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Live Oak – *Quercus virginiana*: An Ecological Heritage

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Live oak (Quercus virginiana) is an ecological and cultural icon of the Southern United States. The species live oak has a diverse set of individual traits across many types of sites, and contains a number of varieties and hybrids. Live oak can be a massive spreading tree along the lower Coastal Plain. Live oak can also be a small, wind-swept tree growing on sand ridges near the ocean. Live oak is much more varied than its stereotype.

Live oaks are ecological structures with great canopy and root spread outward from a large diameter, squat stem. The trees are sources of food, protection, and support to a host of other plants and animals. They are life centers and life generators wherever they grow. Live oaks also represent a marker for the history of this nation, and the nations which have come before. Live oaks have served humans and animals as food, fuel, lumber, chemicals, and shade. Today live oak represents both a biological and social heritage.

Spiritual

For humans, live oaks generate awe, reverence, utility, and a sense of place. There are many live oak treaty trees or assembly trees across the South. Live oak is symbolic of history, survival, struggle, and romance. For example, live oaks were the focus of this nation's first publicly owned timber reserves for building naval vessels. The largest trees were valuable to sailing ship builders because of their branch shapes and wood strength. As such, live oaks were also one of the first trees to suffer forest-wide timber thief and old growth decimation in North America.

The mystic feelings and grandeur of the Spanish moss draped, monstrous live oaks are an emblem of both the old and new South. Live oak lined drives, streets, and squares make them pillars of their communities. Live oaks are important enough to people to have their own society. The "Live Oak Society" was founded in 1934, and is active today, to promote conservation and appreciation of large live oaks. Because of its many positive and life-affirming attributes, live oak was selected to represent the State of Georgia as its state tree.

Family

Oaks are in the beech (Fagaceae) family. The oaks (Quercus spp.) are the largest genera of trees in the United States. The nation's oak species are composed of approximately 58 trees and 12 shrubs. Among these species, there are more than 75 recognized hybrids (both natural and human designed). One of these unique species of oak is live oak. Live oak is considered a member of the white oak group.

Names

The scientific name for live oak is Quercus virginiana, officially named in 1768. The Latin and Celtic derived meaning of the scientific name is a "fine tree of Virginia." There still remains some confusion regarding live oak taxonomy dealing with varieties, hybrids, and regional differences. Other scientific names which have been used in the past for live oak at one time or another are: Quercus andromeda; Q. eximea; Q. fusiformis; Q. geminata; Q. maritima; Q. oleoides var. quaterna; Q. sempervirens; and, Q. virens.

Quercus virginiana is the currently accepted scientific name for the typic, standard live oak found growing along the Atlantic and Gulf coasts and inland, across the Southeastern and South-central United States. Across its native range live oak has many common names, most derived from its evergreen habit, its geographic location, or its preference for growing site. Some common names for Quercus virginiana are: live oak, Virginia live oak, Virginia oak, Southern live oak, bay live oak, Spanish live oak, encino, sand live oak, and scrub live oak. Some of these common names are also used for other species of oaks.

Range

Live oak is found growing and reproducing on the lower coastal plain of the Southeastern and South-central United States. Its range begins on the extreme Eastern coast of Virginia, South in a narrow band along the ocean to the middle of the South Carolina coast where its range begins to expand farther inland. The range of live oak continues to expand inland as it moves South, growing across the Southern 1/4 of Georgia and covering all of Florida South to the first few Florida Keys. Live oak grows along the Florida panhandle and around Mobile Bay, on across the Southern-most two tiers of counties in Mississippi. Live oak grows across the Southern third of Louisiana, except for some barrier islands and scattered parts of the most Southern Parishes. Live oak's range continues into Texas, narrowing to hug the coast until just past Port Lavaca, Texas. Figure 1 provides a range map for live oak.

Soils & Sites

Live oak is found in both single and mixed species forests, dotting savannas, and as occasional clumps in grasslands along the lower coastal plain and lower Mississippi valley. Live oak grows in soils ranging from heavy textures (clay loams), to sands with layers of organic materials or fine particles. Live oak can be found dominating some maritime forests, especially where fire periodicity and duration are limited. Live oak is found on higher topographic sites as well as hammocks in marshes and swamps. Live oak hugs the coastline and is rarely found above 300 feet above sea level.

Live oaks grow across a wide range of sites with many moisture regimes – from dry to moist. Live oak survives well on both dry sites and wet areas, effectively handling short duration flooding if water is moving and drainage is good. Good soil drainage is a key resource component for sustained live oak growth. Required precipitation range is 40-65 inches of water per year, preferably in Spring and Summer. Soil is usually acidic, ranging between pH of 5.5 and 6.5.

Hot Water

Live oak is considered a facultative upland species, usually found in non-wetland soils and upland sites, even if surrounded by wetland areas, seeps, springs, bayheads, and swamps. Live oak requires 1-3 feet of well-aerated soil above local water saturation levels. For best growth, a well-drained sandy loam or heavier soil, which maintains a good moisture content but is not wet, is ideal. Live oaks need large amounts of soil volume to occupy, colonize, and hold, in order to grow large and old.

One important constraint on live oak growth is heat and soil moisture. Live oak handles heat well when combined with plenty of precipitation in the growing season. Live oak grows in national heat zones 7 through 11. Live oak tolerates limited summer droughts. The vascular architecture of live oak is designed for hot days and nights, with plenty of precipitation. The farther North and West live oak ranges, the greater are evaporative forces drying growing season soils, and the greater are heat loads on living tissues, both of which limit survival.

Northern Limits

The Northern boundary for the native range of live oak is controlled both by cold temperatures, and by summer dryness and evaporative index. Live oak does well in cold hardiness zones 8b through 11. Live oak's Northern growth limit for temperature is roughly the 42oF minimum sustained winter air temperature zone. Sites which provide non-freezing temperatures maximize the chances for live oak survival. There are some single specimens and multiple stem stands of Northern outliers of planted live oaks which can be found in protected areas.

Growth Tolerance

Live oak is intermediate among forest trees in tolerance of competition and resource scarcity, such as shade. Live oak is relatively fast growing and long lived. Shoots continue to elongate throughout the growing season. Young live oaks are susceptible to fire damage. Short intervals between fires can eliminate live oak regeneration on a site. Because of sprouts from stumps and tops of large roots, and its intermediate tolerance of resource scarcity, live oak can successionally hold onto a site for decades. As a result of this vegetative reproduction, live oaks tend to grow in a clump (copse) or family group.

Live oak is tolerant of salt spray on foliage compared with other plants. Moderately high concentrations of salt in soils is tolerated if drainage remains good and the soil is not saturated. Live oak does not handle salt water flooding or brackish soil water well. Live oak is intermediate to intolerant (i.e. becoming more intolerant with age) of construction damage and soil compaction. Live oak is cited as tolerant to sulfur dioxide air pollution, and phenoxy and dicamba pesticides.

Size

Live oak is a medium height tree which develops a massive diameter but short stem over time. Primary branches can grow to be large in diameter and long. A number of branches are generated low on the trunk, growing large in diameter and, if space is available and pruning treatments are not applied, can many times remain wide spreading and almost horizontal. Branch spread in large mature trees can easily be greater than tree height. Branches can recline on the soil surface and some form roots where they touch the soil.

The theoretical maximum size reached by a live oak could be 80 feet tall, 13 feet in diameter, and 170 feet crown diameter or 85 feet branch spread radius. An expected normal mature size is around 40-65 feet tall, 4-6 feet in diameter, and 80-110 feet crown diameter. Figure 2 shows mature tree sizes in one geographic location. Example tree height and stem diameters are given in Figure 3 for a highly stressed site.

Shape

At a distance, natural crown shape appears as a short, shallow, and widespread dome of dense appearing foliage. Mature live oaks tend to have a crown spread to tree height ratio of 1.2 to 2.0. An example of live oak crown area per tree diameter in one geographic location is given in Figure 4. For trees on highly stressed sites, Figure 5 provides crown and stem diameters. Part of the dense foliage appearance is the concentration of leaves around the outside edge of crowns. This leaf concentration is due to both leaf physiology not functioning well under shaded conditions (i.e. few shade leaves), and growth of many small twigs holding many leaves clustered near the twig tips.

Actually, live oak crowns have been found to not be any more dense in total than most other broadleaf trees. There is only a limited amount of sunlight impacting an area at any one time, and trees optimize leaf developement for light capture. Greater leaf density would lead to serious problems in self-shading — photosynthetic efficiency. In addition, interfering plant leaves, like Spanish moss, mistletoe, or vines, can build up and shade out live oak leaves.

In poorly drained or very thin soil, the basal trunk flair of live oak may be buttressed as large root tops around the stem base grow upward forming I-beam, T-beam, and plank shaped supporting structures. The root plate area (zone of rapid taper) around the trunk base is relatively large in diameter compared with other trees, containing a number of large diameter roots growing horizontally just below the soil surface. A relatively large root plate area is generated in aging live oaks because of the biomechanical necessities of supporting a wide-spreading crown and limited ecologically viable soil depth.

Ageless

On a good site, a live oak should reach mature proportional size in under 75 years. In a limited number of samples, live oaks on good open sites grew as much as 0.75 inches per year in diameter and sustained this level of growth over many decades. The largest trees in the native range, especially along the Atlantic coast, are seldom over 250 years old with a maximum expected lifespan of 500 years. Many old large trees have myths developed around them regarding their age and historic value. Many large live oaks are not as old as people believe. In addition, some large diameter live oaks may actually be composed of a number of sprouts from an old stump which have grown together. Due to the hardness of the wood and the decay columns in old live oaks, it is many times difficult to accurately determine actual tree age.

Identification

Identifying live oak is more than recognizing the nearly evergreen leaves and Spanish moss drapes. Live oak, especially when the tree is small or juvenile, can be mistaken for several other trees. Key live oak attributes and characters are described below and can help with both the identification and appreciation of this majestic tree.

Leaves — Live oak leaves grow alternately along twigs. Leaves are simple, unlobed, thick, stiff, and leathery. Leaves are elliptical to elongated-elliptical in shape with a more-or-less wedge-shaped base. Live oak is considered evergreen because leaves remain green and persist on a tree until after new leaves expand the following Spring. Leaves are 1.5 to 4.5 inches long and ½ to 2 inches wide. The leaf edge is smooth to slightly wavy, with rarely a few scattered teeth especially on juvenile shoots. The leaf edge

is slightly curled under, not tightly rolled. The leaf tip is rounded without a bristle tip. Leaf shape and size are highly variable, especially in special habitats and physiographic locations. Leaf shape varies so widely, live oak has been misidentified or formed into small regional varieties in the past.

Live oak leaves are shiny dark green in color on top and gray-green below. The underside is covered with many trichomes (plant hairs). Live oak trichomes are star-shaped (stellate). The main vein on the underside is yellowish in color. Side leaf veins can be visualized by the slight depressions they form on the leaf's upper surface. The side veins unite just before the outer leaf edge. The leaf petiole is stiff and short (~1/4 inch long).

There are at least seven evergreen or persistent leaved oaks with overlapping ranges with live oak. These oaks are: Chapman oak (Q. chapmanii), Darlington oak (Q. hemisphaerica), bluejack oak (Q. incana), laurel oak (Q. x laurifolia), Texas live oak (Q. fusiformis), dwarf live oak (Q. minima), sand live oak (Q. geminata), and various varieties and hybrids of live oak (Q. virginiana). Live, sand live, dwarf live, Texas live, and bluejack all have stellate tricombes on leaf undersides and have a leaf edge which is thickened and rolls beneath. Live oak, dwarf live, Texas live, and sand live oak have a rounded leaf tip without a bristle tip. Because of the similar appearance and growth patterns of live oak species, varieties, and hybrids, identification can be difficult.

Flowers — Live oak flowers are wind pollinated. Live oak is monoecious (both sexes on the same tree), but each flower is either male or female. Flowers are functional in Spring from February to March for about two weeks. The male flowers are a light yellow-colored dangling catkin 2-3 inches long. Male flowers develop in last year's leaf axils. Several female flowers are found on one-inch long, pale green spikes growing from the current year's leaf axils. Female flowers have a bright red stigma.

Different forms of live oak maintain their genetic uniqueness by flowering at slightly different times. For example, typical live oak flowers several weeks before sand live oak in the same area. Live oak becomes sexually mature relatively quickly. Stump and root sprouts are sexually mature and flower the next year after expansion. Seedlings become sexually mature and flower about five years after germination. Full flower production does not occur for 7-12 years. Trees older than 100 years old usually do not generate as many female flowers as middle-aged trees with full crowns, although some flowering does continue to the end of life.

Acorns — Live oaks generate an oblong, barrel-shaped acorn 3/4 to 1 inch long with a short point at the end. Acorns are held at the end of a long stem (1-4 inch long peduncle). Acorns grow in clusters of up to five per clump with 2-3 per clump typical. The acorn cap is bowl-like, top-shaped, and covers 1/3 to ½ of the acorn. The acorn cap has thin reddish-brown hairy scales.

As in the rest of the white oak group, live oak acorns mature and are ready to germinate at the end of the current growing season. Acorns mature by October to a dark blackish-brown color and fall by January 1. Acorns contain an embryo surrounded by two fleshy cotyledons enclosed by a hard outer shell. Figure 6 shows a simplified diagram of a live oak acorn. The inner surface of the acorn shell is smooth. Live oak acorns are not viable for long, and quickly die and decay.

The acorn is small but sweet tasting with a slightly bitter after-taste. The acorns are used by a host of wildlife species. Many animals eat, distribute, or cache live oak acorns (mammals, opossums, and birds). The small size of acorns allow for major caching of seeds by relatively small animals. Early Native American cultures within the live oak range used live oak acorns for food (rinsing the bitter tannins out with water), and for a cooking oil (boil crushed acorns — skimming oil off the top of the water). Live oak acorns contain approximately 5% protein and 6% fat.

Acorn production is usually good every year with little periodicity (no masting cycle). There are approximately 20-25 acorns per ounce. Acorns will germinate immediately on moist, warm, mineral soil. Acorns not germinated by mid-Spring can be considered dead due to pests (especially from Curculio spp. weevils). To minimize acorn production, and associated litter, an ethephon containing growth regulation chemical can be applied at a 30 ounces per 10 gallons of water rate (following current label guidlines). At this rate little foliage damage is visible. Live oaks should be treated to prevent seed set in early Spring when female flowers are at full bloom.

Periderm & Twigs — Live oak periderm has a range of colors modified by exposure and surface growths. Periderm can be dark-brown, greyish-brown, or dark reddish-brown, but is generally described as a medium brown color. The periderm has shallow furrows with flat scaly ridges between. Periderm is rough, divided into rough squares, and intermediate among regional tree species in thickness when mature, but thin while juvenile. Periderm on branches reclining onto soil or close to ground can be discolored by abrasion or by soil water splash staining from rain. Live oak periderm sustained limited use in the past for generating tannins for leather.

Twigs are stiff, but slender and hairy. The pith is solid and continuous. Winter buds are blunt on the ends and about 1/16 inch long. Buds have chestnut brown scales with tiny white hairs at the margins. Leaf scars are half round with the main bundle scar clearly present. Twigs have minute stipule scars. Sprouts from stumps and tops of large roots, as well as young twigs, provide forage for a number of animals.

Roots — Live oak root systems are wide-spreading and shallow, requiring good drainage and plenty of oxygen. When calculating root system extent and size for young trees, unlike other tree species, there is no strong relationship between root spread and crown spread. The root plate (zone of rapid taper or structural root area) can be calculated by using the diameter measure of the stem at 4.5 feet above the soil measured in inches multiplied by 0.9 to yield the diameter of the root plate in feet (centered on the trunk). For example, a 20 inch diameter live oak tree would have a root plate diameter in an unconstrained area of 18 feet (9 feet radius out from the trunk). It is essential in live oak to conserve root plate areas and prevent paving, trenching, compaction and other forms of root or soil damage from occurring.

The minimum effective rooting diameter of live oak is calculated by multiplying the stem diameter in inches (measured at 4.5 feet above the soil surface) by 2.5. The result is the minimum effective rooting diameter in feet. For example, a 20 inch diameter live oak tree would have a minimum effective rooting diameter of 50 feet (or 25 feet radius centered on the stem base.) Prevent encroachment and impacts by humans, machines, animals, and hardscapes over this area. Live oak roots are widespread and shallow, easily damaged by soil surface activities.

Live oaks generate roots running just below the soil surface coming from the stem base, or from large branches permanently in contact with the soil surface. These roots can generate new sprouts seen growing around live oaks and are a good source for reproduction cuttings. Live oak root systems are large and well interconnected both within and between trees. Many times separate stems will share an interconnected root system because they arose from the same stump, and so will have the same genetic content (copse or clonal system). Live oak roots can be naturally or artificially infected with ectomycorrhizae fungi, a beneficial symbiant. Ectomycorrhizae fungi infection increases fine root mass in mature live oaks on stressed sites.

Wood — Live oak wood is extremely dense and hard, making it strong and durable in use. Live oak heartwood averages 54 pounds of dry weight per cubic foot, and almost 90 pounds of wet / green weight per cubic foot. Unlike the other oaks in the region, live oak xylem is diffuse porous making the annual increments difficult to count. False ring (annual increment) production can occur. Sapwood is whitish in color and heartwood is greyish-brown. There are a few broad rays and many narrow rays present. The wood has no noticeable odor or taste.

Wood density values provide for a hot burning and high energy content fuelwood or charcoal. In the past, strength and durability of live oak wood prevented most hand powered sawing, and so planks were seldom generated. Historically hubs of wheels and machine cogs were hewed and carved from live oak. The most celebrated use of live oak wood was using the natural shape of branches and stems in building ribs and knees of wooden ship frames. The frame work would be of live oak, the exterior shell of longleaf pine, the masts of longleaf or white pine, and the interior trim of the captain's quarters of redbay (i.e. a live oak forest neighbor).

Early lumber producers found the wood difficult to work, and hard on labor and equipment. The wood is heavy and can be deceptive in how much different sized parts weight. The weight of live oak tree parts has two components, weight of the wood material and weight of the moisture in the wood. The moisture content of living live oak xylem and associated tissues can vary greatly. In live oak, an estimate of greenwood moisture content in a living tree is 70-80% on an oven-dry basis.

Figure 7 estimates how many cubic feet of woody material is in a given branch, stem or root segment based upon its average diameter (outside the bark) and length of the segment considered. Bark weight, cavities, soil, included foreign materials, and atypical growths are not included in the volume estimates and the subsequent weight calculation. Segment weight can be estimated from multiplying the volume in cubic feet determined in Table 1 by the average greenwood density of live oak in pounds per cubic feet (~90 lbs/ft3). The formula is: [90 (lbs/ft3) X volume of live oak segment (ft3)] = Estimated Weight of Live Oak Segment (lbs.). For example, a branch with an average diameter of 10 inches weights 54 pounds for each foot of length, or 324 pounds for a 6 feet long segment.

Sorting Out Live Oaks

Live oak identification is more difficult in different parts of its native range where varieties and closely related species exist. Live oak is placed within the white oak group due to its flowering and fruiting characteristics. Unlike most other oaks its shoot growth pattern is indeterminate and manifold, and so its wood is diffuse porous. Across its range, different scientists have visualized the live oak species differently depending upon specific trees and sites observed.

Unique tree localities and physiographic regions, coupled with the variability of leaf forms, have all led to different sortings and subdivisions of live oak varieties. Added to this natural variability, the plasticity of leaf appearance from site to site with hybridization, compounded with confusion over similar looking associated species in the same area, and live oak identification becomes complex with a tremendous range of identification difficulties. To recognize the genetic concept of live oak requires more carefully clarifying species, cultivars, hybrids, and varieties.

Historic Varieties

Live oak has been seen as having a number of varieties depending upon how detailed an observer wants to be and how much of the live oak range is reviewed. There is a functional value in reviewing a list of historic Sargent live oak varieties, which are based primarily on site and leaf size, to demonstrate

the variability of live oak as seen by one trained observer in the early 1900s. Note – even though leaves change sizes, acorn and flower sizes are almost always conserved across all live oak varieties. Figure 8 lists the historical Sargent live oak varieties by name and where they were found. Figure 9 provides a loaction map for these historic live oak varieties.

Current Species

The Cuban live oak, once considered a live oak variety (Quercus virginiana var. sagreana) is now considered a variety of a separate species (Quercus oleoides var. sagreana). Cuban live oak is thought by some to be an ancient hybrid of Q. virginiana var. geminata and Q. oleoides.

Quercus minima is now the scientific name for dwarf live oak In the recent past, dwarf live oak was called (Quercus virginiana var. minima, or Quercus virginiana var. dentata). Dwarf live oak is now considered a separate species and not a variety of live oak. Dwarf live oak is a small leaved shrub on beach sands of the lower coastal plain from Southeastern North Carolina to Eastern Texas including coastal Florida. Unfortunately for clear thinking regarding this species, dwarf live oak does hybridize with live oak.

Texas live oak (Q. fusiformis) was considered a scrubby, upland variety of live oak once called Q. virginiana var. fusiformis or Quercus oleoides var. quaterna, but is now seen as a unique species. Texas live oak is a shrubby, small tree with small leaves and elongated fruit growing on dry, upland, and inland sites in central Texas with spots in Southwestern Oklahoma & Northeastern Mexico. Texas live oak and live oak generate hybrids in Texas where their ranges merge and overlap.

Until recently, a shrubby variety of live oak was called maritime live oak (Quercus virginiana var. maritima). This small statured variety was found on sand dunes back away from the water's edge along beaches. This maritime live oak variety was misidentified early in the last century, but has now been reclassified as a variety of Quercus x laurifolia. This variety is partially equivalent to Quercus hemisphaerica (Darlington oak). This tree has red oak group traits including bristle tipped leaves which fall just before new leaves in early Spring. Acorns have thin saucer shaped caps, not the top- or bowl-shaped caps of live oak. There is now no maritime live oak classification accepted.

Modern Varieties

The most commonly accepted varieties of live oak today are: 1 = Quercus virginiana var. virginiana – the typical live oak across its range; and, 2 = Quercus virginiana var. geminata — the sand live oak of the lower coastal plain growing upon sand dunes and sand ridges from Southeast North Carolina around the Coastal Plain to Southeast Louisiana.

For many dendrologists, sand live oak can be considered a separate species (Quercus geminata). Sand live oak is a small to medium sized tree with paired acorns on the end of each seed stalk. Sand live oak leaves have edges more tightly curled under than typical live oak. The top leaf surface shows indentations above where leaf veins occur. The trichomes (hairs) on the leaf underside are both star-shaped and upright. Sand live oak flowers roughly 2 to 3 weeks after live oak (Quercus virginiana var. virginiana). Sand live oaks are typically 30-40 feet tall and two feet in diameter, growing in a clump (called a "copse"). Generally, mature sand live oak has about 1/2 the stem diameter, and only 2/3 the crown diameter, of mature live oak. The largest sand live oaks reach 65 feet tall, 5 feet in stem diameter, and 100 feet in crown spread.

Hybrids & Cultivars

Live oak forms a number of hybrids with other oaks. Cataloged hybrids include crosses with: Q. bicolor (= x nessina); Q. durandii; Q. fusiformis; Q. lyrata (= x comptoniae — a fast growing tree with good cold tolerance for hardiness zones 7-9); Q. macrocarpa; Q. minima (= x succulenta — a Quercus geminata cross); and, Q. stellata (= x harbisonii).

In addition to hybrids, there are a number of live oak cultivars: **Boardwalk** 'FBQV22' with a pyramidal shaped crown, a strong central leader, and perpendicular branch angles; **Cathedral** 'SDLN' (PP#12,015) with a dense canopy, a strong central leader, and evenly spaced branches; **Grandview Gold** (gold colored foliage); **Heritage Oak** with a wide upright crown shape from Texas origins; **Highrise** 'QVTIA' (PP#11,219) with a strongly upright / columnar crown and dominant leader; **Millennium** 'CLTF2' (PP# 11,097) with large dark green leaves, and strong stem and branch taper; **Parkside** 'FBQV1' (or **Park Side**) with a dense canopy, broadly pyramidal in shape, and with perpendicularly attached branches; **Shadowlawn**; and, **Sky Climber** with a very upright crown form. Not all cultivars listed in the literature can be found currently in the commercial nursery trade.

Historic Tragedy

Live oaks have dense, hard, and strong wood which is resistant to weather, water, and mechanical strain. The massive, low, curved branches and sweeping stems were useless for straight-grained, dried lumber as made from other trees. But the natural growth pattern of live oak made the perfect structural components for wooden sailing ships. Live oak forests first seen by Europeans were storm pruned, extensive, and contained many massive individual trees. Commerce and wars of the 1700's generated demand for this premium wood for ship hull ribs, knees, and support parts. The old growth live oak forests were decimated by European nations, colonists, and early acts of our new nation.

"Live-oaking" was a way of life for Northern ship builders. Live oaks accessible to water transport were targets. Large trees were first cut to see if they were sound, and then divided into the largest and most effective parts for use in ship design. Many trees damaged by centuries of storms, were cut only to reveal they were internally decayed and would not meet the stringent specifications of New England, Atlantic Canadians, or English shipwrights. These cut trees were left to rot. No new trees were planted, nor sprouts conserved. Sustainable forest management was nonexistent.

Hired gangs of loggers and carpenters from all over were dispatched to hunt and convert live oaks into wooden ship components. The new United States of America federal government attached preserves, laws and bounties to live oak trees. Tree poaching, timber theft on public and private lands, federal agent corruption, and timber pirates were so common (and results so lucrative), only the demise of easily accessible live oaks and iron boat hulls halted live oak tree slaying and forest destruction. Major parts of the Atlantic coast old-growth live oak forests were gone by 1870. The Gulf coast live oaks were conserved more effectively for a longer period of time.

Thinking Big

We today cannot imagine the tree sizes, numbers, and distribution of live oak forests of the 1700's. What is lost cannot be recreated except through our appreciation of history and a celebration of some of the remaining tree giants (i.e. survivors). Figure 10 shows where the largest of the remaining live oaks are growing. Live oaks are today visible pillars, ceilings, and walls of old Southern coastal

landscapes, and line older streets, squares, and parks, while large wooden sailing ships of commerce and war are but a romantic memory.

Conclusions

Live oaks are historic ecological structures. Live oaks are sources of food, protection, and support to a host of other plants and animals. They are life-centers and life-generators where they grow. For people, live oak is a difficult tree to precisely identify, carefully grow, properly transplant, appropriately train, and sustainably manage across time.

Live oak represents a marker of this nation's history, and the nations which have come before. They have been, and remain a factory, product, and ecological treasure. Understandings about live oak are in great demand for use in new plantings and for ancient tree conservation. Part of these understandings are how live oak presents a complex biological, ecological, and risk management problem. Today live oaks represent both an essential ecological structure and a valuable cultural heritage.

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Selected Literature

The literature cited below helps provide entry into important information about live oak. This is not a comprehensive literature review, but citations of the most critical publications and articles which can help tree health care providers and tree owners with live oaks.

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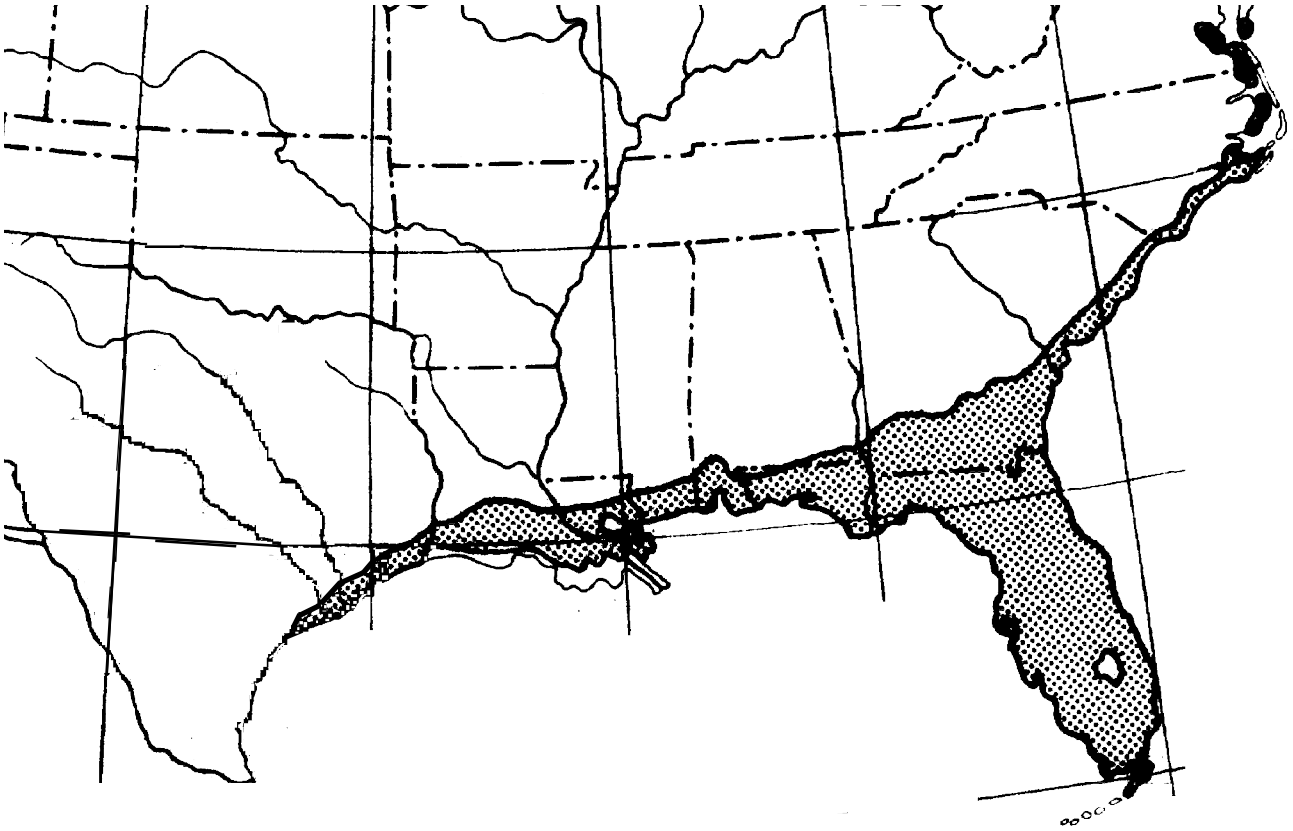

Figure 1: Live oak (Quercus virginiana var. virginiana) native range.

Modified from:

1) Little, Elbert L., Jr. 1971. **Atlas of United States Trees: Volume #1 -- Conifers & Important Hardwoods.** USDA-Forest Service, Miscellaneous Publication #1146. Washington D.C.

2) Muller, C.H. 1961. The origin of Quercus fusiformis. Journal of the Linnean Botanical Society 58:1-12.

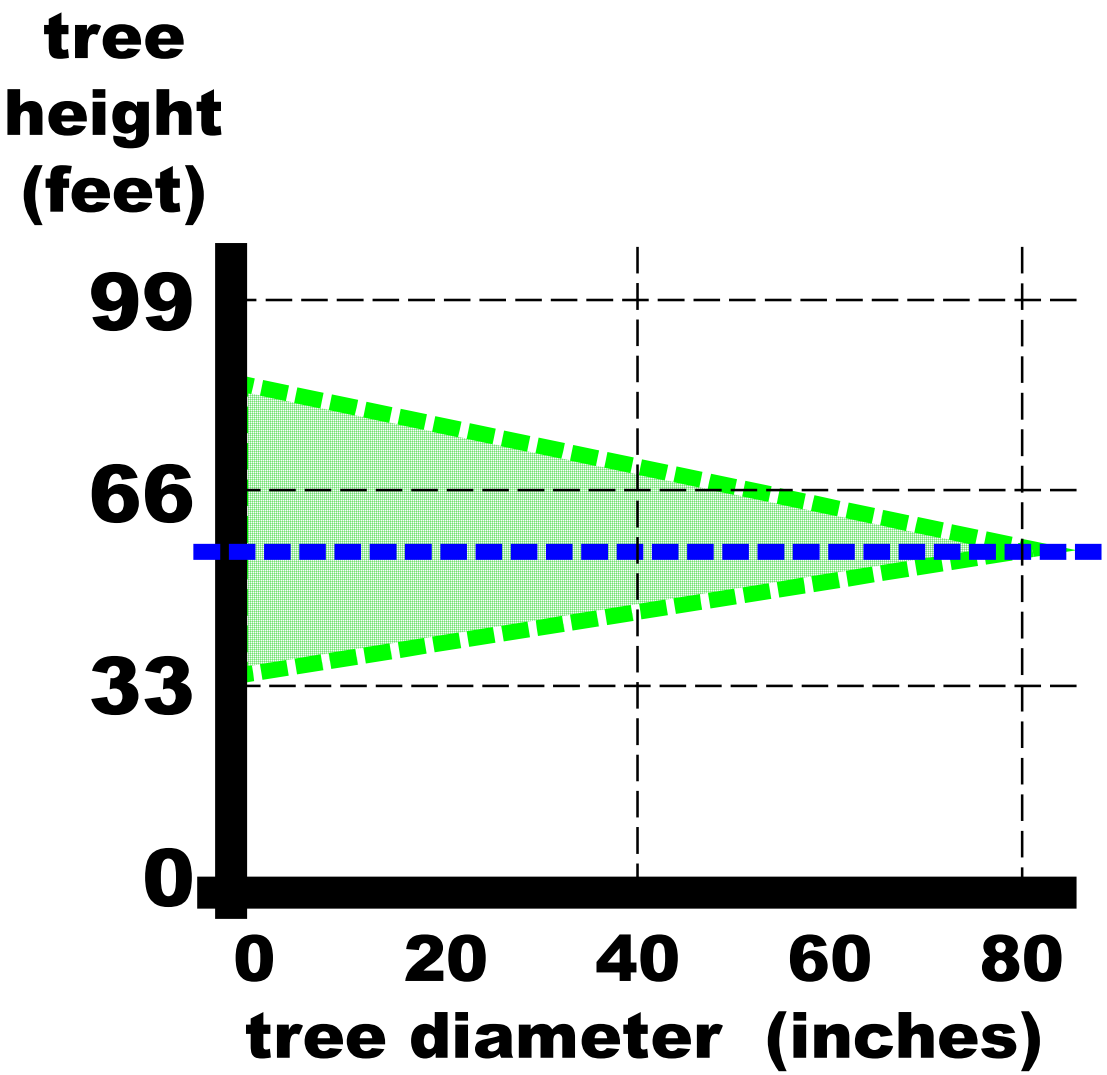

Figure 2: A range of open-grown, middle-aged live oak heights in feet and diameters in inches for one geographic area within the live oak's native range. Average tree height centered around 55 feet tall.
(modified from Spector & Putz 2006)

Figure 3: A range of tree height in feet and tree diameters in inches for small to medium live oaks growing in parking lots within one geographic area of live oak's native range.
(modified from Grabosky & Gilman, 2004)

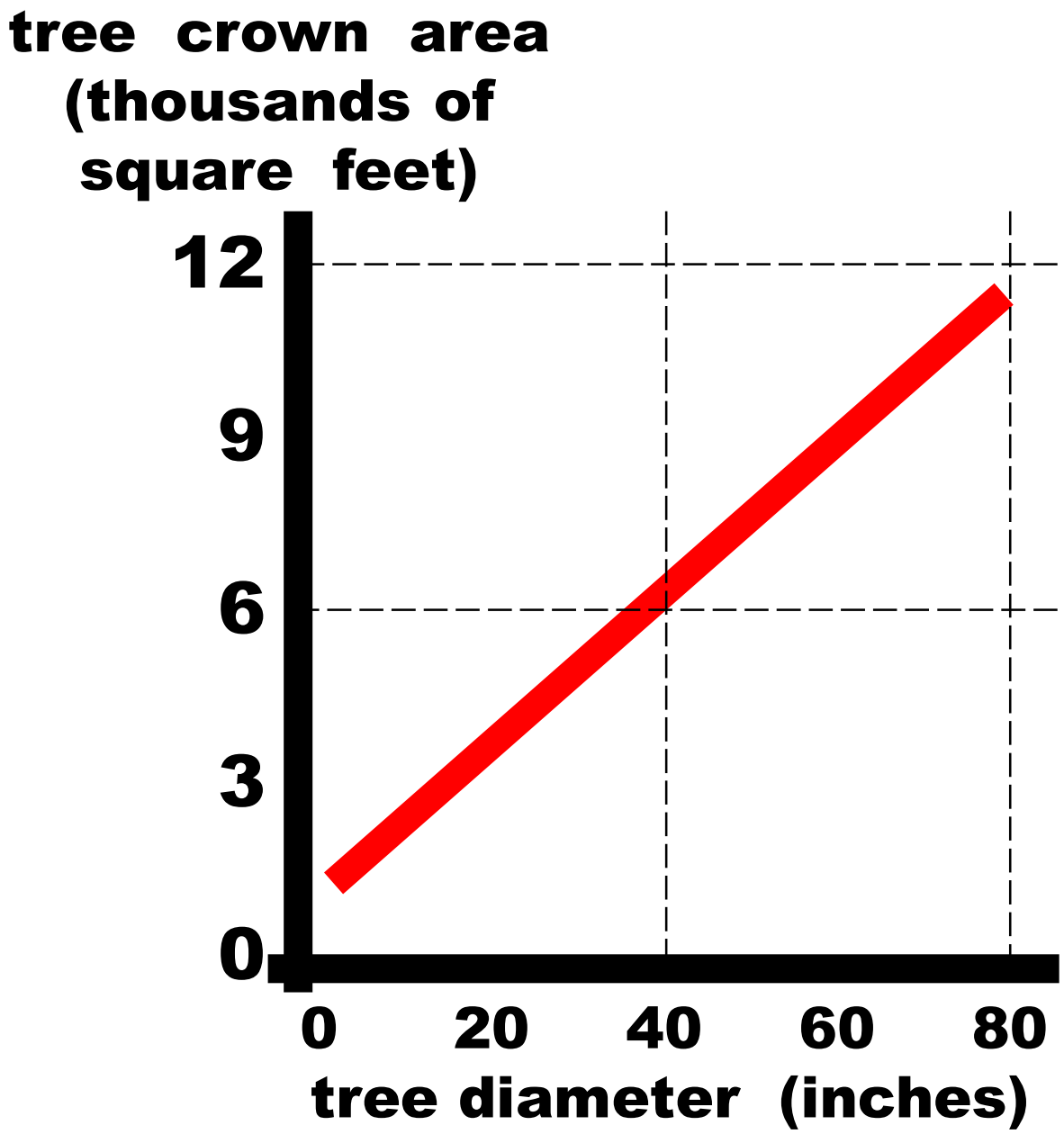

Figure 4: A range of open-grown, middle-aged live oak crown areas in square feet and tree diameters in inches for one geographic area within live oak's native range.
(modified from Spector & Putz 2006)

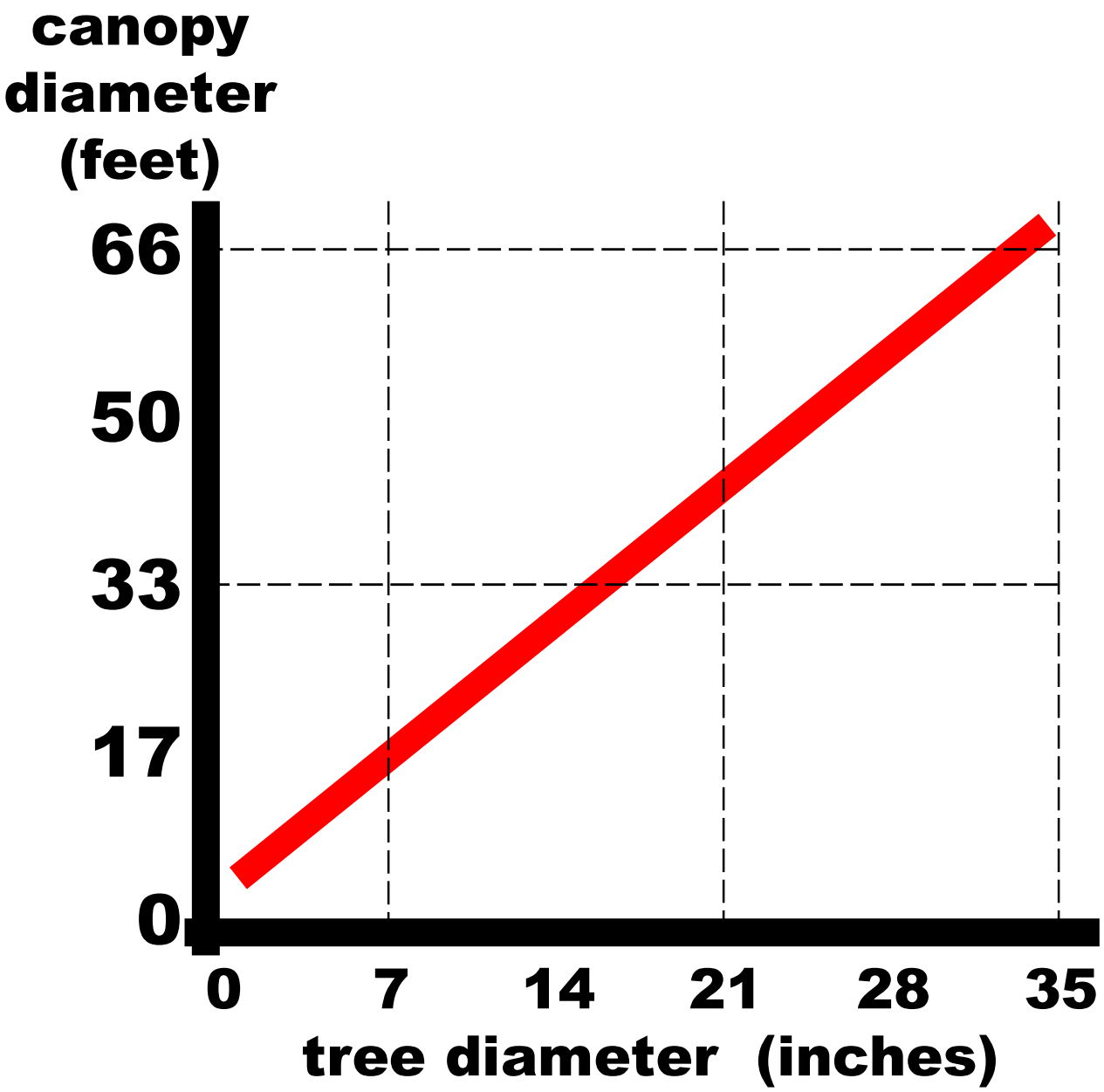

Figure 5: A range of canopy diameters in feet and tree diameters in inches for small to medium live oaks growing in parking lots within one geographic area of live oak's native range.
(modified from Grabosky & Gilman, 2004)

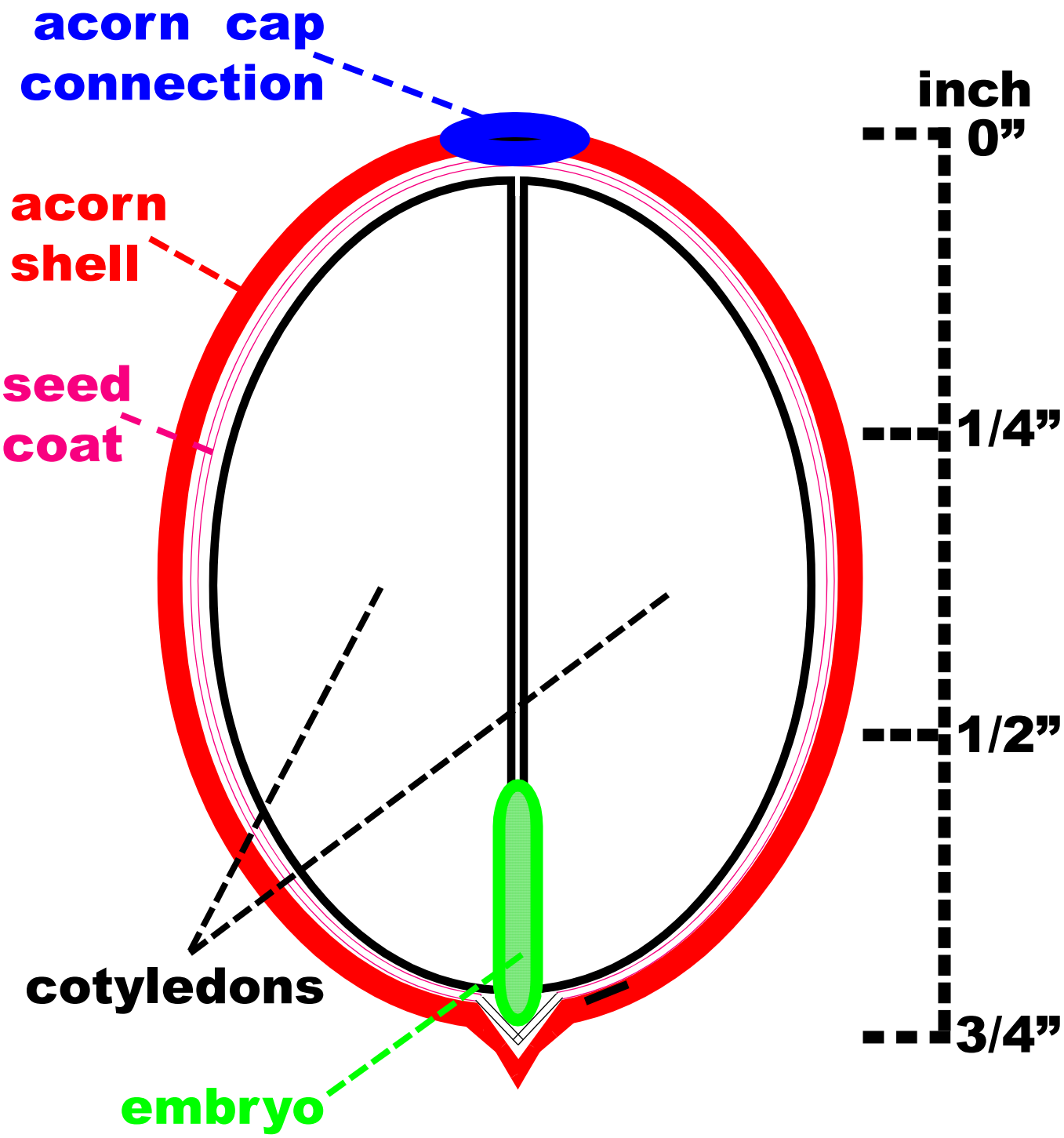

Figure 6: Idealized live oak acorn cut longitudinally. Size selected as average for SE Georgia.

Live Oak – *Quercus virginiana* ***K.D. Coder***

UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

diameter (inches)	circumference (inches)	length (feet) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	6.3	0.02	0.04	0.07	0.09	0.11	0.13	0.15	0.17	0.2	0.2	0.2	0.3	0.3	0.3	0.3
3	9.4	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.4	0.5	0.5	0.6	0.6	0.7	0.7
4	13	0.1	0.2	0.3	0.35	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.1	1.2	1.3
5	16	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.2	1.4	1.5	1.6	1.8	1.9	2.1
6	19	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
7	22	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.0
8	25	0.4	0.7	1.1	1.4	1.8	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.5	5.0	5
9	28	0.4	0.9	1.3	1.8	2.2	2.7	3.1	3.5	4.0	4.4	5	5	6	6	7
10	31	0.6	1.1	1.6	2.2	2.7	3.3	3.8	4.4	5.0	6	6	7	7	8	8
12	38	0.8	1.6	2	3	3.9	5	6	6	7	8	9	9	10	11	12
14	44	1.1	2	3	4	5	6	8	9	10	11	12	13	14	15	16
16	50	1.4	3	4	6	7	8	10	11	13	14	15	17	18	20	21
18	57	1.8	4	5	7	9	11	12	14	16	18	20	21	23	25	27
20	63	2.2	4	7	9	11	13	15	18	20	22	24	26	28	31	33
22	69	2.6	5	8	11	13.	16	19	21	24	26	29	32	34	37	40
24	75	3.1	6	9	13	16	19	22	25	28	31	35	38	41	44	47
26	82	3.7	7	11	15	18	22	26	30	33	37	41	44	48	52	55
28	88	4.3	9	13	17	21	26	30	34	39	43	47	51	56	60	64
30	94	4.9	10	15	20	25	30	34	39	44	49	54	59	64	69	74
32	101	6	11	17	22	28	34	39	45	50	56	62	67	73	78	84
34	107	6	13	19	25	32	38	44	51	57	63	69	76	82	88	95
36	113	7	14	21	28	35	42	50	57	64	71	78	85	92	99	106
38	119	8	16	24	32	39	47	55	63	71	79	87	95	102	110	118
40	126	9	18	26	35	44	52	61	70	79	87	96	105	114	122	131
42	132	10	19	29	39	48	58	67	77	87	96	106	116	125	135	144
44	138	11	21	32	42	53	63	74	85	95	106	116	127	137	148	159
46	145	12	23	35	46	58	69	81	92	104	116	127	139	150	162	173
48	151	13	25	38	50	63	75	88	101	113	126	138	151	164	176	189
50	157	14	27	41	55	68	82	96	109	123	136	150	164	177	191	205
55	173	17	33	50	66	83	99	116	132	149	165	182	198	215	231	248
60	189	20	39	59	79	98	118	138	157	177	197	216	236	255	275	295
65	204	23	46	69	92	115	138	161	184	208	231	254	277	300	323	346
70	220	27	54	80	107	134	160	187	214	241	267	294	321	348	374	401
75	236	31	61	92	123	155	184	215	246	276	307	338	368	399	430	460

Estimated live oak branch, stem, or root segment weight in pounds determined by:
[90 (lbs/ft^3) X volume of live oak segment as determined above (ft^3)].

Figure 7: Approximate number of cubic feet (ft^3) in a live oak branch, stem or root segment with a given average diameter or circumference (in.) and a given length (ft.).

map #	genus	species	variety / form name	description
1.	**Quercus**	**virginiana**	**virginiana**	**typical live oak across range**
2.			dentata* (minima)	shrubs on coastal sand dunes across live oak range
3.			eximea	narrow leaved, small trees of Eastcentral Louisiana
4.			fusiformis*	small leaved, small trees of Westcentral Texas with spots in Southwest Oklahoma & Northeast Mexico
5.			geminata*	medium sized trees on sandy soils from North Carolina to Mississippi
6.			grandifolia	large leaf form in Florida
7.			macrophylla	large leaved, medium sized trees in Texas
8.			pygmaea	leaves with small lobes near end on small shrubs, acorn almost enclosed by cap with short stalk in Florida (hybrid w/ Q. chapmani)
9.			sagreana*	Cuban live oak on Western end of island
10.			virescens	leaves bright green with few tricobes on medium sized trees in Central and Southern Florida

Figure 8: Historical listing of Sargent's live oak varieties and where they were found. (* = now considered a seperate species)

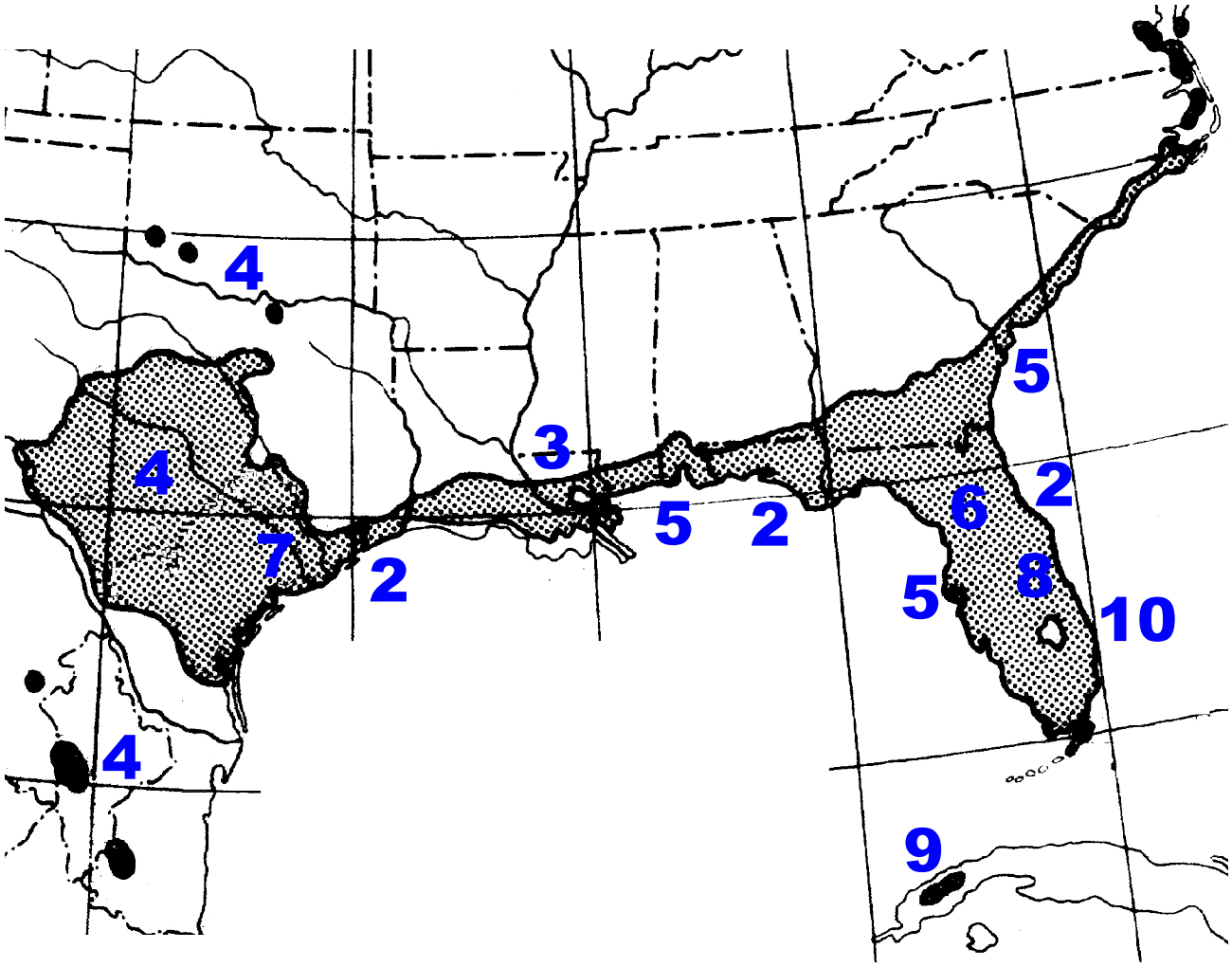

Figure 9: Live oak historic varieties locations. Numbers correspond to different varieties of live oak identified by Sargent as presented in Figure 8.

Modified From:

Little, Elbert L., Jr. 1971. Atlas of U.S. Trees: Vol. #1 -- Conifers and Important Hardwoods. USDA-Forest Service, Misc. Pub. #1146. Washington D.C.

Sargent, Charles S. 1965 (reprint 1922 original). Manual of the Trees of North America: Vol. #1. Dover Publishing, New York.

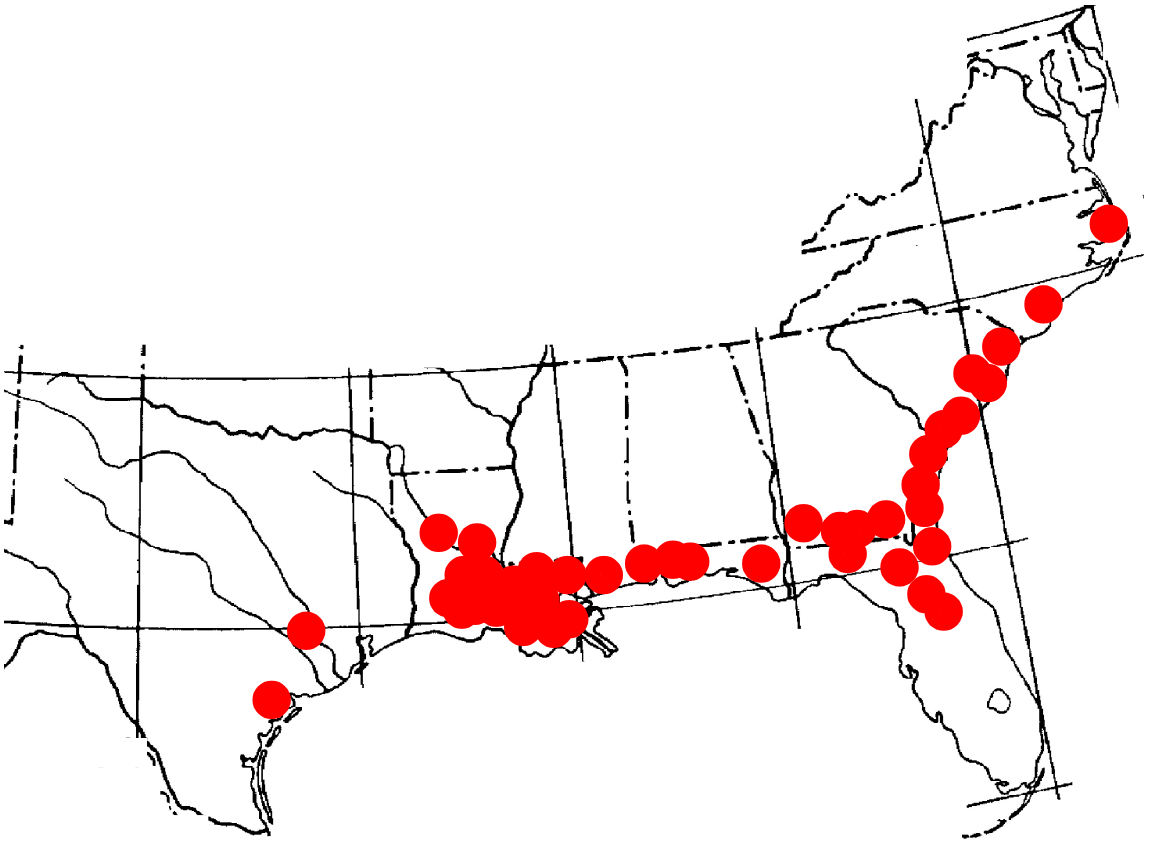

Figure 10: General location of the largest (i.e. >8 feet stem diameter) living live oaks.
(from Live Oak Society, registrations available on-line)