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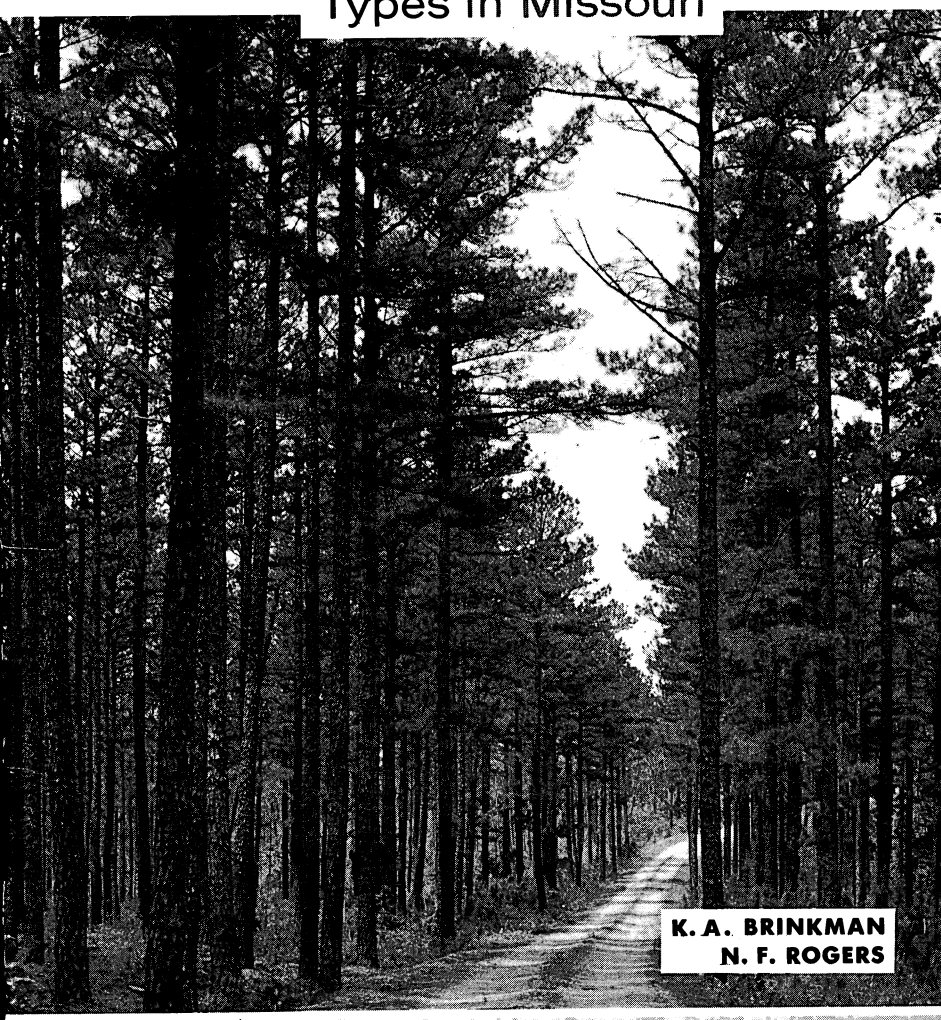

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Contents

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The management practices recommended here for the shortleaf pine and oak-pine types in Missouri are based on published information, research in progress, and the knowledge and experience of forest managers. The suggested practices should not, however, be interpreted as the final word in management — modifications will be necesary as forest researchers and managers learn more about the silviculture of these types. Furthermore, no set of rules can replace the need for technical knowledge and judgment by the forest manager. But the guides do provide a basis for decision making, and their use will improve continuity in the management of these important forest types.

Alternatives of management are not discussed. The decision to favor pine or oak-pine stands over hardwood stands must be made on the basis of the objectives of the landowner and within the limitations of site productivity.

Pine Range and Type Descriptions

Shortleaf pine, the only pine species growing naturally in Missouri, is found within a gross area of 6 million acres in the State. The natural stands are in the southern part, most of them in the southeast. Beginning in the middle 1930's, the species' range was extended by plantings over much of Missouri. Many trees in these plantations have already grown to merchantable size.

Shortleaf pine is usually found growing with oaks and other hardwoods. Nearly pure stands of pine may develop after a fire or as a result of intensive management, but the ecological trend is toward stands containing more hardwood trees. Thus the pine component of stands may vary widely within the species' natural range. For convenience, two forest types are commonly recognized.

The shortleaf pine type consists of stands in which pine comprises 50 percent or more of the cubic volume in sawlog or poletimber stands, or of the total number of trees in seedling or sapling stands.

In the oak-pine type, hardwoods (usually upland oaks) make up 50 percent or more of the cubic volume in large trees or of the number of smaller trees, with shortleaf pine providing from 25 to 49 percent of the stand.

The above type descriptions are the ones used in Forest Survey reports. Like any type descriptions they are somewhat arbitrary. Some foresters may prefer to use basal area instead of cubic volume as a basis for judging the type.

Cutting relatively few trees in some stands would, of course, change the type designation.

Soils

Except for colluvial slopes and alluvial bottom lands, the soils of the Ozark Highlands are residual in origin. A thin layer of loess, deposited during glacial periods, has nearly all been eroded away, and weathering and erosion of the underlying rocks have left a mantle of insoluble chert over most of the area.

The chert content of stony soils may vary from a few fragments to 75 percent by volume of the soil mass to a depth of about 5 feet. In more than one-half of the soil types 30 percent or more of the soil is chert; it may be most abundant in the surface (A) horizon or distributed evenly throughout the soil profile. A high content of

chert in the soil profile or the presence of a fragipan seriously affects the soil moisture regime, causing soils to be drouthy. These drouthy conditions are more pronounced on ridgetops, upper slopes, and south and west aspects.

The shortleaf pine type usually occurs naturally on soils characterized by dryness. Soils series generally classified as gravelly or stony loams, being low in clay content and relatively low in fertility, include Bodine, Clarksville, Christian, and Coulstone. The Dickson, Hobson, Lebanon, and Nixa soils have definite fragipans.

Oak-pine stands are better suited to soils developed from dolomitic parent materials rather than cherty limestones. These soils contain considerably less chert, lack well-developed fragipans, are weathered deeper, and provide a better moisture supply than soils on typical pine sites. The principal soil series are: Baxter, Dewey, Fullerton, Minvale, and Talbott.

Sites

Shortleaf pine trees are not always present on sites where the forest manager suspects that pine would grow well. But black oak trees 40 to 60 years old occur on a wide variety of sites; therefore, it is convenient to discuss site quality for both pine and oak in terms of black oak site index. (Site index usually is expressed as the height that dominant trees will attain in 50 years.)

Although shortleaf pine occurs naturally where the black oak site index may vary from 30 to 80, commercial production of pine may not be profitable on all these sites. In general, where the site index is 45 or less, growth rates usually are too low to warrant intensive management of either oaks or pine, and where site index exceeds 65, oaks and other hardwoods grow fast enough to overtop pine trees unless they are released periodically. So pine or oak-pine stands usually will be managed where the site index ranges from 50 to 65.

In unmanaged stands the shortleaf pine type is usually limited to narrow ridgetops and the upper slopes with south and west exposures. On these drouthy sites, pines predominate because they tolerate the inadequate moisture supply better than most other desirable species. Where the pine type occurs naturally, site index usually is 50 or less, but pine stands can be grown on much better sites.

The more extensive oak-pine type occurs on north and east exposures and on middle and lower slopes of south and west exposures where moisture is more abundant. Site index usually ranges from 50 to 65. Where the oaks are of poorer quality, pine should be favored.

In the oak-pine type where the site index exceeds 65, periodic release of the pines from the fast-growing hardwoods may be profitable only where good pine markets exist.

Silvical Characteristics of Shortleaf Pine

Tolerance

Although older shortleaf pine trees are intolerant to shade, suppressed seedling and sapling pines in the understory respond well to release up to age 25 if they are not too badly deformed.

Seed Production

Good seed crops usually occur at intervals of 5 to 7 years. Some seed is produced nearly every year by full-crowned dominant trees, and some trees consistently bear seed. Heavy thinnings, leaving 30 to 50 square feet of basal area per acre in stands over 30 years old, will result in larger tree crowns and increased seed production.

Regeneration

Where an adequate seed source is present, obtaining natural pine regeneration on prepared sites is not difficult. At least 5, preferably 10, well-distributed good seed trees per acre are required.

Thinned stands sometimes have abundant pine reproduction, but a dense hardwood understory or a heavy hardwood leaf litter often precludes successful pine establishment. Such sites can be prepared by killing the unwanted hardwoods with herbicides and then, in the late summer or early fall of a good pine seed year, making a prescribed burn. Where there are too few pine seed trees, direct seeding (or planting) can be used. On rocky sites where machine planting is impossible, direct seeding costs much less than hand planting and usually will be equally successful. Because good pine seed crops are produced infrequently, the time required to establish natural regeneration will be reduced by direct seeding.

Growth

Where site index is 55 to 60, pine trees will attain heights of 35 to 40 feet by age 25 (fig. 1). Height growth rate averages a foot a year between ages 25 and 40, 0.8 foot from age 41 to 60, and 0.5 foot in older stands. These growth rates are similar to those for black oak and scarlet oak to age 40, but older oak trees maintain rapid height growth somewhat longer than pines, especially where oak site index exceeds 65.

Diameter growth rates of individual trees are directly proportional to crown size. For maximum growth, crown length should be at least one-third of total tree height. Where good crowns are maintained on trees by periodic thinnings in post-size or larger stands, average d.b.h. growth rate is about 2 inches with every 10-foot increase in total height. Both diameter and height growth rates decrease with tree age and size, but good merchant-

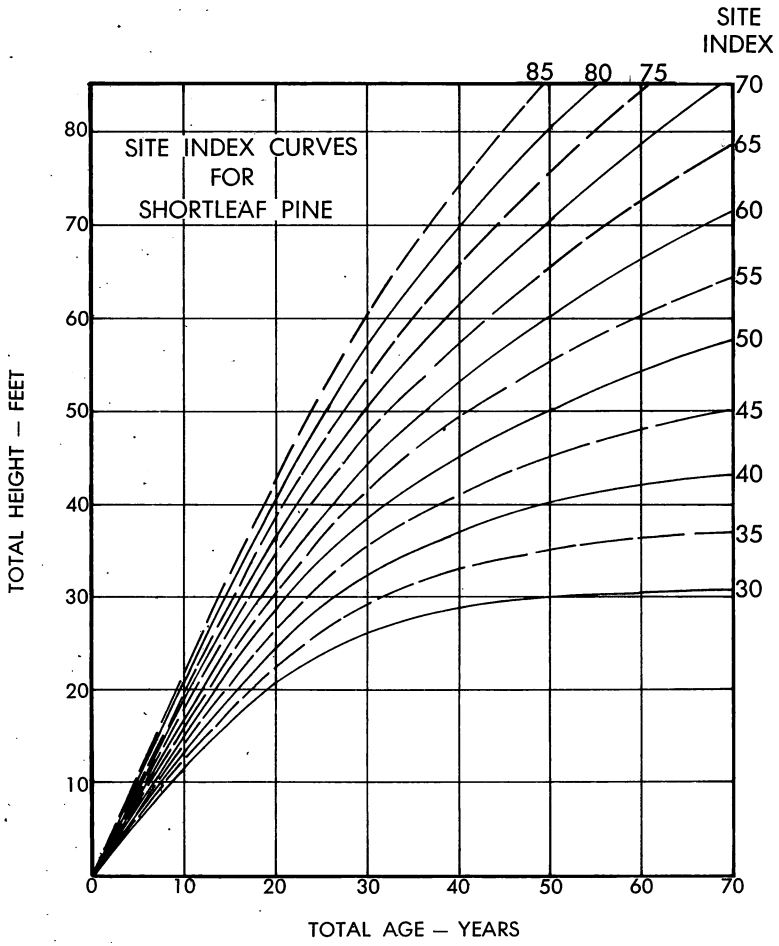

Figure 1. — Site index curves for shortleaf pine in Missouri. From A. J. Nash, "A method of classifying shortleaf pine sites in Missouri," Missouri Agr. Exp. Sta. Res. Bull. 824; 1963.

able volume growth rate of larger trees is maintained for many years.

Susceptibility to Damage

Fire. — Tops of pines in the seedling and sapling size classes may be killed by light fires. Because thrifty trees as large as 3 inches d.b.h. usually sprout vigorously, the major effect of fire on such trees is loss of growth rather than mortality. However, multiple-stemmed trees result where several sprouts persist.

Fire damage to larger trees usually is limited to butt scars caused by heavy fuels burning near the base of trees; these scars usually pitch over and thereby prevent entrance of decay fungi.

Crown fires are rare in the shortleaf pine type; but when they do occur, both pole and sawlog-size trees may be killed.

Insects. — Larvae of Nantucket tipmoth, red-headed pine sawfly, and loblolly pine sawfly injure the growing tips and eat the foliage of pine trees. Tipmoth populations may be locally destructive for several years before natural predators control the insects. Damage is most severe in plantations outside the natural pine range. No practical direct control method is known.

Turpentine and engraver beetles may kill healthy as well as weakened trees after nearby stands have been logged. Valuable trees, as in seed production areas, can be protected by spraying the lower trunks of the trees with a 0.5-percent solution of benzene hexachloride in fuel oil.

Disease. — The greatest threat to pines is *Fomes annosus,* a root rot that is most common in planted old-field stands. It also occurs in natural stands, but there the rate of spread is much lower and no treatments are needed. Once the disease is established on old-field sites,

however, it is persistent. Dusting fresh-cut stumps with powdered Borateem[1] or applying a 10-percent Borateem-water solution prevents establishment of the fungus. This must be done immediately after trees are cut. To further reduce opportunity for infection on old-field sites, the number of thinnings should be limited.

The round galls caused by *Cronartium cerebrum* are found on many trees, but they seldom damage the main stem except on badly suppressed young trees. Heavily infected trees should be removed in first thinnings and seed should not be collected from such trees.

Basic Management Guidelines

The objective of timber management is to achieve the highest economic returns the site can produce in the shortest period of time. Returns are commonly measured in dollars, but other, less tangible values may be involved. To meet the various multiple-use objectives on National Forests, some reduction in expected dollar values may be justified. Regardless of the specific management objective in the pine or oak-pine types, the following general guidelines apply:

1. Manage both types as even-aged stands; avoid creating two-storied stands. Do not cut potential oak crop trees to release pine seedlings or saplings unless (1) the oaks compete directly with a better tree in the main stand; or (2) you are harvesting the main stand. Because white oaks take longer to reach sawlog size than pines and the other desirable oaks, manage white oak in even-aged groups of trees where these occur on good sites.

2. As early as feasible in the rotation, select and favor potential crop trees on the basis of species, tree quality and vigor, and site index. Plan to increase the

[1] *The mention of this product does not constitute its endorsement by the U.S. Department of Agriculture.*

proportion of pine in young oak-pine stands where site index is 45 to 55 by eliminating inferior-quality hardwoods through commercial sale and TSI (timber stand improvement) operations. Where site index is 55 to 65, leave more oak crop trees and manage as the oak-pine type.

3. Control the density and composition of growing stock through periodic intermediate cuttings to produce maximum volume and value returns during the rotation. Beginning about age 20 to 25, commercial thinnings may be made in pine stands and in the pine component of oak-pine stands. The poor market for small hardwoods usually means that these trees cannot be sold at a profit. Kill unwanted trees with herbicide to favor potential crop trees.

4. Select a rotation length in keeping with site potential, species composition, and management objectives. Rotation ages of most major species are similar. For intensively managed pine and oak-pine stands, the economic rotation usually will be 70 years or less, but an 80-year rotation often will be used on National Forests. And on good sites supporting stands of high-quality trees, the rotation may be as long as 90 years if the expected net returns for large trees are great enough to offset the additional costs for the longer rotation. In contrast, where the site index is 45 to 50, a post-pole rotation should be planned. Short rotations may be most profitable even on better sites, especially for plantations.

5. Provide for adequate regeneration of preferred species when mature stands are harvested or when converting hardwood stands to pine or oak-pine. Site preparation, direct seeding, planting, or other cultural measures should be applied where needed. In general, pine should be favored over oak species where the site index is 45 to 55. Release established pine regeneration in subsequent timber sales and by TSI.

Stand Conditions and Prescriptions

Pine and Oak-Pine Stands on Forest Sites

Seedling and sapling stands. — If pine reproduction is adequate, remove any overstory hardwoods or pines by commercial sale or TSI. Where needed to complete pine regeneration, retain four to six good seed trees per acre, or direct-seed the openings to pine. Prepare the site as necessary. Thin or clean sapling stands to release potential crop trees spaced at least 10 to 12 feet apart; provide about 3 feet of crown growing space on two or three sides of such trees.

Pole stands. — Harvest or kill any old residual trees to leave an even-aged stand. Thin pine stands when the trees reach post size to leave about 65 square feet of basal area per acre. Increase "leave" basal area to 80 (trees 5-inch class and larger) at age 40. Provide about 4 feet of crown growing space on two or three sides of each potential crop tree.

The oaks have wider crowns than pines of the same d.b.h., so leave from 5 to 10 square feet less basal area after thinnings in the oak-pine than in the pine type. Thus the basal area to leave will be adjusted for stand composition.

The basal area stockings shown here and elsewhere in the guide apply to uniform stands. Be sure to thin any clumps of trees to the prescribed level even though this may result in less than prescribed average basal area per acre. The main objective is to provide adequate growing space for crop trees.

Sawlog stands. — Desirable stocking level is 80 to 90 square feet of basal area per acre for uniformly stocked pine sawlog stands and somewhat less for oak-pine stands. Most trees this large show little response to release, but

thinnings will provide adequate crown space to maintain good volume growth. Harvest excess merchantable trees, especially hardwoods and the poorer quality pines. Kill unmerchantable hardwoods with herbicides.

Regeneration stage. — Where pine regeneration is inadequate when the stand reaches maturity, make a seed-tree cutting about 10 years before the final harvest cut. On pine sites, reduce stocking to leave about 40 square feet of basal area in pine. Prepare the site for regeneration by killing unwanted understory hardwoods with herbicides. If necessary, prescribe-burn in the fall just before a good seed crop matures. When at least 300 well-distributed pine seedlings per acre are established, harvest the pine seed trees. An alternative procedure is to clear cut the mature stand, prepare the site as above, and direct-seed to pine.

On oak-pine sites, somewhat more finesse is required to obtain the desired species mixture. Increase pine regeneration as needed and kill unwanted species or individual poor-quality oaks with herbicides. If the hardwoods are merely cut, their vigorous sprouts soon overtop adjacent pine seedlings.

Pine Plantations on Old-Field Sites

Pole stands. — Because of the greater hazard of *Fomes annosus* infection, delay the first thinning until age 30-35. Leave about 65 square feet of basal area per acre and *treat stumps.* The second and last thinning should be made about age 50; leave 80 square feet of basal area.

Harvest cutting. — Economic rotation for most plantations is about 65 years when most trees can be sold for large poles or sawlogs.

If root rot (*Fomes annosus*) has not become established in the stand and growth has been satisfactory, plan to regenerate the stand. Leave about 25 seed trees per

acre; control excess hardwoods with herbicide; and prescribe-burn if necessary prior to seed fall. Harvest the rest of the trees as soon as adequate regeneration is obtained. An alternate procedure is to harvest the entire stand, prepare the site, and direct-seed. Always treat stumps of cut trees.

Examples of Recommended Treatments

Shortleaf Pine Sites

Stand Description	*Prescription*
Well-stocked pine stands more than 70 years old. Understory includes at least 300 well-distributed pine seedlings or 150 saplings per acre.	Unless expected future value justifies holding stand longer, harvest or kill all trees except pine regeneration. Control excess small hardwoods in understory with herbicides.
Stands as above but with inadequate pine reproduction.	Reduce stocking to leave 40 to 50 square feet basal area of pine per acre. Prepare site for regeneration by killing excess understory hardwoods with herbicides. If necessary, also prescribe-burn litter just prior to fall of good pine seed crop. Harvest pine seed-trees after regeneration is established. Alternate procedure is to harvest all trees, prepare site, and direct-seed or plant.
Pole stands (30 to 45 years old) or immature sawtimber stands with more than 70 square feet basal area of pine per acre.	Favoring pine where possible, reduce basal area of crop trees to 70 to 85 square feet; amount will vary with age and size of trees. Leave potential hardwood crop trees not competing with pines. Harvest or kill all other trees in main stand.

Pole or immature sawtimber stands with 50 to 70 square feet basal area of pine or hardwood crop trees per acre.	Leave any potential hardwood crop trees not competing with pines; thin dense clumps of pine to leave 70 to 80 square feet basal area (hardwood crop trees and pine) per acre. Sell or kill other trees of any species. Convert stand to pine type at maturity.
Pole or immature sawtimber stands overstocked with inferior hardwoods and with less than 50 square feet basal area of pine or hardwood crop trees per acre.	These problem stands often are not worth managing to maturity. Either (1) provide growing space for pine and oak crop trees by removing competing inferior-quality hardwoods, or (2) convert stand to pine by direct-seeding.
Well-stocked seedling and sapling stands of pine under partial canopy of sawlog-size trees.	Remove overstory trees and treat young pine stands as described on page 10.

Oak-Pine Sites

Stand Description	*Prescription*
Mature stands with at least 300 seedlings or 150 saplings per acre of desirable species and form.	Harvest or kill all overstory trees and release pine and desirable hardwoods with herbicides.
Mature stands but with desirable reproduction inadequate to form new stand.	Harvest or kill all hardwoods, and all but 10 to 12 pine seed trees per acre. Prepare site for pine regeneration. Or clear-cut and direct-seed pine.

Pole stands (30 to 45 years old) and immature sawtimber stands with more than 70 square feet basal area per acre of potential crop trees.	Select potential crop trees (favoring pine where possible) and provide release on 2 or 3 sides by harvesting or killing competing trees. Leave 65 to 75 square feet basal area per acre depending on tree size and stand composition.
Pole or immature sawtimber stands with 50 to 70 square feet basal area per acre of potential crop trees.	On average or better sites stocking density will reach acceptable level within 10 years. Release potential crop trees by sale or TSI, favoring pine trees. In next cut, reduce basal area to 65 to 75 square feet basal area per acre.
Pole or immature sawtimber stands with only 30 to 50 square feet basal area per acre of potential crop trees. Balance of stand inferior-quality hardwoods.	On most sites very little investment can be justified in such stands until more trees are large enough to sell. Then harvest merchantable hardwoods and kill any others that compete with crop trees. These marginal sites usually are better suited for pine than hardwoods, so plan to convert to pine at maturity, usually by direct-seeding.
Sapling stands with 150 or more potential pine or oak crop trees per acre.	Release about 150 potential crop trees per acre with herbicides. Provide 3 to 5 feet of crown growing space on all sides of these trees.

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