those that offer basic nutrition but have relatively less protein and energy. They are considered to be maintenance foods that prevent starvation until the preferred foods become available again.

Since deer require 13 – 16 percent crude protein in the diet for optimum growth and development, preferred foods are those that can provide a level of protein near or exceeding that requirement. While there are a number of plants growing on delta soils that can provide high protein levels, the same plants on soils with low natural fertility will have far lower crude protein content. Therefore, preferred plants are those with the highest protein available in a particular region. In addition, protein content will vary and will generally be higher in spring and early summer and will decline as fall approaches.

Preferred foods for spring and summer have a relatively high protein content and high digestibility. Broadleaf weeds such as common ragweed and other herbaceous plants are preferred because of their high protein content and palatability. Some of the invasive plants that are not native are also preferred in most locations and include kudzu, Japanese honeysuckle, and Chinese privet hedge.

Acorns are a preferred food in fall, but are preferred for a different reason. As winter approaches, deer instinctively prefer foods high in energy. While acorns are relatively low in protein, they are high in fat and energy and are, therefore, "preferred" because deer instinctively recognize their need to build fat reserves for the winter. Pecans are also used to build fat reserves for winter, particularly in the Mississippi delta region.

Staple foods are those present throughout much of the year. Native vines and the twigs of shrubs and trees provide basic sustenance for deer in winter when preferred foods become limited. Browse plants include blackberry and dewberry, greenbrier (smilax species), poison ivy, trumpet creeper, American beauty berry (French mulberry) and yellow jasmine. Plants that are not native include Japanese honeysuckle and Chinese privet hedge, and these plants are very important as staple browse plants in many areas. Tree twigs browsed by deer include

black gum, dogwood, willow, maple, cottonwood, and many others. Stump sprouts of many hardwood species are a staple food for deer.

Common Ragweed frequently contains crude protein levels in excess of 20 percent and flourishes on disturbed soil sites during summer months.

Delicacies are also important to deer and to deer hunters. The native persimmon is highly preferred along with honey locust pods, muscadine grapes and vines, crabapples, and other seasonal fruits. Mushrooms are also heavily used by deer as a delicacy food.

Deer also make use of the forage and crop residues available in adjoining agricultural fields, and this food supply should be considered in any management plan. In summer, the deer prefer soybeans and peanuts and winter wheat and ryegrass pastures in the winter, if available. They also use grain residues such as those from corn and soybeans.

Wildlife food plots are also valuable, especially in the regions of the state with poor soil fertility. A well-limed and fertilized food plot can grow up to 10 times more digestible protein per acre than is present in adjacent woodlands. On rich delta soils, the difference is not as great, but supplemental food plots can be managed to provide additional nutrition.

The two stress periods for deer in Mississippi are late summer and late winter. A supplemental food plot program should attempt to produce forages that will be available to increase nutrition for deer during those stress periods. Legumes are preferred, and the best warm-season plants that can withstand at least some browse pressure in summer are cowpeas and alycee clover (a white clover). Cool-season plantings should include small grains such as oats and wheat. The addition of clover is also very beneficial. In areas that have no significant hard mast production, deer can benefit from corn planted to provide a diet high in energy.

While cool-season food plots are relatively easy to grow, the production of high quality warm-season plantings requires more effort and skill. Soil pH is more important, and both pre-emergent and post-emergent herbicide applications may be required to control competing vegetation.

For optimum growth and yield, plant food plots on a smooth, firm seedbed that is well limed and fertilized according to soil tests. Consult your local County Extension Office for assistance. Another very valuable source for information on planting wildlife food plots is the Quality Deer Management Association (QDMA). This organization can be found on line at www.qdma.com. They offer a wide range of resources for the deer manager, including a very good book on the establishment and management of wildlife food plots.

Because deer thrive in early to middle succession plant communities, land managers who want to create and maintain good deer habitat should use frequent timber sales and other land-management activities that will allow sunlight to reach the forest floor. Streamside Management Zones (SMZ) should be managed with selective harvest practices to favor both hard and soft mast species.

When possible, pine forests should contain a number of different age classes and should be managed for a variety of ground covers of different ages. Pine stands should be burned on 3- to 5-year intervals with some burning done each year to produce horizontal diversity for forage production and for bedding cover.

Many pine stands in Mississippi have dense mid-story layers of sweet gum and other shade-tolerant species. These trees compete with pines and reduce growth rates. They also shade out ground-level plants that provide deer browse and cover. Visibility is also greatly reduced,

and hunting success can be decreased. Quality Vegetation Management (QVM) is a relatively new concept in pine management. Herbicides are used to kill this mid-story vegetation, and fire is reintroduced to manage for increased plant biomass at the ground level where it is beneficial to most animals. Managers interested in implementing Quality Vegetation Management should consult with a registered forester or a certified wildlife biologist with experience in QVM.

Another technique that can be used, especially in pine plantation stands, is soil disturbance by "light" disking or by the use of a "Herschel drag." The Herschel drag is a tool bar that has bulldozer tracks attached to it. The drag can be pulled by a small bulldozer or a high horsepower tractor. The ground disturbance simulates a timber sale by exposing bare soil, allowing a variety of broadleaf weeds to germinate and grow on the site. Two years after the first thinning is a good time to use this technique in a pine plantation.

Hardwood stands can be managed with a variety of harvest strategies. Small clear-cuts and group-selection harvests can be used regularly to maintain a diversity of relatively open ground cover as well as thick areas for both forage and bedding cover.

Deer harvest is a key component of good deer management, and antlerless deer harvest should be used as appropriate. Deer can degrade their own habitat over time if deer numbers exceed the land's ability to support them at a healthy level.

Because habitat conditions and deer productivity vary so greatly, recommended harvest rates vary also. Harvest in good habitat in the better soil regions of Mississippi can be as high as one deer harvested per 30 acres of habitat on an annual basis. Antlerless deer should comprise 50 to 65 percent of the harvest. Harvest rates in the poorest regions of the state can be as low as one deer per 150 – 200 acres with 40 to 50 percent of the harvest in antlerless deer. Consequently, all regions in between those two extremes would have harvest rates somewhere in between and should be designed to keep the population stable. A good average in many areas of Mississippi is a harvest of one deer per 50 to 60 acres with 50 percent of the harvest as antlerless deer.

For more information, a qualified deer management professional can determine what is best for your situation.

Wild Turkey

Wildlife biologists once believed that wild turkeys could not survive apart from huge expanses of mature hardwood and mixed pine hardwood forests. The current knowledge now demonstrates that turkeys do quite well in a variety of landscapes, as long as they are given adequate protection from illegal hunting. Even pine plantations provide good turkey habitat when they are managed by frequent harvest cuts and with fire on a regular basis. Streamside Management Zones (SMZ) adjacent to the pine stands provide adequate diversity by furnishing hard and soft mast, leaf litter for invertebrate insects, water, and other critical elements for turkey survival.

Pine stands that have been thinned and burned offer good brood habitat, and logging decks are often managed as openings in the years following a harvest cut. Soil disturbances associated with harvest cuts grow early succession vegetation that hens and poults use as "bugging" areas as they forage for insects. Brood habitat can be a limiting factor since young turkeys need a diet comprised almost entirely of insects for the first several weeks of their lives. As the weeks progress, they begin to eat more seeds and tender plants. Pine stands can also furnish a number of other foods such as pine seeds, grape and huckleberry fruits, blackberry and dewberry, dogwood fruits, and a variety of others such as smilax and poison ivy.

Turkeys spend a lot of time in and near openings; therefore, managers who want to manage for turkeys should have a good open-area management program in place.

Use a variety of techniques to provide several different stages of plant succession from 1 to 5 years old. Strip disking, food-plot planting, and maintenance of perennial food plots such as clover can pay big dividends. Wild turkeys also make extensive use of agricultural fields to forage for a variety of crop residues, germinating weeds, grasses, and insects.

Hardwoods should be managed to provide good supplies of hard and soft mast. Also present in hardwood forests are a number of vines that furnish food such as several species of grapes, smilax, and even poison ivy berries.

In regions where acorns may be scarce, food plots can provide high-energy foods such as corn and grain sorghum. Clovers are also very beneficial because they furnish forage directly, and they also provide insects. Managing perennial clover fields by a combination of clipping and herbicide use can provide turkeys with a very valuable year-round opening.

While ground-nest predators can have an effect on turkey populations, you can minimize their effect by creating forest conditions that furnish a wide range of good nesting habitat scattered across the landscape. Research on predators of bobwhite quail has demonstrated that quail populations can be improved in areas of extensive predator control, and the same is thought to be true for wild turkeys. However, the predators quickly return within 2 years. Therefore, a predator-control program designed to improve quail and turkey populations should be very aggressive and should be maintained from year to year. A better alternative may be to provide ideal habitat to mitigate the effect of the predators.

While controlled burning is very valuable to produce new growth at ground level, it should not be so extensively practiced that all good nesting and escape cover is eliminated. Annual burns will gradually convert the ground level vegetation to grasses and will eliminate many broadleaf weeds, vines, and shrub components. A good controlled burning program in pine forests should include a 3-year rotation. Landowners should maintain a number of areas that are not burned across the property. These areas should be reasonably thick at ground level to provide escape cover and low-roosting cover. They should also be larger than one acre in size and should be irregular in shape with a feathered edge if possible. Leave plum thickets, switch cane thickets, and other areas of dense shrubs intact for escape and nesting cover.

Other good vegetation management practices for turkeys include strip disking to produce nesting and escape cover. Areas set aside for strip disking should be several acres in size. Disk one third to one fifth of the area each year to control and maintain the area in the bare-ground stage and other areas up to the shrub and small tree stages. QVM is also a good practice to use to gradually reclaim pine stands that have extensive mid-story layers of sweet gum so effective controlled burning can resume.

Harvest rates for wild turkey also vary widely because of differences in population levels. Long-term harvest rates of one to two adult gobblers per square mile will serve as a guide for most regions of Mississippi.

Bobwhite Quail

Bobwhite quail numbers depend heavily on land use. The largest numbers of quail in recent history occurred in Mississippi from 1940 to 1970. This is because small-scale agriculture, extensive use of fire, and other land-use patterns created early plant- succession habitats that are ideal for bobwhite quail. Quail numbers have declined by 70 percent since the 1970's, however, because of several factors, including predators and parasites. While these factors are certainly important, the most significant reason for the decline was a loss of quail habitat.

Ideal quail habitat depends upon early plant succession habitats that provide bare ground, native clump grasses, woody cover, and seeds and insects for food. Clean farming practices, the increased use of sod-forming grasses that are not native, dense tree stands, and other land-management practices do not provide the ideal habitat for quail.

While many landowners will be content to enjoy the quail that naturally occur on their property, many will want to manage for more quail. Great quail habitat and great quail hunting are possible if you use a variety of techniques to intensively manage your land for early succession plant communities.

Pine stands should be managed with frequent fire and should be thinned frequently to maintain an open canopy. Soil disturbances such as strip disking, the use of a Herschel drag (as mentioned above in the section on white-tailed deer) and other practices that will produce bare ground on an annual basis are important for good brood habitat.

Numerous small food plots that mimic small scale agriculture should be interspersed near thick woody cover, such as plum thickets and overgrown fencerows. Plant a wide variety of crops such as grain sorghum and corn to small grains and clovers. Encourage native clump grasses, and control or eliminate grasses that are not native, such as Bahia grass, Bermuda grass and other sod-forming grasses. Encourage native leguminous plants such as partridge pea and beggar lice with fire and soil disturbance.

Intensive predator control and supplemental food-plot management can increase quail populations. However, control must be intense and continuous because predators will return to high numbers one to two years after control is terminated.

For more information on bobwhite quail management, please visit the Mississippi State University Extension Service Web Site at http://msucares.com/wildfish/wildlife/quail.html.

Small Game Animals

Small game animal populations vary greatly with habitat quality. Rabbits are abundant in early plant-succession plant communities, while squirrels depend more on mid- to late-succession forests of hardwood and mixed pine hardwood stands.

Squirrels. Squirrels eat a variety of plant materials such as tree buds, seasonal fruits, and soft mast. However, they depend most on soft and hard mast. Soft mast species consumed by squirrels include black gum and tupelo gum, dogwood berries, and the berries of several woody vines. Hard mast includes pine and cypress seeds, acorns, hickory nuts, and pecans.

Landowners who want to manage for squirrels should maintain good streamside management zones (SMZ) in their pine stands and should practice good hardwood management in the SMZ and in hardwood stands. Oaks and other mast-bearing trees generally produce greater mast crops when their crowns are full and they are not overcrowded. Good hardwood-management practices that are designed to keep the hardwood stand healthy and actively growing will also be the best management techniques for squirrels.

Rabbits. Management practices that favor and produce an abundance of low-growing plants and thickets favor rabbits. Rabbits are generally most abundant during the third through the seventh year of a pine plantation because of abundant food and cover. Landowners interested in rabbit hunting should make certain they have frequent site disturbances such as timber sales, strip disking, etc. Any management practice that produces or maintains plant communities with abundant ground cover will benefit rabbits and will make for great rabbit hunting.

Economic Considerations of Wildlife Management

As a general rule, good timber management is good wildlife management. Actively growing timber stands are healthy and will produce the most food for most wildlife species. Because diversity across the landscape is very important to good wildlife populations, frequent timber sales will help to produce that diversity.

Timber management and wildlife habitat management are linked together, and the timber management plan will affect the wildlife habitat management plan. Healthy wildlife populations produce a quality outdoor experience for the landowner, family, and guests, or for the persons who lease the property for hunting and fishing. Fees paid for hunting leases vary greatly across Mississippi and are tied directly to the abundance and quality of the white-tailed deer herd on the property and in the region in general. Good hunting lands with high deer populations often command $10 or more per acre. The Delta, Loess Hills, Brown Loam, and Black Belt Prairie Regions generally command the highest per acre lease prices. The Coastal Plains and Coastal Flatwoods regions have the lowest lease prices.

Landowners who are leasing, or who want to lease their lands, should have a good open-area management philosophy. Hunters want to see wildlife as well as harvest it, and wildlife viewing is enhanced with good visibility provided by food plots and other open areas such as those managed by strip disking, etc. Any areas left open and not growing timber will be a sacrifice because the timber growth that is worth about $75 or more per acre per year will be lost. However, this revenue can be recovered easily by a slight increase in the per acre lease price to compensate for it. For example, if a 1,000-acre property has 2 percent in openings, 20 acres will be left open and not growing timber. If timber growth is valued at $75 per acre per year, this would be $1,500 per year. If 40 acres are left open, then $3,000 per year would be sacrificed to lost timber growth.

Knowing that hunters will pay more per acre for a hunting lease with open areas for planting food plots and for good hunting visibility, a simple increase in the lease price will recover the costs. For the 20 open acres mentioned above, an increase of $1.50 per acre will cover the loss and is actually better because the financial return is received in the present instead of in the future at the sale of the timber. If the value of the increase in hunting lease is invested, foregoing the future timber sale revenue for the present, income of the increased hunting lease revenue is equal to or better than keeping that 20 acres in timber.

Food-plot planting and management are extremely popular. Hunters will pay more for a property that will allow them to plant a sizeable number of good sized food plots. Landowners can easily compensate for the timber growth loss by charging more for the lease.

Hunting leases should be executed through use of a formal contract that spells out the expectations of the lessor and the lessee. The landowner should also require hunting club liability insurance. A number of vendors can supply hunting club insurance. The Mississippi Forestry Association and the Quality Deer Management Association can be helpful in finding a good policy for a hunting club.

Food plots managed for Osceola Ladino (a white Ladino clover) do well on sandy loam soils in Mississippi. During a mild summer with average rainfall, good growth may persist into August, as seen in this photo.-

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12 Taxes and the Family Forest Owner

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Owning forestland vests certain responsibilities with the landowner. One of these responsibilities is paying federal, state, and local taxes.

All private forest landowners in the United States are subject to income tax regulations. For the most part, taxation for forest landowners is the same as for any other hobby, business, or investment. However, several provisions within the tax code are specific to forestry. Forest landowners also pay property taxes on their forestland according to state and local tax regulations. Some states assess taxes on harvested timber in the form of yield or severance taxes.

Unfortunately, many forest landowners are not familiar with either the general tax laws or those specific to forestry. Also, many accountants and tax professionals are unfamiliar with the application of regulations that apply to forestry, because they have few clients fortunate enough to own forestland. As a forest landowner, you should take the time and make an effort to learn the basics of timber taxation—both to comply with the law and to recover your investment expenses in timber.

The subject of taxation is intimidating for many people. Establishing a basic knowledge of taxation principles, as applied to forestry, will allow landowners to determine what applies to their situation and where more intense knowledge is needed. It will also enable you to make sure your tax professional is up to date with federal taxation as applied to forestland ownership and management. Some basic principles are discussed in this chapter to help you get started.

Selection of Ownership Structure

Forest landowners may structure their forestland in several ways to satisfy the Internal Revenue Code. These general structures are based on profit motive, level of activity, and some level of self-determination. The four basic ownership structures are personal use or hobby, investment, and business including the spiral farm category. Ownership practices and structure determine if deductions are allowed for ordinary operating expenses, how deductions are claimed, and the amount of recordkeeping required.

Hobby or Personal Use

Landowners who use their land for hobby or personal use are motivated to grow timber for reasons other than profit. Typical goals for these landowners include recreation, hunting, conservation, private home sites, and the sentiment of keeping land in one's family. Hobby owners cannot deduct expenses except in years when they have offsetting hobby income. Expenses in other years are not deductible. Timber sales generally qualify for capital gains treatment.

Investor

Investors manage timber for a long-term profit. Investors tend to be less active in their ownership than business owners. They may have only one or two timber sales during their lifetime or may have a sale every few years. Reasonable investment expenses are deducted as miscellaneous itemized deductions. If the standard deduction is used, expenses may be capitalized (added to the timber basis) if the proper steps are taken. Investors must keep adequate records to justify deductions and to claim timber depletion. Timber sales may qualify as long-term capital gain or loss. Casualty losses of timber are deductible if there is a timber basis.

Business

Many forest landowners operate their forests as a business. There is no requirement to be incorporated or to use any specific business structure. The business owner is expected to operate in a business-like manner, which includes reasonable accounting records. Other good business practices to consider include creating a name for the forestry business; maintaining a separate bank account to avoid co-mingling personal and business funds; and selection of an appropriate business structure, such as a partnership, corporation, s-corporation or other. Business owners treat their forest- management expenses as business expenses. The sale of standing timber may be treated as a capital gain or loss. A portion of the income from the sale of products, such as cut firewood, pulpwood bolts, or harvested sawtimber is treated as ordinary income. Casualty and noncasualty business losses are deductible if the timber has a basis.

Farmers

Farmers are in a special type of business category. Owning and managing a forest is not normally considered a farming activity. However, many farmers have a forest which is part of their farm. For these owners, it is possible to treat the forest activities as part of the farm. Farmers may treat their forest-management expenses as farm expenses. The sale of standing timber may be treated as a capital gain or loss. A portion of the income from the sale of products, such as cut firewood, pulpwood bolts, or harvested sawtimber is treated as ordinary income. Casualty and noncasualty business losses are deductible if the timber has a basis.

Selection of an Operating Structure

Selection of the correct structure for owning and managing forestland is important. The IRS identifies the structure by how deductions are taken and income is reported. The Timber Tax Website at *www.timbertax.org* has detailed information on the various structures available.

Recordkeeping

Recordkeeping is required for all owners. One reason so many forest landowners are not able to take full advantage of available deductions is that they do not keep adequate records. At a minimum, forest landowners should establish a tree farm journal. This is a dated activity log with columns to post financial events. For landowners with many expenses, a more detailed bookkeeping system would be helpful. The use of commercially available computer software makes this a relatively simple process. The IRS does not prescribe the type of recordkeeping, but if audited, you must have records to back up your tax returns.

Another good reason for family forest landowners to keep records is to provide guidance and information to future owners. A well-kept detailed tree farm journal can provide insight, especially if the landowner has not involved his or her heirs with the forest and land management. One way to help future owners is to include a section within the journal containing the names and addresses of firms and individuals associated with the forest, such as neighboring landowners, vendors, timber buyers, loggers, consulting foresters, public service foresters, or hunting lease holders.

While the IRS has no specific recordkeeping format requirements, IRS Form T: Forest Activities Schedule and its associated instructions provide guidance for details required for timber sales, basis records, reforestation expense, and capitalization. One of the most important financial records to keep is that of the basis, or investment value, of the timber and land ownership.

Basis of Land and Timber

Basis is the investment value of an asset. When an asset is acquired, it has an initial basis, which varies according to how property was acquired. For landowners with limited holdings, the basis is only adjusted when necessary—before and after timber is sold, when a loss is claimed, or when undeducted expenses are capitalized into the basis.

Basis is adjusted when expenses are added to the current basis rather than being deducted—a process known as capitalization.

Basis is recovered by a process called depletion or by applying the basis against sales proceeds. When timber is sold, the taxpayer is not taxed on the gross proceeds, but on the gross proceeds less the sales expenses and the timber depletion (amount of timber basis in the sold timber). Casualty or noncasualty business losses also require basis depletion.

The following example explains the use of basis:

Martin Nester owns 100 acres of timberland. His basis in his timber is $100,000. Martin spends $5,000 on pruning his timber to encourage sawlog production. Since pruning is a capital investment, it must be capitalized or added to the basis rather than deducted. Using IRS Form T: Part IV: Reforestation and Timber Stand Activities, Martin notifies the IRS that he is capitalizing the $5,000 into his timber basis account. His adjusted basis is now $105,000. Ten years later, Martin sells the timber for $250,000. He pays a consulting forester 7 percent commission on sale of the timber, a total of $17,500. The taxable gain on the timber sale is $250,000 less adjusted basis of $105,000 and less sales expenses of $17,500. His net taxable gain is $127,500. Since Martin sells all his timber, the entire basis is depleted. If he had made a partial sale, such as a thinning, improvement cut, or partial harvest, only a portion of the basis would be depleted.

Initial Basis Determination

Timber can be acquired in four ways: through purchase, inheritance, gift, or reforestation investment.

- When the timber is first acquired, it has an initial basis. The amount of the basis depends on how the property was acquired.

- For purchased property, the initial basis is the proportion of the total acquisition cost allocated to the asset.

- For inherited property, the initial basis is "stepped up" to fair market value at the time of the decedent's death or alternative evaluation date.

- For gifted property, the initial basis is the basis of the giver and is called a "carryover" or "transfer" basis. If gift tax is paid on the gift, that affects the gifted asset's basis.

The following examples illustrate the initial basis determination methods and how they affect the net gain on timber sales:

Purchased Timberland. Initial basis for a new landowner is the total acquisition cost. This is the purchase price plus the associated costs such as lawyer's fees, filing fees, timber cruising fees, and realtor's fee. The total acquisition cost must be divided between the various assets that make up the total asset. This division is based on the proportion that each asset contributes to fair market value.

For example:

Rufus Maple purchases 40 acres of forestland for $40,000. He spends $10,000 on legal fees, consulting forester fees for a timber cruise, title search, recording fees, and title insurance. His total acquisition cost is $50,000. Based on current values of land and standing timber, his timber is 60 percent of the total value of the timberland, while the land is 40 percent. His timber basis is $30,000 (60% of $50,000), and his land basis is $20,000 (40% of $50,000).

Inherited Timberland. Determining the basis of inherited timber requires a different rule. This requires an appraisal of the asset after the original owner's death. The land and timber should be appraised separately. A consulting forester can appraise timber.

Let us consider the following example:

Ivy Birch inherited 100 acres of timberland from her father. Ivy realized that she needed to have her timber basis account established. She hired Forester Fred to set up her timber basis. Fred determined that the volume of timber was 100 MBF of pine sawtimber, valued at $40,000, and 200 cords of pine pulpwood valued at $4,000. Ivy's initial timber basis was $44,000.

Gifted Timberland. Often family forests are gifted or deeded to someone rather than allowing the ownership of the forest to transfer at death. Gifted property has a transfer or "carryover" basis. The donor's basis generally becomes the recipient's basis. All or part of any gift tax paid may be added into the basis, depending on the date of the gift. More complete information on basis of gifted property may be found in IRS Publication 551: The Basis of Assets.

For Example:

Fern Frond purchased 100 acres of pastureland. Her total acquisition cost was $5,000. She abandoned the pasture and allowed a natural forest to develop on the property. Twenty years later, Fern deeded the 100 acres to her grandson, Felix. She did not pay gift tax on this transfer of ownership. Fern's basis in the property carries over to Felix. Felix will have a $50/acre basis in land. He will have no basis in timber as Fern did not purchase timber and had not invested money in growing timber.

Retroactive Basis Determination

Many individuals do not have proper accounting records for supporting their timber basis. If the timber has not been harvested and there are adequate records, a consulting forester may be able to establish a basis retroactively. The IRS Timber Casualty Loss Audit Techniques Guide contains instructions on retroactive basis establishment. This guide is available from the *www.irs.gov* website.

Timber Sales and Capital Gains

Proceeds from the sale of standing timber is usually treated as a capital gain or loss. If the timber has been owned for the required holding period (a year and a day) then it will qualify as a long-term capital gain, subject to the lower capital gains tax rate. In addition, it will not be subject to self-employment tax.

Inherited property has no required holding period to qualify for as a long term capital gain. For gifted property, the required holding period can be met by adding the ownership time of the donor and the recipient.

IRS Form T: Forest Activities Schedule can be used to determine the profit from the sale of timber. This form helps calculate basis depletion, which allows landowners to recover their investment in the timber and reduce the tax paid on the timber sale. If all of the timber is sold at one time, the entire timber basis is applied against the timber sale. If the sale is for part of the timber, such as for a thinning, improvement cut, or partial harvest, the basis must be allocated between the timber harvested and the remaining timber, based on per unit values called the depletion unit. A consulting forester may help allocate basis for a partial sale. Form T supplements the other tax forms used to report a capital gain such as Schedule D (Form 1040) Capital Gains and Losses and Form 4797 Sales of Business Property.

Reforestation and Site-Preparation Costs

Site preparation and reforestation expenses are investments in the capital asset of timber. The IRS has specific provisions to deal with their cost recovery. These rules apply whether costs are for artificial or natural regeneration following a timber sale or for establishing a new forest on bare ground. Trusts must capitalize costs into the timber basis account and recover them when timber is sold or a loss is claimed.

The American Jobs Creation Act of 2004 created our current method of recovering reforestation costs. Under these rules, forest landowners can deduct outright the first $10,000 of qualified reforestation expenses during each tax year for each qualified timber property. In addition, landowners can amortize and deduct all reforestation expenses in excess of $10,000 over an 84-month period using a specified formula. Trusts are not eligible for the initial deduction and the IRS currently not allowing amortization.

As an example, assume a forest owner spent $14,000 to reforest a cutover tract. The owner can claim a $10,000 reforestation deduction. The remaining $4,000 is the amortizable basis, which is the amount over the initial $10,000 deduction. This amount may be amortized and deducted over the next 8 years (2006-2013) using this formula:

Year 1:	**1/14 of amortizable basis**
Years 2-7:	**1/7 of amortizable basis**
Year 8:	**1/14 of amortizable basis**

This means that on the owner's first tax return, one-fourteenth of $4,000 or $288 is deducted along with the initial $10,000 deduction. For the next 6 years, the landowner can deduct one-seventh of $4,000 or $571, with the remaining $288 deducted in the 8th year.

Operating Expenses

The ordinary and necessary expenses of forest management may be deducted for forest landowners with a profit motive. This includes investor, business, and farm categories. Such expenses include consulting fees for forest-management plans, boundary line maintenance, herbicide application not associated with reforestation, hazard-reduction burning, tools and supplies, equipment operating costs, office expenses, forestry educational materials, and many other similar expenses. Investors deduct such expenses as miscellaneous itemized deductions. Business owners deduct them as business expenses. Farmers deduct them as farm expenses.

Operating expenses must be reasonable, necessary, and have a profit-related motive in order to be deducted. Judging such expenses by industry standards can help the taxpayer determine if an expense is justifiable. If the expense is standard for industrial forest owners, then it is a reasonable expense. For example, industrial forestland is often treated with prescribed burning to reduce the hazard of wildfire. The nonindustrial private forest landowner may follow suit and claim a tax deduction on this activity. Hobby owners may not deduct operating expenses except in the years in which they have income from the hobby activity.

Casualty and Other Losses

Recently planted forests, young stands, and mature timber stands all contain an element of risk from losses due to natural and unnatural events. Normal losses, such as the death of seedlings from poor planting practices are not deductible. Casualty and noncasualty business losses may be deductible if the forest landowner has basis in the timber. Deductible losses are limited to the loss in fair market value of the asset or the adjusted basis, whichever is less. Insurance or other compensation for losses must also be considered in determining if there is a deductible loss. Deduction of losses is quite complicated and requires the help of a forester to determine the loss in fair market value. The IRS has a Timber Casualty Loss Audit Techniques Guide, available at *www.irs.gov*, which clearly illustrates the determination of the casualty loss deduction.

Timber and Taxation

As this chapter indicates, timber taxation can be quite complicated. The materials presented here have been simplified in order to present general principles. It is important for forest landowners to understand some basic timber taxation principles to maximize overall profits from forestland. Wise landowners will educate themselves about forest taxation or seek assistance from qualified professionals on forest tax issues. The best source of information on timber taxation is the Timber Taxation website, *www.timbertax.org*. The IRS website has many publications on topics of interest to forest landowners at *www.irs.gov*. Additional information is available from state forestry extension offices.

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13 Forest Health

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Protecting our forests is a continuing challenge. Damage to forests can come from wind, water (drought and or prolonged standing water), ice, lightning, fire, invasive species (such as kudzu and Cogongrass), diseases, and insects.

To protect your forest's health, follow these basic prevention guidelines:

- Match your site with the appropriate tree species.
- Alter stand density.
- Promptly salvage all lightning-struck, logging-damaged, diseased, or otherwise high-risk trees.
- Harvest overly mature trees when pest activity is low.
- Plant trees only in their natural range.
- Minimize site and stand disturbance.
- Harvest all mature trees at, or shortly after, rotation age.

Following these recommendations will promote a healthy forest.

Numerous insects and diseases can be observed in our forests. However, only a few currently cause major problems. We must, however, always be aware that new exotic species may be introduced into our forests and severely impact their health. The agents that are damaging to our pine resources are our greatest concern.

Insects

Pales and Pitch-Eating Weevils

These insects can severely damage recently planted pine seedlings. Under high population levels, young plantations may also be damaged. Adult weevils are attracted to freshly cut stumps where they reproduce and feed on the succulent young bark of seedlings and on developing shoots of older trees. When heavy feeding occurs, the stems of the seedlings are girdled, resulting in tree death.

If you follow recommendations associated with a hazard-rating system that has been developed for these weevils, you can reduce their impact on stands being regenerated. The hazard-rating system is based on logging date and planting date. When logging takes place during the winter and spring, and when planting does not occur until the following December to February, the hazard rating is low. If at all possible, this is the recommended approach to prevent damaging losses to seedlings from reproductive weevils. The stumps have had sufficient time to harden off and are not attractive to the weevil adults.

If logging occurs during the summer months with planting the following February to March, there would be a

medium hazard for weevil activity. With this situation, the seedlings should be treated with a recommended insecticide to prevent the weevils from killing them. Logging during the fall and winter followed with an immediate planting is our highest hazard condition. The stumps are attractive, and if there is a weevil population in the area to respond to the freshly cut stumps, a great deal of damage can occur. Again, with these conditions, the seedlings should be treated with a recommended insecticide in the form of a top dip, root dip, granular, or spray, depending on the conditions.

Pine Tip Moths

At least three species of pine tip moths damage young pines in Mississippi. The Nantucket pine tip moth is the most common, feeding on buds and current shoots of trees up to about 15 feet in height. They also prefer the fastest growing trees. The effect of the feeding is a reduction in height and increment growth. Severe infestations also stunt the trees' growth. The leading terminal shoot is the site attacked most often. As a result of tip moth damage, an excessive amount of compression wood can be formed within the stem, ultimately resulting in reduced lumber quality and pulp yield.

Currently, the primary method of reducing the impact from tip moth damage is the use of insecticides that are timed with each generation. It is generally accepted that the first generation is the largest and most damaging generation. Therefore, it is important that if an insecticide is going to be used, it should be timed to impact the first generation and then timed to reduce subsequent generations. In Mississippi, there may be three to four (generations) spray periods. Monitoring flight periods with pheromone traps can assist in the timing of the applications.

Southern Pine Bark Beetles

The southern pine beetle has been a major cause of mortality to pine stands in Mississippi. With extreme weather events such as Hurricane Katrina, followed by an extended drought, other bark beetles have caused significant mortality to our pine resources. These other beetles are the Ips engraver beetles (three different species) and the black turpentine beetle.

Ips beetles are less aggressive than southern pine beetles and prefer host material that is stressed because of a moisture deficit, slash from harvesting operations, or wind-thrown material. It is essential to recognize that that there are three Ips species that can kill our pines.

The southern pine beetle is a more aggressive species and attacks apparently healthy trees in groups, commonly referred to as "a spot." These beetles are commonly associated with many different adverse conditions, such as natural disturbances (lightning), extremes in moisture, high stand densities or stocking, reduced radial growth rates, and pathogenic fungi.

In addition to following the basic prevention guidelines outlined above, you should follow the following preventive silviculture options:

- favor resistant species
- remove high hazard trees (lightning-struck trees)
- regulate stocking
- mix stands of oak and pine
- minimize logging damage and
- harvest/actively manage overly mature stands.

Of prime consideration is an understanding of the bark beetle/ host interaction and the elements essential in promoting vigor and forest health.

Direct control of the bark beetles mentioned above involves salvage, cut-and-leave, or pile-and-burn. Chemical treatments are limited because in treating standing trees, the treatment has to extend to the first live limbs. Specialized equipment is needed to get the spray to the height of those limbs. In addition, the availability of compounds may be limited because of environmental restrictions.

Ips mortality has greatly increased since Hurricane Katrina. Drought also plays a significant role in increasing the susceptibility of pine to bark beetle attack. Ips beetles prefer material left after hurricanes, tornados, and ice storms as well as thinning slash. Ips and black turpentine beetles do not create spots, as does the southern pine beetle. They attack individual trees throughout a stand, in fencerows, along highways, and in the median, as well as in our yards. Trees are particularly susceptible during the early fall. Pine trees in yards and other recreational settings should receive at least an inch of water a week, if possible, to decrease their susceptibility to Ips attack.

Numerous insects can be seen feeding on pines, but they are seldom of serious concern. Forestry commission employees, extension specialists and county directors, or consulting foresters can assist with their identification. Numerous websites such as www.bugwood.org and www.forestpests.org can also be accessed and provide useful information.

Insects that Affect Hardwoods

Periodically, vast acreages of our hardwood forests are defoliated. This defoliation results in reduced tree growth, seed production, and potential mortality. During stand establishment, cottonwood plantations are particularly susceptible to defoliation by the cottonwood leaf beetle. In the first year, mortality can occur, requiring replanting to fully occupy the space. Generally, the cottonwood leaf beetle can be controlled by the timely application of a biocide or insecticide. Other defoliators, such as oak worms, can also defoliate vast acreages of oaks. While broad scale defoliation can happen, it rarely occurs.

Trunk borers are the most destructive group of insects in hardwoods, and are, therefore, very important economically. Larvae of the carpenter worm and the longhorn beetle attack trees throughout their growth, building large galleries in the wood. Galleries are chambers made under the bark by the insects. These chambers provide spaces for the insects to reproduce, introduce pathogens into the tree, and can directly kill the tree by girdling it.

Bark injuries at entrance holes become ingrown bark pockets. Microorganisms stain and decay the wood along and adjacent to the galleries. This damage may be greatly expanded by carpenter ants that occupy vacated borer tunnels and hollow out larger cavities. Many smaller species of beetles add to the damage. The removal of weak cull trees that harbor both insects and disease will reduce the level of attack in nearby vigorous trees. In addition, trees being removed during harvesting operations should be removed from the forest as soon as possible. They should then be processed or put under water storage to prevent them from being attacked by ambrosia beetles, another group of destructive beetles.

Diseases

Diseases of southern pines cause considerable losses each year. These losses are similar to those caused by insects in the form of mortality, growth loss, and product degrades. Of major concern, are fusiform rust, brown spot, needle blight, pitch canker, and annosum root.

Fusiform Rust

Fusiform rust is one of the most destructive forest diseases in the South in loblolly and slash pines. Longleaf and shortleaf pine are immune. Fusiform rust has increased dramatically in response to the increased use of pine plantations over the past several decades. An abundance of oak trees is positively correlated with the occurrence of fusiform rust. Oak trees serve as the primary source of inoculum for fusiform rust. Early evaluation and strategically timed actions are necessary for the successful management of established stands with high levels of fusiform rust. Management strategies include the following: avoid movement of rust-infected stock from the nursery; use resistant seeds or seedlings, if available; if practical, reduce the oak population.

Brown Spot Needle Blight

Brown spot needle blight is a serious disease of longleaf pine seedlings. Longleaf pine has a grass stage in which the terminal shoots of seedlings do not elongate. This stage may last from one to several years. The more vigorous the trees are, the sooner they begin height growth. By reducing tree vigor, the brown spot disease retards height growth, creating stands that are poorly stocked and uneven in size.

Moisture in the form of rain or dew favors brown spot inoculum production in the forest floor and its spread and ultimate infection of seedlings. The grass stage environment promotes favorable moisture conditions and, therefore, higher infection rates. To prevent needle blight, use high quality vigorous seedlings, prescribed burns, and the appropriate mechanical and chemical site-preparation activities at the time of planting. The use of herbicides, along with scalping, produces ideal planting beds for longleaf, and often results in a shorter grass stage period. Prescribed burns reduce competing vegetation and destroy the fungal spores and diseased tissues that are present.

Annosum Root Rot

Annosum root rot is commonly associated with certain sites and cultural practices. Soils with 12 inches or more of sand in the upper soil layers are considered high-hazard sites, as are old-field sites. Avoid heavy losses on high hazard sites by planting more resistant species such as longleaf pine rather than the more susceptible loblolly or slash pines. On high hazard sites, close spacing favors rapid spread of the disease after the first thinning. Delay this thinning as long as possible, and make it in the summer when few fungus spores are present. In the summer, stump temperatures during the day are usually hot enough to prevent spore ger-

mination. Apply powdered borax to cut surfaces of stumps immediately after felling on high hazard sites during cooler periods.

Pitch Canker

In recent years we have seen an increase in pitch canker in loblolly pine stands in Mississippi, especially in stands close to poultry houses. The amount of dieback that can occur depends on the location of the canker and the number of cankers on a tree. Symptoms include resin soaking under the bark and dieback of growing shoots and branch tips. Resin may also be found flowing from stem or shoot cankers. The disease can occur in seed orchards, nursery seedlings, and planted seedlings, as well as in young plantations. The greatest impact is reduced growth. Lightly or moderately infected trees (less than 20-30 percent crown loss) usually recover unless they are repeatedly infected or are attacked by insects that ultimately cause mortality. Management options for control are not well tested. Salvage harvests and sanitation thinning should reduce the amount of pitch canker annoculum present in the stand.

Removal of severely weakened trees will also reduce the potential breeding sites for the deodar weevil, a known carrier of the pathogen. Pitch canker is best managed by integrating preventive practices into the forest-management plan. This disease has the ability to increase rapidly, changing from endemic to epidemic status in only a few years. Therefore, it is important to regularly monitor your forests so that you can respond quickly if you see symptoms of this disease.

Hardwood Diseases/Pathogens

Rots in hardwood stands are of extreme concern because of the economic impact on the value of a tree that is not harvested at the appropriate time. Individual tree value continues to decline as rot increases annually.

Numerous pathogens can cause a disease if the right conditions exist. There are numerous diseases that can be observed but cause minor damage over all. Forestry commission employees, Extension agents, and universities can assist with their identification of diseases. Numerous websites can also provide useful information, such as *www.bugwood.org* and *www.forestpests.org*.

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