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SILVICULTURAL GUIDELINES FOR FOREST OWNERS IN GEORGIA

PREPARED BY
Georgia Chapter,
Society of American
Foresters

RESEARCH DIVISION
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SILVICULTURAL GUIDELINES

FOR

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INTRODUCTION

By
E. V. Brender[1]

The Georgia Chapter of the Society of American Foresters established a committee to develop silvicultural guidelines for nonindustrial forests so that landowners could become aware of various methods that can be used for regenerating and tending Georgia forests. It is realized that not all forest landowners are solely interested in wood production. Many have different objectives, such as game management, recreation and aesthetics, conservation of an inheritance, or just plain love of the woods and nature lore. Most of these objectives are not in conflict with growing usable wood products. In fact, all of the demands made upon a forest can be met with good forest management practices. A well-managed forest can enhance the aesthetics, improve recreation and game habitat, conserve soil, water, and environmental values, and still grow sawtimber and pulpwood. A mosaic of stand conditions from seedlings to saplings to pulpwood and sawtimber, growing a variety of tree species adapted to different sites, and manipulation of stand densities will accomplish varied owner objectives while still growing wood products.

Georgia, with a land area of 37.4 million acres, is the largest state east of the Mississippi River. Two-thirds of the State is classified as commercial forest land capable of growing diversified forest products, such as sawtimber, veneer stock, poles, pulpwood, naval stores, and miscellaneous products, including wood as a source of energy. The economy of the State is closely tied to the raw material that comes from its forests. The value of forest products sold on the stump is estimated at $275 million annually. Timber based industries employ some 62,000 people and generate an annual payroll of $500 million. About 60 percent of the standing wood volume consists of pine species and 40 percent is made up of miscellaneous hardwoods. However, over three-fourths of the volume harvested is pine, and less than one-fourth is hardwoods.

Georgia has the largest acreage of privately owned forests of any state in the nation. The nonindustrial private landowner controls three-fourths of the commercial forest acreage and has for years supplied the bulk of wood for industry. This steady supply of raw materials can be credited in part to natural and artificial regeneration of abandoned agricultural lands during the last 50 years. Each year some of these old-field pine stands grew into merchantable products of either pulpwood or sawtimber. Some partially cut stands also reseeded to pine and some abandoned fields were planted to pine, especially during the Soil Bank Program. All of this contributed to the yearly supply of roundwood products for industry.

With the recent cessation of farmland abandonment, new forests are no longer being added, in fact, forest acreage in the State of Georgia is shrinking. Between 1961 and 1972 nearly a million acres of forest was converted to pasture and cropland, mostly in the Coastal Plain; and 600,000 acres were diverted to urban and industrial expansion, highways, and utility rights-of-way. In addition, it is estimated that if present cutting practices continue, over one-half of existing pine forests will convert from pine to mixed pine-hardwoods, and to low-value hardwoods.

Opportunities for growing forest products are excellent. By the use of good silvicultural practices one could double the growth of merchantable wood products. During the 10-year period 1962-1972 more wood was grown than was cut. However, this trend cannot be expected to continue. Demand for wood products steadily increases, and forest acreage continues to shrink. Our forest will become less productive unless better silvicultural practices are employed to keep the land stocked with desirable trees. If the forest-based economy in Georgia is to remain healthy, planned efforts must be made to keep forest land restocked with desirable tree species.

Georgia contains a number of geographic regions (fig. 1). They differ in topography, elevation, soil type, and climate. In consequence, different tree species and forest types, understory shrubs, vines, herbs, and grasses are encountered in these regions. Silvicultural methods of managing the woods also differ by forest types. Three broad geographic regions, where the forestry problems are similar, will be recognized and discussed in these guidelines: the Mountains, the Piedmont, and the Coastal Plain. No fast line delineates the boundaries of these areas. Distribution of native coniferous species could be used to approximate the boundaries, though some species occur in more

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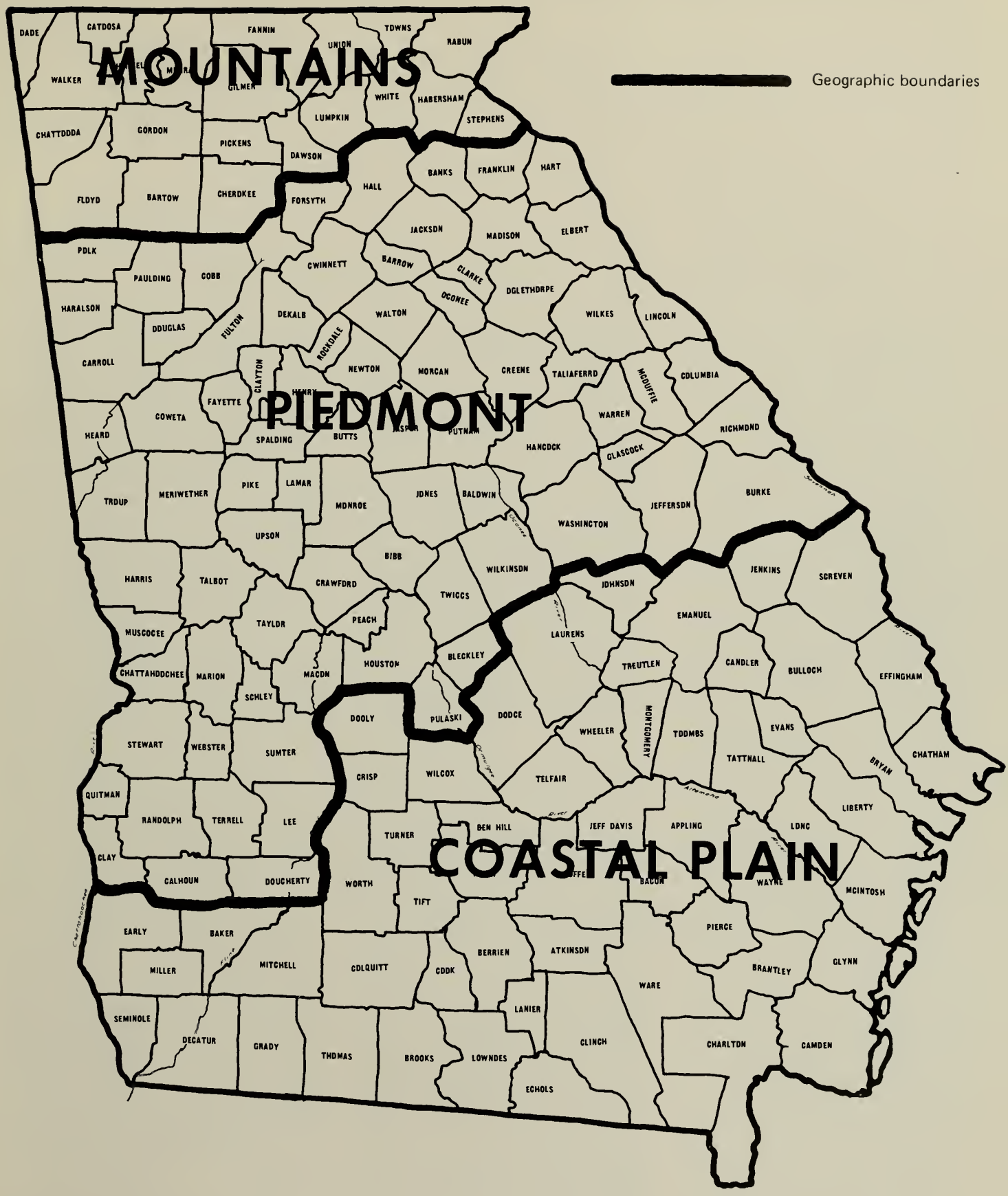

Figure 1. Broad geographic areas.

than one province. Table 1 indicates the distribution of pine types as of 1972 in the three broadly defined regions. It shows that white pine, pitch pine, and Virginia pine occur mostly in the mountains. Loblolly and shortleaf pines are most prevalent in the Piedmont. Slash and longleaf pines are the principal species in the Coastal Plain.

For the State, as a whole, the pine and hardwood acreages are about the same. But in the mountains the hardwood types cover twice as much area as do the pine types, and in the Coastal Plain the pine type exceeds the hardwood type by about 10 percent (table 2). The hardwood types are distributed over the entire State, with the exception of the oak-gum-cypress type which does not occur in the mountains.

The guidelines will be geared to the forest type rather than the geographic region. However, it must be remembered that the same forest type may present different problems in other areas. Associated tree species, shrubs, and logging terrain may differ and dictate different silvicultural practices. This applies also within a region where differences in topography, soil type, and site quality account for different stand conditions.

Table 1.--Distribution of pine types by geographic regions.

Pine Type	Mountains	Piedmont	Coastal Plain	Total
	Thousand Acres			
Loblolly	377.9	4025.3	611.7	5014.9
Slash	---	468.0	4059.6	4527.6
Shortleaf	287.0	955.1	38.8	1280.9
Longleaf	6.4	75.6	738.6	820.6
Virginia	325.0	52.7	---	377.7
Pond, Spruce & Sand	---	16.5	215.2	231.7
White, Pitch	44.4	---	---	44.4
Red Cedar	4.8	16.8	5.7	27.3
Total	1045.5	5610.0	5669.6	12325.1

Table 2.--Distribution of hardwood types by geographic regions.

Hardwood Type	Mountains	Piedmont	Coastal Plain	Total
	Thousand Acres			
Oak-pine	619.2	2003.8	1519.9	4142.9
Oak-hickory	1459.7	2317.1	928.3	4705.1
Southern scrub oak	23.2	244.3	198.2	465.7
Oak-gum-cypress	---	399.4	140.1	539.5
Elm-ash-cottonwood	44.9	746.5	1869.3	2660.7
Total	2147.0	5711.1	4655.8	12513.9

THE COASTAL PLAIN PROVINCE

By

W. H. McComb[1]

The Coastal Plain of Georgia, located in the southern half of the State, includes all of Georgia lying south of an imaginary line connecting the cities of Augusta, Macon, and Columbus. This area comprises about 40 percent of the total area of the State. It is flat in the southeast, gradually increasing in elevation and becoming undulating toward the north and northwest, reaching an elevation of 600 feet at the fall line. The Coastal Plain may be subdivided into the upper and lower Coastal Plain.

The economically most important forest types in the Coastal Plain are longleaf, slash, and loblolly pines, and pure and mixed species of bottomland hardwoods. The species in these types also occur in combination with each other.

The evolvement of these types is a product of the total environment, the most important factors of which are past land use, climate, topography, and soils.

Average annual rainfall in the Coastal Plain ranges from 46 inches in the northwest and central portion to as high as 54 inches in the extreme southwest corner. Frost-free days average 255 annually.

History and Land Use

During the decade prior to World War II, owners were rather apathetic toward their pine forests because of poor markets, low prices and wildfires. Turpentining was about the only woods operation that paid off. Longleaf and slash pine of all sizes were destructively cupped for naval stores. Fire was used indiscriminately to aid movement through the woods, to provide grazing for open range cattle, to kill boll weevils, and in some cases purely because it was the custom. Only a small portion of the counties in the state were under organized fire protection.

With the coming of the war, naval stores operations were intensified and heavy cutting was started to provide lumber and other wood products. As a result, much of the longleaf-slash pine forest became severely understocked and grew at a low level by the end of the war. Stocking on the average woodland holding was so low that meaningful returns from intensified management efforts did not appear possible within reasonable time limits. More than 56 percent of the land area in the Coastal Plain was classified as forest land but farming and allied interests were the major lines of activity. With renewed interest because of better markets and rising prices for wood products, organized fire protection spread county by county until a majority of the counties had this program.

Successful fire protection enabled landowners to initiate productive forest management practices. The preaching and practicing of fire exclusion in many cases was taken to the extreme and no-fire policies over prolonged periods had their deleterious effect. Even today, Georgia has one of the highest incidence of wildfires of any state in the nation. The "era" of fire exclusion resulted in wildfires that were uncontrollable due to the heavy buildup of litter and the occurrence of extreme periodic droughts. The lessons learned from these disastrous occurrences brought about the use of fire as a practical forest management tool.

The control of wildfires and prescribed burning caused low fire tolerant slash pine to literally "come out of the swamp", gradually replacing the fire and drought resistant but competitively intolerant longleaf. There has been a reduction in the longleaf pine forest in its entire range—an estimated 60 million acres in Colonial times to less than 10 million acres today. Slash pine occurs in pure stands or mixed slash-longleaf stands. Some longleaf stands have been perpetuated through the use of prescribed fire.

Longleaf pine's relatively poor survival from transplanted nursery stock has markedly limited its occurrence in plantations.

Loblolly pine occurs as scattered trees mixed with longleaf and/or slash pine, and bottomland hardwoods occur throughout the Coastal Plain. Loblolly occurs in pure stands in a relatively narrow strip along the coast and Alabama border. Although this species grows well here, it is usually less favored than longleaf or slash due to its inability to produce commercial naval stores products.

Topography and Soils

The upper Coastal Plain is characterized principally by well-drained surface soils, usually more or less sandy. The lower Coastal Plain or "flatwoods" are characterized by clay loams, sand, and sandy loams. Low elevations, seldom more than 25 feet above sea level, result in extremely poor soil drainage.

The clay loams (Bladen) are exceptionally poorly drained and often times have an inch of water on their surface. The sandy soils (Leon) are more favorably drained in the surface horizons but have high water tables.

On shallow soils, heavy thinnings, and particularly seed tree regeneration cuttings may be disasterous, resulting in considerable windthrow. Sub-soiling hardpan areas is suggested. Seed trees should be removed soon after the new crop is established in order to minimize the risk of windthrow.

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SLASH PINE

By

Earle P. Jones, Jr.[1]

Slash pine has historically been a favorite with timber growers in south Georgia. It grows in pure stands and mixed with longleaf and/or loblolly pines. Along with longleaf pine, it gives the owner the opportunity for additional income from naval stores as well as having value for posts, pulpwood, poles, sawtimber, and veneer logs.

Slash pine by itself is not a climax type. On most sites where it occurs there is a natural tendency for the type to change to oak-pine or oak-hickory, which are climax types. In today's market, slash pine is more valuable, so forest management strategies are usually designed to maintain it and prevent the encroachment by, and eventual conversion to, the oaks and hickories. When slash and longleaf pines are growing together, fire tends to favor the domination of the site by longleaf pine, because of that tree's unique fire resistance. Given adequate fire protection, slash pine will expand in acreage and take over some former longleaf pine sites.

Slash pine is one of the most widely planted of the southern pines, and some plantations date back to about 1925. It was widely used for planting during the Soil Bank Program (1956-1960). Slash pine is especially desirable for planting on old fields where it is not unusual for it to average 3 feet per year in height growth for the first 10 years. The ease by which slash pine is planted, in comparison with longleaf, makes it the best choice in areas where naval stores give an additional return for the plantation.

Planted stands offer four general advantages: (1) a new stand can be quickly established, (2) the desired number of trees per acre and distribution of stocking are easily accomplished, (3) genetically improved stock can be used, and (4) plantations are more efficient to operate and schedule for year-to-year management routines. The chief disadvantages are the cost outlay for planting and, if needed, the sometimes sizable cost for site preparation.

There are also advantages to natural stand management for slash pine: (1) there is little cost directly associated with stand establishment, (2) natural stand management may be more dollar efficient, depending on how well nature does the stand establishment job, (3) site disturbance is minimized and this may be important in critical watershed areas. The chief disadvantages of natural stand management are: (1) delayed or extended stand establishment, (2) irregular stocking with too many or too few trees, (3) a rather wide range of tree sizes, (4) less opportunity for genetic improvement, and (5) costly precommercial thinnings are required in many cases.

Silvical Characteristics

Slash pine is moderately tolerant, meaning that it does not grow well under partial shade but grows best in full sunlight. It is therefore best managed in even-aged stands where all the trees are about the same size and all share about equally in the sunlight, especially during the juvenile years.

Slash pines grow best on moist, well-drained sites, but it does not do well in standing water or on very deep sands. Perhaps the best sites are the edges of drains and ponds where moisture is plentiful but flooding is rare. Sites that have good surface drainage, but slow internal drainage, indicative of a shallow clay pan, usually are good slash pine sites. On deep sand sites, longleaf or sand pines are better suited than slash pine.

HARVEST CUTTING AND REGENERATION

Rotation length, the time span from establishment to final harvest of a stand, is flexible for slash pine in either natural or planted stands. Slash pine cubic-foot volume growth rate culminates between 20 and 30 years of age so stands usually should be carried to at least 25 or 30 years. Better sites reach peak volume production earlier than poor sites, and more trees per acre can be carried on better sites. Slash pine stands will continue to grow well until age 40 or 50 years, if crowns are maintained in at least a codominant position. Rotation length is usually decided by owner objectives and existing stand conditions. Usually, a 25 to 30-year rotation is used if pulpwood is the only product intended, and up to 50 years for sawtimber and veneer log production.

Yield estimates, in board feet, cords, or cubic feet, vary with stand age, site index, and density of stocking. Volumes also are different between planted and natural stands. Consult a forester for information about the amount of wood volume present in a particular stand, or the future volume growth that may be expected.

The final removal cut of a stand, the harvest cut, dictates how the stand will be regenerated. In a strict sense of forest management, the harvest cut, sometimes called the regeneration cut, is the last of a series of planned operations.

Natural regeneration is the least expensive way to establish a slash pine stand. The species usually starts

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producing seed by age 20. Some seed are produced every year, but good seed crops come about three years apart. Natural seedling establishment may be adequate without any site preparation, even in unmanaged stands, but it is usually advisable to at least burn under a stand to be regenerated. This will expose more of the mineral soil on which the seed will germinate, and it will reduce competition against the seedlings during the first year or two. Scarification from logging will further improve germination by exposing more soil.

Clearcutting with Seedlings in Place

On some lightly stocked areas to be clearcut, there rarely may be enough natural regeneration to form the new stand. Although the history of the site may not be known, this is the fortuitous result of conditions similar to those described below for seed tree and shelterwood cuttings. The young "volunteer" stand should be carefully examined after clearcutting to be sure there are enough well-distributed trees surviving logging damage.

Seed Tree Cutting

This method requires 6 to 10 good quality trees per acre be left for seed producers. They should be well spaced over the area to insure adequate seed distribution. About 90 percent of slash pine seed fall within 150 feet of the parent tree. The seed trees should be harvested 3 to 5 years later, after the new stand is established; if left in place indefinitely, they may cause over-dense stocking because of additional seed fall. There may be a problem in getting a logger to remove the few seed trees left, but a reduced stumpage rate may be negotiated.

Shelterwood Cutting

Slash pine can be successfully regenerated under a shelterwood cutting system in which an initial harvest is made leaving 25 to 40 trees per acre of the best trees. With proper site preparation treatment, sufficient young trees will become established in 3 to 5 years and shelterwood trees can be removed at a later cut.

Clearcutting with Planting

Planting is the preferred method for establishing slash pine if an intensive management program is being followed. This has the advantage of getting the site into production as quickly as possible with reasonable assurance of the desired level and distribution of stocking. One-year-old seedlings may be purchased from the Georgia Forestry Commission or from some other source. All of the slash pine seedlings now sold by the Georgia Forestry Commission are called "improved seedlings", having been grown from seed collected in a seed orchard where parent trees have certain desirable characteristics. Chief among these characteristics to date is high resistance to attack by fusiform rust disease, and better than average growth, form, and gum yields.

Planting should be during the dormant season, from November 1 to March 15, at a time when the soil is not too dry. Most planting now is done with tree planting machines. Spacing may be selected to suit the management objectives, e.g., 6 x 10 feet to 10 x 10 feet. At least 10 feet between rows is desirable, to allow enough space for equipment operation. A survival rate of about 75 percent can usually be expected if seedlings have been properly cared for and planted, and soil moisture and weather conditions after planting are not adverse. A satisfactory stand may be 400 to 700 stems per acre surviving at the end of the first growing season.

Slash pine should not be interplanted, even only one year later. Research has shown that in a slash pine planting as sparse as 200 trees per acre, doubling the number of stems by interplanting alternate rows one year later added less than 10 percent to the volume at age 25. Similar results can be expected for underplanting in natural stands. Low plantation survival should not be too hastily condemned. Judgment should be made according to projected volume production. For example, 300 trees per acre on an average old-field site at age 20 will produce 80 percent of the cubic-foot volume that will be produced by 600 trees per acre. In this case, 50 percent of the intended survival will yield 80 percent of the anticipated cubic-foot production.

Seedlings may be hand planted with a dibble and one man working alone can probably plant about 100 spots per hour. Consult a forester for proper dibble planting procedures. Hand planting may be used to fill in areas not accessible by machine planting, such as areas near drains where the soil may be too wet for tractor operation.

Direct Seeding

Slash pine can be successfully regenerated by direct seeding. Aerial seeding is a quick way to regenerate large areas, and specially designed agricultural-type equipment can be used on small areas. Slash pine seed preferably should be covered 1/4-inch deep in mineral soil, and the bed pressed after planting, but this is not practical in the broadcast methods. In south Georgia, December through March is the best time to direct seed slash pine. Only treated seed should be used, to protect them from birds, rodents, and fungi. Treated seed can be purchased or they may be treated by the landowner. Sites to be direct seeded should be prepared by burning as a minimum treatment, and additional preparation may be needed, according to the method of seeding to be used. The landowner should consult a professional forester for details concerning the advisability and techniques for direct seeding. There are several methods which may be used.

Broadcast seeding—Treated seed are scattered by a hand-operated seeder as the operator walks over the area, or they may be broadcast from a seeder mounted on a tractor or harrow. Seedling distribution will be at random, similar to a naturally seeded stand.

Spot seeding—Small spots about 2 feet in diameter are prepared by raking away the debris to expose the mineral soil, and 6 to 8 treated seed are dropped in place and covered with a little soil. Spots are located in a pattern to obtain the desired distribution of seedlings.

Row seeding—Tractor-drawn row seeders, similar to corn planters, are available. Treated seed are planted or "drilled" in rows over the area. The site may be prepared before seeding, or some machines have attached equipment that prepares a small seed

bed ahead of the seed drop. An advantage of row seeding is that seedling distribution can be aligned in one direction, leaving access space between rows.

Site Preparation

Site preparation for natural or artificial regeneration is not always necessary, but some degree of it is usually desirable. Site preparation may accomplish one or more improvements: (1) eliminate or reduce competition, (2) improve soil tilth, (3) improve surface or internal drainage, (4) incorporate organic matter into mineral soil, (5) provide early fire protection, and (6) make tree planting easier.

Burning—Burning is usually the cheapest form of site preparation. Successful seedling establishment in natural or planted stands depends on controlling the competing vegetation. Burning is the minimum treatment that will accomplish this. Burning for natural regeneration is best done before the harvest cut, and logging scarification provides additional preparation for the seed to reach mineral soil. Old fields to be planted should be burned. Cutover areas to be planted may require a 12 to 18 months delay before burning to allow fuel to cure and accumulate, but the delay is worthwhile to get a good burn, despite the loss of a growing season.

Harrowing—If competing vegetation is very light, or logging residue is scattered, disc harrowing may be satisfactory site preparation. Conventional farm equipment may be used on small areas to be treated. More difficult areas may require heavier equipment such as a tandem offset harrow.

Chopping—Heavy rough can be effectively treated by chopping. It has the advantage of disturbing the soil the least of all mechanical site preparation methods. Chopping equipment usually is not available to non-industrial private forest landowners, but the work is available from site preparation contractors.

Bedding—The chief reason for bedding is to elevate the rooting zone above the surface water in poorly drained areas, thus permitting planting in areas that would otherwise be too wet for pine regeneration. Initial survival and early growth are improved, but the long-term benefit of bedding in comparison with other site treatments of poorly-drained sites has not yet been fully researched. Bedding gives good control of row width during the planting operation, and it provides benefits, to some degree, of just about every form of site preparation: vegetation control, improved soil tilth, a deeper topsoil, a smooth planting surface for machine planting and the resulting better control of planting depth. Although high beds (12 inches) settle down in time, the undulating effects caused by bedding on a site may cause some problems during cultural or cutting operations later.

Ditching—Ditches may be used to improve drainage in order to convert a wet area for pine regeneration. Costs are likely to be very high if ditching is to be charged only to the forestry program. Consult a professional forestry or soil conservation technician for advice if ditching is being considered. Industrial operations often incorporate ditching and road systems in order to improve the site and accessibility.

CULTURAL OPERATIONS

Cultural practices are those activities carried on during the life or rotation of a timber stand to enhance its growth and development, or to effect some change necessary to meet the management objectives. A number of practices are recognized as being desirable in the proper management of natural and planted slash pine stands.

Prescribed Burning

Prescribed fire during the rotation may be used to accomplish several objectives: (1) reduce the amount of forest fuel thereby protecting the stand from damaging wildfire, (2) restrict development of unwanted understory species, (3) improve wildlife habitat, (4) control some diseases, (5) improve woods grazing, and (6) improve visibility for operational and aesthetic reasons.

Prescribed burns can usually be made in a slash pine stand by the time it averages 15 to 18 feet tall, which may be at age 7 to 10 years. After the initial burn when the trees are tall enough, additional burns may be at 5-year intervals, although 2- or 3-year intervals are more desirable where rough re-grows rapidly. Per-acre costs are less for the more frequent burns.

Burns cannot be made in stands being worked for naval stores or where worked-out faces are still present. Burns should be scheduled before cutting operations rather than afterwards when the residual logging debris makes it too dangerous to burn for 3 to 5 years following. Prescribed fire inhibits the development of fusiform rust by reducing the amount of oak leaf surface, which is the alternate development site for the rust disease. Prescribed fire will also kill back any low growing pine branches on which the rust may be growing thereby preventing it from growing into the more valuable stem of the tree. Prescribed fire "fireproofs" the stand by reducing fuel accumulation and lessens the risk of damaging wildfires.

Hardwood Control

Since slash pine is a subclimax species, there is a natural tendency for the climax hardwoods to encroach and occupy the site. Hardwood control has been recommended in the regeneration stage, to keep hardwoods from shading out young slash pine trees. It is advisable to maintain control over the hardwoods throughout the rotation, and this will reduce the need for major site treatment at the time for regeneration. Prescribed fire is the cheapest way to control unwanted hardwoods, and it is most effective as repeat summer burns. Chemical herbicides can often be used as a spray applied by hand-operated or mechanized equipment. Aerial applications should not be used on small tracts. Herbicides may be applied to individual stems by means of tree injectors, or as pellets scattered on the ground beneath the trees to be killed. In any case, the selected herbicide must be approved by the Environmental Protection Agency for the type of use, and it must be applied under the supervision of a certified operator.

Precommercial Thinning

As the name implies, precommercial thinning means to thin the stand before the trees have commercial

value. Very dense stands of slash pine may have become established by natural seed fall or by better than expected success with direct seeding. Stocking density of more than 1,000 stems per acre is too much for best growth of usable wood products. Such stands should be thinned to about 500 to 750 trees per acre as early as possible, preferably before age 5. The thinning work is less costly and more effective if it is done early, when small equipment can be used such as a rotary mower or heavy harrow. Optimum growth may be achieved by cutting all but the best of the young trees, but practicality usually dictates mowing out swaths 8 to 12 feet wide and leaving strips of trees 2 to 8 feet wide. Averages from a study near Cordele, Georgia, showed that approximately 20,000 slash pine stems at age 3 resulted in 5,800 stems and only 1.5 cords per acre at age 17; a comparative area thinned to 450 stems at age 3 had 17 cords per acre at age 17.

Cultivation

Cultivating young planted slash pines may be an attractive option on some small forest ownerships. Harrowing or even mowing between planted rows 1 or 2 times per growing season reduces competition from weeds and helps conserve soil moisture for tree use. These advantages usually result in increased tree growth. This practice is perhaps not useful beyond the fourth or fifth year. Cultivation also affords better fire protection to the young plantation.

INTERMEDIATE CUTTING

Thinning will not significantly increase total wood yields for short rotations (20 to 25 years) if pulpwood is the only intended product. However, for longer rotations and especially for sawtimber, thinning should be included in the management scheme to maintain good stand growth and vigor, and to concentrate growth on the best trees for the final harvest.

If thinnings are to be used in slash pine, it is important that they be started early, while the trees still have the capacity to add green crown surface and thereby respond with improved stand growth. A commercial thinning can usually be made by age 20; of course, the trees to be cut must be large enough to sell.

The density to leave after thinning cannot be standardized because it depends on several factors which include: present age and stocking, condition of the stand, frequency of thinnings, final product, available markets, and accessibility. Thinning requirements for a particular stand can best be resolved after examination by a forester. In general, residual density for slash pine may range from 70 to 100 square feet of basal area per acre, or 200 to 500 trees per acre. Better sites will support more growing stock, and if frequent thinnings are to be made (e.g., at 5-year intervals), basal area of 80 to 100 square feet may be left. If only one thinning is to be made, even on a good site, 70 square feet of basal area may be better. A rule of thumb for thinning is to leave a distance in feet between trees equal to 1.75 times the tree diameter in inches. On the average, this will leave 77 square feet of basal area per acre.

Increased use of specialized logging equipment, designed for moving larger quantities of wood, may dictate the kind of thinning that can be done, especially on small acreages. Small landowners may want to look around or make special negotiations to get a good thinning job that provides sivicultural benefits to the residual stand.

Selection Thinning

Each merchantable-size tree in the stand is inspected and individuals are selected for removal regardless of size. The chief criteria for selection are quality and spacing of the residual stand. Fusiform rust on the stem is a common reason for selecting a tree to be removed. In addition, large trees are often taken because of poor form, or excessive crown, and small trees are taken because they are being overtopped by the larger ones. Some commercial pulpwood producers and loggers are not geared to do a good selective thinning job. They may not get all of the marked wood, an they may do excessive damage to the residual stand.

Row Thinning

This is quite effective in plantations, especially for the first thinning and if the initial spacing was close. It has the advantage of opening up a stand for growing space and equipment accessibility, with a minimum investment in marking and administration of the thinning. It is more effective if the uncut rows are also selectively thinned. Row thinning patterns vary, depending upon the intensity of thinning immediately needed and future thinning plans. As examples, every other row will remove one-half the stocking; and every fourth row will take one-fourth the stocking now and a second thinning can remove the middle row in each of the residual three rows. A disadvantage of row thinning is that if the cut rows include submerchantable-size trees, they will be wasted; but recent developments in total tree utilization may eliminate this kind of waste.

INJURIOUS AGENTS

Fusiform rust is the worst disease threatening slash pine. Besides extensive mortality, it also causes costly degrade in high value products such as poles, sawtimber, and veneer. There is no practical cure, although prescribed fire and pruning may help reduce the incidence of the disease. The severity of rust in planted slash pine increases in a northwesterly direction across the Coastal Plain of Georgia, therefore, current practice of some forest managers is to not plant slash pine outside the lower Coastal Plain. The rust is judged less severe in natural stands than in plantations, and this is partly due to the higher densities and greater competition among natural seedlings which causes early mortality of the diseased trees. Genetically improved nursery seedlings provide for more rust resistance in recent plantations. Annosus root rot inflicts severe mortality in some slash pine plantations. Prevention methods include thinning only during the summer and borax applications on freshly cut stumps.

The most serious insect threats to slash pine are: the southern pine beetle, the black turpentine beetle, and the engraver bark beetles. Generally, they are all associated with unhealthy stand conditions such as

mechanical damage, lightning strikes, widlfire, drought, crowding, and dead and dying trees. There are several other diseases and insects that may affect slash pine stands in local situations. Consult a forester for advice about any disease and insect conditions, and ask for his recommendations for remedies to specific problems.

LONGLEAF PINE

By

W. H. McComb

Range and Silvical Characteristics

Longleaf pine occurs commercially in the Coastal Plain from southeastern Virginia to the Florida Everglades and west to eastern Texas. There are occasional trees found in Georgia as far north as Rome.

Longleaf pine is probably the most difficult of the southern yellow pines to regenerate naturally. The time required to get adequate reproduction due to infrequent seed crops and the grass stage delay, makes it an undesirable species for many forest owners.

Longleaf's two unique characteristics are its grass stage and its resistance to fire. These are prime factors related to its survival and growth. There is no height growth during the grass stage which starts the first year after germination and usually lasts between four and five years, but may last up to twenty years. During this period, the roots continue to grow and get a firm foothold. If competing species, hardwood or pine, are present, they will dominate the site and longleaf will not regain dominance unless released early and allowed to grow freely. Though vulnerable to fire their first year or two, seedlings develop a large relatively insulated terminal bud. A groundline diameter of 0.3 inches may be considered as the size at which grass stage seedlings become resistant to fire. After seedlings begin height growth, they are susceptible again to fire until about three feet in height when light fire will do little damage.

HARVEST CUT AND REGENERATION

Clearcutting Method

Advance reproduction is usually scarce and would be destroyed in a heavy cut. Longleaf seed are not stored in the duff, so they must come from adjacent longleaf pine stands. Unfortunately, longleaf seed have a short dispersal range. Four requirements for success with the clearcutting method are: (1) areas to be regenerated must be within 100 feet of a seed source; (2) there must be a good seed crop on the adjacent timber; (3) seedbed condition must be favorable, and (4) predator pressure must be low. In good seed years, clear-cutting in groups or as progressive strips may meet these requirements. In poor seed years, success is doubtful for brush will invade rapidly and corrective measures will be expensive.

Seed-Tree Method

By seed-tree method all mature trees on the area are removed, except five to ten of the better, well-distributed seed bearers per acre. A good seedbed must be prepared shortly before a good seed fall to insure a chance for success. Use of this method is risky unless a bumper seed crop is present at time of cut and the seedbed is ideal.

Shelterwood Method

The shelterwood method is usually more successful and more practical than the seed-tree method. To aid in regeneration, periodic prescribed burning toward the end of the rotation will reduce vegetative competition, and light thinnings from below will insure good crown development of the seed trees.

The shelterwood method employs two or three cuts. In the three-cut method, a preparatory cut is made to remove trees not suited as seed trees. This cut is then followed in about five years by a seed tree cut that removes all trees not needed for seed production. The final, third cut removes the seed tree overstory after the seedling stand is well established. The two-cut method is similar except that the preparatory and seed cuts are combined.

The Preparatory and Seed Tree Cut—The preparatory cut is essentially a thinning from below leaving the larger trees of good quality. Optimum residual density after the preparatory cut ranges from 60 square feet basal area on poor sites to 70 square feet on better sites.

The seed tree release cut is designed to stimulate seed production. By reducing the density of the overstory, logging damage to seedlings during the removal cut is minimized. Trees selected to be left should be, if possible, above average in height, form, and volume, and should be fruitful as evidenced by the cones on the ground under them. The trees should be at least 30 years of age, and 10 inches d.b.h. or larger. The stand should be reduced to a basal area of approximately 25 square feet per acre. Basal area more or less than this

amount results in a reduction of maximum seed production.

Several years may elapse between the seed cut and establishment of adequate regeneration. Reduced stand density permits vigorous growth of hardwoods which must be kept under control by timely burning under carefully controlled conditions.

Monitoring the Seed Crop—After the seed tree cut, forecasts of seed crops should be made for the purpose of timing seedbed preparation. The amount of seed necessary to insure a new stand depends on many factors. Under fairly good conditions, a seed crop of 50,000 seed per acre may be considered a good crop. This is estimated by counting the cones on sample trees and multiplying this by the number of seed per cone; the latter usually averages 50 seed per cone in good seed years.

Seedbed Preparation—Seedbed preparation must be carefully timed. It is usually ineffective if done more than one year in advance of seed fall, because litter and grass accumulate and hinder germination. Seedbeds are prepared by burning, mechanical means or a combination of both. No treatment is almost surely to result in complete failure.

Burns should be done in the winter or fall preceding seed fall. Survival and growth are usually better from fall burns, but damage to seed trees is ordinary less and loss of seed to predators is less in winter burns. A combination of burning and mechanical treatment usually results in increased establishment over either of these treatments alone.

Seedling Protection—Until the trees reach the sapling stage, hogs and sheep must be excluded. Cattle grazing, if permitted at all, should be at low rates of stocking. Fires should be kept out after seedlings are established until the reproduction is released in the removal cut.

The Final Removal Cut—The removal cut is made one or two years after adequate and well-distributed reproduction is established. The level of seedling stocking should be determined by annual inventories with full allowance made for probable mortality.

A criterion of success is at least 500 well-distributed seedlings per acre, at heights of 3 feet or more for better resistance to fire. There should be 6,000 to 7,000 well-distributed seedlings per acre at time of seed tree removal so as to provide for the 500 crop trees per acre. Stocking requirements vary widely according to conditions and locality. These recommendations are a general guide allowing for loss from brownspot, damage from logging, prescribed burns, predators, and other unforeseen causes. Care should be taken in the removal cut to avoid damage to seedlings, and to avoid skidding under extremely wet conditions. Density of the seed tree overstory should not exceed 40 square feet basal area per acre at time of final cut. Heavier overstories should be removed in two cuts, spread at least two years apart, to avoid logging damage to seedlings.

After Harvest Treatment—The most important consideration after the overstory has been removed is seedling height growth. Height growth may be delayed by brush competition or brownspot. The only practical means of controlling brownspot in natural stands is by prescribed burning. If there is much logging slash, burning should be delayed for about two years after the removal cut. Brownspot does not, as a rule, become severe during this period. Degree of infection and possible damage to the stand should be determined. If crop seedlings are less than 20 percent infected, burning should be postponed. If infection is more than 20 percent on crop seedlings and estimated damage to the seedlings would be light, a prescribed burn should be made in the dormant season. With favorable weather conditions a headfire is very effective.

Chemical control of brush may be required. After seedlings are released and begin height growth, precommercial thinning is usually unnecessary because longleaf expresses dominance better than any of the southern pine.

Planting

The unreliable results from planting longleaf seedlings, especially in the eastern portion of its range, has rendered this method impractical on most large scale operations. Any degree of success requires special skills and techniques which should be attempted only by experienced foresters.

Direct Seeding

Almost complete control of hardwoods before or immediately after seeding is essential. Hardwoods often harbor large populations of rodents. Seed treated with predator-resistant chemicals must be used to insure any degree of successful planting. Treated seed should be obtained from a commercial seed source. Orders should be placed at least 6 months before seed are needed.

A light grass rough which develops 6 or 8 months after a burn usually provides the best seedbed. This gives the seed and young seedling protection against the drying effect of wind, sun and high temperatures. Seeding after fresh burns and disking are also successful but usually suffer more losses from bird predators.

Site Preparation

Prescribed Burning—When soil moisture is not critical autumn burns may be very satisfactory and necessary when wet weather has prevented spring burns. Scheduling fall burns for seedbed preparation is unwise because if weather conditions prevent burning at this time, a year will be lost before the next sowing season. A more reliable schedule is to burn in April or May and reserve fall burning for special contingencies.

Disking—On dry sites, disking usually improves survival by eliminating competition for soil moisture. Thorough disking on good sites will promote seedling growth if brownspot is not severe. The best procedure is to burn in winter prior to seeding, followed by two diskings in the summer, the first being done in the hottest, driest time followed by another disking in strips eight feet wide with rows eight feet apart. If flooding is likely, elevating the soil in the rows and seeding on them may prevent flooding. Disking which exposes mineral soil may cause increased brownspot infection and should be avoided on high hazard brownspot areas.

Rate and Season of Sowing

The amount of seed to sow should be about three pounds of dewinged, untreated seed per acre. If sown in disked strips, one and one-half pounds per gross acre is recommended. Seeds should be sown in

November or early December after maximum daily temperatures drop below 80°F and soil moisture is sufficient to sustain germination. Seed may be sown in early spring on disked sites, but summer droughts make this practice extremely risky. In the northern portion of the longleaf belt, especially on the heavier soils, winter damage to seed and seedlings may occur. In such situations seeding should be delayed until late February.

Methods of Seeding

Broadcast seeding with a hand operated "Cyclone" seeder requires walking one-half mile per acre, sowing about ten acres per day. Exposure of personnel to dust from the repellant coating restricts hand seeders to small jobs or to operations in which anthraquinone is the only repellant.

Tractor mounted "Cyclone" seeders can cover three to four times the area covered by walking. Some machines have been developed to meter out seed at regular intervals while firming the soil. These machines are most successful on disked areas. On flatwood sites, it is necessary to elevate the rows.

Another method of seeding is by aircraft. A conventional agricultural plane flying at 90 mph at an altitude of 80 to 100 feet will sow a strip approximately 66 feet wide. An efficient operation will sow about 1,500 acres per day.

Initial Stocking and First Year Survival

An estimate of stocking should be made in the spring after sowing and at the end of the first growing season to determine the degree of success of regeneration. A very rough estimate for initial stocking from broadcast seeding in the spring following seeding should give no less than 2,500 well-distributed seedlings per acre on burned sites, and no less than 2,000 seedlings per acre on disked sites, and about 2,000 and 1,600 seedlings respectively after the first year's growing season. Spring inventories provide knowledge of losses primarily from lack of germination and predators; whereas, end of summer inventories show additional losses primarily from drought.

NAVAL STORES PRACTICES

Depending upon stand conditions, markets and owners' objectives, the following practices should be used when installing virgin cups:

Selective Cupping—The object of this practice is to fit naval stores operations into timber production by cupping those trees which are scheduled for cutting five years hence. This provides for leaving a stand of the best trees that will yield the highest possible returns from both gum and wood production. This practice should be followed throughout the rotation.

Restricted Cupping—Cup only previously worked trees. This permits your round timber to grow into larger and more profitable trees before being cupped. Use this practice when recupping sparse stands. Leave your round trees to grow before being worked.

Diameter Cupping—Cup only trees which measure at breast height 9 inches or larger, or 10 inches or larger, or 11 inches or larger, or 12 inches or larger. The larger the minimum diameter limit the better the practice.

Back faces should be installed only on trees at least 14 inches d.b.h. leaving at least a four-inch bark strip between faces. Bark hacks, acid, double-headed nails, and spiral gutter or Varn aprons should be used in gum production.

CULTURAL PRACTICES

Prescribed Burning

Prescribed burning is a good forest management tool, but is extremely hazardous and should be performed only by experienced personnel. Prescribed burning is burning the woods under prescribed conditions for a specific purpose.

The most important factors in prescribed burning are climate, fuel and terrain, and their relation to each other. Preferred conditions for winter burning in the Coastal Plain are to burn 24-48 hours after a cold front has passed through, followed by a mass of cold air bringing one-half inch or more of rain. Winds from the northwest or southwest at two to seven miles per hour, humidity of 30 - 50 percent, temperatures of 20° - 50°, and fuel moisture of litter of 5 - 10 percent. Headfires, backfire and flank fires are used with various burning techniques depending upon conditions prevailing, time of year, and results desired.

Smoke management—Prescribed burning, however useful, can contribute to air pollution, but prescribed fire reduces air pollution from wildfire. Precaution must be taken to minimize adverse effects of fire on the environment.

Weeding

Loblolly, slash and shortleaf pines growing in association with longleaf pine may get an early start in regeneration and their removal in the seedling and sapling stage by fire or cutting may be necessary to eliminate them and to maintain longleaf pine as part of the stand.

Some hardwood trees of no commercial value, except possibly for fuel wood, must be controlled for the benefit of longleaf pine; examples are: blackjack, bluejack, post, southern red, and turkey oak. These trees are difficult to control and those less than ten inches in diameter, sprout profusely when cut. Control may be obtained by one or a combination of the following treatments: chemical treatment by foliage spray, stem spray, girdling, stem injection, cutting and stump spraying, and fire. Heavy power-driven equipment with shearing and pushing blades or brush choppers can also be employed.

Precommercial Thinning

Longleaf pine expresses dominance more readily than the other southern pines. The development of longleaf, therefore, suffers less than that of other southern pines in dense unthinned stands. Natural thinning is usually sufficient in the seedling and sapling stages, except perhaps when wide spacing is desired for naval stores production.

Pruning

It is much more economical to grow trees in fully stocked stands so they will naturally prune themselves. This is particularly true of longleaf and slash pine as they are the best of the southern pines for natural

pruning. The purpose of pruning trees is to improve the quality of wood by removing limbs in the lower portion of the crown, thereby insuring future clear, knot-free wood.

Only selected crop trees should be chosen for pruning. Pruning should be performed with saws and/or shears. Axes should not be used as they cause unavoidable damage to the trees. Pruning can be done at any season of the year except during extreme drought conditions occurring during the growing season. Limbs should be pruned even with the trunk, leaving no branch stubs. Limbs up to 2 1/2 inches can be pruned with a single cut. Larger limbs should be pruned with two cuts—an undercut and an overcut. Caution must be taken not to remove too much of the crown as this would reduce the rate of growth of the trees. Very little growth is lost if the crown length is not reduced to less than one-third of the total tree height.

Probably the most economical and profitable method of pruning is a two-phase system. The first phase is to prune about eight feet of the bowl when the tree reaches four inches d.b.h.; the second phase follows several years later when an additional nine feet is pruned—a total of 17 feet or one log.

INTERMEDIATE CUTTING

Thinning

To determine whether or not a stand of longleaf pine should be thinned, various growth characteristics which indicate growth patterns should be observed. Individual tree crowns whose length comprises one-third or less of the total height of the tree indicates growth retardation. The use of an increment borer is an indisputable means of determining growth rates.

Optimum basal area stocking for longleaf pine stands on average sites should be about 70 square feet, increasing on better sites and decreasing on poorer ones. To maintain a well-developed stand, frequent thinnings at intervals of five to ten years should be started early.

Dense stands should be thinned from below because of the inferiority of suppressed trees. Enough dominant and codominant trees should be removed to maintain good crown ratios. Trees unmerchantable merely because they are small should be retained if they do not interfere with the crowns of crop trees. Even in dense stands, there are some wide-crowned trees that should be removed early, such as the rough stemmed dominants prevalent in old field stands.

Improvement Cuttings

Stand improvement cuttings should remove trees that encroach on better individuals. Wolf trees are easily recognized. These and others of low present or potential value should be cut early. Poorly formed or defective trees of valuable species may be cut to encourage the growth of well-formed and sound trees of a species in less active commercial demand. The potential development of trees and relative market values of their products must be considered by timber markers. Only in this way can species and stands receive the joint consideration necessary in stand improvement operations.

THE GEORGIA PIEDMONT

By

E. V. Brender

The Georgia Piedmont is a plateau worn down by erosion and dissected by numerous streams to form a rolling topography. Ridges between streams are narrow and irregular, fingering out from main divides in all directions to create all possible slope exposures. Upland slopes range from 2 percent to over 14 percent. Only about 8 percent of the land is classified as bottom land. The climate is highly favorable to tree growth, with over 200 frost-free days and an average rainfall of 48 inches per year.

Soils in the Georgia Piedmont originally were sandy-loams underlain by clay loams. The topsoil over a big portion of the land was 15 to 18 inches deep, extremely fertile and supported magnificent hardwoods. The virgin forest consisted principally of oaks and hickories; associated with it were yellow-poplar, basswood, black walnut, beech, sweet and black gum, and scattered shortleaf and loblolly pines.

This virgin forest was liquidated during a 50-year period as settlers advanced westward from the Savannah River to the Chattahoochee River. Then a 100-year period of cotton growing wore out the land through sheet and gully erosion. The topsoil washed into stream channels, clogging them and converting once well-drained bottoms into swamps. Much of the land became too poor to grow cotton and was abandoned from cultivation, especially when the boll-weevil hit in 1920.

These lands reverted again to forests. Light-seeded loblolly and shortleaf pines became established if a source of seed was nearby. Hardwoods slowly encroached upon the land in the absence of a pine seed source. These forests were not stable plant communities. Nature's trend is toward reestablishing the oak-hickory forest types. As established pine stands got older, hardwoods invaded on moist slopes underneath the pine canopy. These hardwoods became dominant when the pine was cut. Presently, approximately one-half of the Piedmont forest is in pine species and the other half in miscellaneous hardwoods (table 3).

Hardwoods are more demanding upon good soil structure and soil fertility than pines and do not grow well on these eroded sites. On one-fifth of the forest land, where some topsoil is left, quality hardwoods can still be grown with proper silvicultural practices. The remaining forest land is probably best suited for pine. Silvicultural practices

Table 3.--Forest types in the Piedmont of Georgia

Pine types		Hardwood types	
	Percent of forest land		
Loblolly	35.6	Oak-pine	17.7
Shortleaf	8.4	Oak-hickory	20.5
Slash	4.2	Scrub oak	2.2
Longleaf	.7	Oak-gum-cypress	3.5
Virginia	.5	Elm-ash-cottonwood	6.6
Cedar	.1		
Totals	49.5		50.5

geared to land capabilities can maintain and develop highly productive forests that will satisfy various demands and owner objectives.

This section of the report presents silvicultural guidelines for loblolly pine, shortleaf pine, and various types of upland and bottomland hardwoods in the Piedmont and Coastal Plain.

LOBLOLLY PINE

By

E. V. Brender

Pure stands of loblolly pine comprise 4 million acres in the Piedmont of Georgia. Loblolly pine is widely used for lumber, plywood, pulpwood, post and piling, and for production of particle board and fiber board. It also contributes to soil and water conservation, provides wildlife habitat and enhances recreational opportunities. It is a most versatile tree that grows under a variety of soil and topographic conditions.

Botanical Characteristics

An understanding of its botanical characteristics is essential for prescribing appropriate silvicultural methods of management. Loblolly pine produces a prolific amount of seed at irregular intervals. When seed bearing trees are released from crown competition seed production becomes more reliable and the amount of seed produced is increased three- to six-fold. Loblolly pine seed germinate readily on exposed mineral soil. Seedlings are fairly shade tolerant while young, but become less so as they get older. On dry aspects and ridge tops loblolly pine has a tendency to develop two-storied stands. Advanced reproduction responds well to release from the pine overstory. The species makes good juvenile height growth when free from overtopping hardwoods. Loblolly pine must be grown under mutual competition to form a well-shaped tree without excessive taper.

REGENERATION METHODS

Silvicultural practices which provide adequate stocking are the key to successful management of loblolly pine. Several regeneration methods are available for accomplishing this. Careful planning based upon your forest conditions and economic factors is required for deciding which of the following methods of harvest cutting and regeneration fit your needs:

1. Clearcutting with seed or seedlings in place.
2. Seed tree cutting.
3. Shelterwood cutting.
4. Selection cutting.
5. Clearcutting with planting or direct seeding.

Natural regeneration methods depend upon adequate seed supply, a receptive seed bed, adequate rainfall to get seedlings established, and control of competing vegetation.

Seed supply can be increased by release of seed trees. A receptive seed bed can be prepared by prescribed burning or mechanical soil scarification. Competing vegetation can be checked by scheduling prescribed burns prior to harvest cuts or by mechanical means, or a combination of burning and harrowing. Injection of chemicals, to kill hardwoods 4 inches d.b.h. and larger, may also have to be done in conjunction with burning.

Clearcutting with Seed or Seedlings in Place

This method often works on dry sites that support sawtimber-size stands of loblolly pine that regularly produce a lot of seed. Clearcutting is done after peak seedfall but prior to germination of loblolly pine seed (November through March). If logging cannot be completed by the end of March, it should be suspended until seedlings are firmly rooted and hardened off. Logging may be resumed in August with "seedlings in place". To reduce logging damage to seedlings, trees should be bucked up into log lengths and skidded over well planned skid trails to loading areas. This method of regeneration requires careful scheduling based on seed forecasts.

Seed Tree Cutting

This method is suited for even-aged regeneration of stands that contain adequate, well-distributed seed-bearing trees. Release of about 10 square feet basal area of cone-bearing seed trees should be done 3 to 5 years prior to the regeneration cut to stimulate seed production. It requires 6 to 12 seed trees per acre depending upon their size to make up 10 square feet of basal area.

Seed bed preparation should be coordinated with good seed crops. Hardwood and brush control must be done prior to seedfall, using prescribed fire, or mechanical control with heavy duty harrows, and injec-

tion with herbicides of hardwoods 4 inches d.b.h. and larger, or combinations of all three methods. When close to 1,000 well-distributed seedlings are established per acre the seed trees can be cut. Release of seedlings from overtopping hardwood sprouts may be needed a few years later, especially on moist sites.

Shelterwood Cutting

With shelterwood cutting, about 25 square feet basal area per acre are left to produce seed. Again, release of fruitful trees, at least 3 years before the regeneration cut, is recommended to stimulate seed production. This will assure a reliable supply of seed. Seedbed preparation as described for seed tree cutting must be done prior to seedfall. On dry aspects pine reproduction becomes readily established, on moist aspects reproduction may have to be released from hardwood sprouts. The pine overstory may be retained until the pine seedlings are 8 feet tall. The overstory retards the lush juvenile growth which is highly susceptible to infection by fusiform rust. When the shelterwood seed trees are cut care must be taken to prevent excessive damage to advance reproduction. Instead of tree-length logging, felled trees should be cut into log lengths and skidded by winch and cable to well-planned logging roads.

Selective Cutting

Loblolly pine stands sometimes have an uneven-aged stand structure, where seedlings, saplings, pulpwood, and small and large sawtimber-size trees are all represented. Such stands can be cut for sawtimber on a 6- to 8-year cutting cycle. The growth that accrues during the cutting cycle period is harvested. If a stand grew at an annual rate of 400 board feet per acre, 3,200 board feet could be harvested on an 8-year cutting cycle. Trees of objective size, plus trees of poor form and vigor are harvested; releasing smaller, vigorous trees for accelerated growth. Openings created by removal of a mature loblolly pine will reseed to pine, however, on moist sites the seedlings will need to be released from overtopping hardwoods.

Clearcutting with Planting

Because of its relatively low tolerance to shade, loblolly pine is ideally suited for artificial regeneration as even-aged plantations. For best results, the clearcut site should be free of most logging debris and competing vegetation.

After the site has been cleared of the logging debris, it may be planted or seeded. Often the site is further prepared, especially if machine planting is intended. About 900 seedlings per acre should be planted. Seedlings are 1-year-old, often genetically improved plants grown in tree nurseries. The average first-year survival of loblolly pine plantations planted with these seedlings is about 75 percent. Clearcutting with planting or direct seeding is the costliest method of reproducing a forest stand. This method is preferred when conditions of the stand are such that there is an inadequate seed source or where maximum stocking is needed immediately. This method is a must where forest land rehabilitation to loblolly pine is the objective.

CULTURAL OPERATIONS

Regardless of the silvicultural system of management used, timely cultural operations are essential to the success of regenerating and developing a productive forest. The intensity of cultural work depends upon the owner's objective, the lay of the land, and the previous care given the forest. If the owner wants full stocking of pine on every acre, he needs to practice a higher level of cultural work than what is needed if he is satisfied with marginal stocking. That area of his forest that lays on dry sites requires less intensive treatment than one on moist sites. And where a forest has been properly tended, less intensive treatments will perpetuate it than what is needed in a neglected forest. Cultural operations entail delayed dividends which, however, may double the yield in 20 years.

Prescribed Burning

Prescribed burning is an efficient and economic cultural practice on sites where competition from hardwoods is not a problem. Occasional winter burns for fuel reduction and a prescribed burn for seed bed preparation may be all that is needed. On such sites pine reproduction is usually too dense and will benefit from precommercial thinning.

On sites where understory hardwoods inhibit regeneration of pine, several successive burns may be needed to check the hardwoods. Growing season burns made before the carbohydrates are translocated into the rootstock reduce the vigor of sprouts, also kill back most hardwoods 2 inches d.b.h. and smaller, and even some 3- and 4-inch diameter trees.

Prescription burning is a highly technical job to be used only by those trained and experienced in its use. A detailed plan for fire and smoke control should be prepared stating the objectives to be accomplished, the fuel and weather conditions under which burning is to be done, location of fire breaks, and the firing method to be employed.

Release Cutting

Release cuts may be needed soon after stand establishment. They may involve release of 3- to 10-year-old pine seedlings and small saplings from over-topping hardwoods. Rate of height growth of pine seedlings following release may be doubled and rate of diameter growth quadrupled in 2 years. At these young stand ages, sufficient release should be applied to assure a stand of about 450 crop trees per acre.

Hardwood Control

Hardwoods over 4 inches d.b.h. are seldom killed by fire. Such trees in upland pine-hardwood stands are usually short-boled, limby, and fast tapering. Eliminating them from the stand favors pine establishment and growth.

Most hardwoods sprout when cut. This further interferes with pine culture. Application of certain chemicals will kill the hardwoods and prevent sprouting. Some species are more readily killed than others. Different chemicals and methods of application will kill different species. Growing-season treatments are more effective in killing trees than dormant-season applications.

Hardwood control with chemicals is also a highly technical job and assistance should be sought from people qualified in their use. Some of the methods available for the control of hardwoods are:

1. A limited amount of low-value hardwoods can be cut and used as fuel for energy production; this use may increase in the future.
2. Freshly cut stumps can be treated with herbicides to reduce sprouting.
3. Poor sprouting species can be deadened by ax-girdling. Standing dead trees provide a necessary habitat for cavity nesting birds and for some mammals.
4. Others may be killed with herbicide solutions poured into overlapping ax-frills.
5. Ammate crystals can be applied to stump notches or cups cut at base of trees.
6. Chemicals can be injected into tree stems using tree injectors or hypohatchets.
7. Soil sterilants can be applied broadcast or selectively.

Precommercial Thinning

On dry aspect sites excessive densities of loblolly pine seedlings and saplings can become established. On fertile sites individual trees will express dominance at an early age and self-thinning takes place at a satisfactory rate, but on average and lower sites self-thinning is slow and precommercial thinning will pay dividends.

A combination of mechanical thinning plus hand thinning is recommended. When loblolly pine saplings are 5 to 7 years old, cut lanes through the stand 7 to 8 feet wide, leaving strips of pine trees 3 feet wide; hand-thin the residual 3-foot strips to about 550 trees per acre. Such thinning has increased the merchantable volume 3- and 4-fold by the time stands reached 20 years of age.

INTERMEDIATE CUTTING

Intermediate cuttings are made in established stands until they reach the desired size. Most loblolly pine stands periodically need some attention if maximum growth and yield are to be obtained.

Commercial Thinning

The earliest time for commercial thinning in natural stands is at age 15 to 20 years. The degree of thinning is determined by owner objective and quality of the site. Moderate to heavy thinning is recommended where sawtimber or veneer bolts are the objectives; light thinning may be best where pulpwood is the end product. For good growth, on average sites, one should maintain about 80 square feet of basal area per acre. That means about 400 trees, averaging 6 inched d.b.h.; about 150 trees when they average 10 inches d.b.h.; and about 80 trees per acre when they average 13 inches d.b.h. With that kind of stocking one can, on average productive land, expect a mean annual yield of 1 cord or 400 boardfeet per acre at rotation ages 30 and 50 years respectively. There are other criteria to be considered such as the crown ratio of trees. A ratio of 40 percent for young trees and 33 percent for older trees is recommended. Thinning may have to be repeated at 5-year intervals to maintain these crown ratios.

Plantations present a different problem. Where rows are closer than 10 feet, some form of row thinning may be considered. One can cut one row out of three, or one row out of seven and do selective thinning in between the uncut rows. Thinning in plantations may invite the spread of the Annosus root rot. To minimize the danger of infection, thinnings should be scheduled for summer when high temperatures tend to kill the mycelia of the fungus. When cutting is done during cooler weather, treatment of stumps with borax or Pheniophora spores will minimize the spread of this root rot.

Improvement Cutting

Improvement cuttings are made to favor growth of the well-formed, healthy, and thrifty trees in the stand. It consists of cutting weed trees, trees that threaten to occupy too much room, and crooked, forked, and otherwise deformed trees. It includes salvage cutting of bad-risk trees, trees which have scars that extend more than one-half way around the circumference of trees. Salvage and sanitation cutting provide means of salvaging trees infested or killed by the southern pine beetle.

Some of these objectives are also accomplished in thinnings or while doing selective cutting at given intervals. However, where these operations are not carried out, improvement cuttings should be scheduled periodically.

SHORTLEAF PINE

By

Roger P. Belanger[1]

Shortleaf pine contributes significantly to the income of many forest landowners in Georgia. It is found throughout the Piedmont, occurs on a wide range of sites, and is a component of most old-field natural pine stands. The shortleaf type represents about 1 million acres of commercial forest land and one-fifth of the total pine volume in this region of the state. Approximately 80 percent of the type is in small non-industrial ownerships.

Silvical Characteristics

The growth and yield of shortleaf pine is closely related to depth of the surface soil and consistency of the subsoil. Growth is good on friable subsoils but poor on heavy clay subsoils. Soil and site conditions are important considerations in the selection and application of silvicultural systems suited for shortleaf pine. Several regeneration methods and intermediate practices can be used on sandy or loamy soils to establish new stands and maintain good tree growth. Silvicultural options are limited on heavy clay soils and hilly topography. These sites have a high erosion potential and require careful tending.

Loblolly pine occurs with shortleaf pine throughout the Piedmont of Georgia. Silvicultural practices should favor loblolly over shortleaf pine in most instances. Loblolly pine generally grows better, has a more expansive root system, is more resistant to insect attack, and is less susceptible to littleleaf disease than shortleaf pine.

Shortleaf pine does have the advantage of being highly resistant to fusiform rust. For this reason it is being hybridized with susceptible southern pines to develop quality trees that are highly resistant to rust infections.

The following recommendations are for stands in which shortleaf pine is the predominant species.

REGENERATION METHODS

Seed Tree Method

The seed tree method can be used to regenerate shortleaf pine stands that are well stocked with mature seed bearing trees and are growing on high quality sites. Seed trees should be 12 inches or more in diameter, well distributed over the area, and demonstrate seed producing ability. Between 10 and 15 shortleaf pine trees should be left per acre. Number of seed trees will vary depending on size of the trees, seedbed conditions, and distribution of seed bearing trees in the stand.

Moisture and sunlight are required for seed germination and seedling growth. Prescribed burning prior to harvesting is recommended to reduce heavy litter accumulations, brush, and small hardwoods. Disking to expose mineral soil and herbicide application to reduce competition from large hardwoods are recommended to aid regeneration after logging. Seed trees should be removed when seedlings are established and well distributed over the area.

The seed tree method should not be used to regenerate shortleaf pine on heavy clay soils. Conditions on these severe sites are unfavorable for germination and establishment of seedlings. There is also the possibility of losing shortleaf pine seed trees to windthrow. The root system of shortleaf pine is generally shallow on heavy clay soils.

Shelterwood Method

The shelterwood method can be used to regenerate shortleaf pine on both heavy and light textured soils. Stands are usually harvested by the two-cut method. The first cut removes all but 20-30 mature seed bearing trees per acre. Seed trees should be 10 inches or greater in diameter and well distributed over the area. Burning, disking, and herbicide application are recommended as means of preparing the seedbed and reducing competition from hardwoods. Choice of cultural treatments depends on amounts of litter and hardwoods in the stand.

Competition from the residual pine overstory will hamper the survival and growth of shortleaf seedlings. The removal cut, therefore, should be made as soon as reproduction is established and well distributed over the area. Shortleaf pine seedlings should respond to release by the second or third year. The shelterwood method is well suited for the natural regeneration of shortleaf pine.

Selection Method

Shortleaf pine stands can be regenerated using the selection method, mature timber being removed in small groups one-tenth to one-fourth acre in size. Herbicide application with tree injectors or mist blowers is recommended immediately after harvesting to reduce brush and hardwood competition in the openings. Broadcast burning and disking are not suited to the selection method because of the scattered distribution of the openings. The structure of the residual stands is many-aged. Results are aesthetically pleasing and suited for diverse wildlife

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populations. The selection method is recommended only where the landowner is willing to make a long-term commitment to intensive and skillful tending of the forest.

Clearcut and Plant

Loblolly pine is recommended for planting on pine sites in the Piedmont. Studies have repeatedly shown the growth, yield, and management options associated with loblolly pine are superior to those for shortleaf pine over a wide range of conditions. See chapter on loblolly pine for silvicultural guidelines.

CULTURAL OPERATIONS

Prescribed Burning

Burning is an effective, economical, and energy efficient method of preparing seedbeds and controlling hardwoods. Summer burns are recommended to kill brush and hardwoods. Winter burns are recommended to reduce heavy fuel and litter accumulations. Burning is not advisable on steep slopes or soils subject to erosion. Organic matter is necessary to stabilize and improve these problem sites.

Thinning

Thinning is recommended for young, overstocked shortleaf pine stands growing on good quality sites. Vigorous dominant and codominant trees are favored; slow growing and poor quality trees are cut. Thinning stimulates the growth of the residual trees and increases yield of merchantable products. Maintaining stand vigor also reduces the susceptibility of shortleaf pine stands to insect attack.

Improvement and Salvage Cuttings

Improvement cuttings are made to improve the quality and composition of mature stands. Inferior species and poorly formed trees are removed to encourage growth of desirable trees. Salvage cuttings remove and utilize trees damaged or killed by insects, disease, or from other causes. Improvement and salvage cuttings are important practices in the proper management of shortleaf pine stands.

Sanitation Cuttings

Sanitation cuttings remove dead, damaged, or susceptible trees to prevent the spread of insects or disease. This practice is a means of reducing losses from the southern pine beetle.

INJURIOUS AGENTS

Littleleaf Disease

Shortleaf pine stands growing on heavy soils with poor internal drainage are subject to losses from littleleaf disease. Symptoms are a yellowing of the foliage, shorter needles than usual, and a sudden reduction in radial growth due to root mortality caused by the fungus. Stands less than 20 years are seldom attacked. Symptoms usually occur when stands are 30 to 50 years old. Frequent salvage cuttings are recommended to utilize diseased or dead trees. Stands should be regenerated before they reach advanced stages of decline. Loblolly pine and healthy shortleaf pine should be favored as seed trees. Hardwoods should be left when possible to improve the site.

The Southern Pine Beetle

Mature stands of shortleaf pine growing on heavy clay soils are highly susceptible to southern pine beetle attack. Symptoms of attack are yellow or reddish-brown crowns, small pitch tubes on the middle or upper sections of the tree, and S-shaped egg galleries on the under surface of the bark. Problem areas should be observed carefully and frequently during outbreaks. Intermediate cuttings should be made promptly when stands are infested. Salvage cuttings are recommended to utilize dead trees; sanitation cuttings will reduce spread to healthy trees. Loblolly should be favored over shortleaf pine in the treatment of high hazard stands. Managing pine and hardwood in mixtures also reduces the probability of attack and spread in shortleaf pine stands.

PIEDMONT AND COASTAL PLAIN HARDWOODS

By

Charles H. Fitzgerald[1]

Hardwoods of the Piedmont Plateau and Coastal Plain of Georgia are of significant importance to fiber based industries and to manufacturers of solid wood products. High quality trees grown on rotations of 35 to 50 years bring excellent stumpage prices when sold for furniture lumber, or cabinet and paneling veneer, but associated lower grade material channeled to fiber, pallet, or tie markets sells for negligible value. Small trees removed in thinnings or improvement cuttings contribute little to forest income. Indeed, under present economic conditions, it is difficult to interest logging contractors in any type of partial removal cutting in hardwood stands of any size or age.

This economic harvesting problem is confused by the mixed composition of many natural hardwood stands and the relative monetary value of different sizes and species. Hardwoods, in pure or mixed stands, are site sensitive and produce high quality individuals only on sites upon which a given species is best adapted. Suitable sites for quality hardwood production are found in the uplands and bottomlands of the Piedmont and Coastal Plain Provinces.

UPLAND HARDWOODS

Hardwoods require more soil moisture, deeper topsoil, higher fertility levels, and greater soil organic matter content than pines. Therefore, high quality, commercial upland hardwood production in both the Piedmont and Coastal Plain usually is limited to less eroded lower slopes, toe slopes, and draws of intermittent streams and small branches without a developed floodplain. Better form and growth rate at higher contour levels will be obtained on moist slopes with northerly to easterly aspects. Ridge tops, upper slopes, and eroded lower slopes should be managed for pine production.

Forest Cover Types

Forest cover types, or species associations, are difficult to recognize because of mixed composition which varies from one site to another. Key species may not predominate in numbers within a stand. Separation by geographic region is not exact because some types occupy sites in both the Lower Piedmont and Upper Coastal Plain. This overlap also exists in bottomlands of larger streams with broad floodplains.

1. **Mixed Hardwood:** The principal component is usually oak represented by southern red, white, scarlet, northern red, black, blackjack, and post oaks. Associated are a few pine, blackgum, various hickories, beech, sweetgum, yellow poplar, winged elm, and many smaller noncommercial species including sourwood and dogwood. In the Upper Piedmont northern red and scarlet oaks may predominate while in the Lower Piedmont and Coastal Plain these yield to greater numbers of southern red, blackjack, and hickories. This type has a commercial potential on some lower and middle slopes. Species to be favored during intermediate and regeneration cuttings are northern red, southern red, white, and scarlet oaks.
2. **Mixed Pine-Hardwood:** This type contains the same hardwoods listed above with a pine component of 25 to 75 percent. Shortleaf and (or) Virginia pine may be the principal species in the Upper Piedmont. Southward loblolly usually is the predominating pine. Composition has been influenced by past agricultural and logging practices. Favor the hardwood species listed under the Mixed Hardwood type and the pine present in developing stands.
3. **Sweetgum-Yellow Poplar:** This type occupies moist lower slopes, toe slopes, and draws of intermittent streams and small spring branches without developed floodplains. Stands are pure or mixed with respect to the name species. Associates include loblolly pine, red maple, ash, beech, water oak, and willow oak in varying proportions. Yellow poplar does not extend into swampy areas. At the time of regeneration and in developing stands; yellow poplar, sweetgum, loblolly pine, ash, and water or willow oak are to be favored as crop species.

REGENERATION OF UPLAND HARDWOODS

Regeneration of the hardwood type with desirable species is complex (Table 4). Certain oaks are more desirable from the toe to middle slopes. Planting oak or other commercial species following extensive site preparation is possible but costly.

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Table 4.--Hardwood cover types of the Piedmont and Coastal Plain, regeneration systems, and species favored in regeneration and intermediate cuttings

Cover type	Regeneration system	Species favored
Upland		
Mixed Hardwood	Shelterwood Seedlings, seed, and sprouts in place.	Northern red, southern red. white, and scarlet oaks
Mixed Pine-Hardwood	See above	Pine and above hardwoods
Sweetgum-Yellow Poplar	See above	Yellow poplar, sweetgum, pine, ash, water and willow oaks
Bottomland		
Well drained sites		
Swamp Chestnut Oak-Cherrybark oak	Clearcut Shelterwood Group Cutting Artificial regeneration	Swamp chestnut oak, Cherry-bark oak, sweetgum, sycamore ash, blackgum, basswood, sugarberry, water and willow oaks. Occasionally: yellow poplar, cottonwood, loblolly pine, magnolia, spruce pine.
Moderately drained sites		
Sweetgum-Willow Oak	Clearcut Group cutting Shelterwood	Sweetgum; water, willow, and laurel oaks, ash, sugar-berry, American elm.
Sugarberry, American elm, greenash	See above	See above
Poorly drained sites		
Wet flats, ponds, and sloughs	Clearcut, Group Cutting	Willow and water oak, green ash, red maple, water tupelo swamp tupelo, cypress, over-cup oak.
Sweetbay, swamp tupelo, red maple	Clearcut Group cutting	Water tupelo, swamp tupelo Sweetbay, red maple, water and willow oak.
Water tupelo, bald cypress, pond cypress	Clearcut Group cutting	Baldcypress, water tupelo

Herbaceous weed control for one or more growing seasons will be necessary. Some plantings have not been effective.

Natural regeneration systems involve less establishment cost but do not eliminate the need for woody weed control. Many commercial, upland hardwood stands are "two-storied". The lower canopy is often composed of semi-tolerant to tolerant species, frequently small trees and shrubs of no commercial value. These include dogwood, redbud, possum haws, hawthorn, hornbeams, and many other species that may prevent natural establishment or retard growth of commercial hardwoods.

Shelterwood Method

To obtain natural regeneration the canopy must be opened to allow light penetration to the forest floor. Oaks are heavy seeded species requiring relatively high densities of residual trees to seed the area evenly. In well-stocked, mature stands with an average diameter of 18 inches, the seed cut of a shelterwood operation should remove the less desirable commercial species, a portion of the more desirable species, and include the removal of all culls without commercial potential by injection with 2, 4-D amine salts or other herbicide formulations labeled for tree injection. A residual basal area of 30 to 40 square feet per acre of oak should reseed the site within 2 to 4 years. If possible, it is desirable to time the seed cut in a year of good seed production. Seedlings established on the site at the time of this initial cutting and desirable sprouts will contribute to stocking the new stand. Overwood should be removed following establishment, preferably within 2 to 4 years. Excessive delay of overwood removal will lead to seedling suppression, prolonged possibility of windthrow, and epicormic sprouting on the high quality overwood trees.

On extreme lower slopes, toe slopes, and small branch depressions the Sweetgum-Yellow Poplar type should be encouraged. These species have light, wind-borne seed. At maturity, when average diameter is 18 inches, a shelterwood cutting leaving 20 to 25 square feet basal area per acre combined with woody weed injection will regenerate the stand. Full light on the forest floor is necessary for seed germination. The new stand will initiate from seed present in the forest litter supplemented by desirable sprouts in the growing season following cutting. Seed from overwood will complete stocking within 1 to 3 years. Overwood should be removed soon after establishment to release regeneration, avoid windthrow, and prevent degrade from epicormic branching.

Seedlings, Seed and Sprouts in Place

The shelterwood systems assume sufficient volume per acre and favorable harvesting economics to justify a "two-stage" cutting. If insufficient volume is present to warrant commercial partial removal it will be necessary to remove culls and woody weedy species by herbicide injection, hold the stand for 2 or 3 years, and liquidate desirables. Seedlings initiated by partial canopy opening following weed control, sprouts, and seed in place at the time of cutting should regenerate a hardwood mixture. Developing undesirable species may be eliminated later by injection. This "practice" is based on the clearcutting regeneration method but requires weed removal several years before harvest.

BOTTOMLAND HARDWOODS

In the extreme Upper Piedmont, hills approach the stream banks and the narrow valley bottoms are frequently well drained without broad floodplains. Upland mixed hardwoods usually occupy these sites with increases in numbers of yellow poplar, red maple, ash, and other moist site species.

As the streams meander the Lower Piedmont and Coastal Plain, floodplains broaden and site characteristics may change abruptly within a few hundred feet or remain constant over many acres. The levee, terraces, and terrace ridges each contain subsites: marshes, flats, ponds, and sloughs. These are recognized by differences in elevation, soil texture and structure, soil moisture regimes, surface drainage, and depth to water table. As red water rivers approach tidal marshes of the Lower Coastal Plain, site systems become better developed and more extensive in area. Each has forest cover types best adapted to specific sites until salt content excludes tree growth. These bottomland cover types are similar in composition in the Upper Coastal Plain and Lower Piedmont river systems. Major red rivers are the Savannah, the Altamaha-Ocmulgee-Oconee, and the Chattahoochee-Flint systems.

Black water creeks and rivers, which arise within the Coastal Plain, have bottomland topographic features but floodplains are less extensive and terrace development does not equal that of red water rivers except in the vicinity of confluence. Soil fertility in black water systems may be lower, a factor affecting composition and growth.

The best guide to species preference is empirical; observe the existing stand and favor those species that have developed commercial potential. If commercial species are not present, regeneration decisions must be made on subtle differences in elevation, drainage, and soil characteristics.

Forest Cover Types

Bottomland cover types are difficult to recognize and classify by name. Composition varies widely; name species may be predominant, represented only as indicators, or absent! Therefore, existing stands and sites are more easily recognized by bottomland topographic features and associated drainage characteristics:

1. **Well Drained Sites:** In the Coastal Plain these include the second terrace, first terrace ridges, and the levee or natural alluvial terrace adjacent to the river. Battures, newly formed lands between the levee and the river, are well drained but not as frequent or extensive in area as those in the Mississippi system. True terraces of extensive acreage are not evident in the immature bottomlands of Piedmont streams, but elevational differences occur which influence cover types. Good external and internal drainage patterns are evident with soil texture ranging from loams to loamy sands.

The Swamp Chestnut Oak-Cherrybark Oak type is basic on many of these well drained sites, especially

on second terraces and comparable soil and drainage systems, but name species may be wanting or only occasionally represented in the Piedmont. Past logging practices have selectively high-graded Coastal Plain stands and reduced name species numbers. Swamp chestnut oak (cow oak) and cherrybark oak should be favored in all intermediate and regeneration cuttings with the more desirable associated species including sweetgum, sycamore ash, blackgum, basswood, sugarberry (southern hackberry), and water and willow oaks. Occasional desirable individuals on the best drained sites include yellow-poplar, cottonwood, loblolly pine, and magnolia. In the Coastal Plain, spruce pine may be a major component occurring in even-aged groups or distributed throughout the stand on second terraces and first terrace ridges.

Associates with less merchantable potential include hickories, beech, winged elm, red maple, river birch, and boxelder. Overcup oak and water hickory (bitter or scaley bark pecan) have encroached on some better drained sites and may dominate because of high-grading in past logging practice.

Well-drained sites can be regenerated by any of the suggested methods.

2) **Moderately drained sites:** These include better drained first terrace sites and second terrace flats. Soils are characterized by higher silt and clay content and poorer internal drainage compared to lighter textured soils on well-drained sites. Elevational differences and surface slope may lead to water covering or remaining puddled on these sites for several weeks following stream overflow.

The **Sweetgum-Willow Oak** type is frequent on moderately drained sites. Water oak is a strongly represented associate and frequently predominates willow oak, especially in the Piedmont. Species to be favored are sweetgum; water, willow, and laurel oaks; ash, sugarberry, and American elm. Less desirable associates are overcup oak, water hickory, red maple, and honeylocust.

A transient type, **Sugarberry-American Elm-Green Ash,** is frequently represented and may intermix with the Sweetgum-Willow Oak type so that recognition is difficult. Frequently the same species are present so separation must be made on the basis of predominating species.

Natural regeneration may be by shelterwood, clearcutting, or group cutting. Planting may be difficult because of poor drainage and access.

3) **Wet flats, ponds, and sloughs:** These sites are covered with water for prolonged periods or may never dry. High soil clay content results in poor internal soil drainage.

In wet flats the **Overcup Oak-Water Hickory** type is common. Neither species is highly desirable, but often they are the only species that tolerate the site. Willow and water oak, green ash, red maple, water tupelo, swamp tupelo (swamp blackgum), and cypress are more desirable when present; although, their best form and growth rate are seldom realized on these wet flats.

With better internal drainage on moist to marshy soil, the **Sweetbay-Swamp Tupelo-Red Maple** type with the frequent associate, water tupelo, has higher commercial value.

Permanent ponds and sloughs support little tree growth other than water tupelo, baldcypress, and pond cypress. The more desirable baldcypress will tolerate standing water but attains better growth rates with better bole form on moist soils with light texture and good internal drainage. These three species need full sunlight for good regeneration and development.

Planned regeneration of wet sites is difficult. Clearcutting or group cutting is probably advisable but woody weed control is necessary to prevent the eventual site domination by water hickory and water elm. Planting is extremely costly or impossible and product growth rates and quality do not justify the expense.

REGENERATION OF BOTTOMLAND HARDWOODS

Currently three natural regeneration systems are proposed:

Clearcutting

Clearcut by harvesting all merchantable material and removing all non-merchantable culls by felling with a chain saw or injection of herbicides. Foliage spraying with herbicides should be avoided because it may eliminate desirable sprouts, seedlings in place, and their root systems. Regeneration by this method depends on seed in place and desirable sprouts. Broadcast herbicide spraying can only be used in cases where all residuals are non-commercial species. In this case complete site preparation and planting may be advisable. On floodplains subject to overflow, seed in place may be washed from the site but seed from upstream sites will be deposited by floodwaters. This simple method of natural regeneration assumes that the species most adapted to the site will become established and predominate. Many site-adapted species may have little or no commercial value so release by improvement cuttings or herbicide injection may be required to free the commercial stand component. The cost of early release operations will be high because of the density and impenetrable nature of the woody and herbaceous vegetation following clearcutting on these fertile sites. Physically and economically it may be necessary to delay intermediate operations until dense lower vegetation is naturally controlled by competition, and instead apply an improvement cutting after the stand exceeds an average diameter of 4 inches. Selective herbicides for foliage application are not currently available.

Group Cutting

This is more "practice" than traditional method. Commercial bottomland species of the South are intolerant; they need full sunlight to regenerate and develop with their best growth rate and form. The single tree and true group selection methods, which may be used for narrow strips of timber on stream banks for aesthetic values or siltation prevention, lead to the eventual dominance of the site by commercially undesirable tolerant species. However, varying bottomland topography and past harvesting practices have led to very irregular, patchy, current stand conditions on areas of

3 to 10 (or more) acres. **Group cutting** is the clearcutting of these small areas that are overmature, mature, understocked, or stocked with undesirable species. Intermixed areas that are stocked with desirable species in the intermediate growing stage of development are left untouched or treated with a thinning or improvement cutting. The rules of the clearcutting method, including weed control, apply to these "groups" that are clearcut. This practice excludes the cutting of developing stands which are of sufficient size, composition, and quality to provide income in the near future.

Shelterwood Cutting

The shelterwood method may be more desirable, especially on large areas and terraces or ridges subject to infrequent overflow, if a two phase harvesting program is economically feasible. The amount of overwood basal area depends on the species and its mode of seed dispersal. Heavy seeded species, the oaks, will require 35 to 40 square feet per acre opposed to 20 to 25 square feet per acre for species with wind dispersed seed, sweetgum. In areas subject to windthrow, more basal area of light seeded species should be left to provide mutual protection of overwood. Overwood removal will be necessary with 2 to 4 years, especially when densities are high, to prevent competitive effects and economic decline caused by water sprouts. Some limited damage to the young stand caused by the final cutting may be beneficial, substituting for precommercial thinning and release. Cull individuals of commercial species and woody weeds must be removed by herbicide injection.

Planting

Artificial regeneration is possible on the better drained sites but has been reliable only with species such as sycamore, cottonwood, and green ash that develop height growth rapidly in the first growing season. Herbaceous weed control by mechanical methods is required in the first, and possibly the second, growing seasons. No herbicides are currently labeled for herbaceous weed control in hardwood plantations. State extension personnel are informed of current herbicide developments. Costs of site preparation, planting, and herbaceous weed control are high. The availability of hardwood seedlings from Georgia nurseries should be confirmed before beginning operations. Plantation systems are currently limited to the best drained sites and require precise timing to prevent operational interference from flood waters.

INTERMEDIATE CUTTING

If young, actively growing, upland hardwood or mixed pine-hardwood stands are established on appropriate sites, they should be managed to maturity. The cost of liquidation of young stands for conversion to pine plantations is high. The monetary returns from liquidation of immature hardwood stands for conversion to pine are poor. Interest in hardwoods as a source of forest products and, more recently, energy, is increasing. By the time these stands mature, value may have increased and the perpetuation of hardwood types may have become more desirable economically.

Intermediate cuttings—thinnings, release, and improvement—will benefit developing hardwood stands on all sites. These practices should be applied as needed if access and economic conditions justify partial harvesting operations.

Precommercial thinning and early release cuttings in young stands are usually impractical because of the high cost associated with the removal of large numbers of stems per unit area. After growth and development of the stand has eliminated understory vegetation, improvement cuttings by tree injection should be used to remove undesirable species and individuals of commercial species that have poor form and quality.

During thinnings and other intermediate operations excessive opening of the canopy should be avoided to prevent water sprouts on residual trees. Basal area of residuals should not be reduced below 70 square feet per acre.

Professional aid is usually required to properly manage and regenerate hardwood types.

THE GEORGIA MOUNTAINS

By

Vaughn H. Hofeldt[1]

Georgia's Mountain Province is described as the northern portion of the state above the boundary of the Piedmont. The Mountain Province includes three physiographic regions: the Cumberland Plateau (Sand Mountain), the Southern Appalachian Ridges and Valleys, and the Southern terminus of the Blue Ridge Mountains.

Blue Ridge

This unique mountain environment in Georgia includes the major portion of the Chattahoochee National Forest. Although rugged in topography, the overall private land elevation rarely exceeds 3,000 feet. Many mountain peaks go 4,000 feet and higher. There is a relief of over 2,000 feet between valleys and peaks. The characteristic land ownership pattern is National Forest on the high ground and private ownership in the lowlands.

History and Land Use

Poor access to markets and the unsuitability of the land for agriculture contributed to past local dependence on marginal farms, logging and mining. In the 1920's, loggers cut the virgin shortleaf pine on the ridges and loblolly pine at lower elevations, often leaving only Virginia pine. This continued as late as the 1950's. The band sawmills generally left trees less than 16 inch d.b.h. in the 1940's and '50's. Hickory was rarely cut in many areas. Under World War II pressures, Virginia, loblolly and shortleaf pines were cut to 9 inches d.b.h.

Ridges and Valleys

Valley land is primarily committed to agriculture, industry, and residential use. Forested slopes are primarily owned by forest industry, private non-industrial owners of moderate size, with a limited amount of National Forest and State land ownership of the high mountains and ridges. Urban influences are increasingly felt with some counties already in either the Atlanta or Chattánooga metropolitan statistical areas.

Forest Resources

Taken as a whole, Georgia's mountain province is in the oak-hickory-pine forest type.

The more valuable species of the oak-hickory forests are intolerant to moderately tolerant of shade. However, maples, blackgum, elms, beech, and understory species such as dogwood, redbud, and many shrubs are much more shade tolerant, and grow rapidly when released by removal of the commercial species. This fact, plus the long-term effect of selective cutting of the valuable species, has left a less-than-satisfactory commercial forest in the province.

White, northern red, and black oaks are also found in the province. Other common oaks are scarlet and chestnut oaks, post, blackjack, and southern red oaks. Although the oaks are more abundant, the hickories—especially shagbark, pignut, mockernut, and bitternut—are components. Associated species vary widely and may include ashes, blackgum, yellow poplar, elms, maples, sassafras, black locust, black walnut, and many other hardwoods. On suitable sites, shortleaf, pitch, white, and Virginia pines, and eastern red cedar may also be found.

Cove hardwood sites comprise one of the most productive hardwood types of the North Temperate Zone. The type is found in the coves and on the moist slopes of the province. Stands are characterized by a large number of dominant and subdominant species and by the great diversity of their mixture. Cove species composition is typically a mixture that may contain 20 or more species, including a few conifers such as eastern white pine and eastern hemlock.

Conifer Sites

Western and southern lower slopes of the province contain the bulk of the conifer forest. Virginia pine frequently occurs in dense, pure stands on the poorest, sandiest areas, even in bedrock outcrops. Mixtures of shortleaf and white pine occupy the better pine sites. Loblolly plantations have been successful in the Valley and Ridge province, and white pine plantations grow well in the Blue Ridge region.

Recreation opportunities are wholesale within the province from the most highly developed to the least developed. Campgrounds, ski areas, caves, marinas, hunting preserves, and a multitude of tourist attractions and service outlets are found. Indian and settlement history is rich.

Water is one of the province's most abundant and valuable resources. Water quality is good with mean annual rainfall from 56 to 68 inches. Cold water fishery consists of native species and 'put and take' brook, rainbow, and brown trout.

Wildlife in the mountain province is represented by black bear, whitetail deer, bobcat, gray fox, raccoon, gray and fox squirrels, cottontails, turkey, ruffed grouse, bobwhite quail, and mourning dove. The avian population is also large and varied.

Present Situation

Since 1961 in North Georgia, the area of commercial forest land has

[1] Consulting Forester, Gainesville, Georgia.

decreased by 85,000 acres. The ownership of some half million acres of commercial forest land has shifted from the farmer to the miscellaneous private class. Average basal area of all live trees 5 inches and larger has increased from 47 to 66 square feet per acre on commercial forest land.

In 1971, net growth of growing stock averaged 55 cubic feet per acre on commercial forest land and totaled 175 million cubic feet. Although hardwoods made up 55 percent of the growing-stock inventory, soft woods accounted for over 60 percent of the net growth. By ownership class, 23 percent of the growth occurred on publicly-owned forests, 8 percent on lands owned by forest industry, 28 percent on farm woodlands, and the remaining 41 percent on other private lands. The net growth of all species included 520 million board feet of saw-timber.

In 1971, removals of growing stock totaled about one-half of the net growth. Mortality of growing stock reduced growth by some 10 percent. The province contained the following land classes in thousands of acres:

All land	4,226.4
Total forest land	3,208.7
Commercial forest land	3,192.5
Non-forest land	1017.7
Other	16.2

In summary, commercial forests occupy 3.2 million acres, or 75 percent of the total land in the 21-county area of North Georgia. In the latest Forest Survey, 7 out of every 10 acres now classified as commercial forest showed no evidence of treatment over the past 11 years. Net annual growth averaged 55 cubic feet per acre, almost double the removal volume.

APPLACHIAN MOUNTAIN HARDWOODS

By

Lee S. Settel[1]

Hardwoods are a significant source of income to forest landowners in the mountain area of North Georgia. Recent inventories of the hardwood resource in this region report 1.8 billion cubic feet of growing stock and 4.7 billion board feet of sawtimber. Approximately 50 percent of the hardwood sawtimber occurs on nonindustrial private forest lands.

Silvical Characteristics

Oak-hickory and oak-pine are the predominant hardwood types in North Georgia. Associated commercial species include yellow-poplar, ashes, gums, black birch, beech, black locust, black cherry, buckeye, soft maples, cucumber magnolia, wahoo, silverbell sourwood, persimmon, basswood, and dogwood.

Appalachian hardwoods vary in shade tolerance from the very intolerant yelow poplar through intermediately tolerant oaks and hickories to the very tolerant American beech. They also vary in response to release from suppression.

Most hardwoods, particularly white oak and yellow-poplar, will produce epicormic (water) sprouts when tree trunks are fully exposed to light. This excess branching will greatly reduce the quality of stem wood. Epicormic branching can be prevented or minimized by careful control of stand density.

The most important silvical characteristic of most hardwood groups is the ability to regenerate from stump sprouts as well as from seed. The forester can use this unique physiological adaptation in many instances to efficiently and effectively regenerate mountain hardwoods.

[1] Consulting Forester, Ellijay, Georgia.

REGENERATION METHODS

Silvicultural options in the Mountains of North Georgia are determined by management objectives, types of available logging equipment, soil characteristics, and topography. Emphasis is on natural methods of regeneration. They are presently no planting contractors in the mountain area. The planting of 1-0 yellow-poplar seedlings is justified, however, on many sites. It is conservatively estimated that 90 percent of the current logging is done with large, rubber-tired, 4-wheel-drive skidding tractors. Some animal and farm-type tractor logging still persists in the region. Heavy equipment should not be used on clay soils or on steep slopes which are subject to erosion.

Group Selection

This system creates small openings for the regeneration of light seeded, intolerant species such as poplar and ash in hardwood types, and pine in the pine-hardwood types. It is most useful in creating islands of poplar where a perimeter seed source is available and the site quality is good or excellent. A 1/2-acre opening is usually sufficient to establish regeneration. An acre opening looks like a small clearcut. Although the method can satisfy the objectives of many owners, it is all too likely to result in the cutting of some high quality trees that are currently at their peak earning period.

Rate-of-Return Tree Selection

This type of selection cutting can also be applied to meet most small landowner objectives. Rate of return is based upon rate of growth, quality and increased value. It favors the retention of larger desirable trees on the better sites, and smaller size crop trees on poorer sites. Trees are first marked that would come out in an improvement cut. All southern red and scarlet oaks over 24 inches d.b.h. would be cut because of excessive mortality of these older trees on most Mountain sites. Low, medium, and high (2, 4, and 6 percent) rate-of-return criteria are then applied to vigorous and sound dominant and codominant leave crop trees. Marking should be aimed at a residual basal area of 55 to 70 square feet per acre on good sites and 40 to 55 square feet per acre on fair sites. Maintaining these residual basal areas should permit harvesting on a 10-year cutting cycle on the better sites.

Rate-of-return selection needs to be applied by a skilled forester with an intensive knowledge of forest types, markets, log grades, and tree vigor classes. He should also recognize stands and individual trees that are highly susceptible to fungal and insect attack.

Contour Shelterwood

Contour shelterwood is a combination shelterwood and strip clearcut system that suits multiple timber and non-timber use objectives. Alternating cut and leave strips, generally 100-200 feet wide on the contour, minimizes soil loss and creates a seed bed that favors regeneration of yellow poplar, white ash, and pine. The width of the strips may vary with the severity of the slope although some departure from rigid contour limits is left to the judgement of an experienced timber marker. Leave strips are left on high ground. Selective cutting in the leave strip is limited

to trees that can be winched into the clearcut strip without damage to desirable growing stock in the leave strip. This system is particularly applicable where no alternatives exists to tree length harvesting.

The contour shelterwood system may require 2 or 3 cuts to fully regenerate the stand. The objective of the first cut is to establish regeneration in the leave and cut strips. A second cut may be necessary to promote seed production and seedling establishment in the leave strip. The pine component can be increased by leaving a majority of pine seed trees until the final removal of the original leave strips. The final cut removes the mature overstory trees.

INTERMEDIATE CUTTING

Thinning

Thinning of overstocked stands is a gainful practice provided that it can be accomplished without significant damage to the residual stand. As fuelwood markets develop, more viable cutting options should present themselves. What are currently described as precommercial thinnings at out-of-pocket cost to the landowner, will pay delayed dividends provided the right trees are cut or left. Vigorous dominant and codominant trees will be left while slower growing, poorly shaped trees will be cut.

Improvement Cutting

Improvement cuttings are made to improve the quality and composition of mature stands. Inferior species and poorly formed trees are removed to encourage the growth of desirable trees.

Salvage Cutting

Salvage cuttings follow death or damage of merchantable trees due to windthrow, fire, insects, and disease. Prompt removal of trees killed or dying from oak wilt is a highly desirable practice.

INJURIOUS AGENTS

Ice Damage and Windthrow

The hardwoods are more resistant to ice and wind than pines; however, windthrow of hardwoods is significant in the area. The author believes the best protection over the length of a rotation is a system of light cuttings at approximately five-year intervals varying with site quality.

Insects

Forest insects are serious pests that often reduce the ultimate product value of most hardwoods, but rarely are fatal as primary attackers. Occasionally, a defoliator like the elm spanworm becomes epidemic in the Appalachian region of Georgia.

Diseases

Appalachian hardwoods, particularly oak, hickory, red maple, and beech are subject to many plant diseases. All but oak wilt are generally recognized by their fruiting bodies and/or signs of rot. Oak wilt, a vascular disease, is particularly injurious to the red oak group. External symptoms in the red oaks may show as early as May, with bronzing and apparent water-soaking of irregular leaf areas followed by copious shedding of leaves, often while still green. Death is quite sudden in the red oaks, while members of the white oak group die slowly, often a limb at a time.

Any significant outbreak of insect or disease pests should be quickly reported to the nearest office of the Georgia Forestry Commission, the U.S. Forest Service, or to the Southeastern Forest Experiment Station in Athens, Georgia.

YELLOW-POPLAR

By

Vaughn H. Hofeldt and E. V. Brender

Pure stands of yellow-poplar are some of the most valuable timber producing forests in the eastern United States. The species grows well in the Georgia mountains; it is also found on uplands and coves of the Piedmont and Coastal Plain. Latest Forestry Survey data for Georgia indicate 2,974.8 million board feet of yellow-poplar sawtimber on commercial forest land with net annual growth of 59 million cubic feet and annual timber removals of 27.4 million cubic feet (97.7 million board feet).

Yellow-poplar is also known as tulip tree, poplar, whitewood, and hickory poplar. Best development occurs on fertile soils in the Appalachians. The tree is usually a fast grower with a long bole, small limbs, and a short crown, all features which make for easy conversion into lumber. The wood consists of two distinct zones: a heartwood ranging from olive-brown to brown to deeply colored with shades of pink and purple, and a clear sapwood. The overall versatility of the wood, relative abundance, growth characteristics and its rate of growth make yellow-poplar one of our most important hardwoods.

BOTANICAL CHARACTERISTICS

Yellow-poplar can grow under a variety of climatic conditions but for good growth it is exacting in soil and moisture requirements. It grows well on moderately moist, well-drained, and loose-textured soils. Sites in mountain coves, lower slopes, toe slopes, and draws of intermittent streams are well suited for the growth of yellow-poplar. It also grows well on upper, moist slopes with northerly or easterly exposures, provided good soil is present.

Yellow-poplar is an intolerant tree and occurs in pure stands as a pioneer species in abandoned fields or in clearcut areas if a source of seed is present. It starts producing seed at about 20 years. Bumper crops occur at irregular intervals, but the seed is low in viability. It is disseminated a distance of four to five times the height of the trees. The seed accumulate in the litter and surface soil. Some of these accumulated seed will germinate up to four years after dispersion. After all trees are harvested, a new stand can develop from the stored seed. Disturbance of litter during harvesting or a low-intensity fire immediately after harvesting enhance germination of stored seed. But neither of these practices is essential because yellow-poplar seedlings often are numerous in undisturbed areas.

Yellow-poplar trees can live 200 years and reach great size. Record trees measured 12 feet in diameter, 198 feet in height, with a crown spread of 122 feet. At ages 50 to 60 years they attain diameters of 18 to 24 inches and heights of over 120 feet.

REGENERATION

Clearcutting with Seed or Seedlings in Place

Yellow-poplar has been given a custodial management treatment for a hundred years. That is, marketable stands were harvested, the natural regeneration protected from fire, and new stands harvested again when the stands were merchantable. The minimum cultural practices for custodial management are:

1. Keep harvested areas larger than about 1 acre; there is no optimum upper size limit.
2. During or after harvest remove or fell all trees larger than about 2 inches d.b.h. This is the only treatment requiring special effort.
3. After the seedlings are established, the stand should be protected from fire.

Continued custodial management of eastern hardwood forests can double the annual harvest of yellow-poplar from trees larger than 14 inches d.b.h. The management identified above reflects an objective for yellow-poplar alone, or at the most with its type companion, sweetgum.

Seed Tree Cutting

In most cases if seed-producing yellow-poplars were present in the harvested stand, seed trees need not be left. Otherwise 8 to 10 seed trees 14 to 20 inches in diameter are considered necessary for regeneration of cutover land.

Shelterwood Cutting

Cut everything except 20-25 square feet basal area of yellow-poplar seed trees per acre to regenerate the stand. Seed crops from the overwood will complete stocking within 1 to 3 years. Cull and weed trees should be injected with a herbicide. Seed trees should be removed after 2 to 3 years.

Clearcutting and Planting

Where yellow-poplar stands are scheduled for clearcutting and planting, competing vegetation must be controlled. This may be accomplished by prescribed burning and harrowing. Planting should be confined to fertile, moist, well-drained and uneroded sites. It is very important to plant-graded seedlings that have a root collar of 1/4 inch or more

in diameter. A combination of root pruning and grading of seedlings improves survival and growth.

CULTURAL PRACTICES

Release Cutting

Because yellow-poplar is intolerant, release of seedlings and saplings is an important part of management. Overtopped or intermediate trees with good vigor respond quite readily in diameter and height growth when released from competition.

Thinning

In well-stocked stands on good sites, individual tree growth slows down at stand age 20. Moderate thinning at 8- to 10-year intervals is recommended to maintain good board-foot-growth which during the latter part of a 60-year rotation may, under an intensive thinning regime, be nearly 1000 board feet per acre per year.

INJURIOUS AGENTS

Yellow-poplar is considered to be unusually free from damaging diseases and insects. Deer heavily browse twigs and branches on young trees and rabbits feed on the bark and buds of seedlings and saplings. Yellow-poplar seed are eaten by quail, squirrels, and mice. Decay follows top breakage caused by sleet and glaze storms and decay enters through butt wounds resulting from fire or logging damage. Grapevines and Japanese honeysuckle are serious competitors to reproduction on the best sites.

WHITE PINE

By

W. Pat Thomas[1]

Eastern white pine is found growing in the coves and valleys of the North Georgia Mountains. It is the dominant species on 34,000 acres with about 42 percent of this found in Rabun County. White pine prefers a cool humid climate. It grows best on well-drained sandy loams but adapts well to a variety of soil conditions with adequate moisture. More than 80 percent of this forest type occurs in the Chattahoochee National Forest.

White pine is economically important throughout its range — New England, south through the Appalachians and west to Iowa. The lumber is creamy white to light brown in color, light weight and generally straight grained. The wood is used for constructing furniture, patterns, caskets, matches and crating. White pine is favored as an ornamental because of its bluegreen color and vigorous growth. Sheared and shaped, white pines are used for Christmas trees.

Silvical Characteristics

White pine will grow in nearly pure stands or in a mixture with hardwoods or other conifers. It will successfully compete with its associated species and is surpassed in height growth only by yellow-poplar, on the best sites. Good seed crops usually occur every 3 to 5 years and seldom as infrequently as 10 years. Wind borne seeds are known to travel over seven hundred feet in open areas and up to two hundred feet within stands. The dominant trees usually produce twice as many seeds as codominants. Although intermediate in tolerance, white pine will survive and grow with as little as 20 percent sunlight. The more tolerant associated species will usually displace white pine on the most fertile sites but white pine will persist as a minor component in the stand. White pine is frequently found in the understory on cove hardwood sites and will temporarily take over the site unless controlled.

[1] Forest Supervisor, Chattahoochee-Oconee National Forest, Gainesville, Georgia.

REGENERATION METHODS

The following silvicultural recommendations are for predominant stands of white pine where the objective is harvest cutting and regeneration of this forest type.

Clearcutting

White pine can be successfully regenerated by clearcutting with seed in place when a favorable seedbed exists and timing of the cut coincides with a heavy seed fall. However, the short time available for preparing the seedbed makes this method impractical on all except small areas.

Clearcutting and planting is the preferred method of regeneration when a good seed crop is uncertain. Seedlings are planted as close as 4 by 4 feet for Christmas trees or at 12 by 12 feet for timber production.

Cutting in small strips or patches can be used for regeneration where wind borne seed is available from adjacent stands. White pine seed germinates best on moist mineral soil or on a site with a medium to light density of short grass. Poor survival can be expected on seedbeds of conifer litter, dense grass or brush, or dry mineral soil.

Seed Tree Method

Sporadic seed crops and vulnerability of seed trees to windthrow can result in insufficient seed for regeneration. Also, seed trees offer little protection for the newly germinated seedlings. This method of regeneration is not recommended.

Shelterwood Cutting

This is the most versatile system for regenerating white pine. By controlling the overstory density, the seedbed is improved, seed and seedlings are allowed to accumulate and herbaceous vegetation competition and the risk of weevil attack are reduced. A two- or three-cut system spanning 10 to 15 years generally results in successful regeneration. A primary advantage of this system is that the final cut can be delayed until an abundance of seedlings are present.

Selective Cutting

Single tree selection is not practical for regenerating white pine because of its intermediate tolerance to shade. Where aesthetics are important, group selection can be used. For regeneration, openings should be one-tenth to one-half acre in size and have a prepared seedbed.

CULTURAL OPERATIONS

Even aged management of white pine requires some cultural treatments throughout its development.

Hardwood Control

White pine cannot compete with most other species in its early stages of development. Seedling height growth is slow for the first few years but height growth begins after the fifth year. Best height growth generally occurs between the tenth and twentieth years where an annual increase of two or more feet of height growth is common. A common practice is to release white pine seedlings from competing hardwoods the third year after establishment by treating the unwanted stems with herbicides. White pine will usually gain and maintain its dominance after this treatment.

Pruning

This practice is recommended only for the best white pine sites. Considerations for pruning are:

1. Select 300 or less well-formed trees per acre and begin pruning when average stand diameter is four inches and limbs small.
2. Prune only one-third of the live crown during any treatment.
3. Make frequent light thinnings in the stand, usually at about five-year intervals, to keep it growing vigorously.
4. It is economical to prune only the first log.

Prescribed Burning

Fire is not routinely used in the management of white pine. It can, however, be used to prepare a seedbed in a stand prior to regeneration.

INTERMEDIATE CUTTING

Commercial Thinning

The first commercial cut in white pine can usually be made at age 20 on the better site where a market for small roundwood products exists. Thinnings should be light and frequent, at five-year intervals to age 40 and at 10-year intervals thereafter.

The response of white pine to precommercial thinning is dependent on the length of time and the degree of suppression endured. Generally, trees with at least one-third live crown and under 30 years of age will respond to treatment.

INJURIOUS AGENTS

Injurious agents of white pine are the white pine weevil, blister rust, annosus root rot, fire and air pollution. The white pine weevil seldom causes mortality but damages the terminal shoot causing a loss of height growth and bole form. Blister rust is highly virulent and can destroy a stand in any stage of development. Annosus root rot may result in mortality or windthrow of individuals or groups of trees in the stand. The thin bark of white pine and its shallow roots make white pine especially susceptible to fire in its early development. Air pollution can result in the death of a single tree, portions of a tree, or an entire stand.

VIRGINIA PINE

By

Vaughn H. Hofeldt

Virginia pine is found throughout the Georgia Mountain province and extends into the northern parts of the Piedmont. Occurring on a wide range of sites, it is the dominant tree species on 377,000 acres of land in Georgia. Virginia pine is also known as scrub pine, poverty pine, spruce pine, and possum pine. Approximately 80 percent of the acreage in this type is owned by non-industry private landowners.

Silvical Characteristics

Virginia pine is often found in pure stands. Where a seed source is available, it establishes readily on old fields and disturbed exposed surface areas. Its reproductive power is its most important silvicultural characteristic. Good seed years are periodic. Properly stored seeds will retain vitality for many years. Best natural reseeding is usually within 200 feet of the seed source. Young natural stands may contain 10,000 stems per acre. Well-stocked stands on an average site may have as many as 1,600 stems per acre at 20 years of age.

Injurious agents in natural stands are primarily the southern pine beetle (see Shortleaf Pine) and the Virginia pine sawfly. Pales weevils and Nantucket pine tip moths can be severe problems to plantation growers.

Primary economic use of Virginia pine has been for pulpwood, due to its good pulping qualities and yield per acre. Straight form, gradual taper, and acceptable size make use in log form practical for cabin and barn construction. The species is rapidly gaining popularity as a Christmas tree in Georgia. The local cooperative Extension Service County Agent provides information and assistance to landowners on Christmas tree production in the northern half of the state.

A limited number of silvicultural practices are commended for this species. Regeneration methods and intermediate cuttings must be carefully planned based on variations in climate, soil, stand composition and density, age, and management objectives. The following silvicultural recommendations are for pure or predominant stands of Virginia pine where the objective is harvest cutting and regeneration of this forest type.

REGENERATION METHODS

Seed Tree and Shelterwood Cuttings

These methods will give regeneration results but pose too high a risk from "blow downs". Application may be useful in a mixed species stand where individual Virginia pine trees are obviously wind firm.

Strip Clearcutting

Strip-cutting and patch-cutting have been successful as methods of harvesting and obtaining reproduction. Virginia pine stands may shed as many as 70,000 seeds per acre on adjoining clearcut strips (132 feet wide). Patches should be small and strips narrow (100 feet have been recommended), so as to obtain a maximum amount of seed from the residual stand and for erosion control on steep slopes. Very close utilization should be required in the clearcut areas, to remove as much material as possible, stir up the litter, and thereby expose the mineral soil for a good seedbed.

Clearcutting with Seed in Place

This method is commonly used whether planned or not. The usual viability and vigor of the seed generally brings in a strong seedling catch.

Clearcutting and Planting

For immediate establishment of a forest cover on so-called disaster sites, planting Virginia pine may be the answer for landowners desiring fast-growing native forest cover. Direct seeding on exposed soil has been used as a practice, but with unreliable results. Seed and planting stock source should be local or at least regional. Spacings of 6 by 6 feet to 8 by 8 feet may be employed, with closer spacings reserved for those sites where excessive herbaceous competition or other adverse site conditions indicate that a low percent survival is to be expected. Intolerance of young seedlings to shade and weed competition must be considered. Except for unusual erosion control or on poor site situations, plantations of Virginia pine might be second or third choices over more productive and attractive species in Georgia.

CULTURAL OPERATIONS

Virginia pine management problems relate to its intolerance, its shallow-root system, and its susceptibility to damage by fire, wind, and ice. Management in even-aged stands is required. Weeding should be done only at early ages to remove hardwood competition. Young stands of saplings may be killed outright by grass fires that would not

noticeably affect shortleaf or loblolly pines. Careful cutting practices can reduce or eliminate losses from bark beetle attacks.

Precommercial Thinnings

Early thinnings at about 8 years of age have been successful in increasing volume. A practice of clearing strips using a small bulldozer in dense young stands has had beneficial results. Virginia pine will not respond to thinning if the stands are more than about 15 years old. At high densities of stems, tree crowns become so small the trees have less chance to respond to thinning. Natural pruning of the species is very slow.

Commercial Thinnings

Basal areas should be maintained at 100 square feet per acre or greater if the management objective is high yields of wood fiber. For production of small saw logs by age 40, basal areas should be maintained at 60 to 80 square feet per acre. Live crown ratio of individual trees should be at least 40 percent to insure continuously rapid growth.

Thinning is not recommended when high yields of wood fiber are the objective of management. Moderate to heavy thinnings will reduce total volume yields below those of densely stocked stands. Economic returns from growing saw logs may justify the sacrifice of total cubic-foot volume and other expenses incurred in stand density control.

GLOSSARY

Advance reproduction—Seedlings or saplings which have become established naturally before regeneration operations are begun.

Annosus root rot—A stringy root rot that kills trees.

Anthraquinone—A bird repellent.

Basal area of a stand—The total cross sectional area at breast height of all trees on one acre, expressed in square feet.

Backfire—A fire moving against the wind.

Climax type—A stable forest for a given environment.

Codominant trees—Trees with crowns forming the general level of the stand canopy and receiving light from above but comparatively little from the side.

Clearcutting—A silvicultural system in which all merchantable trees are harvested over a specific area at one time and cull and weed species are removed from a site to assure new stand establishment.

Crown ratio—The ratio of live crown to total tree height.

Cutting cycle—Planned periodic cutting interval.

Dominant trees—Trees with crowns extending above the general level of the stand canopy and receiving full sunlight from above and partly from the side.

Even-aged—A stand composed of trees having relatively small differences in age.

Epicormic branch—A shoot arising from the main stem of the tree, commonly known as a water sprout.

Fusiform rust—Fungus infection causing cankers on pine trees.

Hardwoods—Any species with broadleaf characteristics opposed to conifer or needle-leaf species.

Headfire—A fire moving with the wind.

Intolerant—Light demanding species.

Intermediate cutting—A cutting made in a stand between the time of its formation and its final harvest and regeneration.

Improvement cutting—A cutting made in a stand past the sapling stage for the purpose of improving its composition and character, by removing trees or less desirable species, form, and condition in the main canopy.

Littleleaf disease—Attacks the root tips of trees, weakens them, and gradually kills them.

Overstory, Overwood—That portion of the trees in a forest stand forming the upper crown cover.

Release cutting—A cutting made in young stands, not past the sapling stage, for the purpose of freeing young trees from competition.

Reproduction—The young tree crop replacing older trees removed by harvesting.

Rotation—The period of time required to establish, grow, and harvest a crop of trees of a given size.

Round trees, round timber—Trees untapped for naval stores.

Round wood—Felled trees in the form of bolts, logs, or poles.

Silvical characteristics—The life history and botanical characteristics of a species.

Silviculture—The science and art of cultivating and tending a forest.

Silvicultural system—A process, following accepted silvicultural principals of harvesting and regenerating a forest.

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