Oak–Pine

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The oak–pine type includes some 35 million acres of predominantly upland sites in the Southern and Eastern United States (33). Its range extends from southern New York and New Jersey to Pennsylvania, southern Ohio, Kentucky, southwestern Illinois and southern Missouri, south through Arkansas to eastern Oklahoma and east to northern Florida and north through the Atlantic Coast States to Delaware (6, 12, 14).

The several pine and oak species that comprise the oak–pine type are adaptable to a great variety of site and soil conditions. The type is found on all topographic positions from dry rocky ridges and steep slopes of the Appalachians and Ozarks to the gently rolling or flat terrain of the Piedmont or Atlantic and Gulf Coastal Plains. Ultisols are the dominant soils throughout the oak–pine range. Soils are derived from a wide variety of parent materials, including sedimentary and metamorphic rocks, marine terrace, and loess, and range from clays to sandy loams. The type is much less common on soils with high pH values or high calcium content (14).

The oak–pine type occurs at elevations as low as 10 feet (3 m) in southern New Jersey to 3,000 feet (915 m) in the Appalachians, although the type is most common at elevations of from 150 feet (45 m) in the Coastal Plain to about 1,500 to 2,000 feet (455 to 610 m) in the Piedmont and mountainous regions (14).

Climatic conditions vary widely throughout the oak–pine range. Annual precipitation averages 37 to 40 inches (940 to 1015 mm) in the northeastern and western portions of the range and 60 inches (1525 mm) along the Gulf Coast (31). Mean annual temperatures vary from 48° to 70° F (8.9° to 21.1° C), and the frost-free period ranges from 160 days in the north to about 250 days on the Gulf Coast.

The oak–pine type is composed of forests in which upland oaks and other hardwoods comprise 50 to 75 percent of the stocking and southern pines constitute the remainder (32). It encompasses the major pine–hardwood forest cover types as classified by the Society of American Foresters (12) including: Shortleaf Pine–Oak (type 76), Virginia Pine–Oak (type 78), and upland portions of Loblolly Pine–Hardwood (type 82). Pitch pine–oak variants of the Pitch Pine type (type 45) are common in the northeast and on poorer sites in the Appalachians, while Longleaf Pine–Scrub Oak (type 71) is common on the Atlantic and Gulf Coastal Plains. The oak–pine type is closely associated with and is most common within the geographic range of the Shortleaf Pine (type 75) and Loblolly Pine–Shortleaf Pine (type 80) forest types. Major oak species include white (*Quercus alba* L.), post (*Q. stellata* Wangenh.), black (*Q. velutina* Lam.), scarlet (*Q. coccinea* Muenchh.), northern red (*Q. rubra* L.), southern red (*Q. falcata* Michx. var. *falcata*), and chestnut (*Q. prinus* L.). Associated hardwoods include hickories (*Carya* spp.), yellow-poplar (*Liriodendron tulipifera* L.), sweetgum (*Liquidambar styraciflua* L.), black gum (*Nyssa sylvatica* Marsh.), and red maple (*Acer rubrum* L.). Major pine species are shortleaf (*Pinus echinata* Mill.), loblolly (*P. taeda* L.), Virginia (*P. virginiana* Mill.), and, to a lesser extent, pitch (*P. rigida* Mill.) (21).

Oak–pine represents a transitional stage of the successional pattern from an essentially pine-dominated forest to the climax forest types dominated by oaks and other hardwoods (25, 26). When farmlands are abandoned, southern pines become established on the open lands. Tolerant hardwood species invade the understory of pine stands and gradually increase in numbers, height, and basal area. Under heavy overstory shade, pine reproduction cannot compete successfully with the hardwoods for light and moisture, and few survive (18, 19, 35). Harvesting of large pines and losses by windthrow, insects, and disease create small openings in pine forests which are quickly occupied by oaks and other hardwoods already present in the understory. Over time, the pine-dominated stands are transformed to oak–pine stands, which in turn will be replaced by oak and other hardwood-dominated stands. Unless followed by adequate cultural treatments, repeated cuttings in pine stands will increase the amount of hardwoods and hasten the succession to oak–pine and then to oak–hickory (3, 4, 5, 34). By 1973, more than 70 million acres (28.3 million ha) of pine site lands were occupied by oak–pine or hardwood types (24), and the acreage has continued to increase through 1979 (3, 4).

Yield of oak–pine stands will vary with the amount of pine, but on upland sites yield will be intermediate between pine and oak–hickory types. For natural stands on upland sites in North Carolina and eastern Virginia, oak–pine yields at age 50 averaged about 2,600 cubic feet and 9,400 board feet (fbm) (International ¼-inch) per acre (182.0 and 131.6 m^3/ha, respectively)[1] on good sites and about 1,600 cubic feet and 2,700 fbm per acre (112.0 and 37.8 m^3/ha, respectively) on poor sites. Board foot volumes averaged about 50 percent less on both sites while cubic foot volumes were 25 percent less on good sites but were approximately the same as pure loblolly pine stands on poor sites. Upland hardwoods, primarily oak–hickory, produced the lowest average yields on all sites (16). Across the southern region, average loss in yield resulting from hardwood competition in natural pine stands has been estimated at 25 percent (13).

On better sites, oaks and associated species produce desirable stems and the succession from oak–pine to oak and other hardwood types should be encouraged. Also, hardwood species are aggressive on better sites and control is difficult and expensive. On medium to poor sites, the silvicultural objective for timber production in the oak–pine type is to increase the pine and reduce the hardwood components. Pines are favored over hardwoods because of the greater demand for pine products and because of faster growth, greater yields, and high quality and value of pines on most upland sites. On poorer sites, pine will produce moderate

[1] Cubic foot and metric conversions of measurements expressed in board feet should be viewed as estimates because of the assumptions involved in the conversion process.

yields of merchantable material while associated hardwoods are usually of poor quality, grow slowly, and produce lower yields.

The several pine species of the oak–pine type are intolerant of shade (14) and are best suited to an even-aged system of management. To obtain maximum pine stocking in future stands, harvest cuttings must be accompanied by intensive hardwood control methods such as prescribed burning, chemicals, or mechanical site preparation (7, 36, 37). Natural pine regeneration can be obtained with shelterwood, seed-tree, and patch or strip clearcut systems, providing suitable seedbed preparation and competition control measures are achieved (7, 20). Pure stands of pines (particularly loblolly) of excessive densities frequently become established by natural or broadcast seeding on well-prepared sites. Dense natural stands of southern pines usually respond well to precommercial thinning. To insure best volume gains, stocking should be reduced to 500 to 700 stems per acre (1240 to 1730/ha) by age 5 (15, 22).

Clearcutting followed by site preparation, hardwood control, and seeding or planting has been the most effective and desirable system to regenerate southern pines. This system results in more uniform stocking and spacing, permits introduction of superior planting stock or insect and disease resistant strains, and allows more flexibility in selecting the pine species most suitable to a particular planting site. Loblolly pine should be favored over shortleaf on sites where littleleaf disease (*Phytophthora cinnamomi* Rands) hazard is high (8). Planting or seeding also permits replacing loblolly with shortleaf in the northern part of the range where loblolly is susceptible to ice and snow damage and in the southern areas where loblolly is vulnerable to fusiform rust (*Cronartium quercuum* (Berk.) Miy. ex Shirai f. sp. *fusiforme* Burds. & Snow)(10).

Even-aged management with intensive site preparation and hardwood control measures will inevitably result in conversion of oak–pine to the pine forest types. Conversion measures are expensive and costs increase with the amount and size of the hardwood component (1). Such measures are feasible under a management system where timber production is the primary objective. However, nearly 70 percent of the oak–pine type is controlled by nonindustrial private owners whose management objectives for their forest land are varied and generally not oriented toward maximum timber production. Most nonindustrial landowners, for a variety of social and economical reasons, passively permit the more tolerant hardwoods to increase after the harvest of pines (4). Consequently, a high percentage of the oak–pine forest is in poor condition and has low stocking in trees that could be featured in management (17).

Although even-aged methods are preferred as the best timber management, the use of uneven-aged management with group selection cutting and natural regeneration can be used as an alternative to increase productivity over the exploitive cutting common to most nonindustrial private forest lands. Uneven-aged management can be effective on small ownerships and is adapted to both understocked and well-stocked stand conditions (38), and has been successfully applied to a limited extent in pine (7, 27) and hardwood forests (23). A combination of silvicultural practices—cleaning, improvement, liberation, and salvage cuts and thinnings when combined with group selection cutting—can effectively rehabilitate depleted oak–pine stands (30). Where better quality hardwoods occur on suitable sites, they should be favored. Yellow-poplar, like the southern pines, is intolerant of heavy shade and requires the same degree of overstory release and understory control as the pines for successful regeneration. Although intermediate in tolerance, desirable oak species also attain optimum growth under relatively open conditions, and openings of ½ acre (0.2 ha) or more are recommended. Adequate oak reproduction, as advance reproduction already established on the site or expected from stump sprouting, must be assured before the harvest cut (28). Feasibility of the more intensive rehabilitation treatments have been enhanced in the eastern portion of the oak–pine range by expanded markets for low value hardwoods and the increased use of whole-tree chippers. If a pine seed source is absent following a clean harvest operation, a mixed pine–hardwood stand can be established by planting pine. Establishment costs would be relatively low and the pine component can be increased with follow-up release (29).

Mixed uneven-aged oak–pine forests are esthetically pleasing and provide a diversity of habitat for many game and nongame wildlife species (9, 11). Mixed stands also have a lower incidence of attack by insects such as the southern pine beetle (*Dendroctonus frontalis* Zimmermann) (2). However, without some hardwood control in regeneration openings, the group selection system favors tolerant noncommercial hardwood species. Fire cannot be used for seedbed preparation, since seedlings in nearby regeneration openings would be killed. Group selection openings are generally too small for machine operation and sites must be prepared by scarification incidental with logging. If desirable reproduction is not obtained promptly, more expensive hand methods will be needed to control undesirable hardwoods that usually dominate the small openings.

Single tree selection cutting is not recommended for management in the oak–pine type because it discriminates sharply against the more light-demanding species. Openings created by removal of individual trees are usually too small to insure adequate reproduction of southern pines, yellow-poplar, and most upland oak species that dominate the oak–pine type. Successful regeneration of these species requires forest openings of at least 0.3 acre (0.1 ha) but preferably larger (14, 23, 28, 38).

Oak–pine stands with their diversity of species offer a variety of spring-flowering and fall coloration which are esthetically pleasing to forest visitors and recreationists. Regeneration cuttings in even-aged management and group selection cuttings in uneven-aged management, through the openings they create, provide abundant food and shelter for a variety of wildlife species. For rare and endangered species, silvicultural operations must provide the special habitat requirements that will ensure their continued existence. Impacts of well-planned silvicultural operations are minimal on water quality.

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United States
Department of
Agriculture

Forest
Service

Agriculture
Handbook
No. 445

Silvicultural Systems for the Major Forest Types of the United States

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Technical Compiler
Timber Management Research

U.S. Department of Agriculture
Washington, D.C.

Forest Service
Revised December 1983