Quercus prinus L. Chestnut Oak

Fagaceae Beech family

Robert A. McQuilkin

Chestnut oak (Quercus *prinus),* sometimes called rock chestnut oak, rock oak, or tanbark oak, is commonly found in the Appalachian region on dry, infertile soils and rocky ridges but reaches best growth on rich well-drained soils along streams. Good acorn crops on this medium-sized, long-lived tree are infrequent, but the sweet nuts are eaten by wildlife when available. Chestnut oak is slow growing and the lumber is cut and sold as white oak.

Habitat

Native Range

Chestnut oak (figs. 1, 2) extends from southwestern Maine west through New York to extreme southern Ontario, southeastern Michigan, southern Indiana and Illinois, south to northeastern Mississippi, and east to central Alabama and Georgia; then north to Delaware, mostly west of the Coastal Plain. Its best growth occurs in the mountains of the Carolinas and Tennessee *(18).*

Climate

The climate throughout most of the range of chestnut oak is humid, with small superhumid areas in the Appalachian Mountains. The average annual precipitation varies from 810 mm (32 in) in western New York and southern Ontario to more than 2030 mm (80 in) in the southern Appalachians; however, annual precipitation for the majority of the chestnut oak range is between 1020 and 1220 mm (40 and 48 in). Length of growing season varies from 120 days in New England to 240 days in northern Alabama and Georgia *(18).*

Soils and Topography

Chestnut oak is most commonly found on dry upland sites such as ridgetops and upper slopes with shallow soils, south- and west-facing upper slopes, and sandy or rocky soils with low moisture-holding capacity of the orders Ultisols and Inceptiols. Chestnut oak grows from near sea level on the Coastal Plain of New Jersey and Long Island to elevations of approximately 1400 m (4,600 ft) in the southern Appalachians *(4,8).*

In the Blue Ridge Mountains of northern Georgia, site index for chestnut oak ranges from 12 to 25 m (39 to 83 ft), and averages about 20 m (65 ft). Site index is greater on steep slopes, lower slope positions, and at elevations below 800 m (2,600 ft) than elsewhere. Other indicators of good chestnut oak sites are subsoils with more than 15 percent silt, loam or sandy loam surface soils, and sites where litter decomposes rapidly *(15).* Chestnut oak growth is poorest on soils of the Porters (Humic Hapludult) and Ashe (Typic Dystrochrept) series, intermediate on soils of the Hayesville and Halewood series (Typic Hapludults), and best on soils of the Tusquitee and Brevard series (Humic and Typic Hapludults, respectively) *(6).*

Associated Forest Cover

Chestnut oak is a major component in 2 forest cover types and an associated species in 10 others (8). Chestnut Oak (Society of American Foresters Type 44) is found primarily on dry south- and west-facing slopes, ridgetops, and rocky outcrops throughout the Appalachian Mountains at elevations from 450 to 1400 m (1,475 to 4,600 ft). Associated species in this type vary greatly by region, elevation, topographic position, and soils, and include other upland oaks (Quercus spp.) and hickories *(Carya* spp.); sweet birch *(Betula lenta)*; yellow-poplar *(Liriodendron tulipifera);* blackgum *(Nyssa sylvatica)*; sweetgum *(Liquidambar styraciflua)*; black cherry *(Prunus serotina);* black walnut *(Juglans nigra);* red *(Acer rubrum)* and sugar *(A. saccharum)* maples; eastern redcedar *(Juniperus virginiana);* eastern hemlock *(Tsuga canadensis)*; and red *(Pinus resinosa),* eastern white *(P. strobus),* pitch *(P. rigida),* Table Mountain *(P. pungens),* shortleaf *(P. echinata),* Virginia *(I? virginiana),* and longleaf *(P. palustris)* pines. A variant of this type, chestnut oak-northern red oak, is found in disturbed forests in the Catskills in New York and on Massanutten Mountain in Virginia. The variant chestnut oak-scarlet oak is identified in the central Appalachians, while the variants chestnut oak-pitch pine, chestnut oak-eastern white pine-northern red oak, and chestnut oak-black oak–scarlet oak occur in the southern Appalachians.

White Pine-Chestnut Oak (Type 51) is found in the Appalachian region from West Virginia to Georgia. It is most common in southwestern Virginia, eastern

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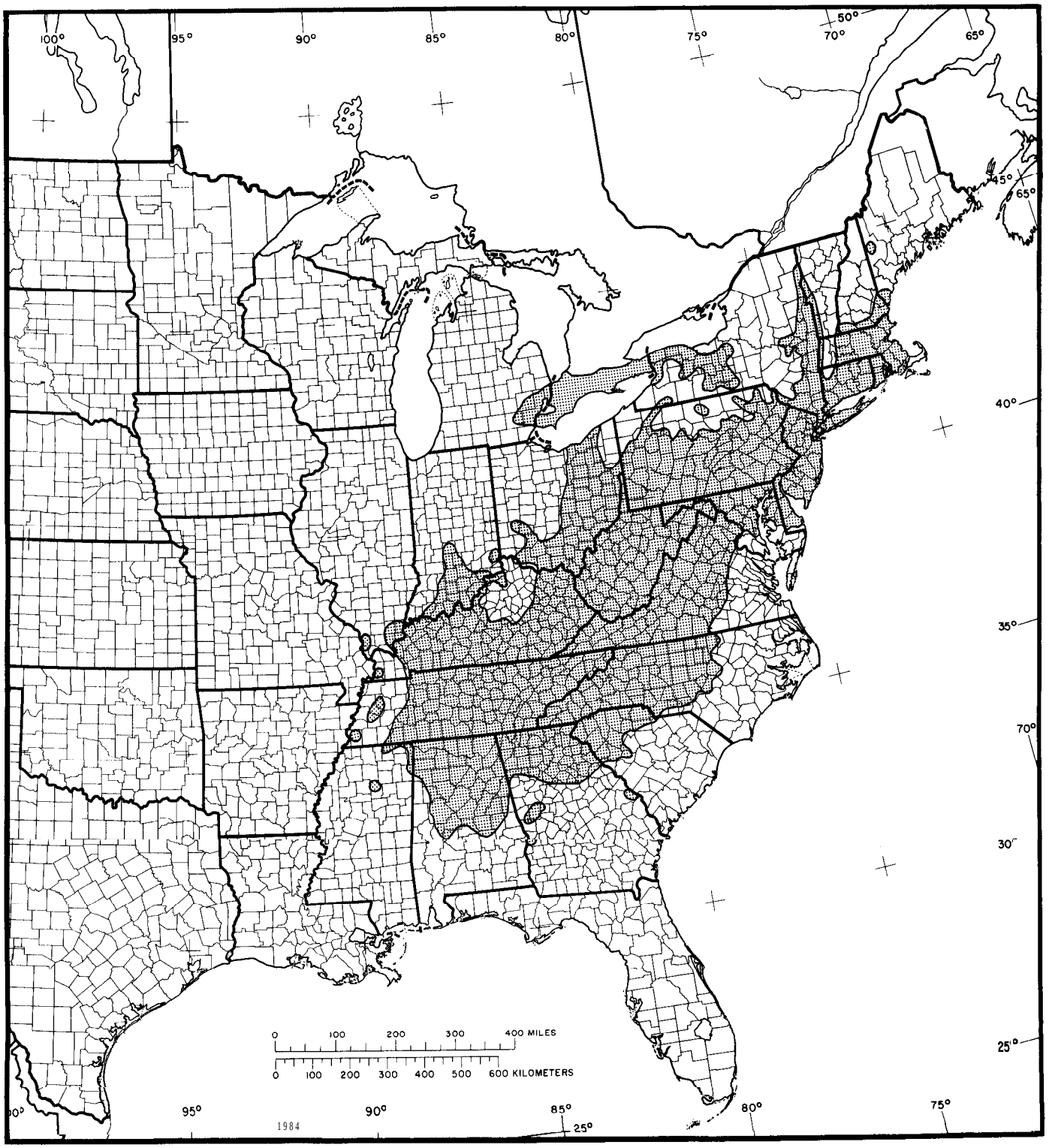

Figure *1-The native range of chestnut oak.*

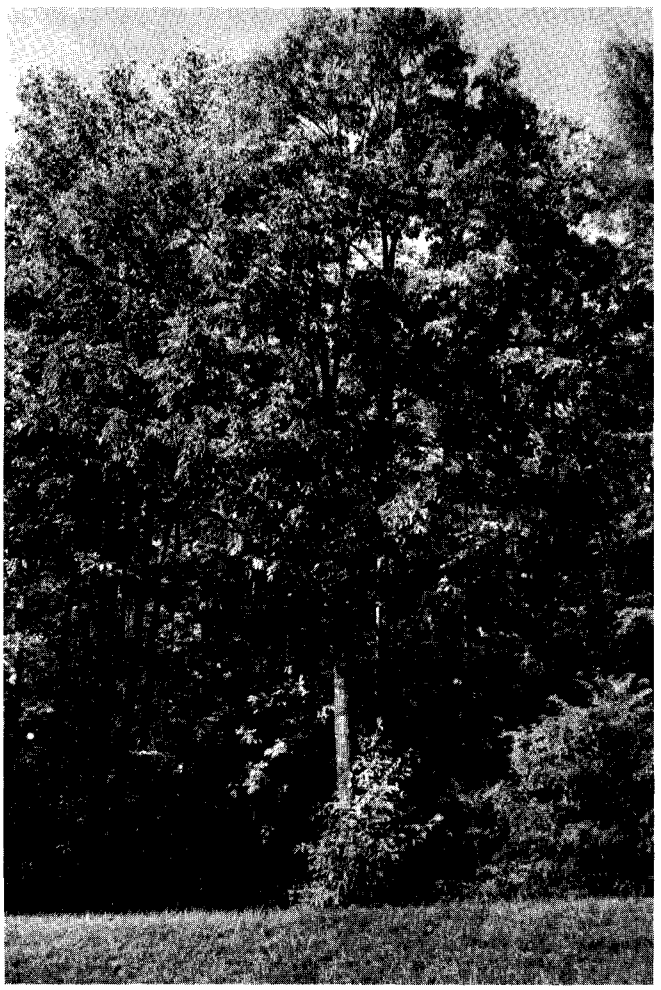

Figure 2—*Chestnut* oak.

Tennessee, and western North Carolina at elevations between 360 and 1100 m (1,200 and 3,600 ft). On the drier sites, common associated species include scarlet ***(Quercus coccinea)***, white *(Q. alba)*, post *(Q. stellata)*, and black *(Q. velutina)* oaks; hickories; blackgum; sourwood ***(Oxydendrum arboreum)***; red maple; and pitch, Table Mountain, Virginia, and shortleaf pines. On more mesic sites, associated species include northern red ***(Quercus rubra)*** and white oaks, black locust ***(Robinia pseudoacacia)***, yellow-poplar, sugar and red maples, and black cherry.

Chestnut oak is also an associated species in the following cover types: Eastern White Pine (Type 21); White Pine-Hemlock (Type 22); Red Maple (Type 108); Bear Oak (Type 43); White Oak-Black Oak–Northern Red Oak (Type 52) and its variants white oak-black oak-chestnut oak, black oak-scarlet oak–chestnut oak, and scarlet oak-chestnut oak; White Oak (Type 53); Black Oak (Type 110); Pitch Pine (Type 45) and its variant pitch pine-chestnut oak; Virginia Pine (Type 79); and Virginia Pine-Oak (Type 78).

Common shrub associates of chestnut oak include highbush and lowbush blueberry *(Vaccinum corymbosum* and *V. angustifolium)*, dwarf chinkapin oak ***(Quercus prinoides)***, and mountain-laurel *(Kalmia latifolia)*.

Before the demise of American chestnut ***(Castanea dentata)***, chestnut oak was an important component of the Appalachian oak-chestnut forests. Since then, hickory, chestnut oak, northern red oak, and white oak have replaced American chestnut as these stands have gradually changed to oak-hickory stands *(20)*.

Life History

Reproduction and Early Growth

Flowering and Fruiting-Chestnut oak is monoecious; the flowers develop in the spring at the time of bud-break and leaf development. The staminate flowers are borne on aments (catkins) that originate from buds in the terminal bud cluster of the previous year's shoots. Development of the aments begins with the first expansion of these buds, when minimum air temperatures remain above 10" C (50" F) for more than 10 days. Pistillate flowers develop on short stalks in the axils of the new leaves from 5 to 10 days after the aments emerge. Pollination is by wind; pollen dispersal occurs 10 to 20 days after the aments emerge and is controlled largely by weather. Above-normal temperatures in late April followed by 13 to 20 days of below-normal temperatures in early May enhance successful pollination and the development of large acorn crops. The early warm period promotes the development of the aments, shoot expansion, and pistillate flower development, and the later cool period delays pollen dispersal to better coincide with pistillate flower maturation. Uniformly increasing temperatures during this period usually result in poor pollination and small acorn crops *(27,28)*.

Chestnut oak produces an abundant crop of aments every year, but the production of pistillate flowers varies considerably from year to year; trees that produce a large crop of flowers and acorns one year usually produce fewer flowers the following year.

Seed Production and Dissemination-chestnut oak acorns mature in one growing season and drop from early September to early October, 2 to 5 weeks before the acorns of other upland oaks. Production of chestnut oak acorns is erratic, and

heavy crops occur only once every 4 or 5 years. In general, chestnut oak produces fewer acorns than other upland oaks, although occasional trees can be prolific seed producers (2).

Chestnut oak begins producing seed at about age 20, but stump sprouts as young as 3 years can produce viable seed, and coppice stands as young as 7 or 8 years can have abundant acorn production. The germinative capacity of sound acorns is around 90 percent. Dissemination is primarily by gravity and squirrels *(4,22,26).*

Seedling Development-Chestnut oak acorns have no dormancy and therefore germinate in the fall. Germination is hypogeal (22). If temperatures are below 16" C (61" F), however, shoot (but not root) development is inhibited by an induced epicotyl dormancy. This dormancy is broken by chilling during the winter, and normal shoot development resumes in the spring (9). Some acorns germinate at day/night temperatures of 10°/2° C (50°/35° F), but most germinate at temperatures at or above 18°/10° C or 65°/50° F). Chestnut oak acorns are much more capable of germinating in dry soil than acorns of white, black, or northern red oak. This difference may be due to a thick parenchyma layer in the acorn pericarp that allows them to absorb and retain more moisture than acorns of other oaks *(17).*

Germination of chestnut oak acorns is enhanced by a covering of leaf litter 2 or 3 cm (1 in) deep, but a covering of more than about 5 cm (2 in) results in many etiolated seedlings. Large numbers of seedlings can become established after good seed years, but such years occur infrequently. Seedling establishment and survival are greatly reduced by dense herbaceous and shrub layers.

Chestnut oak seedlings grow slowly. In Indiana, the height of seedlings 10 years after establishment averaged 15 cm (6 in) in an uncut forest, 24 cm (9 in) where release cuttings were made, and 146 cm (58 in) in a clearcut. In contrast to this slow seedling growth, chestnut oak sprouts in the clearcut were more than 6.4 m (21 ft) tall (4). The seedlings are capable of rapid growth, however, when growing conditions are near optimal. In one nursery study, chestnut oak seedlings produced an average of 4.3 growth flushes during the first growing season and exceeded bear oak and white oak, and equaled or exceeded northern red oak in height, dry weight, and leaf area. Growth of these seedlings was highly correlated with initial leaf area, which in turn was correlated with acorn size (II).

Vegetative Reproduction-When tops die back or are damaged, chestnut oak seedlings and advance reproduction sprout vigorously from dormant buds at the root collar or on the stem. For stems of advanced reproduction that have been cut, the number of sprouts per plant and the growth of the sprouts increase with increasing size of the original stem and root system (25). Stumps of cut trees up to 60 years of age sprout vigorously, but the percent of stumps that sprout declines with increasing size for trees more than 46 cm (18 in) in d.b.h. Incidence of decay is low for stump sprouts that originate within 5 cm (2 in) of the ground and such sprouts can develop into high-quality trees. Sprouting frequency and vigor are greater from stumps of trees cut during the dormant season than from those cut during the growing season *(24,35).*

It has been estimated that 75 percent of the chestnut oak reproduction in the southern Appalachians is of sprout origin (4).

Sapling and Pole Stages to Maturity

Growth and Yield-Chestnut oak is a medium-size tree; at maturity it usually attains a height of 20 to 24 m (65 to 80 ft) and a d.b.h. of 51 to 76 cm (20 to 30 in) depending on site quality. Maximum dimensions are approximately 30 m (100 ft) in height and 183 cm (72 in) in d.b.h. (4). In mixed oak stands, the height growth of adjacent dominant and codominant chestnut, scarlet, northern red, and black oaks is about equal and is greater than that of white oaks *(7,33).* White, chestnut, black, and scarlet oaks of equal site index (height at base age 50 years) have similar height growth patterns up to about age 60. Beyond this age, white oak maintains a better height growth rate than the other three species and, at site indexes below about 18.3 m (60 ft) chestnut oak maintains a height growth intermediate between that of white oak and the black and scarlet oaks (5). On comparable sites in West Virginia, diameter growth of chestnut oak is generally greater than that of white oak, the same as that of scarlet oak, hickory, and beech *(Fagus grandifolia),* but less than that of northern red and black oaks, yellow-poplar, sugar maple, basswood *(Tilia americana),* black cherry, and white ash *(Fraxinus americana) (30,31).*

Sawtimber yield from chestnut oak stands on dry slopes and ridges in the southern Appalachians is about 98.0 m^3/ha (7,000 fbm/acre) at age 80. On average sites, maximum periodic growth is about 1.4 m^3/ha (100 fbm/acre) per year at age 100 (4).

On the better sites, chestnut oak has good form and maintains a bole that is relatively clear of branches and sprouts, although many epicormic sprouts develop if the bole is exposed to sunlight (32).

Rooting Habit-Chestnut oak seedlings initially develop a deep tap root but later lose this configuration. Saplings and larger trees have a root system consisting of 6 to 10 main lateral roots extending 3 to 10 m (10 to 33 ft) from the root crown at depths from near the soil surface to 91 cm (36 in>. Numerous secondary roots branch off these main laterals, and a dense mat of fine roots develops near the soil surface. The root system extends over an area approximately five times that of the crown area. The roots of chestnut oak are slightly deeper than those of northern red oak but not as deep as those of white oak (29).

Chestnut oak seedlings maintain much higher root starch levels during the growing season than white oak or northern red oak and have a higher root-to-shoot ratio and a more rapid initial root development rate than northern red oak. These factors may partially account for the species adaptability to xeric sites *(10,16)*.

Reaction to Competition-Chestnut oak is intermediate in shade tolerance. Among the oaks, it is similar in tolerance to white oak, but more tolerant than northern red, black, or scarlet oak. In closed stands in the Appalachian region, most chestnut oak reproduction lives only a few years. In partial shade, however, seedling sprout advance reproduction may persist for many years. These stems grow slowly and die back and resprout periodically but are capable of rapid growth if released.

In the Appalachian region, chestnut oak typically occupies intermediate to poor sites where it is considered to be the physiographic climax. It is excluded from the more mesic sites by species that grow more rapidly in the seedling and sapling stages, such as northern red, black, and white oaks; yellow-poplar; sugar and red maples; and black cherry. The most xeric sites are typically occupied by species even better adapted to such conditions, such as scarlet oak, post oak, and pitch pine *(8,21,23)*.

Damaging Agents-Because of its predominance on steep slopes and dry sites, chestnut oak has a higher incidence of fire damage and associated decay than other oaks throughout the Appalachians, although its inherent resistance to heartwood decay is greater than that of white, northern red, black, or scarlet oak. Chestnut oak is susceptible to most of the diseases of oaks including oak wilt ***(Cerutocystis fagucearum).*** It is particularly susceptible to the twig-blight fungus ***Diplodia longispora,*** a die-back and branch canker caused by ***Botryodiplodia*** spp., and, from Virginia northward, stem cankers caused by ***Nectria galligena*** and ***Strumella coryneoidea.*** The heartrot fungi ***Spongipellis pachyodon*** commonly occurs around dead branch stubs on chestnut oak in the southeast. Sprout rot, caused primarily by the heart rot fungi ***Stereum gausapatum, Fistulina hepatica,*** and ***Armillaria*** *mellea,* is common in chestnut oak stump sprouts that originate 5 cm (2 in) or more above the ground line, although the incidence of this rot is less in chestnut oak than in other oaks. The more important decay-causing fungi of chestnut oak in Ohio, Kentucky, Indiana, and Illinois are *Inonotus andersonii, Stereum gausapatum, Spongipellis pachyodon, Wolfiporia* **cocos, Inonotus dryophilus, Xylobolus frustulatus, Perenniporia compacta,** and ***Armillaria*** *mellea (3,13)*.

Chestnut oak and white oak are the two species most preferred by the gypsy moth ***(Lymantria dispar).*** Other important defoliators of chestnut oak are the spring and fall cankerworms *(Paleacrita vernata* and ***Alsophila pometaria),*** the forest tent caterpillar *(Malacosoma* ***disstriu)*** and the half-wing geometer ***(Phigalia titea)*** *(1,14,34)*.

Chestnut oak is more resistant to wood borers than most oaks but is particularly susceptible to attack by ambrosia beetles, especially the Columbian timber beetle ***(Corthylus columbianus)*** and several species of the genera ***Platypus*** and ***Xyleborus;*** these beetles are particularly damaging to trees that have been weakened by fire or drought. The more important wood borers that attack chestnut oak are the oak timberworm ***(Arrhenodes minutus),*** the carpenterworm ***(Prionoxystus robiniae),*** and the little carpenterworm *(P.* ***macmurtrei).***

Chestnut oaks are also susceptible to several gall-forming wasps ***(Cynipidae),*** a pit scale *(Asterolecanium* ***quercicola),*** and the golden oak scale ***(A. uariolosum).*** These insects may kill twigs and branches but rarely kill mature trees.

The acorns of chestnut oak are frequently infested with larvae of the nut weevils ***Curculio*** spp. and *Conotrachelus* spp., the moth ***Valentinia glandulella,*** and the cynipid gall wasps ***(Cynipidae).*** However, one study indicated that chestnut oak acorns may have lower insect infestation rates than acorns of other oaks *(2)*.

Special Uses

The acorns of chestnut oak, along with those of the other oaks, are an important food for many wildlife species including deer, turkeys, squirrels, chipmunks, and mice. Chestnut oak lumber is similar to and marketed as white oak ***(12).***

Genetics

No races of chestnut oak are known. Chestnut oak hybridizes with ***Quercus alba*** *(Q.* ***x saulii*** Schneid.);

Q. bicolor*; *Q. robur *(Q. x sargentii* Rehd.); and Q. ***stellata*** *(Q. x bernardiensis* W. Wolf) *(19).*

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