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EXTENSION

Managing the Family Forest

IN MISSISSIPPI

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Contents

Introduction

Mississippi is blessed with some of the most productive and diverse forestland found in the United States. These lands range from the bluff hills lining the east side of 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 are owned by more than 200,000 nonindustrial private forest (NIPF) landowners. There are many different management goals and levels of activity on these acres. To some of these landowners, forest management means only management for timber production. However, true to its broadest sense, forest management means management of forestland for the continuous production of goods and services. This includes timber but increasingly also includes aesthetic value, 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 University Extension, and Mississippi State University Department of Forestry. 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 area office of the Mississippi Forestry Commission, consulting forester, or Mississippi State University Extension forester.

The Management Plan

Brady Self, *Associate Extension Professor, Forestry*, and **John B. Auel**, *Certification Programs Coordinator, Mississippi Forestry Association*
Revised from earlier work by **Britton Hatcher**, *former Extension Associate*

What would you think of starting a trip in an unfamiliar area without a map, GPS, or end destination?

Adventurous? Unwise? Forest landowners who operate without a management plan are very much like that person driving without a travel plan. Most of us would not attempt cross-country travel without using a map or GPS to help us navigate from point A to point B. You can imagine the difficulty in deciding where, when, and how to address each directional decision as it arose. It would be a long, uncertain trip with no guarantee of reaching anywhere in particular. However, many people follow a similar approach when it comes to managing their forests.

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 provides you with the direction needed to successfully reach your goals and objectives in a precise and efficient manner. A plan can also reduce the chance of making costly mistakes with long-term consequences. Of course, if your objectives change, you may need to modify your management plan.

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 landowners engaging in responsible management practices. Limited funding under such programs is sometimes available on a first-come, first-served basis for qualifying landowners. An approved forest-management plan is necessary for forestland to be certified in programs such as the American Tree Farm System, Forest Stewardship Council, or any number of other certification programs worldwide.

Determine Goals and Objectives

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

Once you have determined where you want to go, you need to inventory and evaluate your property's resources to help determine where you are. A detailed inventory will tell a lot about your property, such as stand types, landscape features, and wildlife information.

Once you have determined where you are in the process, the next step is to take necessary actions to get your property where you want it to be. Specific activities listed in the management plan detail how, when, and where to implement scheduled management activities to help reach 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 work with private consulting foresters. Consulting foresters charge a fee for their services, but, once hired, they are obligated to represent your interests. They can take your goals and objectives and turn them into a proactive plan that helps you reach your target. In addition, the Mississippi Forestry 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 nearest MFC area 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 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 one 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.

Best Management Practices for Water Quality

Any forest-management operation, including harvesting, site preparation, and planting, has the potential to cause water pollution. Pollution from forestry operations is classified as nonpoint source (NPS) pollution, meaning it occurs as a result of overland flow depositing sediment in streams and rivers following a rain event. Sediment itself is considered a pollutant. In addition, this sediment can contain other pollutants such as herbicides, fertilizers, fossil fuels, and the like that were deposited on soil following management operations. Preventing sediment from entering waters is how we prevent pollution during and after forest-management operations. Sediment control is accomplished using best management practices (BMPs).

BMPs are a set of operational guidelines that, when properly implemented, will control soil movement and keep sediment out of water bodies. These guidelines were developed by forestry professionals and scientists from the Mississippi Forestry Commission, Mississippi State University, Mississippi Department of Environmental Quality, Mississippi Forestry Association, and forest industry partners to meet the NPS pollution-control requirements under Section 319 of the Clean Water Act, as amended in 1987. *Water Quality and Forestry Best Management Practices* is available from the MFC website: https://www.mfc.ms.gov/forest-health/water-quality-and-forestry-best-management-practices/.

ROADS AND TRAILS

All forest-management activities require access through a system of roads and trails, which also often cross streams. This access network is responsible for most of the soil exposure during and after management. This exposed soil is then subject to movement, or erosion, after rain, which can find its way into streams and rivers. Therefore, most nonpoint source pollution from forestry operations originates from the road system. Proper use of appropriate BMPs will reduce or eliminate sedimentation from the roads and trails needed for management.

Roads act as a conduit for rainwater carrying sediments. Different water-diversion structures are used for permanent and temporary roads and trails. Using a structure such as a water bar or turnout to divert water off the road allows heavy soil particles to be deposited in vegetated areas rather than reaching stream channels. Spacing the structures appropriately for the slope of the road will limit the amount of soil carried by runoff. The steeper the road, the more diversion structures are needed. A good rule of thumb is one diversion structure for every 5- to 6-foot change in elevation.

STREAMSIDE MANAGEMENT ZONES

Streamside management zones (SMZs) are areas adjacent to stream channels that act as a filter strip for overland flow of water that may carry sediments. The ground cover left in these areas disperses runoff, slowing it down and allowing sediment to be deposited in the SMZ before it reaches the stream channel.

Water Quality and Forestry Best Management Practices classifies water channels into three categories: perennial streams, intermittent streams, and drains. Each requires

some type of protection, but the level of protection varies depending on the type. Each has a defined channel.

Perennial streams, or streams that flow all or most of the year, require the highest level of protection. Perennial SMZs may be wider than for other types of streams. The width depends on the slope of the land adjacent to the stream channel, with wider SMZs needed on steeper land to provide adequate distance to disperse runoff and filter out sediments. Trees should be left in perennial SMZs to maintain shade for perennial streams because increased average water temperature of perennial streams is considered a pollutant. The recommendation is to leave 50 percent of the crown cover.

Intermittent streams flow only part of the year. Intermittent SMZs should be at least 30 feet wide to provide the necessary filtration of overland flow. Removal of all trees within an intermittent SMZ is allowed, provided that harvest does not destroy ground cover, which would reduce the SMZ's capacity to filter runoff.

Drains are areas with visible cut banks, but they only carry water after a rain event. This type of water body requires the least protection, but recommendations are to operate in such a way as to preserve banks and not deposit debris into the channel.

COMPLIANCE

BMP compliance is monitored by the Mississippi Forestry Commission every 3 years through a random survey of forest operations. Mississippi's compliance rate has increased steadily over the last 20 years and is currently at 95 percent. The result is reduced pollution from forest operations and improved state water quality.

Detailed recommendations for road networks, streams, and SMZs can be found in *Water Quality and Forestry Best Management Practices* at https://www.mfc.ms.gov/forest-health/water-quality-and-forestry-best-management-practices/. You can also contact your county Extension office to learn more about BMPs and other forestry practices.

Reference

Mississippi Forest Stewardship Program. https://www.mfc.ms.gov/programs/private-landowner-services/forest-stewardship/

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
662-555-5555

Time period covered by this plan
2020–2030

Date prepared
January 1, 2020

INTRODUCTION

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

In addition to providing direction for forestry-related activities, 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-served 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. He would like to produce enough timber that, upon his death, said timber could be sold, providing enough revenue that one son can buy out other siblings' share of the estate without incurring 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 Town.

TRACT ACREAGE

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

124 acres of pine plantation, established 2012

220 acres of pine plantation, established 2020

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 water quality. This protection will be done through use of streamside management zones (SMZs) and other precautions identified in the Best Management Practices (BMPs) 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 Native American mound sites 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 NRCS 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 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 12–50%. 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 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 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 better suited for loblolly pine production 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 forestland into different stands 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 2012

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 above).

There is currently no evidence of any existing erosion problems or threats to water quality in this stand. Care should be taken in management activities to ensure that no such problems occur in the future. This can be accomplished using BMPs in forestry operations (discussed in a separate section of this management plan). An 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 2020

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 above).

There is currently no evidence of any existing erosion problems or threats to water quality in this stand type. Care should be taken in management activities to ensure that no such problems occur in the future. This can be accomplished using BMPs in forestry operations (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 white oak, water oak, cherrybark oak, and hickory. 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 above).

There is currently no evidence of any existing erosion problems or threats to water quality in this stand type. Care should be taken in management activities to ensure that no such future problems occur. This can be accomplished using BMPs in forestry operations (discussed in a separate section of this management plan).

Prescription

Maintain this stand as a hardwood stand. Assess stand conditions periodically for overall health and consider establishment of a shelterwood cut to promote establishment of desired hardwood regeneration five years prior to final harvest. An alternative to thinning would be to make small group selections for regeneration if sufficient advance regeneration exists and uneven-aged management is a goal.

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 can enhance wildlife habitat if implemented correctly.

THREATENED AND ENDANGERED SPECIES

There was no evidence of any threatened or endangered species noted on this property while conducting the field visit.

TENTATIVE 10-YEAR ACTIVITY SCHEDULE

YEAR	STAND #	ACTIVITY
2021		
2022		
2023	3	Perform health assessment
2024		
2025	1	Check for first thinning
2026		
2027		
2028		
2029		
2030		

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.

Site Preparation

Brady Self, *Associate Extension Professor, Forestry*
Revised from earlier work by **Andrew Londo**, *former Extension Professor*

Site preparation is a term used to describe silvicultural treatments applied to logging debris, vegetation, the forest floor, or soil to make a site suitable for regeneration. Proper site preparation will increase early survival and long-term productivity of regeneration. Two different categories of site preparation are used in forestry: chemical and mechanical. The choice of which site-preparation techniques to use is based on site-limiting factors.

Chemical site preparation involves applying herbicides to control competing vegetation. This practice is probably more familiar to most forest landowners than mechanical work. Chemical site preparation is cheaper to implement than mechanical treatments and has less potential for damaging the site. Therefore, chemical site preparation is used much more extensively than mechanical methods.

Nevertheless, mechanical site preparation may be necessary to correct certain physical site issues. These include residual debris, poor drainage, compaction, and rutting. Since mechanical site preparation may involve the physical disturbance of soils, understanding the effect on site productivity is essential. Mechanical site preparation techniques are still used in some situations because they can achieve a particular goal that chemical site preparation alone cannot.

Drainage

Poor 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. Historically, ditching was used to drain large areas of land in forestry efforts. For both environmental and economic reasons, this is not a commonly employed technique in today's forest-management efforts.

The only drainage improvement technique in common use now is that of bedding in areas with high water tables. It is typically performed using a plow or disk to turn soil inward, creating a planting bed a few feet wide and 1 or 2 feet high. This "bed" serves to raise seedling roots out of onsite water, thus increasing seedling survival. When used properly, the benefits are obvious. Conversely, when used on dry sites or in drought years, bedding may result in increased seedling mortality if seedling roots dry out.

Competing Vegetation

Competing vegetation can significantly reduce early survival and growth rates of newly planted stands of trees. It often results in longer rotations with less volume and value at harvest. Many species of plants will compete with newly regenerated forests, but they can be broken down into the broad general categories of grasses, broadleaf herbaceous weeds, vines, and woody shrubs and trees. These different vegetation categories may necessitate different control techniques depending on which provides the most unwanted competition. While prescribed fire is sometimes recommended, the most efficient and least costly method for reducing competing vegetation is using herbicides.

Many herbicides are labeled for use in forest management, but herbicides, herbicide formulations, and their availability can change. The references section of this chapter lists several publications that give current forest herbi-

cide prescriptions and application recommendations. They are maintained and updated regularly to reflect changes in available products, formulations, and application methods. All can be found online at https://extension.msstate.edu/publications. In addition, you can request copies of these publications at your local county MSU Extension office.

Additional technical help in selecting herbicides is available from MSU Extension foresters, MFC area foresters, consulting foresters, and herbicide company representatives and applicators across Mississippi. It is important to use the right herbicides for your targeted vegetation. Remember, herbicides that your neighbor used on his property may not work on the vegetation found on your property for several reasons. Finally, follow all label directions for properly handling, preparing, applying, and storing herbicides. Not knowing that a certain use of herbicide is not permitted does not provide a legal defense against prosecution if herbicides are used incorrectly. More information on herbicide safety and use can be found in the reference section publications.

Debris

Another limitation on some sites is the presence of slash and other logging debris. Slash makes planting trees more difficult and can make natural regeneration harder to achieve in some scenarios. In addition, slash left behind can be a fire hazard. Historically, several types of mechanical treatments have been available to aid in removing this slash. These treatments were used primarily to clear onsite debris, but they also provided a degree of competition reduction as well. However, the arrival of safe and relatively inexpensive herbicides has curtailed their use across most of the South.

MSU Extension Publication 3006 *Mechanical Site Preparation for Forestry in Mississippi* offers in-depth discussion of these mechanical site-preparation methods. Most mechanical site-preparation treatments are still available from a number of vendors, and they are employed across the region on a reduced scale in specialized circumstances. They typically involve a variety of different implements pulled across the landscape by large bulldozers.

Prescribed burning is another treatment sometimes used for reducing debris on a 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 large pieces of debris are dry enough to be consumed in a burn. Before conducting any forestry burning, consult and follow Mississippi Prescribed Burning Act of 1992 guidelines. A full description of these regulations can be found in Chapter 9.

Soil Compaction

Most Mississippi soils do not have inherent compaction problems; however, a few soil types can have a layer called a *fragipan*. These fragipan layers are dense and restrict water flow and drainage as well as the ability of root systems to grow through them. Fragipans are relatively uncommon in most soils and soil compaction is the result of something else entirely. In these cases, compaction is typically a result of the presence of plow pans in retired agricultural fields. Over time, movement of equipment, especially plows and disks, over the same site at the same depth creates a dense, semi-impervious layer of soil called a *plow pan* or *restrictive layer*. Breaking or fracturing of these pan layers is key to early growth and survival of planted seedlings in areas so impacted.

Soils in areas with plow pans can be improved using several different implements, but a subsoiling plow pulled by a tractor or a bulldozer is the most typical method as well as the most cost-efficient. Typically, the plow is pulled at a depth of 12–18 inches, which is deep enough to fracture plow pans at their common depth. Fragipans are usually deeper and cannot be easily fractured. Subsoiling and other compaction corrective techniques are discussed in Publication 3006 *Mechanical Site Preparation for Forestry in Mississippi*.

Site-Preparation Costs

Site-preparation methods have associated costs to consider. Many landowners want the "best" treatment when an "OK" treatment will work. It's important to remember to base treatment selection on site conditions, as well as how it helps meet your goals while staying within your financial limitations.

While costs fluctuate over time, some generalities can be made. Mechanical treatments tend to be the most expensive. Transporting a bulldozer or tractor to and driving it across a site is expensive. Consequently, for sites requiring mechanical treatment, it is common to combine multiple treatments into a single-pass operation. For example, some operators will pull a subsoil plow, bedding plow, and

shearing blade simultaneously. This approach reduces the overall cost of applying treatments individually. However, mechanical site preparation is usually the most expensive form of site preparation.

Most forestry herbicide applications are performed using a helicopter. The cost of chemical site preparation has decreased over the past few years and may in some circumstances cost as little as $55 to $60 per acre. However, with the drastic increase in herbicide costs experienced in 2021–2022, landowners should expect to spend $75 to $90 per acre depending on the amount of acreage being treated, the herbicides being used, and the application rate. In addition, rising costs have made some common herbicides more expensive than other available yet typically more expensive alternatives. Landowners may encounter herbicide prescriptions with unfamiliar active ingredients used in an attempt to keep costs lower. Some applicators use skidders or tractors to perform ground applications instead of using a helicopter. Also, individual stem treatments can be performed through directed-spray applications or stem injection in some specialized situations. Within reason, costs are comparable across all methods. Prescribed burning is the least expensive site-preparation treatment, costing $30 to $40 per acre when using a vendor.

Summary

Many site-preparation options are available to forest landowners, ranging from mechanical and herbicide treatments to prescribed burning. Often these methods are combined to provide the best possible site conditions to achieve success in regeneration efforts. For example, prescribed burning in the fall/winter can be used following a summer herbicide application. This combination can control competing vegetation and remove debris, as well.

It is important to remember that these treatments all have associated expenses. It might be more cost-effective to have your property treated in combination with others nearby. This reduces the vendor costs associated with equipment transport, subsequently reducing landowner costs. Discuss this possibility with your consulting forester or herbicide applicator.

Site-preparation treatments should be tailored to each site. The fact that a certain treatment was needed on one property does not mean that its use is necessary or even appropriate on another piece of land. All site-preparation techniques have upfront costs, which ultimately reduce total earnings. Unless you are very familiar with your forest's needs and the site-preparation treatments available, consulting a professional forester should be a priority.

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Natural Regeneration of Southern Pines

John D. Kushla, *Extension/Research Professor (retired), Forestry*

Pine plantation forestry has grown across the United States since the middle of the 20th century. In the past, industrial ownership of large tracts of land favored the systematic approach of clearcutting, followed by tree planting. Artificial regeneration methods allowed 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 adopted 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 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 fire to the southern forests, creating open areas; consequently, most of the southern pines have adapted to fire ecosystems by necessity. These adaptations include thick bark, such as on longleaf pine (Figure 3.1), and serotinous cones that disperse seeds after a fire, such as with sand and Virginia pines.

Figure 3.1. Naturally regenerated longleaf pine on the Brookwood tree farm in Hancock County, Mississippi.

Figure 3.2. Naturally regenerated stand of shortleaf pine in Union County, Mississippi.

There are many advantages to using natural regeneration. Costs are lower because seedlings do not need to be bought and planted, and, because 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 to grow the trees until final harvest. Managing for solid-wood products such as sawtimber, which commands much higher prices, can offset the cost of a longer rotation length.

Natural regeneration is successful when you use an appropriate method that matches the ecological requirements of the tree species desired (Figure 3.2). Several silvicultural techniques are used for natural pine regeneration. These methods can be examined in two broad categories: even-aged and uneven-aged. Even-aged natural regeneration allows the seed to fall and germinate over a short period (about 5 years), creating a growing stand of trees that are of similar age. Uneven-aged regeneration involves managing multiple age classes (three or more) of a forest in the same time and space. The result is a forest with trees of many sizes and ages across the entire area at all times.

Even-Aged Natural Regeneration of Pines

Even-aged natural regeneration systems involve three phases during the life of the stand or crop rotation:

1. The initial phase, which may take a few years, is the regeneration phase.
2. This is followed by a phase of intermediate treatments to manage the stand while it is growing. This phase is very important to accomplishing the landowner's objectives and to the success of regeneration. These treatments may include prescribed fire, thinning, and/or competition control with herbicides. 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.
3. 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 those crop trees are subsequently removed after regeneration is established.

There are four even-aged regeneration techniques: strip clear-cutting, seed-in-place, seed tree, and shelterwood. They vary by how many trees are left on the site and how much light/shade is present for the new stand of pines. The appropriate technique 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

Strip clear-cutting involves harvesting trees in long, narrow strips (Figure 3.3) generally not exceeding 200 feet wide and often narrower. Seeds for regeneration fall from adjacent stands. 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, such as Virginia, loblolly, and shortleaf. This is the recommended method of naturally regenerating Virginia pine, which is very shade intolerant and tends to invade bare landscapes, such as clear-cuts, retired farmland, and 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. Strip clear-cutting is not recommended on steep terrain because it increases the soil-erosion hazard.

Figure 3.3. Natural regeneration in a loading deck.

SEED-IN-PLACE METHOD

This method is similar to clear-cutting, but harvesting is not necessarily done in strips. To be successful, logging slash must be dispersed across the site because regeneration comes from mature cones left on the ground after harvesting operations. 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 sand, shortleaf, and Virginia pines (Figure 3.4). 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 3.4. Natural regeneration of loblolly near Grenada, Mississippi.

SEED TREE METHOD

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 3.5). This method leaves a few trees on the site to provide seed fall from mature cones and takes place in two cuttings.

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 and 18 inches in diameter are retained. Fewer trees are needed for loblolly and shortleaf pines, and more are needed for longleaf. The selected seed trees should be scattered as uniformly as possible across the site and should be prolific seeders with good form and vigorous health.

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

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

SHELTERWOOD METHOD

This technique is a variation of the seed tree method but leaves more trees to provide seed. The shelterwood method is highly flexible and more likely to provide successful regeneration. This technique allows sufficient sunlight to reach the ground, making it suitable for shade-intolerant species, including all of the southern yellow pines: loblolly, longleaf, shortleaf, and slash (Figure 3.6).

Generally, 15–30 trees between 14 and 18 inches in diameter per acre are left for seed production. Fewer trees are needed for loblolly and shortleaf pines, and more are needed for longleaf. 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.

Figure 3.5. Seed tree regeneration near Macon, Mississippi.

Figure 3.6. Shelterwood regeneration in loblolly pine in central Mississippi.

This approach is most useful for longleaf pine, which produces an erratic seed crop (Figure 3.7). The preparatory cut should leave 40–50 trees per acre that are at least 16 inches in diameter and evenly 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 longleaf seed production, it is best to monitor the cone crop before executing the seed cut. Prescribed burning before seed fall will encourage germination. To minimize damage during the removal cut, seedlings should be 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 3.7. Shelterwood regeneration of longleaf pine near Orange Beach, Alabama.

Uneven-Aged Regeneration Systems

These systems of managing pine forests are challenging to foresters because they require 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-sized 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 involves removing 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, sawtimber, and poles.

This system of management is very flexible because the forester controls the removals in each cutting cycle across the entire forest. If conditions are not 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.

Figure 3.8. Pine regeneration with uneven-aged silviculture in the Crossett Experimental Forest, USDA Forest Service.

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, 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

In single-tree selection, one or two mature trees are removed from a very small area. These openings typically do not exceed one-tenth of an acre in size. Maintaining the proper number 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 in loblolly-shortleaf trees at the Crossett Experimental Forest in southern Arkansas for more than 50 years (Figure 3.8). 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 overgrown 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 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 ½ and 2 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 to use as log decks and allow for site-preparation activities such as burning, chopping, and disking.

This system has been used successfully with longleaf pine (Figure 3.9), which is well adapted to fire, historically creating 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.

Figure 3.9. Longleaf regeneration in a group selection patch at the Jones Center at Ichauway near Newton, Georgia.

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 and poles. Periodic tree removals through harvests, thinning, or cutting cycles will permit a steadier income. Controlling unwanted hardwoods and herbaceous species is essential to ensure regeneration of desired species.

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Artificial Pine Regeneration

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Artificial regeneration is planting trees or broadcasting seeds for the regeneration of forest land. Pine seed is rarely available for direct seeding, so this chapter will focus on artificial regeneration through planting pine seedlings.

Planting is the most common and successful method for artificially regenerating pine trees, but it is important to note that planting in and of itself does not guarantee success. The overall success of your planting operation depends on several factors, including matching the species to the site, seedling quality, proper and adequate site preparation, and proper handling and planting of seedlings.

Figure 4.1. Loblolly pine plantation on Coontail Tree Farm in Monroe County, Mississippi. Loblolly is the most widely planted pine in the U.S.

Choice of Species

Four commercially important southern pines are planted each year in Mississippi: loblolly pine, shortleaf pine, slash pine, and longleaf pine. On many sites, more than one of these species will grow.

LOBLOLLY PINE

The most widely planted species is loblolly pine. Loblolly pine (Figure 4.1) naturally grows well throughout most of Mississippi and currently produces more than half the total timber volume harvested across Mississippi annually. Several insects and diseases are pests of loblolly pine (see Chapter 12). It is also susceptible to damage from ice and wind storms that periodically strike Mississippi.

SHORTLEAF PINE

Another commercially important pine is shortleaf pine. Shortleaf pine (Figure 4.2) grows naturally throughout Mississippi, but it is rarely planted. Shortleaf pine is slower

Figure 4.2. Shortleaf pine plantation in Marshall County, Mississippi.

Figure 4.3. Shortleaf pine seedling showing basal crook. Photo courtesy of Don Bragg, USDA Forest Service.

growing than loblolly pine. However, it 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 and fire. Shortleaf seedlings have a basal crook (Figure 4.3), which keeps dormant buds just below the soil surface for resprouting after fire. Shortleaf pine is susceptible to the southern pine beetle.

SLASH PINE

The natural range of slash pine includes the Lower Coastal Plain, which includes the southernmost counties in Mississippi. Slash pine (Figure 4.4) is sometimes planted in this region for pulpwood, saw log, turpentine, 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 farther north in recent years, only to suffer from ice damage and severe fusiform rust infections. Slash pine is, however, better suited to 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 hurricane damage.

Figure 4.4. Slash pine plantation in Orange County, Florida.

LONGLEAF PINE

Longleaf pine (Figure 4.5) once dominated the Lower Coastal Plain forests of Mississippi. The natural range of longleaf in Mississippi extends from the coast to Claiborne County to 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.

Figure 4.5. Longleaf pine plantation near Orange Beach, Alabama.

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

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 a wide range of 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 brown spot needle blight fungus. When brown spot infestations are severe and prolonged, seedlings will die. Table 4.1 summarizes many traits of the four southern pine species discussed above.

Table 4.1. A comparison of traits found in commercially important southern pine species in Mississippi.

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

Ranking: High = 1, Low = 4. Adapted from Self, 2019.

Species Selection

Species selection in Mississippi is normally easy since loblolly pine is preferred on most sites. Landowners in the southern coastal plain must compare species to determine whether loblolly or slash is best for their sites and their long-term goals. Slash pine has historically been favored along the Lower Coastal Plain for timber production as well as resin and turpentine production. However, the rapid growth and flexible site requirements for loblolly pine have resulted in an increase in acres planted to loblolly.

The following comparisons should help with species 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 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 suited to growing on poorly to somewhat poorly drained sandy soils. It is particularly suited to deep sandy soils, or those having a spodic horizon.
- Slash pine grows better than loblolly on wet 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, 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.
- In areas prone to high winds from tropical storms and hurricanes, slash pine and longleaf pine are better able to withstand damage than loblolly or shortleaf pine.

Genetically Improved Seedlings

An advantage of artificial regeneration is the choices available for genetically improved tree seedlings. Landowners can buy seedlings that are improved for growth, disease resistance, better form, and branch angle. Understanding genetic improvements will help you make better informed decisions on seedling selection.

Forest tree improvement is the process of selectively breeding trees under controlled conditions to produce superior-performing trees and seed. For loblolly and slash pines, tree improvement programs have been ongoing since the 1960s. The best-growing trees in natural stands were selected for good form, fast growth, and disease resistance. Branch tips were collected and grafted onto rootstock and planted in orchards. This represented the first generation of selection.

Testing the performance of seedlings produced from the orchard allowed further selection of the best individuals in the orchard by removing poor-performing trees. A rogued orchard produced a 1.5-generation seedling. Similar testing and removal of poor-performing trees resulted in 2.5- or 3.5-generation orchards. Genetic gains from open-pollinated 1-, 2-, or 3-generation seedlings represent a 10–30 percent improvement over unimproved seedlings.

So, tree breeding in orchards began with open pollination of the mother trees. This practice dominated seed production through the 1990s. By the late 1990s, scientists started bagging both male and female cones on trees. Pollen was collected from known individuals and then injected

into bags covering female cones for specific crosses. Seed could then be collected from specific crosses of both known parents. This process is called mass control-pollination (MCP). Field testing of MCP trees has shown that these trees grow more uniformly in height and diameter (Figure 4.6).

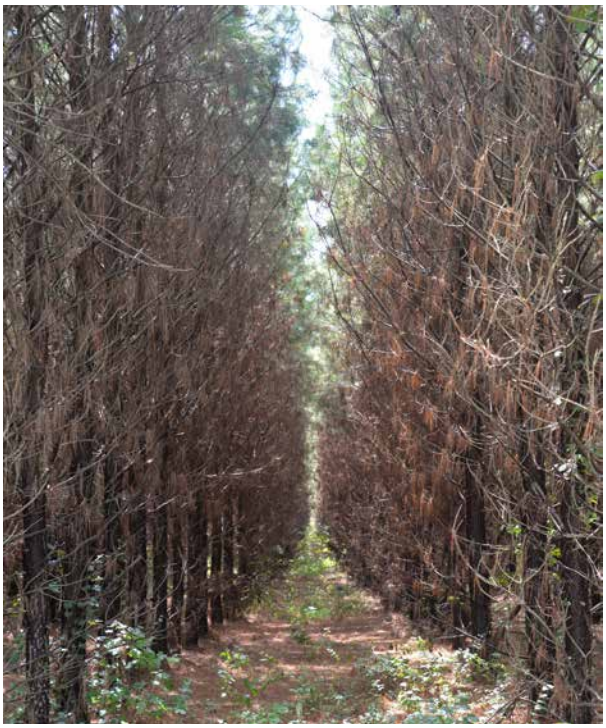

Figure 4.6. Mass control pollinated loblolly pine in a field test plot.

Third-, fourth- or fifth-cycle selections are produced from specific crosses of trees. Geneticists use mathematical models for crosses to maximize genetic gain while minimizing negative effects of inbreeding. Tree improvement programs are now producing the fourth cycle of generation seedlings and starting fifth-cycle selections. As of 2017, approximately 15 percent of pine plantations were established using MCP seedlings.

MCP stands produce greater volume than stands from open-pollinated seed. Substantial genetic gains from some MCP loblolly families significantly improve stand growth in volume (about 20 percent), volume production (about 40 percent), rust resistance (about 80 percent), and straightness (about 120 percent) over unimproved seedlings. These fast-growing MCP loblolly trees have excellent wood properties (the myth about fast-growing trees having poor wood characteristics comes from early harvesting and the consequent higher proportion of juvenile wood). In addition, the impact on the value of a stand is considerable. With enhanced straightness, MCP pine stands often produce a higher relative amount of volume in better grade products (sawtimber, poles, veneer) and lower relative amounts of pulpwood and culls.

Varietal seedlings or clones are now available on the market. Varietal seedlings (Figure 4.7) have the potential to produce even higher genetic gains and volume production than MCP seedlings. However, current testing has shown that the performance of varieties varies with site characteristics. Until more field testing of varieties is done, MCP seedlings offer landowners the best opportunities to improve plantation performance.

Genetically improved seedlings tend to perform well across broad geographic regions. It is important for landowners to make sure their chosen seedlings will perform well in Mississippi. The North Carolina State University Cooperative Tree Improvement Program developed an easy method to rate loblolly pine seedlings, the loblolly Performance Rating System (PRS). It uses a four-part code that describes the deployment region, productivity (P), rust rating (R), and stem straightness (S). This method is very useful to landowners in learning the expected performance of loblolly seedlings they purchase.

It is essential to have good site preparation before planting pine seedlings, especially when planting MCP or varietal seedlings. Broadcast herbaceous weed control in the first growing season is also a must when using advanced genetics. The growth advantages of planting advanced genetics can be lost if unwanted vegetation is permitted to occupy the site and compete with planted seedlings. Planting genetically improved pine seedlings requires more proactive and aggressive forest management. Consider this when budgeting for regeneration.

Figure 4.7. Dr. Randy Rousseau (retired) with varietal loblolly pine after one growing season on a field test in Marshall County, Mississippi.

Finally, genetic improvement itself costs money. Open-pollinated 1-, 2-, or 3-generation

seedlings range in price from $60 to $80 per thousand ($30–40 per acre). Mass control-pollinated pine range in price from $70 to $100 per thousand ($36–50 per acre). Varietal seedlings range from $320 to $440 per thousand ($160–220 per acre). Purchasing containerized seedlings will add about $100 to $120 per thousand. Although varietal seedlings are still very expensive, MCP seedlings are reasonably priced and offer value in timber growth and quality. Also, there are tax incentives and cost-sharing programs to help cover costs for forest regeneration (discussed later in this chapter).

Seedling Types and Ordering

You should have a written forest regeneration plan before planting trees. This properly focuses the harvest operation as a step in the regeneration process. The plan should recommend planting dates based on the conclusion of harvest operations. Planting the same year as harvest should be done only if timber cutting is completed by the end of June; otherwise, reproduction weevils could devastate new plantations. If harvesting is completed in the late summer or fall, there are two options: delay planting for a full year or purchase insecticide-treated seedlings to prevent weevil predation.

A forest regeneration plan provides useful estimates for the cost of site preparation, seedling purchase, planting, and application of herbaceous weed control the first growing season. This information is very useful to a forest landowner practicing sustainable forestry. Regeneration costs should be reserved from timber sale profits to provide the investment capital necessary to grow the next forest. In addition, a written forest regeneration plan is necessary to use the Mississippi Reforestation Tax Credit.

Most seedlings grown and planted are bare-root seedlings. These seedlings are generally precision sown for uniform spacing in a nursery bed at a specified density, such as 25 seed per square foot. Precision sowing has reduced the cull factor to about 1–2 percent. They are grown all season and lifted in early winter. While growing, they are fertilized, watered, and sprayed for insects and diseases. They are usually top-pruned (8–10 inches) once and root-pruned in the alleys between trees. This encourages secondary branches and roots. Before lifting out of the nursery bed, the tap roots are cut 6–8 inches deep to enable lifting from the nursery bed for packing, storing, and shipping.

Figure 4.8. Box of bare-root loblolly pine seedlings.

Nursery practices can be varied to grow bigger seedlings, called *low density* or *morphologically improved seedlings*. They are grown at a lower density in the planting bed, such as 15 seed per square foot. Since they are larger, morphologically improved seed tend to have better survival when planted. However, since the nursery is growing these seedlings at lower bed densities, their unit cost is as much as 40–50 percent higher. Keep in mind that growing conditions at the nursery do not alter the inherent seedling genetics.

If the seedlings are lifted before complete dormancy, they are packed in open bales and shipped for immediate planting. Many forest industries begin planting in late fall due to the amount of regeneration they complete. Typically, forest landowners use completely dormant seedlings, which are generally ready by the end of December. These are lifted and packed in waxed bags or boxes (Figure 4.8) by the thousand. Seedlings are immediately refrigerated until shipped. Refrigeration slows plant respiration so that seedlings can survive storage. Planting season for bare-root seedlings is from the end of December through mid-March.

If the site is difficult to plant during the typical planting season, purchasing container-grown seedlings is an option. These seedlings are grown in small tubes with soil medium. When containerized seedlings are removed, they are planted with soil intact. This enables planting several weeks before (end of November) or after (mid-April) the normal planting season for bare-root seedlings.

To calculate the number of seedlings required for planting, you must know the size of the regeneration area, the genetics of the seedling, and the spacing for planting. Table 4.2 provides information on seedling genetics and suggested spacing for planting. An example calculation follows:

How many seedlings will be required to plant 48.5 acres with bare-root MCP loblolly pine?

1. From Table 4.2, you would plant 450–550 MCP loblolly pine per acre. Your written forest regeneration plan calls for planting on 9-by-9-foot spacing. This represents 537 trees per acre.
2. 48.5 ac × 537 tpa = 26,044 seedlings
3. Using a cull factor of 1%, add 260 seedlings: 26,044 + 260 = 26,304 seedlings
4. Always round up to the nearest thousand: 27,000 seedlings.

Order seedlings early, at least 6 months before the planting season. If your order is large, arrange to take your order in installments. Another option is to store seedlings on-site in a refrigerated trailer. Seedlings need to be kept cool until ready to plant. Seedling containers should not be opened until the seedlings are ready to plant.

Table 4.2. Seedling genetics and planting density.

Seedling Genetics	Trees per Acre (TPA)	Potential Spacing
First- and second-generation pine	500–600	7 ft x 12 ft (518 tpa) 8 ft x 9 ft (605 tpa) 8 ft x 11 ft (495 tpa) 9 ft x 9 ft (537 tpa) 10 ft x 8 ft (544 tpa)
Second-generation pine Mass control-pollinated (MCP) pine Container-grown loblolly pine	450–550	7 ft x 12 ft (518 tpa) 8 ft x 11 ft (495 tpa)* 8 ft x 12 ft (454 tpa) 9 ft x 9 ft (537 tpa) 9 ft x 10 ft (484 tpa) 10 ft x 8 ft (544 tpa)
Varietal pine Container-grown longleaf pine	400–500	8 ft x 11 ft (495 tpa) 9 ft x 10 ft (484 tpa) 10 ft x 10 ft (435 tpa) 10 ft x 11 ft (396 tpa)

Cost-share programs may require more seedlings than some of these spacings allow. Adapted from Self, 2022.

Seedling Handling and Care

The ideal seedling should be 10–12 inches tall with secondary needles and winter buds. The diameter of the stem at groundline should be at least the width of a pencil (7 mm). The root system should be 6–8 inches long with several main laterals off the tap root. Bare-root seedlings are dipped in a slurry before packaging to prevent dehydration. This coating should remain on the roots until the seedling is planted. With modern nursery practices, seedlings should not require any pruning. The number of culls should be minimal.

Properly handling seedlings on the planting site is very important. Once seedling containers are removed from cold storage and their containers are opened, the seedlings are vulnerable to spoiling. As mentioned, seedlings should be kept cool and containers closed until ready to use. Seedling containers should be opened one at a time by tree planters. Discard seedlings that are damaged or much smaller than the above specifications. Plant the seedlings right away. Planting containers should have water in the bottom to keep roots moist until seedlings are put in the ground. Keep on-site seedling containers cool and shaded from direct sunlight. Keep partial bags or boxes closed until the remainder of the seedlings can be used. At night, place a tarp over seedling containers to help keep them from freezing.

Planting

Key to the survival of your planted seedlings is their roots' ability to quickly begin taking up nutrients and water. Plant seedlings 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, 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 may be better suited for hand planting.

When machine planting, it is critical that the planting depth be properly set. Planting too shallowly will allow seedling roots to dry out, while planting too deeply may result in "L-rooted" seedlings. 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 kill the seedlings.

It is useful to have a written contract with tree planters. This contract should include all specifications for the planting operation: type, number, and spacing of seedlings; planting dates; and handling guidelines. Your contract should also specify weather and site conditions for planting. Ideal planting weather is cool (35–60ºF), low wind speed (less than 10 miles per hour), high relative humidity (higher than 40 percent), and good soil moisture. Planting should be suspended if the weather turns warm or below freezing. The contract should also specify guidelines for inspections of the planting operation. Seedlings that turn brown and die within 2–3 weeks of planting generally indicate a poor planting job.

HAND PLANTING

A good hand-planting crew can average about 1,000 seedlings per person per day, depending on the site, weather, and other factors. 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 4.9).

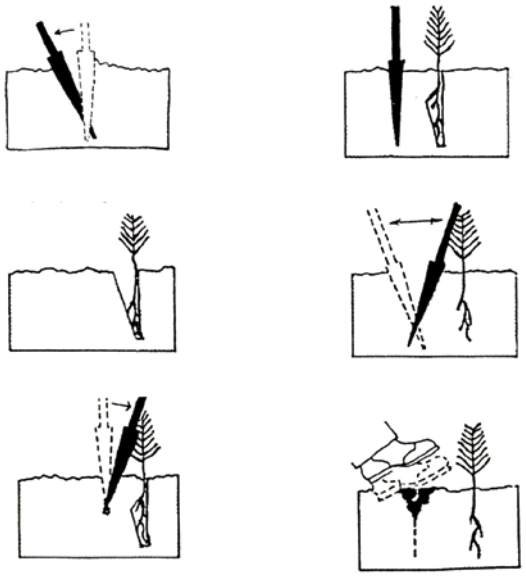

Figure 4.9. Proper dibble bar technique. From Self, 2022.

It is important that there be a crew foreman or supervisor on site. This person should ensure that seedlings are being properly handled and planted. Any concerns you have should be brought to this person's 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 ensure proper spacing.
- Use a shovel to check for air pockets around the roots of planted seedlings as well as the presence of any J- or L-rooted seedlings (Figure 4.10).

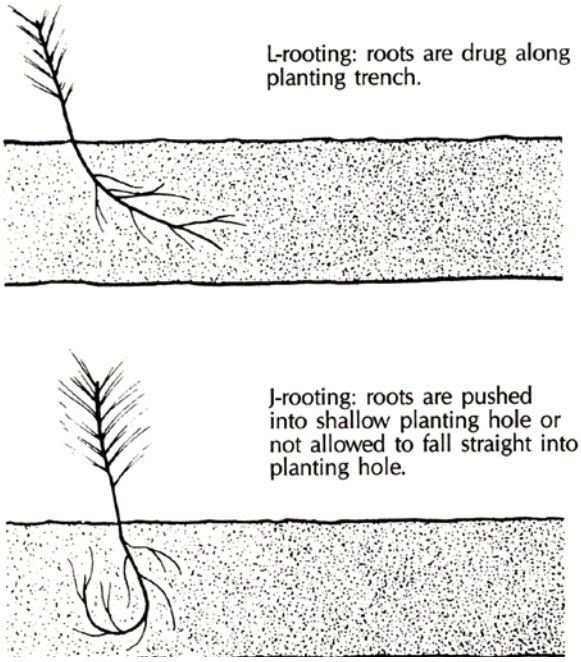

Figure 4.10. L- and J-rooting. From Self, 2022.

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

MACHINE PLANTING

Using the right machine on the right site can result in many thousands more seedlings planted per day (Figure 4.11). Just as with hand planting, frequently check planting performance to ensure 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 ensure that there are no air pockets around the roots of your newly planted seedlings. Seedlings should be planted straight and at the proper depth.

Figure 4.11. Dual-row machine tree planter in Marshall County, Mississippi.

Planting them too quickly or not deeply enough can result in J- or L-rooting, which will likely cause your seedlings to dry out and die.

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.

An adequate sample is about one plot per acre, with usually no more than 30 plots evenly distributed throughout the plantation. Record each plot separately on the tally sheet (Table 4.3). 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 (unless in a grass pasture). From these data, calculate free-to-grow, living, and total seedlings per acre. You can also determine percent survival.

If competing vegetation is too thick to collect data on plots, use row counts 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. Several rows from across the plantation should be counted in this way to get an accurate estimate of survival for the entire plantation. If seedlings are dead, it is important to dig them up to determine why they died. Reasons for mortality could be accounted for in the same way as plots.

Table 4.3. Pine plantation evaluation form. Measure one plot per acre up to 30 plots.

Plot	Number of Live Seedlings Free to Grow	Number of Live Seedlings Under Weeds	Number of Dead Seedlings	Check if Planting Quality Fails	Reason: L or J 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**	

From Self and Dicke, 2020.

TREES PER ACRE

Plantation density is based on your management objectives as well any requirements associated with a cost-share program. For most plantation spacing, plots should average 450–600 live seedlings per acre (Table 4.2). If the average seedling count is low, you should reevaluate the site and decide on whether to reestablish the plantation. No plot should have fewer than three 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 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. This is a good option when weeds are too tough for release. (Be sure that all the existing pines are also destroyed.)

Financial Incentives and Cost Shares

Forest regeneration requires a substantial capital investment. The federal and state governments offer landowners incentives for forest regeneration or afforestation (the planting of fields or pastures not previously in forest). The Internal Revenue Service permits the deduction of all forest-regeneration costs. The code permits deductions up to $10,000 the first year. Any remaining forest-regeneration costs can be amortized over the following 8 years.

Meanwhile, the Mississippi Reforestation Tax Credit permits a forest landowner a lifetime tax credit up to $75,000 for forest regeneration. For reforestation, the landowner is permitted a tax credit of one-half of the acceptable forest-regeneration costs. Note that these are not actual costs. The Mississippi Forestry Commission (MFC) determines acceptable costs for site preparation, seedlings, tree planting, and herbaceous weed control. To use the Mississippi Reforestation Tax Credit, you must file a reforestation plan written by a registered forester with your tax statement. If regeneration costs exceed your state tax liability, the remainder of the credit due can be carried forward. This is a generous incentive to working taxpayers in Mississippi.

Besides tax incentives for forest regeneration, there are government cost-share programs available. These are especially attractive to retired Mississippi forest landowners, whose state tax liability may be lower. The MFC administers the Forest Resource Development Program (FRDP), which includes cost shares for many forest operations, including those for forest regeneration. It is important that landowners have a contract and be enrolled in the FRDP before commencing forest regeneration. Cost shares are reimbursement-based; landowners pay for all forest-regeneration costs, and their government contract reimburses a percentage of their costs.

The federal government also administers several cost-sharing programs that include forest regeneration. These are usually administered through the Natural Resources Conservation Service (NRCS). Again, landowners should contact the NRCS regarding these programs and have a contract of enrollment before commencing forest regeneration. In addition, federal programs are designed to promote national agendas regarding environmental stewardship, so understand all contract obligations before signing. Canceling a contract would require repayment of all cost shares with interest. Also, you may not enroll the same acre of land in two cost-share programs, so choose wisely.

Summary

Artificial regeneration is essential for reforestation with many light-demanding species such as southern pines. Landowners should have a written forest-regeneration plan detailing all items and operations for planting. Site prepa-

ration and herbaceous weed control are essential before planting trees. Artificial regeneration offers landowners opportunities to choose genetically improved pine species that tremendously enhance growth, disease resistance, and form with the potential of greater financial return than unimproved seedlings. Seedlings should be kept in containers until ready to plant. Tree planters should have water in their containers to keep roots moist until planting. Post-planting field inspections should be carried out to ensure that all planting specifications have been met. Finally, financial incentives are available for forest regeneration through the tax code and government cost-share programs.

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MISSISSIPPI STATE

Regenerating Hardwoods in Mississippi

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Southern hardwood forests have long been managed for various products, ranging from pulp for paper to veneer for high-quality furniture.

Much of Mississippi's 19 million acres are owned by private individuals. Obviously, timber value of quality hardwood forests is substantial and often drove management priorities in the past. However, landowners today are often interested in using their land in alternative ways, as well. Frequently, a combination of goals such as recreation, wildlife habitat, and aesthetic appearance is just as important to landowners in their overall management efforts. These changes can result in reduced financial gain at harvest as well as longer rotations, depending on the type of management effort.

It is important to understand that hardwoods can be much more site-specific in their needs than pine species. Consequently, you must understand site conditions before making decisions about regeneration. Another consideration concerns the current species growing on a site. If enough seed-bearing desirable trees are not present, natural regeneration will not be possible and you will have to employ artificial regeneration. These factors, and others, will determine the appropriate measures needed to be successful in your hardwood regeneration efforts.

Compared to the amount of information available for pines, data on hardwood silviculture is more limited. However, the greatest amount of research in hardwood systems has focused on natural regeneration and early establishment methods for artificially regenerated plantations. Consequently, work performed over the past several decades provides a solid base for silvicultural recommendations to achieve regeneration success in both natural and artificial regeneration efforts.

Site Selection

Selecting the proper species/site combinations is one of the most demanding forestry management tasks for private landowners and forest managers when regenerating hardwoods. Choosing the correct hardwood species is difficult in part because of the large number of species available and their varying needs for survival and growth. In many cases, the needs of different species may be met only by a combination of factors existing under specific site and soil conditions. To be successful in regenerating hardwoods, you should understand the nutritional and moisture needs of your primary desired hardwood species and the types of soil that best meet these needs. In general, the most commercially desirable species will survive and grow well only on a narrow range of sites and conditions. Correctly matching species to site will result in a stand capable of growing and thriving over an extended period.

Relatively few commercially valuable hardwood species grow well on very wet or very dry sites. Willows, water tupelo, and cypress are found on sites inundated by water most of the year, if not year-round. On the other hand, there are extremely dry upland sites that support species such as blackjack and post oak. In either scenario, extreme sites are often difficult to regenerate to commercially desirable species. Accordingly, these sites provide minimal economic returns.

Sites falling between the extremes, however, will typically support good hardwood growth of commercially valuable species. A thorough understanding of soil and site conditions will allow you to pick the best species to manage on a given site. While pines are usually planted in the South, most hardwood stands are naturally regenerated. There are several reasons for this, but a main reason is that pine,

especially loblolly pine, will grow well on many sites and soils across the region.

Because hardwood species are very site-sensitive, it is critical to correctly match these species to on-site conditions. A long-standing rule of thumb is to examine and use the existing stand's species composition as a guide to determine which species might perform well. However, many hardwood stands have been high-graded. High-graded stands have had the best stems removed over time, leaving stems of low quality, form, and species behind. While detailed information on the effects of high-grading is outside the scope of this publication, you can read more about it in MSU Extension Publication 3451 *Hardwoods: What Is High-Grading?*

The Natural Resources Conservation Service (NRCS) compiles soils information in county-specific reports called soil surveys. Soil survey reports can provide some basic information that you can use in assessing a site and determining appropriate species for regeneration. The NRCS also supports an excellent online resource called Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) that provides multiple user-friendly tools, several of which allow you to assign appropriate species for regeneration purposes at a given location. The problem with using either of these resources is that both have limited accuracy and precision within base data that somewhat limits their use.

Actual physical site evaluation provides a more accurate assessment for a given site's ability to successfully grow a certain species. Upland hardwood information is more limited, but an excellent tool is available for bottomland hardwood species. The Baker-Broadfoot Method was developed by U.S. Forest Service scientists in 1977. The method uses physical soil condition, growing season moisture availability, nutrient availability, and soil aeration to assess site appropriateness for 14 different hardwood species. Obviously, all hardwood species are not detailed in this publication, but knowledge of common species groupings allows you to apply that information to other species. Consequently, you can have a reasonable expectation of whether a species is appropriate for regeneration on a site. This method can be found in a publication titled *A Practical Field Method of Site Evaluation for Commercially Important Southern Hardwoods,* available from the U.S. Forest Service, Southern Forest Experiment Station.

To fully evaluate a site for hardwood potential, you must understand 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 normally found. An optimal hardwood site will have deep silty-loam to sandy-loam fertile soils, good moisture availability, good soil aeration, neutral to slightly acidic pH, and no soil pans or other restrictive layers that would restrict root growth. This type of site produces excellent growth for a variety of hardwood species. However, sites usually have limitations and will not work for all species. Table 5.1 gives a detailed listing of sites with their associated limitations and appropriate species. For a more detailed review of species/site relationship considerations and the effects of ignoring them, read MSU Extension Publications 2004 *Bottomland Hardwood Management Species/Site Relationships* and 3452 *Effects of Flooding on Southern Bottomland Hardwoods*.

Natural Regeneration

Natural regeneration of desirable hardwood species is not as simple as planting seedlings and can be one of the biggest challenges in hardwood management. Rarely are provisions made for the future of a stand before harvesting, and many landowners decide against using artificial regeneration because of high planting costs. As a system, natural regeneration can be effective for regenerating hardwood stands. It can provide an affordable means of reestablishing a stand using existing trees as a seed source. Obviously, enough desirable trees must be present in the current stand for the process to succeed, but when it is properly conducted, a young stand dominated by desirable species will naturally regenerate with good results.

Hardwood species will regenerate naturally, so many landowners have done little or no actual silvicultural management and simply assume that hardwoods were there before and will remain in the future. However, without silvicultural input, resulting regeneration is often of species either commercially undesirable or undesirable for landowner goals.

To be successful, forest managers must identify desirable species best suited for the site and then try to create stand conditions that will encourage establishment and growth of seedlings of those species. To ensure success, this

Table 5.1. Physiographic site position, site characteristics, soil characteristics, and possible species commonly found on bottomland and upland sites in Mississippi.

Floodplain

Site	Site characteristics	Soil characteristics	Common species
Front	Good surface and internal drainage	Loam to sandy loam soils; pH will limit species	Cottonwood, sycamore, sweetgum, pecan, water oak, 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, cherrybark oak
Flats	Poor internal and surface drainage	Higher clay content	Nuttall and overcup oak, green ash, sugarberry, water hickory, persimmon
Slough	Poor drainage, easily inundated	High clay content	Black willow, overcup oak, 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)

Site	Site characteristics	Soil characteristics	Common species
North slope	Good site for hardwoods, with slower organic matter decomposition allowing for deeper soil surface layers	High amount of organic matter, better moisture availability	Northern and southern red oaks, yellow poplar, black cherry
South slope	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 ridge	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
Cove	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, 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, willow oak

must be done before removing the existing stand. This is done through establishment of seedlings called advance regeneration. These seedlings are typically at least 2 feet tall with well-established root systems. Advance regeneration is necessary for successful natural regeneration for most of the desirable hardwood species.

FACTORS TO CONSIDER

When naturally regenerating your hardwood forest, the primary factors to consider are species availability (seed source), seed crop, soil nutrients, available moisture, and light at the forest floor. Soil nutrients and moisture are not problematic on the typical hardwood site in Mississippi. However, the other factors vary according to previous stand management and climate conditions. These should be examined for each stand being considered for regeneration.

Species Availability/Seed Source: For best results, desirable species should be present *and* well distributed across the site. While a few desirable species (e.g., yellow poplar, green ash, and cottonwood) are light-seeded with wind-disseminated seeds, most have heavy seeds (e.g., oak species) that rely on gravity and even stem distribution or animal manipulation for movement across a site. If a desired species is site-appropriate but not present on the site, artificial regeneration methods will be required to grow it.

Seed Crop: Desirable species do not produce a "bumper crop" of seeds every year, nor does every stem produce a "bumper crop," even in heavy masting years. For these reasons, it is necessary to monitor the seed crop during the growing season to be able to time activities in natural regeneration efforts. Points to consider:

- Light-seeded species have good seed crops more consistently than heavy-seeded species.
- White oak species form and mature acorns in 1 year.
- Red oak species require 2 years to form and mature acorns.

This means that light-seeded species typically produce good seed crops in any given year. However, reliable regeneration of heavy-seeded species requires managers to monitor seed crops annually. Planning regeneration in white oak stands requires seed crop assessment every year, while red oak stands can be evaluated during the year preceding regeneration activities.

Light: Sufficient levels of light are key in regenerating desirable hardwood species. Generally, these species (such as oaks) do not regenerate well in total shade. However, full sunlight is not necessary. Most oaks grow better in partial (30 to 50 percent) sunlight as seedlings. However, after establishment, they typically grow better in full sunlight. It is important for you as a landowner to know the seedling light requirements of the various species if your natural regeneration efforts are to be successful. A more thorough explanation of light level considerations in natural regeneration can be found in MSU Extension Publications 3461 *Bottomland Hardwoods: Natural Regeneration Using the Shelterwood System* and 3476 *Upland Hardwoods: Natural Regeneration.*

STEPS TO NATURAL REGENERATION

There are several types of harvests used in natural regeneration efforts in hardwoods. Two of these harvesting types are commonly used in the South: clear-cutting and shelterwood harvesting. Clear-cutting involves the simultaneous removal of all trees and may be the only way to harvest some stands. If applied properly, it can be an excellent method for regenerating desirable hardwoods. However, if there is not an adequate amount of oak advance regeneration at the time of harvesting and all overstory canopy trees are not removed, reestablishment of species such as oak is unlikely. Often, clear-cutting operations focus only on maximizing profit and leave substantial numbers of small-diameter trees of undesirable species that make development of desirable species like oaks difficult.

Shelterwood harvesting involves a series of cuts designed to leave mature trees of desirable species to produce and protect regeneration. Several cuts are implemented as seedlings establish and develop, and the overstory is removed once advance regeneration is sufficient to carry the stand forward. Shelterwood cutting has been the most successfully implemented natural regeneration system used in southern oak species. Further discussion in this chapter will center on this technique.

Depending on the species of concern, natural regeneration typically includes the following steps:

- Stand assessment
- Pre-harvest preparation
- Partial overstory removal
- Final overstory removal

Stand Assessment: Before attempting natural regeneration, assess your stand for both presence and distribution

of desirable species. This step is essential before making decisions about any pre-harvest work and timing of any operations. If enough stems of desirable species are not present, your stand will most likely need to be artificially regenerated.

Pre-harvest Preparation: If the stand assessment reveals sufficient advance regeneration of desirable species, pre-harvest preparation may not be necessary. Unfortunately, desirable advance regeneration in an appropriate quantity is rarely present. In addition, mature hardwood stands are usually occupied by midstory stems of undesirable species. These trees may range in height from 8 to 50 feet and can be very effective at intercepting sunlight coming through the overstory canopy. This is the primary reason that very few seedlings of shade-tolerant desirable species are recruited into the advance regeneration or sapling classes.

If the midstory has enough of these undesirable stems, they should be controlled before final harvest. This step should be performed when a good seed crop is expected so seeds of desirable species can take advantage of improved light conditions. The most cost-efficient technique for controlling undesirable midstory stems is "hack-n-squirt," or injection using herbicides. Injected trees die, allowing increased levels of light to reach the forest floor and decreasing the level of water and nutrient competition encountered by desired seedlings.

Midstory control is the most often prescribed method in pre-harvest preparation work in hardwood stands for several reasons. Injection is selective, meaning that you can select stems to kill or maintain. The method costs less than mechanical midstory-removal options. In addition, done properly, it kills the root systems of injected stems and controls sprouting. It will not damage desirable non-injected trees when performed properly. Also, the technique requires no specialized equipment, can be done by anyone, and is incredibly effective. Several herbicides are labeled for midstory injection; however, imazapyr has shown the greatest efficacy and cost-efficiency in work across the state. For a detailed description of the process, see MSU Extension Publication 2942 *Tree Injection for Timber Stand Improvement*.

Partial Overstory Removal: The next step in the process is removing a portion of the overstory trees. The purpose of this cut is to open the overstory enough to allow sufficient sunlight through to establish regeneration. The removal should be tailored to the species being regenerated. If the desired species are light-seeded and shade-intolerant, most of the overstory may need to be removed. Seed will disseminate by wind across the site and resulting seedlings will need maximum sunlight. However, greater numbers of overstory trees should be left if regenerating heavy-seeded seedlings.

As previously discussed, heavy-seeded, shade-intolerant species like oaks need greater numbers of overstory stems for successful regeneration to occur. Typically, 50 to 60 percent of canopy trees should be removed. This will produce optimal light conditions for oak regeneration while leaving enough trees to provide shade to reduce herbaceous competition. Research over the last half-century has proven that the optimal level of light for regenerating bottomland oak species is approximately 50 percent available light. In this context, "available light" refers to photosynthetically active radiation (PAR), or light that plants can use for photosynthesis. However, meeting the 50 percent PAR target exactly is difficult, and an acceptable range is 40 to 60 percent available light. Fifty percent available light typically occurs with overstory stem densities of approximately 50 square feet of basal area.

Unless you are familiar with hardwood silviculture and physiology, you should hire a professional consulting forester to mark your stand for partial overstory removal cuts. A partial removal is also an opportunity to remove any undesirable stems from the overstory. You should time partial removal cuts with good seed crops to ensure that seeds fall under the best conditions for germination and survival. This can be challenging, but, once the decision to regenerate the stand has been made and the assessment completed, 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 typically takes a few years for desirable regeneration to establish. For rapidly growing species such as cottonwood or yellow poplar, this may only be 1 or 2 years. However, for oaks and other desirable hardwoods, 3–5 years is normal. Freezing temperatures, flooding, or other unforeseen events can damage or destroy the seed crop or germinated seedlings. If this occurs, the residual overstory can serve as insurance, allowing the manager to reattempt the process if the stand is not degrading and the expectation of another good seed crop is reasonable.

Once desired regeneration is established, the overstory can be removed or left, depending on landowner objectives. Some owners do not like the appearance of a clearcut and may prefer to retain scattered overstory trees across the site. This is possible, but residual overstory trees will slow the new stand's development. In addition, these residual trees are often more valuable because of their size and species. Leave trees will continue to grow but are more susceptible to damaging agents, such as insects, wind, and disease. Leaving them can result in lost monetary value to the landowner. The concern that overstory removal will damage regeneration is not warranted early in the life of the newly regenerated stand. However, as young seedlings develop into saplings, overstory removal without damage to the new stand becomes less likely. For more detailed information on the shelterwood method, consult MSU Extension Publication 3461 *Bottomland Hardwoods: Natural Regeneration Using the Shelterwood System.*

Artificial Hardwood Regeneration

Artificial regeneration in hardwoods involves planting acorns or seedlings. While natural regeneration is typically considered the best option for regeneration for economic and efficiency reasons, it is not always feasible. This typically is the result of a lack of an existing source of seeds or sprouts.

Some hardwood stands can produce only small numbers of seedlings or saplings in the understory. In this situation, artificial regeneration may be needed only to supplement advance regeneration numbers. However, in many instances, no provision was made to ensure establishment of advance regeneration before harvesting, the desired species being regenerated was not present in the previous stand, or no trees existed at all (such as in retired agricultural areas). Artificial regeneration is the only recourse for managers establishing desirable species in postharvest stands in these cases. MSU Extension Publication 3486 *Artificial Regeneration of Bottomland Hardwoods* provides a more thorough primer on artificial regeneration in hardwood plantings, but this chapter gives some of the highlights to consider when determining whether you want to use artificial regeneration in your management efforts.

PLANTING STOCKS

There are three planting stock types that may be used when artificially regenerating oaks:

- Direct-seeded acorns
- Bare-root seedlings
- Containerized seedlings

Direct Seeding: Direct seeding is sowing seed on the soil surface or shallow planting in the soil. This practice was common in the South before the 1990s but became less widespread as planting bare-root seedlings gained popularity. Direct seeding acorns has definite benefits. It is less expensive than planting seedlings. Production, transport, and planting costs are lower compared with planting seedlings, and germinated acorns will undergo natural root development without lifting damage and transplanting shock. However, success with direct seeding is difficult. Seed predation, germination failure from drought or extreme temperatures, problems with saturated or flooded soils, poor-quality seed, improper planting technique, and competition with herbaceous vegetation can all lead to direct seeding failure.

Bare-Root Seedlings: Currently, most hardwood plantings use bare-root seedlings in artificial regeneration. These seedlings are termed "bare-root" because they don't have soil surrounding their root systems after lifting at the nursery. Of the seedling planting stock types, bare-root seedlings are the least expensive to purchase, transport, and plant. They also have the greatest availability, offer much better performance than direct seeding, and offer comparable performance to larger containerized stock if transported and planted correctly.

These seedlings range in size from a few inches to a few feet in height and between one-tenth and nearly an inch at the root collar. If all planting variables and site conditions are ideal, larger seedlings with well-developed tops and root systems are more capable of competing with on-site vegetation and resisting browsing and defoliation pressure. Large seedlings also have increased growth and survival compared to smaller seedlings. However, it is important to remember that large seedlings can pose significant planting problems if you don't have the appropriate equipment to plant them efficiently. In addition, planting and environmental factors are rarely ideal, and smaller, "standard nursery-run" seedlings often catch and sometimes surpass these seed-

lings within a few years of planting. Studies indicate that standard 1-0 (1 year in a nursery bed and was not transplanted in the nursery) bare-root nursery stock seedlings are sufficient to provide excellent survival and growth.

Quality is the most important factor when purchasing seedlings. Good bare-root seedlings should have 18- to 24-inch tops and 8- to 10-inch root systems. Root systems should have root collar diameters between ¼ and ½ inch with eight or more first-order lateral roots present to provide the best chance for competitive ability and planting ease. Larger seedlings are more difficult to plant and often result in unacceptable planting quality and/or dieback from transplant shock. You can expect 90 percent or greater survival at the end of the first growing season if these conditions are met:

- quality seedlings are matched to the site
- seedlings receive proper handling from lifting through planting
- seedlings are afforded proper herbaceous weed control
- seedlings do not encounter limiting environmental variables

Any of these limiting variables can result in increased seedling mortality or even planting failure.

Containerized Seedlings: Containerized seedlings are grown in tubes or containers to encourage well-developed, undisturbed root systems that are not separated from their growing soil before planting. These seedlings are harder to find and more expensive than bare-root seedlings. However, there are some benefits associated with planting containerized seedlings. They may be successfully planted over a longer time span than bare-root seedlings, and some research has shown that they can exhibit greater survival than bare-root seedlings. These factors may warrant the use of containerized seedlings if flooding prevents dormant-season planting.

Most containerized seedlings are grown in small tubes or containers, but some are grown in much larger pots and sold as a means of extremely rapid establishment without some of the mechanical and herbicide requirements needed for smaller seedlings. While potted seedlings may offer some survival and growth benefits, they are much harder to plant (by auger or shovel) and have several associated problems that can affect survival (exposed root system tops, seedlings washing out of potting medium, dieback). Potted seedlings are much more expensive than bare-root seedlings, typically starting around $8 and ranging to more than $20 per seedling. Multiple studies have shown containerized stock is not worth the cost. With proper handling and planting, quality bare-root seedlings often surpass containerized seedlings in growth relatively quickly.

While natural regeneration of hardwoods is preferable due to the expense associated with artificial regeneration, planting seedlings can be successful. If species are matched to site, proper pre- and post-planting procedures are followed, and nature cooperates, planting bare-root seedlings is often the best option for landowners who want to establish hardwood plantings efficiently with minimum establishment costs.

SITE PREPARATION

Chemical Site Preparation: Pine and hardwood silviculture differ in many aspects, but both systems benefit from proper competition control. While post-planting herbicide options differ greatly between pines and hardwoods, chemical site preparation treatments are very similar. Applications using imazapyr and glyphosate are the "gold standard" for cutover sites. Damage to planted hardwoods from residual imazapyr soil activity are extremely rare when herbicide applications are performed at least 16 weeks before planting; glyphosate, a foliar-active-only herbicide, has no soil activity and no residual effects.

Because it has limited control potential on growing-season herbaceous vegetation, very little chemical site preparation is performed in hardwood management. Treatment applications of this nature are intended to help control species that cannot be eliminated with herbicide applications after trees are planted (e.g., controlling woody species that cannot be removed using herbicidal means without severe damage to planted seedlings). However, if deemed necessary, site-preparation applications will be the same as those applied in pine plantings.

Herbaceous Weed Control: Herbaceous weed control (HWC) is a treatment designed solely to control herbaceous competition during the first growing season after planting. While broadcast applications can be used for HWC, herbicides are typically applied in bands 4–6 feet wide. Banding herbicides in this manner reduces overall treatment cost and maintains cover and food sources for wildlife. Research has established that HWC applications of sulfometuron methyl can be incredibly beneficial to

seedling growth and survival in most hardwood plantings. However, in areas that flood regularly, avoid sulfometuron methyl and use other herbicides instead.

Different herbicides exhibit different lengths of vegetative control when applied on targeted vegetation. None of the herbicides used in HWC will provide complete control of vegetation for an entire growing season. The intent of these applications is not to achieve complete growing-season herbaceous control, but rather to provide adequate time for planted seedlings to become established in a "free-to-grow" status.

Mechanical Site Preparation: Chapter 2 provides a general overview of mechanical site-preparation techniques. These are applicable to hardwood regeneration, but there is one special consideration: Most of the land that undergoes artificial regeneration of hardwoods is retired agricultural fields. In these settings, you should always consider subsoiling. For the reasons discussed in Chapter 2, most of these sites have restrictive layers, or *plow pans*, and often need corrective work to ensure planting success. For more information on mechanical site-preparation treatments, consult MSU Extension Publication 3006 *Mechanical Site Preparation for Forestry in Mississippi.*

ESTABLISHMENT

Once you have selected the appropriate species for the site, purchased quality seedlings, and applied necessary herbicide or mechanical treatments, the planting stage seems to be the simplest. However, when planting seedlings, all steps, including handling and planting, are critical in making your planting efforts successful.

Store seedlings properly to ensure quality at planting time. Once seedlings are removed from the cooler, transport them to the site in a covered vehicle. While on-site, keep seedlings out of the sun and wind. Once a bag or box of seedlings has been opened, plant them as quickly as possible. Keep all seedlings bagged until you are ready to plant them. Do not prune root systems, and plant seedlings well below the root collar. Seal planting holes as tightly as possible to promote survival and early growth.

Conclusion

Hardwoods can be regenerated naturally or by seed or seedlings. Natural regeneration is the most economical and, in many cases, the best way to provide sustainable hardwood stands. However, there are times when artificial regeneration may be necessary.

Natural regeneration is effective when adequate advance regeneration of desirable species is present. Artificial regeneration can also be very effective, but several factors must be considered. These include matching species to the site, site preparation, and seedling quality. Other factors, such as proper handling, planting, and growing season competition control, are also critical to the success of hardwood plantation establishment.

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Financial Considerations

Marcus Measells, *Senior Extension Associate, Forestry, and* **James Henderson**, *Professor and Head, Coastal Research and Extension Center*

Owning forestland can have many benefits, including economical and recreational, but, as with any investment, forestry has risks as well. Benefits over other investments include a wider range of markets, multiple products, recreational opportunities, and intangible items. Risks include the length of time before revenues are realized and natural disasters such as hurricanes, tornadoes, ice storms, or pest and disease outbreaks. Taxes are another issue to consider and are covered in Chapter 11.

Timber production requires a long-term approach to investing. Many landowners find it difficult to evaluate their timber's financial opportunity and want to compare it with alternative financial investments.

Income sources can include revenues from thinnings and final harvests, as well as annual lease payments for recreational activities such as hunting and fishing. Other income sources can include pine straw harvesting and other non-timber products, such as payments for carbon credits. Potential costs can include annual management costs, regeneration costs, timber stand improvement costs, and taxes. Of course, depending on your desired objectives and type of forest-management activities implemented, you may have other income and costs.

One important consideration when evaluating forestry investments is the interest rate used in calculations. The interest rate should consider and reflect risk factors associated with 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 from 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 rates you would expect to earn on similar investments. A 2002 study indicated Mississippi forest landowners desired nominal (includes inflation) interest rates varying from 8 percent (for investments lasting 5 years) to 13.1 percent (for investments lasting 25 years). Of course, your desired interest rate may differ 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 anticipated income and costs, you can perform the following calculations to evaluate your forestry investment. Your forestry investment can then be compared with alternative investments.

We will use the following forestry investment scenario as an example to illustrate these terms:

> A landowner wants to know if planting a pine plantation with a final harvest in year 30 is a good investment. The pine plantation will have initial costs and will require a mid-rotation thinning. The estimated costs include initial costs of $125/acre for site preparation and $65/acre for pine seedlings and planting, as well as an annual management cost of $5/acre, which will accrue each year. Revenues include $500/acre for mid-rotation thinning at age 16 and $2,800/acre for final harvest at age 30. The landowner wishes to evaluate this forestry investment at a 6% interest rate, which is comparable to the rate of return from alternative investments the landowner is considering.

There are four basic compounding formulas needed to understand and use the forestry investment terms discussed in this chapter:

1. future value = present value $\times (1 + i)^n$
2. present value = (future value at age n) $\div (1 + i)^n$
3. future value of annual costs = annual cost $\times [\{(1 + i)^n - 1\} \div i]$
4. present value of annual costs = annual cost $\times [\{(1 + i)^n - 1\} \div \{i * (1 + i)^n\}]$

where: i = interest rate in decimal percent

n = the number of periods or years

In the investment example above, establishment costs are present values, while thinning and final harvest revenues are future values.

Net Present Value

Net present value (NPV) is the difference between present value of all costs and incomes (present and future) at a given interest rate. A positive NPV indicates the investment furnishes a higher return than the selected interest rate and is an acceptable investment. An NPV of zero indicates an investment that equals the selected interest rate and is also acceptable. The selected interest rate usually indicates the investor's minimum objective or alternative investment opportunity. NPV is the correct financial measurement 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,* or *present net worth*. All revenues and costs must be discounted to present values to calculate NPV. The NPV formula is:

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

From our example, the present value of all costs includes $125 for site preparation, $65 for planting (both already expressed in present values), and $68.82 (the present value of the annual management cost), which is calculated as:

present value of annual costs = annual cost × $[\{(1 + i)^n - 1\} \div \{i * (1 + i)^n\}]$

present value of annual costs = $\$5 \times [\{(1 + .06)^{30} - 1\} \div \{.06 \times (1 + .06)^{30}\}] = \$68.82$

Therefore, the present value of all costs = $125 + $65 + $68.82 = $258.82

The present value of all revenues includes the present value of $196.82 from thinning at age 16 and $487.51 from final harvest at age 30. The present value of revenues is calculated as:

present value = (future value at age n) ÷ $(1 + i)^n$

present value of thinning = $\$500 \div (1 + .06)^{16} = \$196.82$

present value of final harvest = $\$2{,}800 \div (1 + .06)^{30} = \$487.51$

Therefore, present value of all revenues = $196.82 + $487.51 = $684.33

Now that all costs and revenues are expressed as present values, NPV can be calculated:

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

NPV = $684.33 – $258.82 = $425.51

Benefit-Cost Ratio

Benefit-cost ratio (B/C) is the present value of revenues divided by the present value of costs. This investment criterion is used for 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. B/C ratio is often referred to as the profitability index of a project. The B/C ratio formula is:

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

For our example, the present value of all revenues is $684.33, and the present value of all costs is $258.82. Thus, B/C for this investment is:

B/C = $684.33 ÷ $258.82 = 2.64

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

Equivalent Annual Income

Equivalent annual income (EAI) is the NPV of an investment at a given interest rate that has been annualized. Annualizing 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 (such as agricultural crops) that generate income each year. An investment is acceptable if EAI is greater than zero. EAI is also known as *annual equivalent, annual income equivalent, equal annual income,* or *net annual equivalent*. The EAI formula is:

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

Using our example, NPV at a 6 percent interest rate is $425.51. We can calculate EAI:

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

EAI = $425.51 × [{.06(1 + .06)^{30}} ÷ {(1 + .06)^{30} – 1}] = $30.91

If the landowner incurs these costs and revenues during the 30-year rotation, the pine plantation investment will produce returns equivalent to an annual income of $30.91 per acre.

Rate of Return

Rate of return (ROR) is the rate of compound interest earned by funds invested, or average rate of capital appreciation over the life of an investment. It is the compound interest rate used where NPV is zero. In other words, ROR is the compound interest rate that equates the present value of all future incomes with 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* or *return on investment*. Investments with only one cost and one revenue can be calculated directly, while investments with more than one cost and revenue must use an iterative process. ROR is useful in accept/reject decisions. However, it is not recommended for ranking investments.

From our example, NPV at 6 percent is $425.51. Therefore, ROR is greater than 6 percent 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 an NPV of zero. A 10 percent interest rate produces an NPV of $32.14, and an 11 percent interest rate results in a NPV of -$17.01. So, ROR for this investment is between 10 percent and 11 percent. Continuing this iterative process until NPV equals zero results in a 10.62 percent ROR.

Land Expectation Value

Land expectation value (LEV) estimates value of bare land used for growing timber. LEV 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 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,* or *Faustmann's formula*. The LEV formula is:

LEV = [net value in year n] ÷ [$(1 + i)^n - 1$]

To use the LEV formula, compound all costs and revenues associated with timber production to the end of the first rotation or cutting cycle and subtract costs from revenues to determine net value in year n. Using our example, net value in year 30 is calculated as follows:

The final harvest value of $2,800 at year 30 is already expressed as a future value.

The revenue from thinning at year 16 is compounded 14 years into the future:

Future value = present value × $(1 + i)^n$

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

Future value of site preparation cost at year 30 = $125 $(1 + .06)^{30}$ = $717.94

Future value of seedlings and planting costs at year 30 = $65 $(1 + .06)^{30}$ = $373.33

Future value of annual costs = annual cost × [{$(1 + i)^n - 1$} ÷ i]

Future value of annual management costs at year 30 = $5 × [{$(1 + .06)^{30} - 1$} ÷ .06] = $395.29

Thus, net value in year 30 = $2,800 + $1,130.45 – $717.94 – $373.33 – $395.29 = $2,443.89

Now that all costs and revenues are expressed as future values, LEV can be calculated:

LEV = [net value in year n] ÷ [$(1 + i)^n - 1$]

LEV = $2,443.89 ÷ [$(1 + .06)^{30} - 1$] = $515.21

The most a landowner should pay for bare land for this 30-year pine plantation investment example is $515.21 per acre.

The book *Basic Concepts in Forest Valuation and Investment Analysis* by Bullard and Straka (2011) is a good reference. It covers all the above-mentioned terms and provides detailed examples for forestry investments.

FORVAL Online, developed at Mississippi State University, is a useful application for forestry investment analysis. You input your costs and incomes and set your desired interest rate, and the program calculates your NPV, B/C ratio, ROR, EAI, and LEV, among other financial calculations. You may access FORVAL at https://fwrc.msstate.edu/forval/.

Another useful online application for forestland investment analysis is Timberland Decision Support System (TDSS), developed by Texas A&M Forest Service. Like FORVAL, you can calculate the above financial criteria. It also includes a loblolly pine growth and yield model and a forest thinning scheduler, which allows you to simulate potential growth of your loblolly pine forests and include this in your financial investment analysis. You may access TDSS at https://tfsfrd.tamu.edu/tdss/.

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Marketing Your Timber

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A timber harvest is the realization of many years—often decades—of work. The landowner finally reaps the financial benefits of faithfully following the correct forest management practices. It is critical that landowners understand how to market their timber so they can realize the maximum financial returns. Unfortunately, many landowners do not understand the dynamics of forest marketing.

There is a difference between selling and marketing your timber. Selling involves getting a few bids, or perhaps only one bid, for your timber with little knowledge of the timber's value. Marketing involves activities in a competitive market to assure you get the best possible price. Marketing includes receiving multiple bids and understanding timber quality and quantity. Marketing timber requires planning and pre-sale work before you advertise for competitive bids. Your goal is to get the best price possible for your timber. The following information can help you accomplish this goal.

Know What You Have to Harvest

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 first step in successful timber marketing is to determine how many acres and the quantity of timber you have available to harvest. You must know the total number, species, sizes, and quality of trees you have available.

You can get this information by having your timber inventoried, or cruised, by a professional forester. This inventory is an estimate of these and other characteristics, which can then be used to estimate the value of merchantable timber and determine product types the trees can be used for. An inventory usually provides volumes in cords, board feet, tons, or other volume measurements. It also provides a stand location map, age and growth information, and description of the timber.

Costs for timber inventories vary depending on number of acres involved and amount of merchantable timber present. In general, the greater the timber value, the higher degree of accuracy required from the timber inventory. This is because statistical errors of the estimated timber value are more costly in valuable timber.

Timber inventories should not be viewed as an expense, but as an investment. Investing in a timber inventory before marketing 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 Presale Preparations

As a landowner, you should have all details pertaining to your timber sale worked out before putting it on the market. Potential buyers will usually place higher bids if all their concerns are addressed and answered before bidding. You must resolve any legal issues, such as potential title disputes or liens against the property or timber before the sale. Clearly mark all boundary lines and the timber sale area on the ground so buyers know exactly what they are bidding on. Provide a clear logging access route so buyers know they can move the timber from the woods to the nearest road. You should also decide and describe any restrictions that you may place on the timber harvest.

Bid Methods

Use the proper bid method when marketing your timber. Two commonly used methods are *negotiation* and *sealed bids*. Each has advantages and disadvantages, depending on the timber type and size being sold.

NEGOTIATION

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

However, this method does have advantages in certain situations. 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 during a first thinning. Also, it is very costly to have low-valued pulpwood trees marked and inventoried. For example, a seller and buyer can negotiate a price per ton for pine pulpwood to be cut. This 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 using this method.

SEALED BID

Many landowners utilize the sealed-bid method. Prospective buyers submit confidential written offers for timber. Prospective buyers are only allowed to submit one bid. All sealed bids are opened at a specific time and place. This method often results in higher offers for timber, but it 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 timber volume and value. A timber sale prospectus or bid invitation can then be prepared. The bid invitation is a letter with supporting information that describes sale conditions and timber to be sold. The bid invitation should realistically answer 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 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.)

Sources of Assistance

Professional assistance is essential to market timber properly. This help is readily available, but frequently, only the best-informed landowners use it. The following are available to assist you:

- The Mississippi Forestry Commission employs professional foresters to serve as county or service foresters. They provide active leadership in forest protection, forest management, forest inventory, and effective forest information distribution. Some activities are provided at no cost while others are provided for a fee. For more specific information on the assistance provided by the Mississippi Forestry Commission, contact your local office or visit www.mfc.ms.gov.
- The Mississippi State University Extension Service employs foresters to provide information about forest management, use of wood products, stumpage prices, taxes, and many other topics. These forestry specialists closely follow current research and help get practical research applications into use in the field as soon as possible. For more information, contact your local county Extension office or visit www.extension.msstate.edu/natural-resources/forestry.
- Industrial foresters work with landowners who may be prospective suppliers of wood to their mills. They often provide timber marking and management plans with a request to have "right of first refusal" when you are ready to harvest 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 services

provided. Timber marketing assistance is usually offered on a commission basis. The consulting forester determines which trees should be cut, their volumes, and total value. They then 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 their 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 consultant foresters are very often their best source of help. To locate a consulting forester, visit www.borf.ms.gov.

Summary

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

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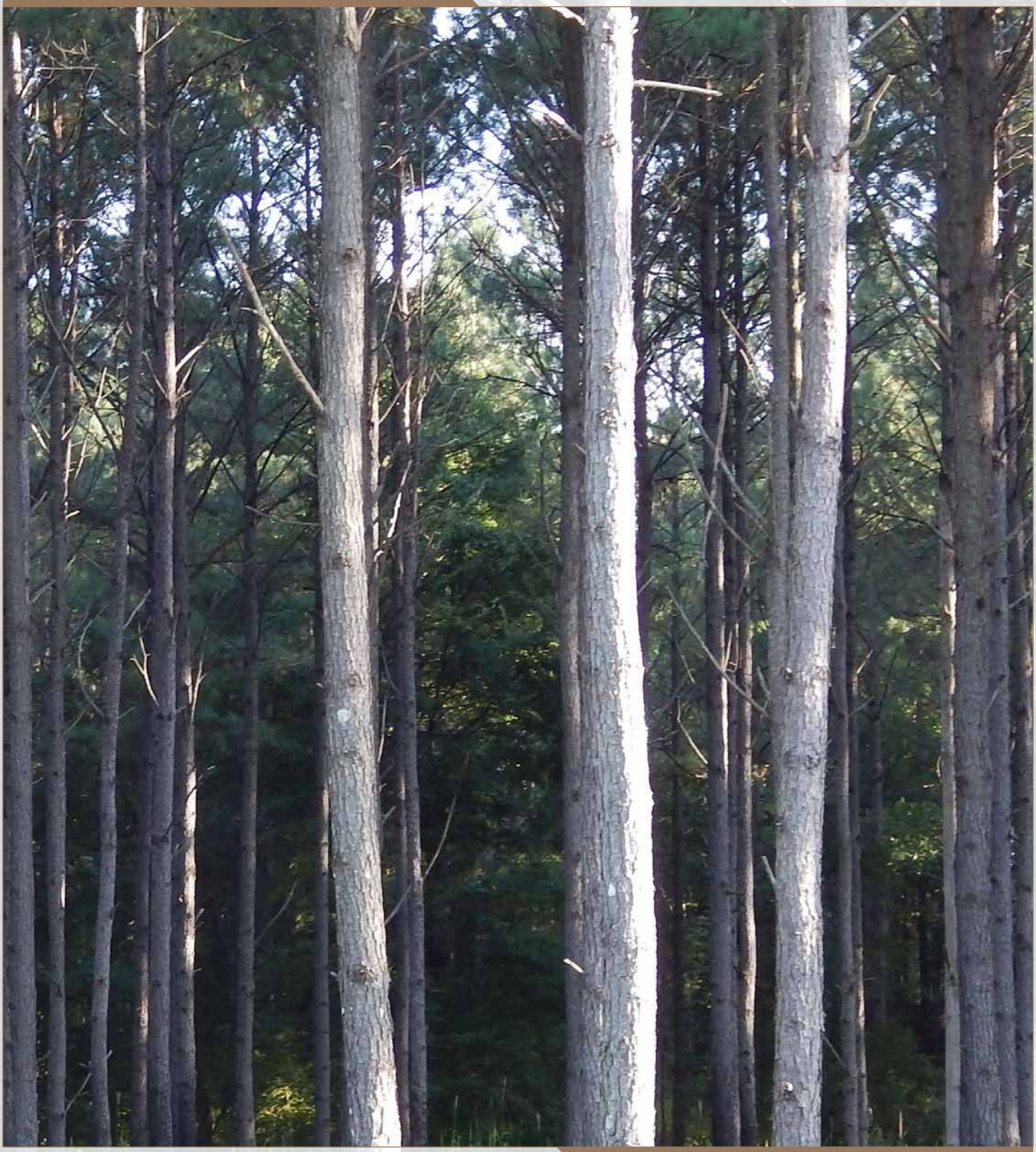

Pine Plantation Thinning

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Revised from earlier work by **Trey DeLoach**, *Consultant, Madison, Mississippi*

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

Foresters plant hundreds of pine trees per acre. As the pine stand ages, trees compete more for site resources: water, nutrients, and sunlight. The trees grow tall and shed their lower branches through competition for sunlight. In this manner, the pine trees develop desirable timber characteristics: long, clear boles for high-value wood products.

Consequently, thinning pine plantations becomes a necessary part of forest management. Once the pine trees fully occupy the site, inter-tree competition becomes fierce. As trees grow larger, weaker individuals die. All the trees become stressed and slow their growth. This stress can attract bark beetles, particularly the southern pine beetle. Without the intervention of thinning, the entire pine stand is in jeopardy.

Thinning plantations accomplishes several objectives:

1. If the smaller trees are now sufficiently large to sell, their removal allows the landowner to capture potential mortality. The timely removal of weaker trees produces income for the landowner.
2. The remaining trees now have more resources to grow. This improves their vigor and overall forest health. The trees are now better able to withstand potential bark beetle attack.
3. Select removal of weaker individuals includes small trees and those with disease, deformity, or poor form. Small trees would die, while the others would remain pulpwood grade, despite becoming larger. Therefore, thinning improves the overall quality of the stand.
4. Thinning allows more sunlight to reach the forest floor. This presents an opportunity to enhance natural wildlife habitat.

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 on-site inspection of the forest. Several guidelines will help you know when it's about time to thin. All thinning practices should be conducted in accordance with the landowner's management objectives. 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 site 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. Often, stand density is expressed in basal area. This is the total cross-sectional area of the trees measured at 4.5 feet above the ground expressed in square feet per acre. Most loblolly pine stands are ready for thinning when their basal area reaches or exceeds 120 square feet per acre.

Stand density index (SDI) is a measure of the carrying capacity of the site. That means, for a given TPA, the average tree diameter has an upper limit. Stands that are growing at this upper limit have reached the self-thinning zone for the site. The continued growth of the stand is now at the expense of weaker individual trees, which die. Figure 8.1 shows the relationship between TPA and DBH. To increase tree size, the number of TPA needs to be reduced,

providing site resources for the remaining trees to grow. Anywhere the number of TPA and DBH intersect above the thin-wait line, the stand needs to be thinned.

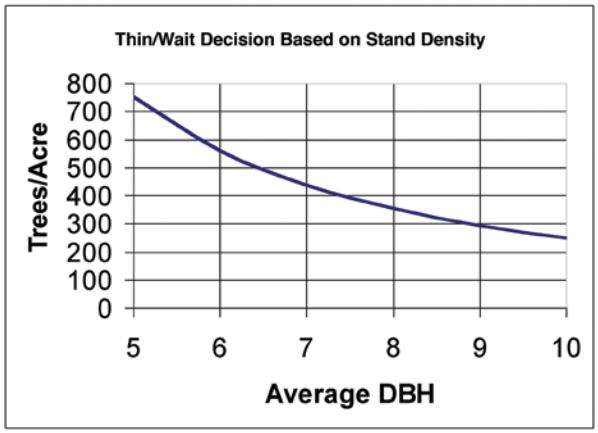

Figure 8.1. Stand density index. Adapted from Self, 2021.

Once stand density indicates a stand is ready to be thinned, consider average stand diameter, tree heights, natural pruning, and growth rates. For a stand to be merchantable (Figure 8.2) it must have an average DBH of 6 inches. Because most 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 8.2. A 17-year-old loblolly pine plantation of merchantable size that is ready for a first thinning, in Marshall County, Mississippi.

Natural pruning occurs because pine trees are shade intolerant. 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, thin when growth rates begin to decline.

Thinning operations are typically conducted at several points during the rotation. 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 must 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 stagnate on the stand.

The overall goal in thinning a pine plantation is to remove the worst trees while saving the best. This gives the better trees more site resources to continue growing. In plantations, this is done by systematically removing a row of trees on a set pattern, creating alleys. The alleys permit logging equipment access into the stand and are necessary because logging is done on a tree-length basis. After the rows are removed, the logger selectively removes poor trees from the residual stand between alleys. Generally, a first thinning removes about 50 percent of the trees and 40 percent of the volume. Depending on landowner objectives, the residual basal area of the stand is commonly specified to range between 60 and 80 square feet per acre. For example, to emphasize wildlife habitat, the residual basal area might be specified as 60 square feet per acre. On the other hand, for high-quality timber production such as poles, 80 square feet per acre might be the objective.

"Are my pine trees ready to thin?" is one of the most frequently asked questions by private landowners. The answer to this question is determined by the size, growth rate, natural pruning, and height of the trees, as well as stand density; it 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
- the growth rate has begun to decline

For a step-by-step process of determining if the stand is ready to thin, read MSU Extension Publication 2260 *Are My Pine Trees Ready to Thin?* In general, a loblolly pine stand will need thinning when the stand density exceeds 120 square feet per acre.

THINNING TECHNIQUES

The ideal thinning of trees uses selection entirely. Removing just the smaller, deformed, or diseased trees is known as *thinning from below* since the canopies of smaller trees are below the main canopy of the forest. The other approach to selection involves opening the main canopy of the stand, called *thinning from above*. Again, the selection here focuses on larger trees that have low growth potential because of disease or poor form. By contrast, there is a completely systematic approach to thinning, which removes all trees in swaths through the stand. This technique is useful in precommercial thinning, which is discussed later.

There are several ways to thin a pine plantation, all of which are hybrids of systematic and selection methods. Such methods are necessary to provide access to large logging equipment for tree-length removals. Each hybrid technique has its advantages and disadvantages. Often, loggers tend to have a preference and experience using particular approaches. If loggers in your area tend to use only one method, it is always better to have the stand thinned than to delay thinning.

A very common method of thinning a plantation is known as third-row thinning. In this technique, every third row of pines is removed for access (Figure 8.3). The logger then selects the weaker individual trees from the remaining two rows. About 25 percent of the remaining trees are removed. Removals from the residual rows now follow the thinning maxim "leave the best and cut the rest." The objective for thinning the residual stand is on selectively removing small, diseased, or deformed trees. The third-row thinning technique favors the logger since less selection is done. Also, removing weaker individuals from remaining rows is easy because each row faces an alley.

Another technique is fourth-row thinning, where every fourth row is removed for access (Figure 8.4). This leaves

Figure 8.3. Third-row thinning in a loblolly pine plantation in Benton County, Mississippi.

three residual rows for selection. Since more residual trees are retained, more selection can be done. About 33 percent of the remaining weaker individual trees are removed. This technique is considered a compromise between logging and landowner objectives. With three residual rows, the logger can remove a tree from the innermost interior row from either side. If the logger is blocked from removing a tree on one side, the other side might provide better access.

The most advantageous, but rarely performed, thinning technique is fifth-row thinning. This method leaves four rows of residual trees for selection. About 40 percent of the weaker individual trees can be selectively removed. This approach is more difficult for the logger to implement because the two middle rows do not have direct access to an alley, making it more difficult to remove trees from the innermost rows. However, this approach gives the landowner the greatest opportunity for selection.

Figure 8.4. Fourth-row thinning in a loblolly pine plantation in Clay County, Mississippi.

Figure 8.5. Second-row thin in a slash pine plantation in Orange County, Florida.

A final technique is for plantations with poorly recognized rows or even-aged, naturally regenerated pine stands. This method is known as strip thinning. The logger cuts a corridor 20 feet wide through the stand, skips a 40-foot swath of residual timber, and cuts another 20-foot strip. This pattern is repeated across the landscape of the pine stand. Once corridors are in place, the logger then removes about 25 percent of the poor-quality trees from the residual strips. This approach approximates a third-row thin when plantation rows cannot be seen and can be adapted to other types of row-thinning by changing the width of the strip removed. Corridors can be narrowed to 10 feet wide, skipping a 40-foot swath of residual trees. This would approximate a fifth-row thin, allowing select removal of about 40 percent of the residual trees.

There are thinning techniques to avoid, including using only a systematic approach to thinning plantations of merchantable timber. Usually, systematic thinnings provide all the advantage to the logger, with no opportunity for selection of residuals to improve the stand or benefit the landowner. An example to avoid is cutting every other row, or second-row thinning (Figure 8.5).

PRECOMMERCIAL THINNING

One of the problems with pine regeneration is overcrowding of seedlings, which is common 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 8.1, stands with more than 800 trees per acre will take a long time to reach a merchantable diameter. Overcrowded stands will stagnate and never become merchantable. A pre-commercial thin will reduce overcrowding in these stands.

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 precommercial thinning (Figure 8.6). 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 9.

Figure 8.6. Precommercial thin of loblolly pines performed using a chainsaw in Lincoln County, Mississippi.

Pine Release and Wildlife Habitat

Despite efforts to control unwanted vegetation when doing site preparation, hardwoods often encroach pine plantations (Figure 8.7). After conducting a first commercial thinning, the stand will have an increased amount of sunlight reaching the forest floor, and any competing hardwoods in the stand will also respond to the increased light. The number of hardwoods per acre and their basal area have a disproportionately negative effect on pine growth. In fact, competing hardwoods can substantially reduce pine growth when their basal area approaches or exceeds as little as 5 square feet per acre in a pine stand.

In these sit uations, you must control competing hardwoods using selective herbicides. This operation is known as pine release from competition. Controlling competing vegetation will ensure that the benefits of thinning for site resources will be allocated to the remaining pines, not the competing hardwoods. This operation also presents an opportunity for enhancing natural wildlife habitat through quality vegetation management (QVM). In addition to detracting from pine growth, hardwoods have relatively little forage value for wildlife; the hardwood midstory in a pine stand has a forage value to support a deer for about 1 week.

The first step of implementing QVM in pine plantations begins with pine release. It requires application of selective herbicides in the late summer or early fall. Selective herbicides, such as imazapyr products, will control unwanted hardwoods but have little effect on pine. These herbicides are absorbed into the plant through foliage and roots. Competing hardwoods are slowly killed over the winter.

Figure 8.7. Hardwood midstory in a pine plantation.

Figure 8.8. Quality vegetation management promotes pine growth and natural wildlife habitat.

The second step for QVM is applying a prescribed burn in the winter to early spring. The burn will help control competing hardwoods and remove the forest floor (pine needles, leaves, branches, and cones that cover the soil surface). In the spring, sunlight will hit the bare mineral soil and warm it, promoting germination of native forbs and grasses that have been dormant in the seed bank. This understory cover is lush and completely available to wildlife for food and cover (Figure 8.8). The forage value of the understory cover can support a deer for 38 weeks on average.

Second or Third Thinning

The objectives of second and subsequent thinnings are to promote stand health, set the stage for final harvest, and provide economic return for the landowner. Subsequent thinnings are entirely done by selection. Access into the stand for logging equipment has already been provided during the first thinning. These later thinnings will use the thin from below or thin from above approaches. 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. Thinning a second or third time will involve marking timber and higher value products. Landowners are encouraged to use registered consulting foresters when conducting timber sales from second or third thinnings.

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 (Figure 8.9). Marking trees to leave makes it easier to see spacing and

quality of remaining crop trees before thinning. Moreover, marked trees are easy to see at the loading deck, and marked stumps are evidence of improper removal. 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 plus or minus 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.

Thinning Considerations for Other Southern Pines

Up to now, the focus of discussion has been on loblolly pine plantations because this is the most widely planted of the southern pines in the United States. But there are three other predominant species of southern yellow pines. These include longleaf, shortleaf, and slash pines. Both loblolly and shortleaf pines have the largest ranges across the southeastern United States and are found across Mississippi except in the Mississippi River floodplain. On the other hand, longleaf and slash pines are found only in South Mississippi (south of I-20) and across the Lower Coastal Plains of the southern states.

In general, all southern yellow pines will respond to thinning when stand density exceeds a basal area of 100 square feet per acre. The approaches discussed here will be applicable to managing longleaf and slash pines that have been artificially regenerated in plantations. With increasing attention and effort to both longleaf and shortleaf pine restoration projects, selection thinning techniques may predominate. The goal of these ecosystem-restoration efforts is using natural regeneration techniques or converting plantations into naturally regenerated stands.

Figure 8.9. Second thinning with trees marked to leave in Oktibbeha County, Mississippi.

Summary

Thinning is a necessary management practice that will produce income for the landowner while increasing the quality of the stand for final harvest. It also provides an opportunity to enhance natural wildlife habitat. Thinning at the proper time will allow trees to continue growing at acceptable rates. Remember the goal of selection in thinning operations is to "leave the best and cut the rest." Anything else will result in reducing the quality of the stand. We encourage landowners to hire a professional forester for all aspects of conducting a thinning operation.

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Prescribed Burning

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Fire is a natural part of many forest types in Mississippi. *Prescribed fire*, the practice of intentionally burning under specific conditions to achieve specific goals, has long been practiced as a cost-effective way to achieve many wide-ranging benefits.

Forest landowners and managers use prescribed fire to achieve a variety of objectives to manage timber, improve wildlife habitat, and improve the forest's general appearance and access. Some of the most common uses for prescribed fire are listed below:

- Site preparation in advance of planting.
- Hazard reduction by removing fuel that could endanger property if a wildfire occurred.
- Reduce aboveground 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 removing the forest floor layer so that wildlife can more easily find seeds.
- Burn some types of fruit-producing plants, such as blueberries and blackberries, to stimulate soft mast 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 costs as little as $25 to $30 per acre. However, as with any tool, there are some drawbacks, and, if done improperly, forest fire can be detrimental or damaging to the forest or nearby structures. Any prescribed fire must be conducted only under exacting weather conditions, which can sometimes change abruptly. A sudden change in wind direction or a drop in humidity over the course of a morning can cause a well-behaved prescribed fire to become a wildfire quickly. While prescribed fire for forest management has been practiced for centuries, many landowners lack the experience to feel comfortable conducting their own burns.

Smoke is the greatest concern 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 today use prescribed burning. Insurance rates to cover potential damage from prescribed burns have increased considerably, causing many people to choose other timber stand improvement tools that seem less risky.

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. This law gives prescribed burn managers some legal protection should an accident occur. In order to receive these protections, the law describes four requirements that any prescribed burn must meet:

- 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 1 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 by the Mississippi Forestry Commission (MFC). MFC typically offers this multi-day short course two to three times each year at locations around the state. The goal of this course is to give people the necessary knowledge base to be able to conduct a prescribed burn safely and effectively.
- Enroll in Forest Fire Laboratory and Lecture (FO 3201 and 3202) in the Department of Forestry at Mississippi State University and pass both.
- 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. It is important to note that the permit is **not** approval that the weather is good for a prescribed burn. The permit simply indicates that the weather is consistent with smoke dispersal. The weather may or may not be appropriate for a prescribed burn given the specific conditions of the forest and the landowner's objectives. Two weather conditions must be met for a permit to be issued:

- 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 requesting 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. While it is not required by law, it is also a good idea to call your local county sheriff's office and/or volunteer fire coordinator to let them know you will be conducting a prescribed fire.

The burn plan must be notarized at least 1 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, you can be found guilty of *simple negligence*. This means that you 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, you can be found guilty of *gross negligence*. This means you can be held liable for actual damages and punitive damages up to $500. You also can be charged with a misdemeanor, which 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 separate written prescribed burn plan for each area to be burned. Some plans may be short and simple. Others are long and complex. In any case, it is essential that the plans are concise and that they include all necessary information.

BURN 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

Include the name and address of the property owner, as well as the name of the person who prepared the plan.

Mississippi requires that a burn plan be notarized at least 1 day before the day of the burn. The notary's signature and number should be on the prescribed burn plan. Record the permit number on the burn plan as well as the date the burn is to be 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 *Fire Behavior Field Reference Guide* (https://gacc.nifc.gov/oncc/predictive/analysis/docs/FBFRG_2014.pdf).

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 manmade fire breaks present. These can include streams, ponds, roads, skid trails, and so forth.

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 is often some structure or site in the vicinity of your burn that you don't want damaged by your fire. It could be a streamside management zone (SMZ) or a hunting cabin, for example. 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 burn vicinity. 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.

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. See Table 9.1 for the estimated distance smoke travels in various situations.

Table 9.1. Smoke traveling distances.

Fire type	Distance
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 degrees from each side of your center line.

Lastly, follow any drainage for one-half the distance determined above. This will account for smoke movement after sundown, as smoke typically settles back to the earth as the heat of the day decreases and humidity increases. 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, it is your responsibility no matter where it goes.

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 investigate to determine if there are any elderly residents, residents with respiratory problems, or farms around the area. 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 one-tenth the smoke travel distance listed in step 1. See Table 9.2 for an example.

Table 9.2. Identifying smoke-critical areas.

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. Sometimes the burn can still be conducted if the weather conditions, such as wind direction, are altered.
- Do something other than burning. Use mechanical operations to remove slash, hazardous fuels, and other vegetation. Herbicides can often be used to achieve similar results to prescribed burning.
- Don't burn windrowed logging debris if there are smoke-sensitive or critical areas present. Windrows produce copious amounts of smoke and take longer than 1 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 on the downwind side, perpendicular to the wind. This type of 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; it can more easily result in lethal temperatures than other firing techniques. The slow rate of spread is also the chief disadvantage of a backfire. Because backfires move slowly, it can be difficult to cover large areas using only this method, 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 where the burn manager has removed fuel and broken the fire triangle. The flames generated by a headfire are generally higher and travel much faster than a backfire. With this technique, there is a danger of *spotting* once the fire reaches the fire break. Spotting is when hot embers are lifted up and over a firebreak, coming back to the 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 need to be documented here. This includes surface and transport wind speeds, mixing heights, stagnation indices, relative humidity, temperature, time of day the fire is to be started, and time of day when the burn should be finished.

Summary of Burn

Once the burn is completed, you should conduct a summary of the burn. The number of acres burned and the techniques used should match 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 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, and so forth. See the sample prescribed burning plan form on the next page.

What Weather Characteristics Are Most Critical?

Several 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, look for these weather characteristics:

- **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 as well as 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 to 20 miles per hour, depending on firing technique.

Other weather variables that might be important include current and projected temperatures and fuel moisture.

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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Sample Prescribed Burning Plan Form

LEGAL DESCRIPTION OF PROPERTY

40#: _____

Section: _____

Township: _____

Range: _____

County: _____

State: _____

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: _____

_____

Manmade: _____

_____

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: _____

2. Transport wind speed: > _____

3. Mixing height: > _____

4. Stagnation index: 0–2

5. Relative humidity: _____

6. Temperature: High: _____ Low: _____

7. Time of day to start: _____

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: _____

Relative humidity: _____

Temperature: High: _____ Low: _____

Remarks: _____

_____

_____

_____

_____

_____

Adapted from Londo et al., 2005.

Managing for Multiple Use

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Several surveys indicate that non-industrial private forest landowners own land for reasons other than timber production. These reasons include aesthetics, wildlife-related recreation, and other natural resource-based activities.

The term *multiple use* in natural resource management is straightforward: it is the management of lands for more than one purpose. Inherently, this management approach is more complex and requires forest landowners to understand and assess each additional use for its compatibility with their long-term forest-management goals. To do this, private landowners need to take the time to evaluate their options and consult local natural resource professionals when developing their forest-management plan. This chapter and publication are an excellent starting point in that process!

There are many alternative uses for non-industrial private forest lands, the most popular being wildlife-related recreation including hunting, fishing, and wildlife watching. Over 104 million people participate in these activities, generating $157 billion in expenditures in the United States. Other popular outdoor recreation includes shooting and water sports, camping, hiking, and various motor vehicle activities such as ATV riding.

Mississippi forest landowners engage in agricultural activities including row crops, livestock, and, more recently, agritourism as alternative enterprises to their forestry operations. Others participate in extraction of natural gas, mining, and other related activities.

This chapter will primarily focus on wildlife-related recreation given the integral connection between forest and wildlife management and its overwhelming popularity among Mississippi forest landowners. The chapter begins with a foundational understanding of wildlife management and concludes with an introduction to natural resource enterprises.

The Needs of Wildlife

All living organisms, including humans, have four major needs to survive and reproduce: food, water, shelter, and space. These physical and biological resources required by an animal constitute its specific *habitat*. Understanding when and where these required resources are needed by a given species is as critical as the resource itself.

The *when* refers to the species' *annual cycle*. This pattern is based on resources that are needed at specific times of the year for survival, reproduction, and rearing of young. For example, to fuel the rapid growth and body development of their poults, wild turkey hens require protein-rich food during the first 2 weeks of brood rearing in the spring. Landowners can provide this resource on their property by creating "bugging areas" by managing early successional native vegetation in forest openings and along daylighted roadsides.

The *where* refers to the physical location of the needed resources on the property for a given species. This requirement is often the most challenging to understand and implement because it is a multi-layered concept.

First, *where* is directly related to the space requirement for each species. Some species like wild turkey require hundreds of acres to meet their seasonal needs. Smaller landowners need to be mindful of this when evaluating their land for use by wildlife with large home ranges. Knowing what habitat requirements are not being fulfilled on surrounding properties allows smaller landowners to tailor their management plan to fill those resource gaps. This could be as simple as providing wildlife travel corridors with ample cover, allowing safe passage between neighboring properties that are providing the remaining habitat requirements.

Second, *where* is also important at the property level. Using the previous wild turkey example, the physical placement of the bugging area is as important as the bugging

area itself. Being located near nesting and roosting areas conserves energy and reduces predation opportunities on the poults and hens as they travel between these areas.

Lastly, *where* is also important in understanding the native range of a species. No level of management or property size will attract a species that does not naturally inhabit the given area. This is a common misconception of landowners interested in attracting songbirds to their forest lands. Conducting a basic review of the native geographic range for the species of interest can help you set realistic management expectations. You can find this information in field identification guides or other electronic sources.

Forest landowners who have a comprehensive understanding of wildlife needs relative to space and time will be more effective at implementing wildlife management on their multi-use properties.

Active Management Principles

Given that 68 percent of the land area in Mississippi is forested—over 19 million acres—wildlife and forests are integrally connected. All forested land, regardless of the forest type, composition, or management status, is providing at least some of the habitat needs for various wildlife species at any given time. As such, landowners should be aware that any actions (e.g., thinning, burning, fertilization, etc.) taken in the forest, including no action, will have differing immediate and long-term effects on certain wildlife species. When forest landowners have a desire to actively manage for wildlife, their habitat requirements need to be incorporated into the forest-management plan.

The purpose of this section is to introduce basic wildlife management concepts to increase a landowner's ability to conduct these practices on their own or confidently communicate when hiring a local consultant. The management concepts presented here are generalizations. Property-specific management recommendations will require consultation with local wildlife and forestry professionals.

Plant Succession

As stated earlier, all living organisms need food, water, cover, and space to survive and reproduce. Plant communities are the primary source of food and cover for wildlife. Plant communities are dynamic systems that change over time and are shaped by soil type, weather, climate, and natural disturbances. This process is known as *plant succession*.

In its simplest form, plant succession is a predictable linear process starting with bare ground that develops over time into a climax plant community (Figure 10.1). 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 climax forest is oak, beech, and magnolia. Climax forests within the major river bottoms will depend on 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.

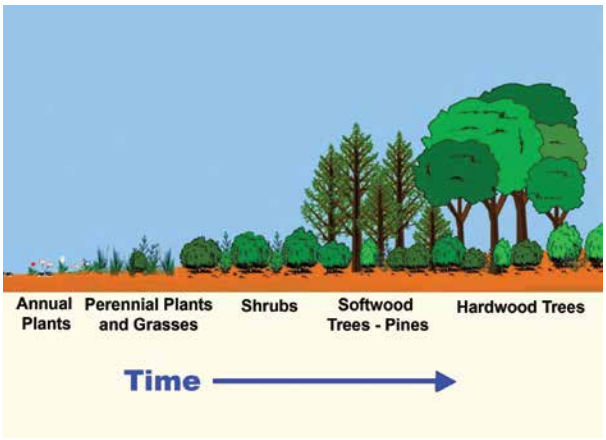

Figure 10.1. Normal plant succession over time.

The species composition of the annual weeds and grasses that germinate and grow on a site depends on past land use and what is present in the *seed bank*. The seed bank consists of seeds that are already on the site or in the soil. These seeds are present because of the vegetation currently growing on that site and in the recent past. Plant succession for 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 native 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.

Plant succession will also differ on soils with high fertility and a favorable moisture profile compared to soils with poor fertility and low moisture capacity and/or poor drainage. The most fertile soils produce greater plant biomass and higher nutrient contents. (See Figure 10.2.)

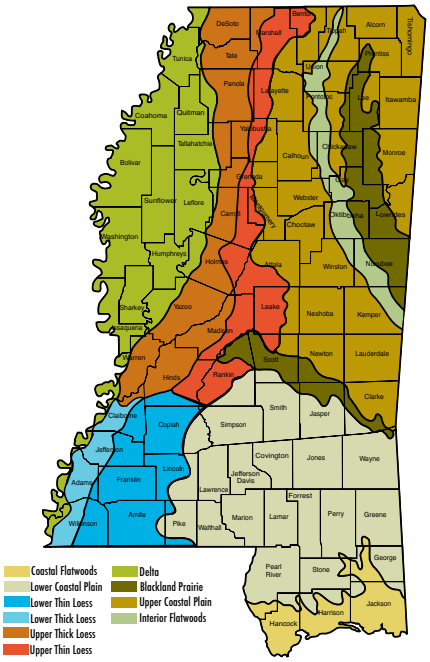

Figure 10.2. Map of Mississippi soils.

Plant succession generally takes place over long periods of time. Each successional stage has a different community of plants and associated wildlife that inhabit it. The successional stage is altered or reset to earlier stages through natural and human-caused disturbances. Natural disturbances include wildfire, plant diseases, tornados, hurricanes, and other weather events. Human disturbances include land use conversion and active management. Land conversion activities like agriculture, house construction, road construction, and other infrastructure activities can have temporary or permanent effects on plant succession. Active vegetation management is used in forestry and wildlife management to reset or maintain a specific plant successional stage.

On forested land, active vegetation management is accomplished through silvicultural practices such as thinning, improvement cuts, prescribed burns, herbicide applications, fertilization, and clear cuts. These practices are discussed in greater detail in other chapters of this book. These practices can be used simultaneously for effective timber and wildlife management when applied correctly.

It is important to understand that no single plant community is ideal for all wildlife species to obtain their required resources. However, many species share the same required resources and can obtain them from the same plant community. Generalist wildlife species like racoons and white-tailed deer are quite adaptable in securing their needed resources across many types of plant communities, but specialist species like gopher tortoises and many species of birds are highly specialized for a specific plant community. Therefore, professional biologists generally recommend managing for a diversity of plant communities to accommodate a broader range of wildlife species.

Managing for Plant and Wildlife Diversity

As with space, *diversity* is a complex concept. Species diversity is a measure of species' richness and evenness. Richness is simply the number of species present on a given site or property. Species evenness refers to the relative number of individuals for each of those species on the site or property. Therefore, species diversity accounts for the number of species and their numeric distribution for a given site or property. To illustrate this, say a property has five species of plants but 80 percent of the property is comprised of just two of those species. This lack of plant diversity will have a direct effect on the wildlife diversity for this property.

Plant communities are determined by many environmental factors including some that cannot be directly influenced by forest landowners. These include geographic location, soil region, soil type, historical seed bank, and climate. Other factors like soil fertility and active management of vegetation can be readily influenced by managers. Managing for vegetation diversity can be broadly conceptualized into two dimensions: horizontal and vertical.

HORIZONTAL DIVERSITY

Horizontal diversity relates to the change in the plant community across the landscape, particularly at ground level. Horizontal diversity is important as you consider where and how to manage for different plant communities on a property. A common approach on forested lands is to create a matrix of plant communities that include different ages and types of stands, openings, and edges. What specific

vegetation the matrix is comprised of and how it is implemented on a given property is guided by the forest-management plan along with several environmental factors such as soil type, topography, historical land use, and physical infrastructure.

A mix of different ages and types of stands typically provides greater diversity of resources for wildlife. Making sure there is variability in successional stages in adjacent stands is a good general recommendation for most wildlife species. However, this approach does not work for wildlife species that require large, unfragmented forests.

Using openings like agricultural fields or loading decks increases horizontal diversity. The increased sunlight in these openings stimulates herbaceous vegetation growth, providing excellent food and cover sources for many wildlife species. These openings can simultaneously serve as hunting areas and be planted in perennial wildlife food plots that can be reclaimed for loading decks for future harvest operations. Several small, irregularly shaped openings throughout the property create more edge (a transitional area between one type of plant community and another) for wildlife as compared to one large opening.

Increased edge around openings equals greater plant diversity and, as a result, greater wildlife diversity. This concept is called *edge effect*. Edges are important to wildlife because they provide access to multiple types of plant communities in a small area. For example, the edge of a mature hardwood stand and an abandoned agricultural field provides both food and cover for white-tailed deer. The hardwood stand provides hard and soft mast, while the field offers forages such as broadleaf weeds, vines, and other types of soft mast. The field provides bedding cover in the form of grasses, and the hardwood edge provides thick escape cover near food resources.

Feathered edges are more desirable between two plant communities than a definite or abrupt boundary, such as a fence with an agricultural field on one side and a pine plantation on the other side. A feathered edge provides an area in between these two plant communities that could be managed for early-succession plant communities that are valuable to quail, rabbits, and many other species. Other transitional areas like streamside management zones, vegetated buffers, and roadsides can also be actively managed to provide edge and serve as travel corridors within the matrix on a given property. This is particularly important for large clear cuts and agricultural fields as these vast expanses impede movement of some wildlife species. Strip disking and prescribed fire are common ways to create and maintain a feathered edge.

VERTICAL DIVERSITY

Vertical diversity relates to the presence—or absence—of different layers in the forest canopy. Mature hardwood forests typically have good vertical diversity because they have an understory, a mid-story, and an upper canopy layer of vegetation. This is particularly important for many types of birds and improves accessibility for tree-dwelling mammals like eastern gray squirrels.

Vertical diversity can sometimes be a limiting factor for wildlife in mature pine plantations that are actively managed. Placement, size, and shape of these plantations, along with implementing openings and edge, may help mitigate this factor during the later stages of pine production.

Understanding these basic ecological concepts will help you plan for and manage plant communities more effectively for wildlife.

Wildlife Habitat Management for Selected Key Species

WHITE-TAILED DEER

White-tailed deer are present in all soil regions of Mississippi (Figure 10.3). Their widespread range can be accredited to their overall adaptability, but it is their ability to use a vast array of plants, hard and soft mast, and other food resources from various types of ecosystems that makes them the ideal habitat generalist.

Feeding Habits

Deer require 13–16 percent crude protein in their diet for optimum growth and antler development. Food plants for deer can be classified as preferred, staple, and delicacy. Preferred foods are those that are high in either protein or energy. Staple foods are those that offer basic nutrition but have relatively less protein and energy. They are maintenance foods that prevent starvation until the preferred foods become available again. While you want to provide as much preferred food plant material as possible, also make sure staple foods are present in adequate amounts at the right time of year. Delicacies are just that: highly prized and sought-after food items that are often seasonal and not broadly available.

Figure 10.3. White-tailed deer.

Preferred foods for spring and summer have a relatively high protein content and high digestibility. Broadleaf weeds such as common ragweed (Figure 10.4) and other herbaceous plants are preferred because of their high protein content and palatability. Some of the nonnative invasive plants like kudzu, Japanese honeysuckle, and Chinese privet hedge are also preferred. 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 for this purpose by deer in the Mississippi Delta region.

Staple foods include native vines and twigs of shrubs and trees including blackberry, dewberry, greenbrier (smilax species), poison ivy, trumpet creeper, American beautyberry (French mulberry), and yellow jasmine. Japanese honeysuckle and Chinese privet hedge also serve as staple foods in many areas of Mississippi.

Figure 10.4. Common ragweed frequently contains crude protein levels in excess of 20 percent and flourishes on disturbed soil sites during the summer months. Photo by John D. Byrd, Mississippi State University, Bugwood.org; used with permission from University Press of Mississippi.

Delicacies are also important to deer and to deer hunters. The native persimmon is highly preferred, along with honey locust pods, muscadine grapes and other native vines, crab-apples, and other seasonal fruits. Deer also readily consume mushrooms. To learn more about deer forages, see MSU Extension Publication 3618 *A Guide to Common Native Deer Forages in Mississippi and the Southeast*.

Deer also make use of the forage and crop residues available in adjoining agricultural fields. In summer, they prefer soybeans and peanuts; in winter, wheat and ryegrass pastures. They also use grain residues such as those from corn and soybeans.

Wildlife food plots are valuable during the two annual stress periods and in the regions of the state with poor soil fertility. The two stress periods for deer in Mississippi are late summer and late winter. A supplemental food plot program should attempt to produce forages for deer during these stress periods. During the summer, legumes like cow peas and wildlife soybeans are preferred, as is alyceclover (a white clover). Cool-season plantings should include small grains such as oats and wheat. The addition of crimson, arrowleaf, or ladino white clovers is beneficial. In areas that have no significant hard mast production, deer can benefit from corn planted to provide a diet high in energy.

Active Vegetation Management

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.

When possible, pine forests should contain several different age classes and should be managed for a variety of ground covers of different ages. Many pine stands in Mississippi have dense mid-story layers of sweet gum and other shade-tolerant plant species. These trees compete with pines and reduce growth rates. They also shade out ground-level plants that provide deer browse and cover. 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 some wildlife species. Once old enough, pine stands should be burned on 3- to 5-year intervals with some burning done each year to

produce a matrix of horizontal diversity for forage production and bedding cover.

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. Manage streamside management zones with selective harvest practices to favor both hard and soft mast species.

When possible, use existing openings and edges like loading decks, roads, and utility rights-of-way to encourage native forages. If your land doesn't currently have these openings, selective timber harvest can provide new openings for white-tailed deer use.

While cool-season food plots are relatively easy to grow, high-quality warm-season plantings require more effort and skill. Soil pH is more important, and both pre- 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 MSU Extension office for assistance. Another valuable source for information on planting wildlife food plots is MSU Extension Publication 2111 *Supplemental Wildlife Food Planting Manual for the Southeast*.

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 their numbers exceed the land's ability to support a healthy population. Because habitat conditions and deer productivity vary so greatly, recommended harvest rates are often site-specific. A qualified deer-management professional can help design a harvest-management plan. The Mississippi Department of Wildlife, Fisheries, and Parks (www.mdwfp.com), MSU Extension, and USDA Natural Resource Conservation Service have professional wildlife biologists who can provide guidance on deer management. Private wildlife and forestry consultants are also available across the state.

For more information about deer management, refer to MSU's Deer Lab at www.msudeer.msstate.edu.

EASTERN WILD TURKEY

Thanks to a concentrated effort by landowners, conservation professionals, and support from the public, wild turkeys (Figure 10.5) are present across much of Mississippi. Like deer, this is a dramatic turnaround from a century ago when turkey populations were decimated by subsistence and market hunting. Although turkeys and deer share a lot of habitat requirements, they differ in their reliance on well-managed open areas for foraging and edges for brooding cover. Although smaller in size than deer, they often sustain larger home range sizes throughout the year to meet their annual needs.

Figure 10.5. Eastern wild turkey adult males and female. Photo by Steve Gulledge; used with permission from University Press of Mississippi.

Feeding Habits

The wild turkey's diet changes throughout the year to meet its physiological needs. As poults, they will spend nearly 90 percent of their day for the first 2 weeks consuming protein mainly from insects to fuel body development. With adequate bugging areas, the hen and her brood will stay within a couple of acres; this highlights the importance of proximity of these areas to nesting and escape cover.

After the first month, the poult's diet becomes like that of an adult turkey, consisting primarily of plant materials including huckleberry, blackberry, dewberry, grape, smilax, poison ivy, dogwood, American beautyberry fruits, and a variety of seed-producing grasses, legumes, and forbs. In the fall, turkey seek hardwood stands for hard and soft mast like acorns and several species of grapes, smilax, and even poison ivy berries.

In regions where acorns are 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 access to large numbers of insects. Wild turkeys also make use of agricultural fields to forage for a variety of crop residues, germinating weeds, grasses, and insects.

Active Vegetation Management

Turkeys spend a lot of time in and near openings like old fields and logging decks. Forest landowners who want to manage for turkeys should have a good open-area management program in place. Using a variety of techniques, such as strip disking and prescribed fire or planting food plots to provide several early-successional areas from 1 to 3 years old, is critical for brooding. Strip disking, prescribed fire, and select herbicide treatments to create feathered edges along these openings provide essential escape cover and bugging areas.

Pine stands that have been thinned to a basal area of 70 square feet per acre and burned often can offer good brooding and foraging areas. While prescribed burning produces valuable new growth at ground level, it should not be so extensively practiced that all good nesting and escape cover is eliminated from a property in the same season. Annual burns will gradually convert the ground-level vegetation to grasses and will eliminate many broadleaf weeds, vines, and shrub components. A balanced prescribed burning program in pine forests should include a 3-year rotation, creating a matrix of burned and not burned areas across the property annually. Turkeys will often forage in the recent burn areas, so protect plum and switch cane thickets in these areas to provide escape and low-roosting cover.

Manage hardwoods to provide good supplies of hard and soft mast from trees and associated vegetation like native vines and shrubs. You can accomplish this through selective thinning to create uneven forest structure, encouraging regeneration of mast-producing species like oak, pecan, and others. This process also provides variation of cover and partial openings throughout the forest, providing both horizontal and vertical diversity within the stand. Hardwood streamside management zones are critical for protecting waterways, but they also provide essential travel corridors, escape cover, and roosting trees for turkeys in agricultural and forest lands across the state.

Managing perennial clover food plots with a combination of clipping and herbicide applications can provide turkeys with year-round openings. Many of the warm- and cool-season food plot mixes used for deer are also beneficial for turkeys.

Harvest rates for wild turkeys also vary widely because of differences in population levels across the state. Long-term harvest rates of one to two adult gobblers per square mile will serve as a guide for most regions of Mississippi, but, as with deer, forest landowners are strongly encouraged to consult with professional wildlife biologists to determine property-specific recommendations.

For more information on wild turkey management, see MSU Extension Publication 3406 *Wild Turkey Ecology and Management for Mississippi and the Southeastern U.S.*

BOBWHITE QUAIL

Quail numbers have declined by 70 percent since the 1970s. While several factors, including predators, parasites, fire ants, and pesticides, have been blamed for the declines, the most significant cause is large-scale land use change resulting in the loss of widespread early-successional plant communities. Modern farming and forestry practices focused on maximizing yields have led to less-diverse landscapes. Urbanization has also contributed to this change as more housing and infrastructure in rural landscapes has occupied and fragmented the landscape. In addition, management practices like prescribed fire are restricted because of safety and liability concerns.

Although the future of bobwhite quail and their management face many challenges, forest landowners are in a unique position to be part of the solution by integrating more quail-friendly practices into their forest management.

Feeding Habits

Chicks primarily consume insects and other invertebrates for optimal growth and development. After 6 weeks, a chick's diet will be similar to that of adult quail, which primarily consume insects, native grass seeds, legumes, forbs, small berries, and other plant material.

Active Vegetation Management

Ideal quail habitat depends on early-succession areas that provide bare ground, native clump grasses, woody cover, seeds, and insects. Like turkeys, nesting, brood-rearing, and escape cover are essential for survival and often the limiting factor of quail being present on the landscape. Cover requirements for quail are like those for wild turkeys: adequate cover provides protection from the elements and predators yet needs to be open on the ground to allow these small birds to travel by foot. Traditional pastures, grasses,

rank stands of unmanaged vegetation, or densely planted pine plantations are not suitable for quail.

Pine stands should be managed with frequent fire and thinned (at 13–18 years, depending on the site) to at least a basal area of 70 square feet per acre to maintain an open canopy and stimulate growth of early-successional plants and forbs. Lower basal areas of 20 to 30 square feet per acre are ideal if quail management is a higher priority than timber production. Rotational soil disturbances such as strip disking and prescribed fire will produce bare ground and stimulate annual plant communities (Figure 10.6).

Figure 10.6. A well-managed pine stand for northern bobwhite quail with quality ground cover. Photo by Richard G. Hamrick, Mississippi Department of Wildlife, Fisheries, and Parks; used with permission from University Press of Mississippi.

Creating numerous openings managed for native grasses and forbs or food plots near thick woody cover, such as plum thickets and overgrown fencerows, provides ideal cover and food plants while increasing horizontal diversity in a forested landscape. Maintaining feathered edges along the perimeter of these openings is also recommended. Food plots containing a wide variety of crops such as grain sorghum, corn, other small grains, and clovers are beneficial to quail.

Given the status of the regional population of bobwhite quail, conservative harvest is strongly encouraged. Harvest rates must be determined from fall covey counts. In general, harvesting less than 20 percent of the fall population is a good rule of thumb; however, landowners are strongly encouraged to consult with professional wildlife biologists to determine property-specific recommendations.

For more information on bobwhite quail management, see MSU Extension Publication 2179 *Ecology and Management of the Northern Bobwhite*.

SMALL GAME ANIMALS

Small game animal populations vary greatly with habitat quality. Squirrels depend more on mid- to late-succession forests of hardwood and mixed pine-hardwood stands, while rabbits are most abundant in early-succession plant communities but can be found in both pine and hardwood stands with managed openings.

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, tupelo gum, dogwood berries, and several woody vine berries. Hard mast includes pine and cypress seeds, acorns, hickory nuts, and pecans.

Hardwood management practices that keep stands and streamside management zones healthy, vertically diverse, and actively growing are ideal for squirrels. Oaks and other mast-bearing trees generally produce greater mast crops when their crowns are full and they are not overcrowded.

For more information on squirrel management, see MSU Extension Publication 2466 *Ecology and Management of Squirrels in Mississippi*.

Rabbits

Early-successional plant communities with an interspersed shrub layer provide excellent food and escape cover for rabbits. Routine site disturbances such as timber sales, strip disking, and prescribed fire applied in an alternating matrix are good for rabbits.

For more information on rabbit management, see MSU Extension Publication 2467 *Ecology and Management of Rabbits in Mississippi*

Natural Resource Enterprises

Mississippi's abundance of natural resources and strong cultural traditions involving outdoor recreation provide excellent economic opportunities for landowners and their local communities. As discussed earlier, there are many types of enterprises that forest landowners could consider in addition to their forestry operations. Because wildlife management and traditional timber operations are compatible, the most logical choice of these enterprises is wildlife-related outdoor recreation.

Hunting and fishing are the prominent wildlife-related activities in Mississippi, generating $1.2 billion and $690 million, respectively, in economic impact. The most common way forest landowners engage in this economic activity is by offering hunting and fishing leases on their properties.

Commonly, hunting leases grant exclusive hunting rights to clients for a fee on an annual (dollar amount per acre) or daily basis (rate determined by experience and service provided). Fishing opportunities are often included in annual hunting leases. However, fishing leases can be offered separately through annual memberships that provide water access and other amenities. As is the case with specific wildlife-management recommendations, leasing rates and fees are site- and enterprise-specific based on available resources, market demands, and the landowner's forest-management and enterprise goals.

Regardless of the type of wildlife-related enterprise you are interested in, the business planning process starts with the forest- and wildlife-management plan. The goals and objectives of this plan will guide all decisions regarding resource management, as discussed in Chapter 1. Other essential information that provides context to the goals includes property maps, resource and infrastructure inventories, and proposed management activities and timelines.

Before going any further in the business-planning process, take time to conduct a personal and family evaluation. Some key questions to ask yourself and family members include:

- Do we have the time to manage this enterprise?
- Are we truly comfortable with non-family members recreating on our land?
- What are the legal and financial risks associated with this type of enterprise?

After honestly answering these questions, you may realize that starting a natural resource enterprise is not in your land's or family's best interest.

If you decide to move forward, the business planning can begin with exploring the ins and outs of your proposed enterprise and its compatibility with the property. These are important questions to consider:

- Does the property have the necessary natural resources for a fee-hunting operation?
- How will this affect the long-term timber-management goals?
- Will we need to make compromises on forest-management goals to accommodate the needs of the wildlife-related enterprise?

Evaluating the market for the proposed enterprise is critical to the success of the potential business. Answer these questions:

- Is there a demand for this type of enterprise? If so, how much?
- Who would be my customers?
- What rate or price point could I charge for these services and experiences?

To find answers to these and other questions, attend seminars and workshops on enterprise development, subscribe to trade journals, join trade associations, and research the websites of similar enterprises for pertinent information. Also, visiting similar enterprises to see how they operate, what services they offer, and who their client base is can give you valuable insight into the planning process.

Once you have this information, begin to formulate your formal business plan for the natural resource enterprise. The core elements of this document are the enterprise goals and objectives, physical resources inventory, marketing plan, organizational structure, operational plan, budget, and legal and liability considerations. For a more detailed description of each of these elements and the entire process, please refer to the conservation planning chapter in *Fish and Wildlife Management: A Handbook for Mississippi Landowners* (see the References section of this chapter).

There is a lot of information to synthesize, process, and consider when entertaining the idea of starting a natural resource enterprise on your property. Don't let that deter you from investigating the potential opportunities that natural resources can provide for you and your family—like adding another financial "egg" to the basket to maintain ownership of the land for future generations, and funding conservation practices that benefit you, your community, and wildlife.

For more information and educational opportunities, please visit MSU's Natural Resource Enterprises program at www.naturalresources.msstate.edu. This program was created to help private non-industrial landowners with natural resource enterprise development through workshops, trainings, and research.

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Taxes and the Family Forest

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Revised from earlier work by **Debbie Gaddis**, *former Associate Extension Professor*

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 forestland 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 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 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 to many people. Establishing a basic knowledge of forestry taxation principles will allow you to determine what applies to your situation. It will also enable you to make sure your tax professional is up-to-date with federal taxation rules for forestland ownership and management. Some basic principles are discussed in this chapter to help you get started.

Selecting Ownership Structure

Forest landowners may structure their forestland in several ways to satisfy the Internal Revenue Service. These general structures are based on profit motive, level of activity, and some level of self-determination. The basic ownership structures are personal use or hobby, investment, and business including the 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, and keeping the land in the family; they may use their land for private home sites. Beginning in 2018, the IRS doesn't allow you to deduct hobby expenses from hobby income; you must claim all hobby income and cannot reduce that income by any expenses. Expenses in other years are not deductible. Timber sales generally qualify for capital gains treatment.

INVESTOR

Investors manage timber for a long-term profit. They 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 may be deducted if they classify as holding costs. Development costs must be capitalized. See Operating Expenses below for more detail.

Investors taking the standard deduction must capitalize both development and holding costs. If they elect to expense holding costs, they no longer qualify for the standard deduction. 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. However, as of 2018, investors must either elect the standard deduction or claim the casualty loss as itemized deductions on form A (line 15 for regular casualties, line 16 for federally declared disasters).

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 comingling personal and business funds; and selecting 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.

FARMER

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 that 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.

Selecting an Operating Structure

Selecting the correct structure for owning and managing forestland is important. The IRS identifies the structure by how deductions are taken and income is reported. Detailed information on the various structures is available at www.timbertax.org.

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 is helpful. 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 for future owners. A well-kept, detailed tree farm journal can provide insight, especially for heirs who have not been involved with the forest and land management. One way to help future owners is to include a section in the journal listing 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, and hunting leaseholders.

To be an investor or business, you must establish a profit motive, and records allow you to see if your expenses are reasonable given the revenues you expect to generate from your property.

While the IRS has no specific recordkeeping format requirements, IRS Form T (Timber), Forest Activities Schedule, is required if you claim a timber-depletion deduction, sell cut products in a business (under Section 631(a)), or sell outright business timber. However, it is not required if you only have occasional timber sales (one or two sales every 3 or 4 years). 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 it 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 deple-

tion (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. If Martin is an investor, he must capitalize these expenses as of the 2017 Tax Cut and Jobs Act. As a business, he has the option to capitalize but may elect to expense this as a development cost. For this example, let's assume he designated as a business. 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: 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. There is a special stepped up basis rule for surviving spouses.
- 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 fees. 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 per acre basis in land. He will have no basis in timber as Fern did not purchase timber and did not invest 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 at www.irs.gov.

Timber Sales and Capital Gains

Income 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 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 but do qualify to elect to amortize qualified expenditures.

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 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 $286, 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 $286 deducted in the eighth year.

Operating Expenses

The ordinary and necessary expenses of forest management may be deducted for forest landowners with a profit motive. Forest management expenses are broken into two categories: holding costs and development costs. Holding costs include annual property taxes, mortgage interest, insurance premiums, and similar costs. Development costs are costs related to developing real property. These can

include but are not limited to noncommercial thinning, timber stand improvements, prescribed burning, travel and training expenses, and other ordinary and necessary expenses for managing a forest investment or business/farm. This applies to investor, business, and farm categories.

Investors must capitalize these expenses as of 2018. Business owners deduct them as business expenses. Both timber businesses and farmers typically deduct these as either business or farm expenses but are allowed to capitalize if desired.

Operating expenses must be reasonable and necessary and have a profit-related motive to be deducted. Judging such expenses by industry standards can help you 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.

Beginning in 2018, the IRS doesn't allow you to deduct hobby expenses from hobby income; you must claim all hobby income and cannot reduce that income by any expenses.

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 that clearly illustrates the casualty loss deduction.

Timber and Taxation

As this chapter indicates, timber taxation can be quite complicated. The materials presented here have been simplified 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 National Timber Tax Website, www.timbertax.org. The IRS website has many publications on topics of interest to forest landowners.

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Forest Health

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Protecting our forests is a continuing challenge. Damage to forests can come from wind, water (drought or prolonged standing water), ice, lightning, fire, invasive species (such as kudzu and cogongrass), diseases, and insects. These threats not only cause mortality to individual trees and sometimes entire stands, but also reduce growth and vigor, lowering economic returns.

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

- Match your site with the appropriate tree species. A registered forester can help with species/site selections.
- Alter stand density to ensure the trees are growing vigorously.
- 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. However, it is important to be aware that new exotic species may be introduced into forests and severely impact their health. The agents that are damaging to 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 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. The stumps have had sufficient time to harden off and are not attractive to the weevil adults. This is the recommended approach to prevent damaging losses to seedlings from reproductive weevils.

If logging occurs during the summer months with planting the following February to March, there is a medium hazard for weevil activity. In this situation, seedlings should be treated with a recommended insecticide to prevent the weevils from killing them.

Logging during the fall and winter followed by an immediate planting results in the 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 top dip, root dip, granular, or spray insecticide, 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 tall. They also prefer the fastest growing trees. The effect of the feeding is a reduction in height and increment growth. Severe infestations also stunt 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 using insecticides that are timed with each generation. It is generally accepted that the first generation is the largest and most damaging generation. Therefore, if an insecticide is going to be used, it should be timed to impact the first generation and then to reduce subsequent generations. In Mississippi, there may be three to four spray periods (generations). Monitoring flight periods with pheromone traps can help you time 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 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. It is important to understand the bark beetle/host interaction and the elements needed to promote a vigorous and healthy forest.

The southern pine beetle is an 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.

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. There are three Ips species that can kill pines.

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 like the southern pine beetle. They attack individual trees throughout a stand, in fencerows, along highways, in medians, and in 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.

In addition to the basic prevention guidelines outlined above, follow these preventive silviculture guidelines:

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

Direct control of bark beetles involves salvage, cut-and-leave, or pile-and-burn. Chemical treatments are limited because, to treat standing trees, the treatment has to extend to the first live limbs, which requires specialized equipment. In addition, the availability of compounds may be limited because of environmental restrictions.

Numerous insects can be seen feeding on pines, but they are seldom of serious concern. Forestry commission employees, Extension specialists and county agents, or consulting foresters can help identify them. Websites such as www.bugwood.org and www.forestpests.org also provide useful information.

EMERALD ASH BORER

The emerald ash borer (EAB) is a new insect pest to Southern forests. It has not been documented in Mississippi yet, but it has been observed in four neighboring states: Arkansas, Louisiana, Tennessee, and Alabama. The EAB is an extremely destructive forest pest, capable of wiping out entire stands of native ash trees.

EAB identification is done by direct sighting of the insects. The EAB adult is a peg-shaped beetle with a tapered, dull-pointed rear and blunt head. They are about three-eighths to one-half inch long and a little less than one-eighth inch wide. The most distinctive characteristic of EAB is its metallic green color. It should be noted, however, that many insects have a similar metallic green appearance, and some EAB are shades of red or blue. One distinguishing characteristic of EAB is its bright purple abdomen (beneath the wings), which is visible when the beetle is in flight.

Currently, there are no effective treatments for timber stands infested with EAB. Salvage of the infested timber is difficult in stands where ash make up a minority of the cover.

REDBAY AMBROSIA BEETLE

The redbay ambrosia beetle is another recently introduced exotic insect that has devastating impacts on native

trees in the laurel family, including redbay, swamp bay, and sassafras. The insect bores into the sapwood and inoculates the tree with a fungus that causes laurel wilt disease. It is this fungal disease that kills the trees.

Redbay ambrosia beetles were first found in the southern Atlantic Coast and have been moving west and north. Evidence of these insects has been documented in the southern half of Mississippi.

There are no tested treatment options for control of the insect or the associated fungal disease. Additionally, it is important that wood or debris from infected trees not be moved off-site because there is a high probability that the pest will be carried with it.

INSECTS THAT AFFECT HARDWOODS

Periodically, vast acreages of hardwood forests are defoliated. This defoliation results in reduced tree growth and 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, timely application of a biocide or insecticide can control the cottonwood leaf beetle. Other defoliators, such as oak worms, can also defoliate vast acreages of oaks. While broad-scale defoliation can happen, it rarely does.

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 the insects make under the bark. 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. Once harvested, these trees must 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 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 pines 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 because oak trees serve as the primary source of inoculum for fusiform rust. Early evaluation and strategically timed actions are necessary for successfully managing established stands with high levels of fusiform rust. Management strategies include avoiding movement of rust-infected stock from the nursery, using resistant seeds or seedlings, and, if practical, reducing 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. Brown spot disease reduces tree vigor, slowing height growth and resulting in 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. Herbicides, along with scalping, produce ideal planting beds for longleaf and often result in a shorter grass stage. Prescribed burns reduce competing vegetation and destroy fungal spores and diseased tissues.

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 germination. 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 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, planted seedlings, and 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 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 inoculum present in the stand.

Removing severely weakened trees will also reduce 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 can move from endemic to epidemic status in only a few years, so it is important to regularly monitor your forests and respond quickly if you see symptoms of this disease.

HARDWOOD DISEASES/PATHOGENS

Rots in hardwood stands are extremely concerning 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 disease if the right conditions exist, but many cause only minor damage. Forestry commission employees, Extension specialists and county Extension agents, or consulting foresters can help identify them. Websites such as www.bugwood.org and www.forestpests.org also provide useful information.

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