

Growth and Management of a Remnant Stand of Engelmann Oak at Los Angeles County Arboretum & Botanic Garden¹

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Abstract

Commercial, residential and ranch development combined with pressures from grazing, foraging and pests have decimated Engelmann oak (*Quercus engelmannii*) populations, resulting in this species being designated as vulnerable by the International Union for Conservation of Nature Red List of Threatened SpeciesTM. Los Angeles County Arboretum and Botanic Garden has the largest population of Engelmann oak in Los Angeles County and therefore has a responsibility to conserve and manage it, ensuring the grove's long-term survival. To achieve this goal, the arboretum has adopted a four-phase management program that includes the following: weed abatement; fostering successful establishment of natural recruits; supplementing natural recruits with nursery-grown saplings from field-collected acorns; and using precipitation and temperature data to guide the frequency and quantity of supplemental irrigation during winter, spring and late summer months. History of the plight of Engelmann oaks, observations about the natural history of the arboretum's population, an overview of our management program, and conservation progress to date are presented.

Key words: conservation, Engelmann oak, management, natural recruits, *Quercus engelmannii*

Introduction

Geological data indicates the historical distribution of Engelmann oak (*Quercus engelmannii*) was from western Arizona to the Pacific Coast south to northern Mexico and west to northern Baja California. Desertification resulting in the Mojave and Sonoran deserts restricted populations to western California south of the San Gabriel Mountains. Current populations exist in the Black Mountains of San Diego County (93 percent), the Santa Rosa Plateau of Riverside County (6 percent), Orange County (0.5 percent), and Los Angeles County (less than 0.1 percent). (Scott 1991).

This species typically occurs on 0 to 10 degree south-facing slopes where water drains rapidly from the topsoil/hardpan interface. The soil can be deep loamy-clay or shallow and rocky, often associated with a source of summer water from springs or streams. They perform best with a minimum of 38.1 cm (15 inches) of annual precipitation, and limited exposure to frost and extreme summer heat. It often occurs as a co-dominant species with coast live oak (*Q. agrifolia*).

Several factors have been responsible for declining populations of Engelmann oak (Pavlik and others 1991). The climate of southern California has changed substantially during the last 2 centuries. It has been conjectured that "our" climate was historically much more moderate with summer monsoonal events and lower summer temperatures, all conducive to a healthier environment for this species. Concurrent with expansion of civilization, predation from domesticated ungulates,

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rodents and insects have further reduced the reproductive potential. Over-grazing has contributed to soil compaction and changes in understory vegetation. Expansion of farmland, residential, and commercial development has resulted in loss of individuals and entire populations, as well as, population fragmentation. Although wind pollinated, the ever increasing distance between fragmented populations reduces successful pollination.

Dwindling populations of Engelmann oaks in the state of California have warranted the designation of vulnerable for Engelmann oak on the IUCN Red List (Nixon and others 1998). Throughout most of its range, it is at best, only secondarily protected, especially on military sites in the Black Mountains of San Diego County. The Santa Rosa Plateau in Riverside County is the only large site that is actively managed, by The Nature Conservancy. This species is virtually unprotected or managed elsewhere throughout the state, except for the small population located at Los Angeles County Arboretum.

Harvesting viable Engelmann oak acorns is challenging at best. Engelmann oak is a masting species on a 3-year cycle. This means acorns are produced in abundance every 3 years with limited numbers produced during the 2 other years. Typical predators include squirrels and at least three species of beetles. The current cycle for our trees is 2010, 2013 and should be again in 2016. It is easy to find viable acorns during mast years because of the abundance of acorns, more than can be predated. However, nearly all acorns are predated during non-mast years. Acorns typically mature and begin falling from the trees in mid-September, continuing into December. It is possible to harvest some viable acorns for *ex situ* production each year, but the greatest probability for natural recruit germination occurs only during mast years.

The greatest concentration of natural recruits occurs within the drip line of mature trees. This zone would typically contain the greatest amount of moisture and provides protection from full sun. Greater rodent predation is reported within the canopy zone of trees. Areas outside of the drip line typically have greater exposure to sun; soils are drier and result in increased attrition. Saplings growing in the nursery and those planted in the landscape tolerate full sun if planted in winter to early spring, allowing time for root establishment, and provided with adequate water.

Conservation management plan

The arboretum's conservation management plan emphasizes the following goals: manage the exotic grasses and forbs; establish a replacement population of trees by preserving natural recruits and planting nursery-grown saplings; use temperature and precipitation data from within the grove to guide frequency and quantity of supplemental irrigation during winter, spring, and late summer. Additional goals include: enhancing the overall health of the mature trees by monitoring environmental factors and pathogens and taking corrective action as needed; introduce sympatric native shrubs, grasses, and forbs to restore the habitat to a natural ecosystem; and educate the public about the plight of Engelmann oaks and the arboretum's effort to preserve its population of trees.

Methodology

One facet of our program entails identifying locations of natural recruits with irrigation flags that act as a visual cue during mechanical control of exotic ground-plane vegetation. The second facet involves harvesting viable acorns, typically during mast years and propagating them in our nursery. The highest probability of

distinguishing viable from nonviable acorns is ascertained by performing the float test—acorns that float are discarded and those that sink are planted (immature endosperm or predation by insect larvae result in air spaces within the acorns making them buoyant). Saplings are planted in March and April after sowing acorns in November or the following late fall and winter after temperatures have dropped and the ground has become saturated by rain or irrigation. Each seedling is provided with an open-mesh poultry wire cage, an accession label (accession number links the lineage of the seedling with the parent tree), three wire stakes to secure the cage in place and a band of colorful flagging tape on the top of the cage. Cages provide protection from mechanical damage from foot traffic and line trimmers used to control ground-plane exotic weeds. Irrigate monthly if in open areas or on the scheme for mature trees when planted within the grove and abate weeds immediately around the cages.

The minimum precipitation for healthy Engelmann oak tree growth is 381 mm (15 inches), an annual amount that is now atypical for this species throughout most of southern California. The conservation management plan mandates supplemental monthly, deep, thorough irrigation from December through May to ultimately achieve more than the minimum annual precipitation needs. Winter precipitation is monitored, in addition to visible stress to the trees (change in leaf color, drooping branches, or defoliation) to determine when supplemental irrigation is needed. The goal is 508 to 635 mm (20 to 25 inches) of cumulative precipitation and supplemental irrigation. This greater volume of “precipitation” is sought because the soil depth is in general shallow, resting on a clay hardpan. All irrigation applications are many hours long, encouraging penetration through leaf litter and mulch to achieve thorough soil saturation. Extreme summer temperatures without monsoonal rains require one additional application of water in mid-August, coinciding with monsoonal rains in Riverside and San Diego Counties.

***In situ* vs. *ex situ* management**

Management of saplings *in situ* is simple and straight forward. Irrigation flags are inserted into the ground next to each sapling, acting as a visual cue for inventory and weed abatement (fig. 1). The best time to spot seedlings is late winter into early spring when new leaves are most visible and weeds don't yet obstruct them. Natural recruits collectively receive a single accession number with unique qualifier to distinguish each sapling. Irrigation follows the regime for mature trees. Weeds are manually removed from a 61 cm (24-inch) diameter circle around each sapling. String trimmers are used between seedlings to reduce weed growth to about 15.2 cm (6 inches).



Figure 1—Irrigation flags are inserted into the ground next to each sapling, acting as a visual cue for inventory and weed abatement.

2010 was a mast-year for the arboretum's Engelmann oak population, resulting in an abundance of acorns. Approximately 3,600 natural recruits were identified and flagged in the grove between March and May of 2011. Only about 400 natural recruits remained in late 2013, an 88.9 percent attrition.

Ex situ management is more complex. Acorns are preferably collected directly from the parent tree. They are collected from the ground only under isolated trees. Each acorn lot is placed in a paper bag labeled with the female parent accession number and collection date. All acorns are subjected to the float test; only those that sink are dried and retained in the original bag; the ratio of sinkers to floaters is recorded on the paper bag and on a spreadsheet. Each lot is assigned a new accession number that references the parent tree accession. The paper bags are stored in a cooler at 4.4 °C (40 °F) until sowing in late November to early December.

Acorns are planted 2.5 cm (1 inch) deep in 17.8 cm (7 inch) single-cell cone-tainers™ provided with artificial medium (fig. 2). Each Cone-tainer™ is marked with a plastic label bearing the lot's accession number, genus, and species, as well as female parentage (fig. 3). All trays are thoroughly watered and covered with a wire cage to exclude rodents. Germinated seedlings are counted monthly through June.



Figure 2—Nine-month-old seedlings in the nursery growing in Ray Leach “Cone-tainer”™ single cells.



Figure 3—Each sown acorn is marked with a plastic label bearing the lot’s accession number, genus, and species, as well as female parentage.

Germination occurs rapidly after sowing. Radicle development is the first growth activity, developing to pencil-dimensions and elongating to 12.7 to 15.2 cm (5 to 6 inches) (fig. 4). Few secondary roots are formed during the first growing season but become more abundant in ensuing months. Shoot development and emergence occurs as rapidly as 4 to 6 weeks, and will continue throughout an acorn population for up to 6 months when given adequate irrigation. Vegetative growth reaches 2.5 to 7.6 cm (1 to 3 inches) tall the first growing season before summer dormancy. Multiple shoots are common and damage to shoots or natural dieback often results in initiation of new shoots.



Figure 4—Radicle development is the first growth activity, developing to pencil-dimensions and elongating to 12.7 to 15.2 cm (5 to 6 inches).

Percent germination across all acorn lots from our site was recorded in 2014 after sowing in November 2013: 26.7 percent in February; 28.7 percent in March (55.4 percent cumulative); 11.5 percent in April (66.9 percent cumulative); 5.9 percent in May (72.8 percent cumulative); 0.5 percent from June to September (73.3 cumulative).

Each sapling is planted with a small metal tag bearing the following information: accession number (for example, 20130425*X; where “2013” represents the collection year, “0425” represents the seed lot designation and “X” is a unique qualifier number assigned to each sapling beginning with “1”), female parent tree (for example, LACA235), genus, species, common name, family, and natural distribution.

Saplings should be planted soon after germination, beginning as soon as 2 months, continuing through March or April. Resume planting the following rainfall season, from December through February and continue through March or April if necessary.

Resume planting the following December after first rainfall or irrigation, continuing as above. Saplings more than 18 months old typically have elongated tap roots or stunted tap roots, less than desirable for planting but definitely worth experimenting with to determine survivability.

The cultural program provided for *ex situ* saplings is critical for their establishment and survival to maturity. Holes are dug in moist soil to a depth that will accommodate the taproot. A sapling is inserted into the hole to a depth that matches both single-cell Cone-tainer™ planting mix and soil surfaces and held in place with one hand. The other hand is used to fill the planting hole halfway and water is poured into the hole to settle the soil. Soil is backfilled to the rim of the planting hole and water is applied at least two more times to completely saturate the new planting. Loosened soil around the sapling is compacted using fingertip pressure and the disturbed area is watered one more time. The wire-staked accession label is inserted into the ground adjacent to the seedling. A 7.6 cm (3 inch) diameter by 45.7 cm (18 inch) tall poultry-wire cage is placed over the seedling and label. Cages are secured with three 40.6 cm (16 inch) wire stakes (fig. 5). Six seedlings are planted per accession with the goal to establish one seedling per parent tree. Seedlings are planted in the vicinity of the female parent tree to simulate natural acorn dispersal. They are watered according to the regime for the mature trees unless planted outside the grove where there is no canopy. These exposed seedlings are watered monthly through the first two summer dormant seasons.



Figure 5—One-year-old sapling showing growth through the open-mesh poultry-wire cage and accession label.

Weeds are removed primarily by hand from within the cages and out to a radius of 30.5 cm (12 inches). String trimmers are used to reduce weed growth to 15.2 cm (6 inches) tall between seedlings. Cutting weeds shorter than 15.2 cm can result in

damaging non-flagged seedlings. Cages are removed when the saplings are 0.6 to 0.9 m (2 to 3 ft) tall. Established saplings are mapped with typical survey equipment using geo-relational monuments that allows their exact placement within the landscape, from which maps can be generated.

Conclusion

Environmental, ecological, and human-influenced pressures have and continue to diminish and fragment *Q. engelmannii* populations. The greatly diminished distribution of Engelmann oaks in southern California prompted the IUCN to assign it a vulnerable status. The arboretum is fortunate to have the largest grove of Engelmann oaks in Los Angeles County and therefore has a responsibility to conserve and manage it, ensuring the grove's long-term survival. A conservation management program has been implemented to guide the process. Results of this program include: concluding that supplemental irrigation is necessary to reduce leaf drop, and maintain health and vigor in the greater Los Angeles area; protecting natural recruits from mechanical damage increases survival rates; *ex situ* sapling production is very successful; and, vegetating with *ex situ* saplings is successful when planted during winter/spring precipitation periods, supplemental irrigation is applied, and protection is provided to prevent mechanical damage.

References

- Nixon, K. [and others]. 1998. *Quercus engelmannii*. **The IUCN red list of threatened species**. Version 2014.3. <http://www.iucnredlist.org/details/full/34020/0>. (20 November 2014).
- Pavlik, B.M.; Muick, P.C.; Johnson, S.G.; Popper, M. 1991. **Oaks of California**. Los Olivos, CA: Cachuma Press. 184 p.
- Scott, Thomas A. 1991. **The distribution of Engelmann oak (*Quercus engelmannii*) in California**. In: Standiford, Richard B., tech. coord. Proceedings of the symposium on oak woodlands and hardwood rangeland management. Gen. Tech. Rep. PSW-126. Berkeley CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 351–359.