# LIVE OAK

## *Quercus virginiana* Mill.

Plant Symbol = QUVI

Cultivated tree, Greensboro, NC. Photographer: Douglas Goldman

*Common Names:* southern live oak, southeastern live oak, Virginia live oak, chêne vert

*Synonyms and other scientific names:* *Quercus andromeda* Riddell; *Quercus virginiana* var. *eximea* Sarg.; *Quercus virginiana* var. *virescens* Sarg.; *Quercus virens* Ait., nom. illeg.

**Description**

*General*: Medium to large trees 50-80 ft (15-25 m) tall, with short trunks, long branches, and very broad crowns occasionally approaching 150 ft (45.7 m) wide, but with longer trunks and narrower crowns in some older woodlands, occasionally to 115 ft (35 m) tall. Very large, old trees can have trunks exceeding 10 ft (3 m) in diameter at breast height. Wood can lack obvious or distinct growth rings, especially towards the southern part of its range (Tomlinson, 1986). Short root suckers often forming near the trunk. Bark is gray, very dark brown, to black, and scaly to blocky. Young twigs tan to pale gray, covered in short hairs, becoming darker and nearly smooth in the second year. Buds small, red-brown, rounded. Leaves thickened, shiny on the upper surface, the lower surface pale with short hairs but green and without hair in shade-grown leaves. Leaves 1.4-3.5 in (35-90 mm) long, 0.8-1.5 in (20-38 mm) wide, usually rounded to oblong, without teeth, but some summer growth and growth on juvenile trees with toothed leaves (Nelson, 1994) that can be smaller. Leaves appear evergreen but actually are deciduous, with trees bare or nearly so for up to a few weeks during or just preceding flowering in the early spring. Male and female flowers inconspicuous, borne separately on the same tree (typical of all oaks), female flowers wind-pollinated, solitary or in clusters of 2-3 or rarely up to 5, male flowers in catkins of several flowers. Acorns stalked, solitary or up to five in a cluster, acorn caps 0.3-0.6 in (8-15 mm) long and wide, bowl- to goblet-shaped, with numerous, tiny, sharp-pointed scales, nuts barrel-shaped to egg-shaped, 0.6-1.0 in (15-25 mm) long, dark brown to black. Seedlings with a swollen primary root developing shortly after germination. For detailed descriptions see Correll & Johnston, 1970; Miller & Lamb, 1985; Nixon & Muller, 1997; Stein et al., 2003; and Tomlinson, 1986.

*Related species:* *Quercus virginiana* is one of seven currently-recognized species of similar oaks contained within the North American and Carribean *Quercus* L. subgenus *Quercus* L. section *Quercus* L. **subsection *Virentes*** (Loudon) A. Camus (section *Virentes* Loudon, [unranked] *Virentes* (Loudon) Trel.), consisting of trees or shrubs with small, rounded buds, leathery, nearly evergreen leaves that in mature plants usually are untoothed or sparsely toothed; acorns that develop in one growing season and have fused cotyledons; acorn caps with flattened, triangular scales that are darkened apically; and seedlings usually with swollen taproots. *Quercus* subsect. *Virentes* is estimated to have been derived around 11 million years before present (Cavender-Bares et al., 2015), and is most closely related to the much more diverse and widespread white oaks in the remainder of *Quercus* sect. *Quercus* (Cavender-Bares et al., 2015; Hipp et al., 2014). Other species within *Quercus* subsect. *Virentes* are: *Q. brandegeei* Goldman, a small to medium-sized tree with very elongate acorns, of lower elevations in mountainous areas in southernmost Baja California, Mexico (Roberts, 1989; Wiggins, 1980); *Q. fusiformis* Small (*Quercus virginiana* var. *fusiformis* (Small) Sarg.), the Texas live oak, perhaps the most cold-hardy member of *Quercus* subsect. *Virentes* (Cavender-Bares et al., 2015; Diggs et al., 1999), a solitary-trunked to thicket-forming, small to large-sized tree or rarely a shrub, bearing somewhat elongated acorns, in various soil types and rock outcrops (especially limestone and granite), of southwestern Oklahoma, central and southern Texas, and northeastern Mexico; *Q. geminata* Small (*Q. virginiana* var. *geminata* (Small) Sarg., *Q. virginiana* var. *maritima* (Chapm.) Sarg.), the sand live oak, a thicket-forming shrub to medium-sized tree with leaves with revolute margins often resembling upside-down boats, of deep, dry, sandy soil in the outer coastal plain from Mississippi to North Carolina; *Q. minima* Small (*Q. virginiana* var. *dentata* (Chapm.) Sarg.; *Q. virginiana* var. *minima* Sarg., nom. illeg.), the dwarf live oak, a low, rhizomatous shrub forming dense colonies, and usually with toothed leaves, in somewhat moist, sandy soil, with a similar distribution to *Q. geminata*; *Q. oleoides* Schltdl. & Cham., a small to large-sized tree of seasonally dry subtropical and tropical forests from northeastern Mexico south to Costa Rica (Boucher, 1983; Jiménez et al., 2016; Kappelle, 2016); and *Q. sagraeana* Nutt. (orthographic variant *Q. sagrana*; *Q. cubana* A. Rich., *Q. oleoides* var. *sagraeana* (Nutt.) C.H. Mull., *Q. virginiana* var. *sagraeana* (Nutt.) Trel.), the sole Caribbean member of the genus (Trelease, 1924), a medium to large-sized tree of sandy to rocky soils in flat to hilly areas of western Cuba (Borhidi,

1996), which could be derived from *Q. virginiana* (Gugger & Cavender-Bares, 2013), or more likely *Q. oleoides* followed by introgression with Florida live oaks (Eaton et al., 2015). Live oaks in sandy soils of southernmost Texas may be hybrids of *Q. fusiformis* with *Q. oleoides*, and the name *Q. oleoides* var. *quaterna* C.H. Mull. has been used for at least some of these trees (Nixon & Muller, 1997). For further information on *Quercus* subsect. *Virentes* see Camus (1939), Muller (1961) and Trelease (1924) for a detailed morphological summary, and Cavender-Bares et al. (2015) for phylogeny and biogeography.

*Hybrids: Quercus virginiana* is known, presumed, or suspected to hybridize with *Q. alba* L., *Q. bicolor* Willd. (an artificial hybrid, *Q.* ×*nessiana* Palmer), *Q. lyrata* Walter (*Q.* ×*comptoniae* Sarg.), *Q. michauxii* Nutt., *Q. minima*, *Q. sinuata* Walter, and *Q. stellata* Wangenh (Douglas Goldman, personal observation; Miller & Lamb, 1985; Nixon & Muller, 1997). *Quercus virginiana* hybridizes with *Q. fusiformis* across central Texas, leading to much confusion between these two species (Eaton et al, 2015; Jones, 1975; Nixon & Muller, 1997; B.J. Simpson, 1988). *Quercus virginiana* occasionally may also hybridize with *Q. geminata* (Cavender-Bares & Pahlich, 2009). Some hybrids with suspected *Q. virginiana* parentage involve other live oak species instead, as with *Q.* × *burnetensis* Little (*Q. fusiformis* × *Q. macrocarpa* Michx.) and *Q.* × *harbisonii* Sarg. (*Q. geminata* × *Q. margaretta* (Ashe) Small).

The largest known living specimen of *Quercus virginiana* is in St. Tammany Parish, Louisiana (American Forests, 2016), with a height of only 68 ft, (20.7 m) but a crown spread of 139 ft (42.4 m) and a trunk circumference of nearly 39 ft (11.9 m). Because this tree has several trunks it may not be a single tree. Close competitors are a three-trunked tree in Waycross, Georgia, and a single-trunked tree in Seminole County, Georgia (Georgia Forestry Commission, 2015). The Waycross tree is 77 ft, (23.5 m) tall, an average crown spread of 155 ft (47.2 m) and a trunk circumference of 35 ft (10.7 m). The Seminole county tree is 89 ft, (27.1 m) tall, an average crown spread of 147 ft (44.8 m) and a trunk circumference of about 32 ft (9.8 m).

*Distribution*: Live oak is native to the coastal plain of the southeastern United States, from southeastern Virginia southward to south Florida and west to eastern Texas (Nixon & Muller, 1997). It is common to abundant throughout much of its natural range, but less so at its northeastern extremity in Virginia where it is relatively rare except along the coast near Virginia Beach (Weakley et al., 2012). For current distribution, please consult the profile page for this species on the PLANTS Web site (USDA NRCS, 2017).

*Habitat*: Warm-temperate to subtropical or marginally tropical woodlands, savannas, and grasslands, on slightly damp to somewhat dry clay, loam, or sand, occasionally on limestone. Perhaps best represented in evergreen woodlands on maritime barrier islands, but also in various forest types in peninsular Florida, including those of floodplains, moist hammocks, and upland tropical hammocks on limestone (Clewell, 1985; Duever et al., 1986, ch. 5; Harms, 1990; Nixon & Muller, 1997; Snyder et al., 1990). Throughout much of its range its branches are hosts to many epiphytic plants, especially bromeliads (such as ball moss, *Tillandsia recurvata* (L.) L, and Spanish moss, *T. usneoides* (L.) L.), ferns (typically resurrection fern, *Pleopeltis polypodioides* (L.) Andrews & Windham), and orchids.

***Adaptation***

Live oak is tolerant of a wide range of soil moisture, pH, and compaction (Dirr, 1998), and survives both significant drought and short periods of flooding (Allen & Kennedy, 1989; Arnold et al.. 2012 [in part for *Q. fusiformis*]; Carey, 1992). Live oak is notably salt-tolerant (Van Arsdel, 1980), and coastal populations of live oak exhibit more leaf succulence due to frequent exposure to salt spray (Sinclair & Lyon, 2005). Live oak also is tolerant of freezing weather, although more northern populations seem to be most tolerant of sub-freezing temperatures as well as salt (Kurtz et al., 2013), and naturally occurring trees from further north within its range display an innate tendency toward partial deciduousness in the winter (Cavender-Bares, 2007). This species also exhibits a combination of both intolerance and tolerance of fire, with the above-ground parts of a tree damaged or killed by even low-intensity ground fires, with smaller trees most susceptible to damage, but the root crown surviving and producing many suckers after a fire (Carey, 1992; Harms, 1990). This species is native to a region likely to experience hurricanes, which this species withstands well (Harms, 1990), perhaps due to its very hard wood. Live oaks in south Florida fully recovered within a decade after severe damage caused by Hurricane Andrew in 1992 (Douglas Goldman, personal observation).

**Uses**

*Timber/wood: Quercus virginiana* wood is brown to nearly white (darker in heartwood than sapwood), close-grained, and is extremely hard, strong, and heavy (Austin, 2004; Green et al., 1999; Panshin & de Zeeuw, 1970). Dry wood has a density of around 56-63 lb/ft$^3$ (900 - 1009 kg/m$^3$, 0.9-1.0 g/cm$^3$; Alden, 1995; Cavender-Bares et al., 2004; National Hardwood Lumber Association, 2014; Meier, 2016), and perhaps higher (Steve Cross, personal communication, August, 2015), and a high specific gravity, around 0.8 for fresh wood and up to 1.00 for oven-dried wood (Alden, 1995; Green et al., 1999; Jenkins et al., 2004; Meier, 2015, 2016; Panshin & de Zeeuw, 1970), making its wood one of the densest of North American tree species.

Live oak wood has a long reputation for hardness and durability. Nuttall (1865, pp. 29-30) found the substantial weight of the wood to be similar to that of lignum vitae (*Guaiacum officinale* L.), a tree species noted for its remarkable wood density. Stuart (1833, p. 94) commented that "the wood of this tree is almost incorruptible", and Catesby (1731, p. 17) stated that the wood was "harder and tougher than any other oak". Consequently, it is appropriate to use for "articles requiring exceptional strength and toughness" (Panshin & de Zeeuw, 1970). The wood can have a satiny surface and receive a high polish (Camus, 1939, p. 450). It is used for durable items like barrels, veneer, cabinetry, furniture, interior trim, and flooring (Meier, 2015, 2016), and also has been used for pulp and firewood (Duncan & Duncan, 1988).

Live oak is best known for its use in ship construction (Loudon, 1854; Wood, 1981), especially in the 18th and 19th centuries. The combination of the hardness of the wood, resistance to decomposition (Meier, 2015, 2016), and varied branch and trunk shapes (Wood, 1981), made *Q. virginiana* an ideal choice for use with many robust structural elements of wooden ships prior to the use of steel. Motivated by attacks on American shipping by Algerian pirates, the U.S. Congress passed the Naval Act of 1794, creating a permanent naval force, which resulted in several decades of Federal acquisition of lands forested with live oak for use in ship construction (Sargent, 1895). One such ship, the USS Constitution, earned the name "Old Ironsides" when cannon balls launched by the HMS Guerriere in August, 1812, were observed bouncing off the Constitution's hull, which was partly constructed of live oak (Wood, 1981). Reports of such events only reinforced the value of live oak timber, and helped result in the establishment, in 1828, of the first Federally-owned and managed tree farm in the United States, the Naval Live Oaks, now part of Gulf Islands National seashore near Pensacola, Florida (Snell, 1983; Wood, 1981). On occasion live oak is still used for ship construction. Beginning in 2011, the Maritime Museum of San Diego began constructing a replica of the Spanish galleon San Salvador, which in 1542 was the first European vessel to visit the west coast of what would become the United States (Maxwell, 2012). Live oak is still used on occasion for the construction of some smaller modern vessels, such as shrimp boats (Wood, 1981).

*Ornamental/landscaping:* Live oak is used commonly in horticulture within its native geographic range, and occasionally in areas beyond it that have similar climatic conditions. First cultivated in 1739 (Olson, 1974), it is used in municipal plantings, and around commercial establishments and homes. It is hardy in areas as cold as USDA Plant Hardiness Zone 7 (Dirr, 1998), even though it is native to Zones 8-10, but it is susceptible to damage from freezes that last for several days (B.J. Simpson, 1988). Its broad shape makes it an elegant horticultural subject, and it can grow rapidly with adequate moisture (Osorio, 2001), especially when young. It is tolerant of diverse soil types and some variation in soil moisture, and transplants relatively easily, especially when young (Dirr, 1998; Rehder, 1940). Because of its salt tolerance it has been considered a good subject for coastal cultivation, although it does require some protection from the wind when planted at coastal sites (Graetz, 1973; Menninger, 1964). Attempts have been made to find cold-hardy live oaks that will survive as far north as Boston, Massachusetts (Dosmann & Aiello, 2013). Despite being cold-hardy beyond its native range, its evergreen habit can make it more susceptible to branch breakage from ice or snow accumulation (Douglas Goldman, personal observation).

*Habitat restoration:* Live oak has been used for reforestation in areas where it is climatologically suitable. It has been used for revegetating well-drained portions of bottomland hardwood areas in the lower Mississippi valley (Allen & Kennedy, 1989), as well as coal mine sites in eastern Texas (Davies & Call, 1989). It also has been a good subject in coastal dune stabilization, and can be planted on-site as seed, not only as transplants (Graetz, 1973)

*Wildlife:* The acorns of this species, and the related *Q. fusiformis*, are valuable forage for waterfowl, turkey, wild pigs, raccoons, and deer (Allen & Kennedy, 1989; Elston & Hewitt, 2010 [treated as *Q. virginiana*]), with this species readily established by animal dispersal (Osorio, 2001).

**Ethnobotany**

Historically, the swollen, tuber-like roots of live oak seedlings were fried and eaten (Nixon & Muller, 1997); Sargent (1895) noted at the time that they were eagerly sought and eaten by African-American children in the southern United States. The Houma tribe of southeastern Louisiana used a decoction of the bark of live oak for treating dysentery (Moerman, 1986). Catesby (1731, p. 17) noted that the acorns were very sweet, and that the native people usually would store them and use them to thicken their venison soup, and extract from them a pleasant oil similar to that of almonds. Bartram (1791, p. 85) similarly noted the natives' use of a sweet acorn oil in cooking, and also observed their roasting the fruit in hot embers, consumed like chestnuts. The earliest human inhabitants of what is now northwestern Costa Rica consumed the acorns of the tropical live oak, *Quercus oleoides* (Janzen & Hallwachs, 2016)

Several old live oak trees have special historical significance. See Miller & Lamb (1985) for a list of such specimens.

**Status**

*Threatened or Endangered*: This species is not listed as threatened or endangered by the Federal government, or by any state where it naturally occurs.

The vague statement "today live oaks are protected for public enjoyment" (Moore, 2002; Nesom, 2003) has led to confusion about the protected status of *Quercus virginiana*. This statement should not be interpreted to mean that this species is excluded from commercial forestry use wherever it occurs. This species is protected only in public parkland, just like any other plant species, or protected in some communities by tree ordinances (e.g. J.D. Simpson, 2015), but outside these areas it is not protected and commercial forestry use can be explored.

*Wetland Indicator:* In all regions where it naturally occurs, this species is considered FACU, or a facultative upland species, usually not occurring in wetlands (U.S. Army Corps of Engineers, 2016). However, it is considered an upland plant (UPL) in the Western Mountains, Valleys, and Coast region (specifically Utah), where it is either a minimally naturalized species or more likely only cultivated.

*Weedy or Invasive:*
Live oak is not an officially designated weed in any state where it occurs.

Please consult with your local NRCS Field Office, Cooperative Extension Service office, state natural resource, or state agriculture department regarding its status and use. Please consult the PLANTS Web site (http://plants.usda.gov/) and your state's Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

**Planting Guidelines**

Live oaks grow rapidly when planted, provided they are given adequate water and are not root-bound in pots prior to planting (Osorio, 2001). They are best transplanted when small (Dirr, 1998), and transplanting success is greatest when planted in raised beds in sandy soil, with root collars at the surrounding soil level but not above or below it (Bryan et al., 2011). Because this species forms large root systems and wide crowns with age, these factors should be considered when planting live oaks in areas where they could obstruct vehicular traffic or damage sidewalks (Osorio, 2001).

**Management**

Live oak that are well-established under favorable conditions or in ideal habitats are very resistant to competition from other plant species (Harms, 1990). When used in habitat revegetation projects this species establishes better when inoculated with mycorrhizae (Davies & Call, 1990). In areas managed for game or browsing animals, the related species, *Q. fusiformis*, can out-compete many valuable forage plant species, even though it is a valuable browse and mast species itself (Fulbright & Garza, 1991 [treated as *Q. virginiana*]). Controlling *Q. fusiformis* thickets with fire only increases the density of these thickets (Springer et al., 1987 [as *Q. virginiana*]). However, with *Q. fusiformis*, abundant browsing can inhibit the establishment of mature trees (Russell & Fowler, 1999).

**Pests and Potential Problems**

Numerous fungal diseases affect live oak. *Quercus virginiana* is susceptible to oak wilt (Diggs et al. 1999; Peacock & Smith, 2013; Sinclair & Lyon, 2005), caused by *Ceratocystis fagacearum* (Bretz) J. Hunt (anamorph *Chalara quercina* B.W. Henry; *Thielaviopsis quercina* (B.W. Henry) A.E. Paulin et al.). The disease is spread by burrowing beetles or root grafts between trees. Symptoms can occur in part or all of the tree, consisting of leaf necrosis, with larger leaf veins becoming yellow to bronze, and gradual branch die-back over one to a few years. Oak wilt can be contained by removing infected trees, injection of systemic fungicides, or breaking root grafts by trenching (Peacock & Smith, 2013; Sinclair & Lyon, 2005). Some diseased Texas live oaks, *Q. fusiformis*, with symptoms once attributed to persimmon wilt, a disease caused by the fungus *Nalanthamala diospyri* (Crand.) Schroers & M.J. Wingf. (*Acremonium diospyri* (Crand.) W. Gams; *Cephalosporium diospyri* Crand.), actually suffered from oak wilt (Lewis & Oliveria, 1979 [treated as *Q. virginiana*]). A canker disease caused by *Lasiodiplodia theobromae* (Pat.) Griffon & Maubl. (*Botryodiplodia theobromae* Pat.; *Diplodia theobromae* (Pat.) W. Nowell; *Botryosphaeria rhodina* (Berk. & M.A. Curtis) Arx.; *Physalospora rhodina* Berk. & M.A. Curtis), a secondary pathogen, can kill live oaks that already are badly damaged by oak wilt (Lewis & Oliveria, 1979). Bot canker, caused by *Diplodia corticola* A.J.L. Phillips et al. (teleomorph *Botryosphaeria corticola* A.J.L. Phillips et al.) and *D. quercivora* Linald. & A.J.L. Phillips (teleomorph not yet identified), causes significant branch dieback in live oak (Dreaden et al., 2014; Mullerin & Smith, 2015). Chrysoporthe canker, a disease typically afflicting *Eucalyptus*, caused by *Chrysoporthe cubensis* (Bruner) Gryzenh. & M.J. Wingf. (*Cryphonectria cubensis* (Bruner) Hodges; *Endothia eugeniae* (Nutman & F.M. Roberts) J. Reid & C. Booth), has been found on *Q. virginiana* in Florida (Sinclair & Lyon, 2005). Chestnut blight, caused by *Cryphonectria parasitica* (Murrill) M.E. Barr (*Endothia parasitica* (Murrill) P.J. Anderson & H.W. Anderson), affects not only chestnut species (*Castanea* Mill.), and causes local damage to slow dieback in live oaks which can be fatal (Phelps, 1974). Live oaks also

experience diebacks caused by *Biscogniauxia atropunctata* (Schwein.) Pouzar (*Hypoxylon atropunctatum* (Schwein.) Cooke) (Van Arsdel, 1972) and *Amphilogia gyrosa* (Berk. & Broome) Gryzenh. et al. (*Cryphonectria gyrosa* (Berk. & Broome) Sacc. & D. Sacc.; *Endothia gyrosa* (Berk. & Broome) Höhn.)(Sinclair & Lyon, 2005), both which can affect several oak species. *Taphrina caerulescens* (Desm. & Mont.) Tul. causes leaf blister, resulting in leaf deformities or some defoliation (Harms, 1990). Two species of fungi are known to occur only on the dead, outer bark of *Q. virginiana*, specifically *Peniophorella baculorubrensis* (Gilb. & M. Blackw.) K.H. Larss. (*Hyphoderma baculorubrense* Gilb. & M. Blackw.) and *Perenniporia phloiophila* Gilb. & M. Blackw., resulting in little harm to the tree other than the loss of areas of the oldest, outermost bark, causing what is otherwise known as "smooth patch" (Gilbertson & Blackwell, 1984).

The bacterium *Xylella fastidiosa* Wells et al. causes leaf scorch in live oak, resulting in branch die-back (McGovern & Hopkins, 1994).

Vascular epiphytic plants, especially *Tillandsia recurvata* and *T. usneioides*, are not parasites, but when present in very large quantities on live oaks they can increase wind loading and shading of foliar surfaces (Coder, 2010). A leafless, vining parasitic plant, *Cassytha filiformis* L., a member of the avocado or laurel family (Lauraceae), uses the sand live oak (*Q. geminata*) as one of many hosts in Florida (Sinclair & Lyon, 2005).

Live oak has a handful of significant insect pests. Twigs often are damaged by gall formation, and although insecticides can control gall-forming wasps reinfestation from untreated trees makes gall inhibition more difficult (Platt Bird et al., 2013). The roots of live oaks can be attacked by the larvae of a large beetle, the live oak root borer, *Archodontes melanopus* (Linnaeus, 1767), resulting in deformed growth of effected trees (Harms, 1990).

"Oak Decline" refers to a generalized decline in growth, vigor, and health of oak trees, potentially fatal, caused by a wide variety of factors, including drought, physical damage caused by construction equipment or storms, soil compaction, insects, and secondary pathogens. Symptoms are slowed growth, undersized or deformed leaves, chlorosis, cankers on trunks and branches, and dieback of twigs and branches. See Sinclair & Lyon (2005) for a detailed summary of Oak Decline.

Competition with other species can have a negative impact on live oak establishment. For example, the presence of the invasive Brazilian peppertree (*Schinus terebinthifolius* Raddi) significantly inhibits the establishment of live oak seedlings (Nickerson & Flory, 2015).

**Environmental Concerns**
The related oak, *Q. fusiformis*, can invade grasslands, reducing available forage for wildlife (Fulbright & Garza, 1991 [treated as *Q. virginiana*]).

**Control**
Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

**Seeds and Plant Production**
*Quercus virginiana* averages about 352 cleaned seeds per pound or 775 per kilogram, with a range of 240-510 per pound or 530-1,125 per kilogram (Bonner, 2008; Olson, 1974). Propagation by seed is preferred (Dirr, 1998), and healthy acorns germinate rapidly and in high percentages (Olson, 1974). Acorns don't require vernalization, but desiccated or frozen acorns become inviable, and those stored unfrozen in moist peat tend to germinate but bear soil-borne fungal pathogens (Dirr & Heuser, 1987), so planting acorns shortly after collection is preferred. Propagation by cuttings, especially from younger trees, has had some success (Dirr & Heuser, 1987), but cuttings made from root suckers have rooted at very high rates and in turn have produced few root suckers themselves (Niu & Wang, 2007).

**Cultivars, Improved, and Selected Materials (and area of origin)**
Several live oak cultivars are available. One of the most popular is High Rise ('QVTIA'), a selection with rapid vertical growth which is well-suited for narrow planting spaces. For a summary of live oak cultivars see Coder (2010) and Dirr (1998).

Cultivars should be selected based on the local climate, resistance to local pests, and intended use. Consult with your local land grant university, local extension or local USDA NRCS office for recommendations on adapted cultivars for use in your area**.**

**Literature Cited**


Alden, H.A. 1995. Hardwoods of North America. General Technical Report FPL-GTR-83. United States Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, WI.

Allen, J.A., & H.E. Kennedy, Jr. 1989. Bottomland hardwood reforestation in the lower Mississippi Valley. U.S. Department of the Interior, Fish and Wildlife Service, National Wetlands Research Center, Slidell, LA; U.S. Department of Agriculture, Forest Service, Southern Forest Experimental Station, Stoneville, MS.

American Forests. 2016. National Big Tree Program. www.americanforests.org

Arnold, M.A., D.L. Bryan, R.I. Cabrera, G.C. Denny, J.J. Griffin, J.K. Iles, A.R. King, G.W. Knox, L. Lombardini, G.V. McDonald, C.B. McKenney, D.T. Montague, G. Niu, H.B. Pemberton, A.L. Purnell, L.J. Shoemake, D.K. Struve, & W.T. Watson. 2012. Provenance experiments with baldcypress, live oak, and sycamore illustrate the potential for selecting more sustainable urban trees. Arborculture & Urban Forestry 38: 205-213.

Austin, D.F. 2004. Florida Ethnobotany. CRC Press, Boca Raton, FL.

Bartram, W. 1791. Travels through North & South Carolina, Georgia, East & West Florida, the Cherokee country, the extensive territories of the Muscogulges, or Creek confederacy, and the country of the Chactaws. James & Johnson, Philadelphia.

Bonner, F.T. 2008. Fagaceae – beech family. *Quercus* L. Oak. *In* The Woody Plant Seed Manual. Agriculture Handbook 727. F.T. Bonner & R.P Karrfalt, eds. United States Department of Agriculture, Forest Service.

Borhidi, A. 1996. Phytogeography and Vegetation Ecology of Cuba. Second Edition. Akadémiai Kiadó, Budapest, Hungary.

Boucher, D.H. 1983. *Quercus oleoides* (Roble Encino, Oak). *In* Costa Rican Natural History. D.H. Janzen, ed. University of Chicago Press, Chicago, IL.

Bryan, D.L., M.A. Arnold, A. Volder, W.T. Watson, L. Lombardini, J.J. Sloan, A. Alarcón, L.A. Valdez-Aguilar, & A.D. Cartmill. 2011. Planting depth and soil amendments affect growth of *Quercus virginiana* Mill. Urban Forestry & Urban Greening 10: 127-132.

Camus, A. 1939. Les Chênes. Monographie du genre *Quercus*. Tome II. Paul Lechevalier, Paris.

Carey, J.H. 1992. *Quercus virginiana*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). [Accessed 25 August 2015] http://www.fs.fed.us/database/feis

Catesby, M. 1731. The natural history of Carolina, Florida and the Bahama Islands. Tome 1. Published by the author, London.

Cavender-Bares, J. 2007. Chilling and freezing stress in live oaks (*Quercus* section *Virentes*): intra- and inter-specific variation in PS II sensitivity corresponds to latitude of origin. Photosynthesis Research 94: 437-453.

Cavender-Bares, J., & A. Pahlich. 2009. Molecular, morphological, and ecological niche differentiation of sympatric sister oak species, *Quercus virginiana* and *Q. geminata* (Fagaceae). American Journal of Botany 96: 1690-1702.

Cavender-Bares, J., A. González-Rodríguez, D.A.R. Eaton, A.A.L. Hipp, & P.S. Manos. 2015. Phylogeny and biogeography of the American live oaks (*Quercus* subsection *Virentes*): a genomic and population genetics approach. Molecular Ecology 24: 3668-3687.

Cavender-Bares, J., K. Kitajima, & F.A. Bazzaz. 2004. Multiple trait associations in relation to habitat differentiation among 17 Floridian oak species. Ecological Monographs 74: 635-662.

Clewell, A.F. 1985. Guide to the Vascular Plants of the Florida Panhandle. Florida State University Press, Tallahassee, FL.

Coder, K.D. 2010. Live oak: historical ecological structures. Document WSFNR10-23. Tree Dendrology Series, Warnell School of forestry and Natural Resources, University of Georgia, Athens, GA.

Correll, D.S., & M.C. Johnston. 1970. Manual of the Vascular Plants of Texas. Texas Research Foundation, Renner, TX. Botanical Research Institute of Texas (BRIT) Press, Ft. Worth, TX.

Davies, F.T., Jr., & C.A. Call. 1989. Mycorrhizae, survival and growth of selected woody plant species in lignite overburden in Texas. Agriculture, Ecosystems and Environment 31: 243-252.

Diggs, G.M. Jr., B.L. Lipscomb, & R.J. O'Kennon. 1999. Shinner & Mahler's Illustrated Flora of North Central Texas.

Dirr, M.A. 1998. Manual of Woody Landscape Plants. Their Identification, Ornamental Characteristics, Culture, Propagation and Uses. Stipes Publishing, Champaign, IL.

Dirr, M.A., & C.W. Heuser, Jr. 1987. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture. Varsity Press, Athens, GA.

Dosmann, M.S., & A.S. Aiello. 2013. The quest for the hardy southern live oak. Arnoldia 70: 12-24.

Dreaden, T.J., A.W. Black, S. Mullerin, & J.A. Smith. 2014. First report of *Diplodia quercivora* causing shoot dieback and branch cankers on live oak (*Quercus virginiana*) in the United States. Plant Disease 98: 282.

Duever, M.J., J.E. Carlson, J.F. Meeder, L.C. Duever, L.H. Gunderson, L.A. Riopelle, T.R. Alexander, R.L. Myers, & D.P. Spangler. 1986. The Big Cypress National Preserve. Research Report no. 8, 2nd printing. National Audubon Society, New York.

Duncan, W.H. & M.B. Duncan. 1988. Trees of the Southeastern United States. University of Georgia Press, Athens, Georgia.

Eaton D.A.R., A.L. Hipp, A. Gonzalez-Rodriguez, & J. Cavender-Bares. 2015. Introgression obscures and reveals historical relationships among the American live oaks. bioRxiv, 016238. http://dx.doi.org/10.1101/016238
Elston, J.J., & D.G. Hewitt. 2010. Intake of mast by wildlife and the potential for competition with wild boars. Southwestern Naturalist 55: 57-66.
Fulbright, T.E., & A. Garza, Jr. 1991. Forage yield and white-tailed deer diets following live oak control. Journal of Range Management 44: 451-455.
Georgia Forestry Commission. 2015. Georgia's Champion Tree Program. [Accessed 28 August 2015] http://www.gfc.state.ga.us
Gilbertson, R.L., & M. Blackwell. 1984. Two new Basidiomycetes on living live oak in the Southeast and Gulf Coast Region. Mycotaxon 20: 85-93.
Graetz, K.E. 1973. Seacoast Plants of the Carolinas for Conservation and Beautification. United States Department of Agriculture, Soil Conservation Service, Raleigh, NC.
Green, D.W., J.E. Winandy, & D.E. Kretschmann. 1999. Mechanical properties of wood. Ch. 4 *in* The Encyclopedia of Wood. U.S. Department of Agriculture, Washington, D.C.
Gugger, P.F., & J. Cavender-Bares. 2013. Molecular and morphological support for a Florida origin of the Cuban oak. Journal of Biogeography 40: 632-645.
Harms, W.R. 1990. *Quercus virginiana* Mill. Live oak. *In* Silvics of North America. Vol. 2, Hardwoods. R.M. Burns & B.H. Honkala, eds. Agriculture Handbook 654. United States Department of Agriculture, Forest Service, Washington, D.C.
Hipp, A.L., D.A.R. Eaton, J. Cavender-Bares, E. Fitzek, R. Nipper, & P.S. Manos. 2014. A framework phylogeny of the American Oak Clade based on sequenced RAD Data. PLoS ONE, 9, e102272. http://dx.doi.org/10.1371/journal.pone.0093975
Janzen, D.H., & W. Hallwachs. 2016. Biodiversity conservation history and future in Costa Rica: The case of Área de Conservación Guanacaste (ACG). Ch. 10 *in* Costa Rican Ecosystems. M. Kappelle, ed. University of Chicago Press, Chicago, IL.
Jenkins, J.C., D.C. Chojnacky, L.S. Heath, & R.A. Birdsey. 2004. Comprehensive database of diameter-based biomass regressions for North American tree species. General Technical Report NE-319. United States Department of Agriculture, Forest Service, Northeastern Research Station, Burlington, VT.
Jiménez, Q., E. Carrillo, & M. Kappelle. 2016. The northern Pacific Lowland seasonal dry forests of Guanacaste and the Nicoya Peninsula. Ch. 9 *in* Costa Rican Ecosystems. M. Kappelle, ed. University of Chicago Press, Chicago, IL.
Jones, F.B. 1975. Flora of the Texas Coastal Bend. Mission Press, Corpus Christi, TX.
Kappelle, M. 2016. Costa Rican ecosystems: A brief summary. Ch. 21 *in* Costa Rican Ecosystems. M. Kappelle, ed. University of Chicago Press, Chicago, IL.
Kurtz, C.M., J.A. Savage, II-Y. Huang, & J. Cavender-Bares. 2013. Consequences of salinity and freezing stress for two populations of *Quercus virginiana* Mill. (Fagaceae) grown in a common garden. Journal of the Torrey Botanical Society 140: 145-156.
Lewis, R., Jr., & F.L. Oliveria. 1979. Live oak decline in Texas. Journal of Arboriculture 5: 241-244.
Loudon, J.C. 1854. Arboretum et Fruticeum Brittanicum. Vol. 3, 2nd edition. Henry G. Bohn, London.
Maxwell, D. 2012 (7 June). Rebuilding history is a Cross passion. Donalsonville News. Donalsonville, GA. http://www.donalsonvillenews.com
McGovern, R.J., & D.L. Hopkins. 1994. Association of *Xylella fastidiosa* with Leaf Scorch and Decline of Live Oak in Florida. Plant Disease 78: 924.
Meier, E. 2015. The Wood Database. Accessed on 13 August 2015. http://www.wood-database.com
Meier, E. 2016. Wood! Identifying and using Hundreds of Woods Worldwide. Published by the author.
Menninger, E.A. 1964. Seaside Plants of the World. A Guide to Planning, Planting, and Maintaining Salt-Resistant Gardens. Hearthside Press Incorporated Publishers, New York.
Miller, H., & S. Lamb. 1985. Oaks of North America. Naturegraph Publishers, Happy Camp, CA.
Moerman, D.E. 1986. Medicinal Plants of Native America. Vol. 1. Museum of Anthropology, University of Michigan, Ann Arbor, MI.
Moore, L. 2002. Plant Fact Sheet for live oak (*Quercus virginiana*). USDA NRCS National Plant Data Center. Baton Rouge, LA.
Muller, C.H. 1961. The live oaks of the series *Virentes*. American Midland Naturalist 65: 17-39.
Mullerin, S., & J.A. Smith. 2015. Bot canker of oak in Florida caused by *Diplodia corticola* and *D. quercivora*. Document FOR318, School of Forestry Resources and Conservation, University of Florida/IFAS Extension. Gainesville, FL.
National Hardwood Lumber Association (NHLA). 2014. Rules for the Measurement and Inspection of Hardwood & Cypress. NHLA, Memphis, TN.
Nelson, G. 1994. The Trees of Florida. A Reference and Field guide. Pineapple Press, Sarasota, FL.
Nesom, G. 2003. Plant Guide for live oak (*Quercus virginiana*). Biota of North America Program, Chapel Hill, NC. Prepared for the USDA NRCS National Plant Data Center. Baton Rouge, LA.

Nickerson, K., & S.L. Flory. 2015. Competitive and allelopathic effects of the invasive shrub *Schinus terebinthifolius* (Brazilian peppertree). Biological Invasions 17: 555-564.
Niu, G., & Y.-T. Wang. 2007. Cloning live oak. A new method of propagating this challenging tree shows promise for producing uniform specimens. American Nurseryman 205: 26-27.
Nixon, K.C., & C.H. Muller. 1997. *Quercus* Linnaeus sect. *Quercus*. White oaks. Pp. 471-506 *in* Flora of North America North of Mexico, vol. 3, Magnoliophyta: Magnoliidae and Hamamelidae, Flora of North America Committee, eds. Oxford University Press, Oxford, UK
Nuttall, T. 1865. North American Sylva. Vol. 1. Rice, Rutter & Co., Philadelphia.
Olson, D.F. 1974. *Quercus* L. Oak. Pp. 692-703 *in* Seeds of Woody Plants in the United States, Agriculture Handbook No. 450, C.S. Schopmeyer, ed. United States Department of Agriculture, Forest Service., Washington, D.C.
Osorio, R. 2001. A Gardener's Guide to Florida's Native Plants. University of Florida Press, Gainesville, FL.
Panshin, A.J., & C. de Zeeuw. 1970. Textbook of Wood Technology, 3rd edition. McGraw-Hill. New York.
Peacock, K., & J. Smith. 2013. Oak wilt: A potential future threat to oaks in Florida. Document FOR274, School of Forestry Resources and Conservation, University of Florida/IFAS Extension. Gainesville, FL.
Phelps, W.R. 1974. Live oak in North Carolina and Florida infected by *Endothia parasitica*. Plant Disease Reporter 58: 596-598,
Platt Bird, J., G. Melika, J.A. Nicholls, & G.N. Stone. 2013. Life history, natural enemies, and management of *Disholcaspis quercusvirens* (Hymenoptera: Cynipidae) on live oak trees. Journal of Economic Entomology 106: 1747-1756.
Rehder, A. 1940. Manual of cultivated Trees and Shrubs Hardy in North America, Exclusive of the Subtropical and Warmer Temperate Regions. Second Edition. Macmillan Co., New York.
Roberts, N.C. 1989. Baja California Plant field Guide. Natural History Publishing Company, La Jolla, CA.
Russell, F.L., & N.L. Fowler. 1999. Rarity of oak saplings in savannas and woodlands of the eastern Edwards Plateau, Texas. Southwestern Naturalist 44: 31-41.
Sargent, C.S. 1895. The Silva of North America. Vol. 8, Cupuliferae (*Quercus*). Houghton, Mifflin & Co., Boston, MA.
Simpson, B.J. 1988. A Field Guide to Texas Trees. Gulf Publishing Company, Houston, TX.
Simpson, J.D. 2015. A review of Tampa's tree regulations. An overview of the history and current status of regulations regarding trees in the City of Tampa with a list of reported issues and comparisons to other jurisdictions. Prepared for the City of Tampa Attorney's Office. October 2015. http://www.tampagov.net/sites/default/files/planning/files/final_legal_tree_code_report_2015_0.pdf
Sinclair, W.A., & H.H. Lyon. 2005. Diseases of Trees and Shrubs, 2nd edition. Cornell University Press, Ithaca, NY.
Snell, C.W. 1983. A History of the Naval Live Oak Reservation Program, 1794-1880: A Forgotten Chapter in the History of American Conservation. Gulf Islands National Seashore, Florida/Mississippi. United States Department of the Interior, National Park Service, Denver Service Center, Denver, CO.
Snyder, J.R., A. Herndon, & W.B. Robertson, Jr.. 1986. South Florida rockland. Ch. 8 *in* Ecosystems of Florida. R.L. Myers & J.J. Ewel, eds. University of Central Florida Press, Orlando, FL.
Springer, M.D., & T.E. Fulbright, & S.L. Beasom. 1987. Long-term response of live oak thickets to prescribed burning. Texas Journal of Science 39: 89-95.
Stein, J., D. Binton, & R. Acciavatti. 2003. Field guide to Native Oak Species of Eastern North America. Document FHTET-2003-01. United States Department of Agriculture, Forest Service, Morgantown, WV.
Stuart, J. 1833. Three Years in North America. Vol. 2. Robert Cadell, Edinburgh.
Tomlinson, P.B. 1986. The Biology of Trees Native to Tropical Florida. Harvard University Printing Office, Alston, MA.
Trelease, W. 1924. The American oaks. Memoirs of the National Academy of Sciences 20: 1-255.
U.S. Army Corps of Engineers. 2016. National Wetland Plant List, version 3.3. U.S. Army Corps of Engineers, Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH. http://wetland_plants.usace.army.mil
USDA NRCS. 2016. The PLANTS Database (http://plants.usda.gov, 14 July 2017). National Plant Data Team, Greensboro, NC 27401-4901 USA.
Van Arsdel, E.P. 1972. Some cankers on oaks in Texas. Plant Disease Reporter 56: 300-304.
Van Arsdel, E.P. 1980. Managing trees to reduce damage from low-level saline irrigation. Weeds, Trees & Turf 19: 26-28, 61.
Weakley, A.S., J.C. Ludwig, & J.F. Townsend. 2012. Flora of Virginia. Botanical Research Institute of Texas (BRIT) Press, Ft. Worth, TX.
Wiggins, I.L. 1980. Flora of Baja California. Stanford University Press, Stanford, CA.
Wood, V.S. 1981. Live Oaking. Southern Timber for Tall Ships. Northeastern University Press, Boston, MA.

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