Conservation Gap Analysis of Native U.S. Oaks

Species profile: *Quercus engelmannii*
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### SPECIES OF CONSERVATION CONCERN

#### CALIFORNIA

- Channel Island endemics: Quercus pacifica, Quercus tomentella
- Southern region: Quercus cedrosensis, Quercus dumosa, *Quercus engelmannii*
- Northern region and/or broad distribution: Quercus lobata, Quercus parvula, Quercus sadleriana

#### SOUTHWESTERN U.S.

- Texas limited-range endemics: Quercus carmenensis, Quercus graciliformis, Quercus hinckleyi, Quercus robusta, Quercus tardifolia
- Concentrated in Arizona: Quercus ajonensis, Quercus palmeri, Quercus toumeyi
- Broad distribution: Quercus havardii, Quercus laceyi

#### SOUTHEASTERN U.S.

- State endemics: Quercus acerifolia, Quercus boytonii
- Concentrated in Florida: Quercus chapmanii, Quercus inopina, Quercus pumila
- Broad distribution: Quercus arkansana, Quercus austriana, Quercus georgiana, Quercus oglethorpensis, Quercus similis
VULNERABILITY OF WILD POPULATIONS

Table 1. Scoring matrix identifying the most severe demographic issues affecting Quercus engelmannii. Cells are highlighted when the species meets the respective vulnerability threshold for each demographic indicator. Average vulnerability score is calculated using only those demographic indicators with sufficient data (i.e., excluding unknown indicators).

<table>
<thead>
<tr>
<th>Demographic indicators</th>
<th>Level of vulnerability</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population size</td>
<td>&gt;= 100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt;= 250</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>&lt; 2,000</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>&gt; 10,000</td>
<td>15</td>
</tr>
<tr>
<td>Range/extension</td>
<td>Very small range or 1 location</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Large range or 2-4 locations</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Very large range or 5+ locations</td>
<td>10</td>
</tr>
<tr>
<td>Population decline</td>
<td>&gt;= 50% decline</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt; 30% decline</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>None or unknown</td>
<td>10</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>Severe fragmentation</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Moderate fragmentation</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Insufficient to maintain current population size</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Sufficient to increase current population size</td>
<td>15</td>
</tr>
<tr>
<td>Genetic variation/integrity</td>
<td>Extremely low</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Low or medium</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>High or very high</td>
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</tr>
<tr>
<td></td>
<td>No score</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Emergency</td>
<td>20</td>
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<tr>
<td>Average vulnerability score</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.0</td>
<td></td>
</tr>
</tbody>
</table>

THREATS TO WILD POPULATIONS

High Impact Threats

Human use of landscape — residential/commercial development, mining, and/or roads: Suburban sprawl, especially in the San Gabriel Valley, is causing Engelmann oak populations to be fragmented to the point of falling rates of pollination and acorn production. Because fire damage to the trees is generally low in grasslands, and high in chaparral, continued human development of grassland areas could leave remaining Engelmann oak populations at greater risk to fire in chaparral communities.6

Human modification of natural systems — disturbance regime modification, pollution, and/or eradication: Another effect of development is the increasing risk of human induced wildfire. The entire range Engelmann oak exists within these risk areas. Two of the largest wildfires in California burned extensive portions of the species’ range in the 2000’s. The 2003 Cedar Fire burned about 53% of monitored trees within Santa Ysabel Open Space Preserve, where the vast majority of Engelmann oak’s total population is located.5

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: Climate change models based solely on habitat suitability predict climate change to be the largest threat to Q. engelmannii, which is worrying since such models often underestimate the total impact of climate change.6 A recent analysis of U.S. tree vulnerability to climate change found Q. engelmannii to have "potential future vulnerability" based on species-specific traits, due to low threat exposure but high threat sensitivity and low adaptive capacity.9 Engelmann oak is also predicted to experience net habitat losses under combined impacts (climate change and land use change), even under best-case unlimited dispersal scenarios.10 Negative impacts due to increased periods of extreme heat, whipplash precipitation cycles (extremely wet to extremely dry), and consecutive years of drought are predicted; such conditions also increase the threat of severe fire (J. Henrich pers. comm., 2018).

Moderate Impact Threats

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: Reproduction of Engelmann oak on the Santa Rosa Plateau is insufficient to maintain its current distribution, abundance, and demographics.1 This is attributed to past, nearly continuous grazing of the area for the last 75 years, causing soil compaction and damage to existing trees.1 In some areas, livestock grazing is still a substantial threat.14

Pests and/or pathogens: There is recent concern regarding Polyphagous and Kuniothia shot hole borers (PSHB/KSHB) in southern California. These beetles are a pathognomonic host for the pathogenic fungus Fusarium oxysporum, which can carry as they bore into the trunks and branches of trees for reproduction.2 This fungus is harmful to Q. engelmannii and has spread throughout Los Angeles and San Diego Counties. It is very difficult to detect before it is too late (T. Thibault pers. comm., 2016). Goldspotted oak borer injuries have also been observed on dead Engelmann oak "but tree mortality...was likely a result of a complex of factors (e.g., drought and root disease)."17

DISTRIBUTION AND ECOLOGY

Quercus engelmannii, or Engelmann oak, is sporadically distributed south from southern California, U.S., to southwestern Baja California, Mexico. It occurs in four California Floristic Provinces: South Coast, San Gabriel Mountains, Peninsular Ranges, and San Jacinto Mountains. A subpopulation is also present on Santa Catalina Island (T. Gaman pers. comm., 2018). Engelmann oak is commonly found growing in stands with Coast live oak. Suitable habitat for Q. engelmannii is restricted by adequate rainfall (at least 15 inches per year), rare instances of frost, and moderate summer temperatures. These landscapes include valley grassland, foothill woodlands above 1,000 feet, and evergreen.

Figure 1. County-level distribution map for the U.S. distribution of Quercus engelmannii. Source: Biota of North America Program (BONAP).9

Figure 2. Documented in situ occurrence points for the U.S. distribution of Quercus engelmannii. Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).8

Synonyms: N/A Common Names: Engelmann oak, Mesa oak, Pasadena oak

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Contributors: Jim Henrich, Los Angeles County Arboretum & Botanic Garden; Tim Thibault, The Huntington

CONSERVATION ACTIVITIES

In 2017 Quercus accessions data were requested from ex situ collections. A total of 162 institutions from 26 countries submitted data for native U.S. oaks (Figures 3 and 4). Past, present, and planned conservation activities for U.S. oak species of concern were also examined through literature review, expert consultation, and conduction of a questionnaire. Questionnaire respondents totaled 252 individuals from 252 organizations, including 78 institutions reporting on species of concern (Figure 6).

Results of 2017 ex situ survey

- Number of ex situ collections reporting this species: 20
- Number of plants in ex situ collections: 566
- Average number of plants per institution: 28
- Percent of ex situ plants of wild origin: 77%
- Percent of wild origin plants with known locality: 99%

A spatial analysis was conducted to estimate the geographic and ecological coverage of ex situ collections (Figure 5). Only the native U.S. distribution of the species was considered in this analysis, due to availability of ecoregion maps. Fifty-kilometer buffers were placed around each in situ occurrence point and the source locality of each plant living in ex situ collections. Collectively, the in situ buffer area serves as the inferred native range of the species, or “combined area in situ” (CAIS50). The ex situ buffer area represents the native range “captured” in ex situ collections, or “combined area ex situ” (CAE50). Geographic coverage of ex situ collections was estimated by dividing CAE50 by CAIS50. Ecological coverage was estimated by dividing the number of EPA Level IV Ecoregions present in CAE50 by the number of ecoregions in CAIS50.

Estimated ex situ representation

- Geographic coverage: 74%
- Ecological coverage: 79%

Figure 3. Number and origin of Quercus engelmannii plants in ex situ collections. Provenance types: W = wild; Z = indirect wild; H = horticultural; U = unknown.

Figure 4. Quercus engelmannii counties of in situ occurrence, reflecting the number of plants from each county in ex situ collections.

Figure 5. Quercus engelmannii in situ occurrence points and ex situ collection source localities within the United States. U.S. EPA Level IV Ecoregions are colored and labelled. County centroid is shown if no precise locality data exist for that county of occurrence. Email treeconservation@mortonarb.org for more information regarding specific coordinates.

A USDA Forest Service report explains the status of protected Q. engelmannii populations in 1991: “The U.S. Forest Service has the largest tracts of Engelmann oak woodlands under one management, and provides the best opportunity for comprehensive planning for the conservation and management of the species. Land Grants, particularly Rossi, which have not been divided into subunits, provide the next largest group of undivided woodland areas...The greatest challenge in Engelmann oak conservation occurs in the small parcels which share 36% of all Engelmann oak woodlands.”

A Multiple Habitat Conservation Plan (MCHP) for the cities of Carlsbad, Encinitas, Escondido, Oceanside, San Marcos, Solana Beach, and Vista requires subarea plans to implement a fire management plan in all conserved populations. Population monitoring and/or occurrence surveys: One institution reported this activity in the conservation action questionnaire, but no other details are currently known.

Wild collecting and/or ex situ curation: At the easternmost edge of the species’ range is Rancho Santa Ana Botanic Garden in Claremont. Since the late 2000s, they have established a Q. engelmannii grove through acclom collection from isolated, wild individuals ranging from Pasadena to Monrovia.

Some significant populations are also held within public gardens, including The Los Angeles County Arboretum, which has a population of nearly 250 Engelmann oak trees and is the largest remaining extant population in Los Angeles County. A smaller, neighboring subpopulation can be found at Santa Anita Park, as well as another small stand within Huntington Botanical Gardens in San Marino.

Sustainable management of land: The Santa Rosa Plateau is the only preserve established specifically for Engelmann oaks and is managed by The Nature Conservancy. At the Ecological Reserve located at the southern end of the Santa Ana Mountains, experimental management fires of the grass layer were initiated in 1988, along with test burns in Riverside County (now the nonminemost ecologically-intact population of Q. engelmannii) and Santa Ysabel Open Space Preserve. The Los Angeles County Arboretum & Botanic Garden has claimed responsibility for the growth and management of a remnant stand of Engelmann oak within their property and adopted a four-phase management program, which begins with weed abatement and fostering successful establishment of natural recruits. The MCHP for the cities of Carlsbad, Encinitas, Escondido, Oceanside, San Marcos, Solana Beach, and Vista requires subarea plans to implement a fire management plan in all conserved populations.
Wildfire damage to established native stands, habitat fragmentation and loss due to land use change are the primary reasons for the dramatic decline of Engelmann oak. Climate change and ongoing drought issues also complicate sustenance of natural populations. Protected outplanting in preserve areas within the native range and in other suitable locations may aid in maintaining this species. Establishment of suitable conditions for natural regeneration, such as in areas protected by gaps in established stands of native shrub species, could also be key to the perpetuation of this species in natural landscapes. Further research may be needed to inform effective restoration protocols. About 36% of Engelmann oak woodlands exist in small land parcels. Therefore, outreach to individual landowners regarding techniques for sustainable management of oak woodlands will be an important component of the species’ conservation. Continued monitoring of wild populations is also necessary, which will aid in the prediction of climate impacts. Further wild collecting for ex situ preservation should be carried out, targeting edge populations not yet held in ex situ collections. Engelmann oak is also predicted to experience net habitat losses under combined impacts (climate change and land use changes), even under best-case unlimited dispersal scenarios. Therefore dispersal will be vital to assuaging future habitat loss.

**REFERENCES**

2. Rosatti, T. J. & Tucker, A. M. (2014). Quercus engelmannii in Japanese Flora Project (Eds.), Japa nonce Flora, Revisited. 2. Retrieved from http://esco.fepusa.org/repository/8556d4f2-4b89-4b45-b899-7c7c0e06b8e0
9. California Dept. of Fish and Game, U.S. Fish and Wildlife Service, & California Oak Coalition. (2016). Oak: life history traits and short-term and long-term climate change projections, to predict the species’ abundance in the future. These models incorporated data regarding land use change, altered fire frequency, and dispersal and seed production. Results predicted “dramatic reduction in Q. engelmannii abundance, especially under drier climates and increased fire frequency.” Another study examined connections between the climate gradient of Englemann oak’s distribution and its spatial genetic structure by combining information from nuclear microsatellite markers and ecological niche modelling. Three main genetic clusters emerged, suggesting that local environmental conditions can influence spatial genetic structure, “even in species with high potential for gene flow and relatively small distribution ranges.”

**Conservation recommendations for Quercus engelmannii**

**Highest Priority**
- Education, outreach, and/or training
- Plant introduction, reinforcement, and/or translocation

**Recommended**
- Population monitoring and/or occurrence surveys
- Risk analysis (density management disturbance regime needs, pest/pathogens, restoration protocols/guidelines)
- Habitat manipulation of land
- Wild collecting and/or ex situ curation

**PRIORITY CONSERVATION ACTIONS**

- Education, outreach, and/or training: The California Native Plant Society provides information to homeowners regarding the tree’s use in landscape, including ecological requirements and locations for purchase. The East Palo Alto Tree Initiative, a “multi-year collaboration to enhance the urban forest in East Palo Alto and plant more than 1,200 trees,” included Q. engelmannii in their urban plantings, in which hundreds of volunteers participated.

- Species protection policies: The city of Los Angeles has adopted a Protected Tree Ordinance that prohibits the removal or relocation of all native California oak species unless a permit is obtained through the Board of Public Works. The Board may require the planting of multiple protected trees within the same property’s boundaries in addition to a fee for the removal or relocation of a native oak.

- Research, reintroduction, reinforcement, and/or translocation: The CA County Arboretum is supplementing their native stand of Q. engelmannii with seedlings grown from wild collected acorns they have propagated in their nursery. The MCHP for the cities of Carlsbad, Encinitas, Escondido, Oceanside, San Marcos, Solana Beach, and Vista requires subarea plans to enhance declining populations, including reinforcement of existing populations. They require that “unless analyses determine that there is no significant genetic variation between populations, introduced plant materials must be from the parent population or a population in proximity.”

- Utilizing dynamic species distribution models, a study examined the interaction of Q. engelmannii life history traits and short-term and long-term climate change projections to predict the species’ abundance in the future. These models incorporated data regarding land use change, altered fire frequency, and dispersal and seed production. Results predicted “dramatic reduction in Q. engelmannii abundance, especially under drier climates and increased fire frequency.” Another study examined connections between the climate gradient of Englemann oak’s distribution and its spatial genetic structure by combining information from nuclear microsatellite markers and ecological niche modelling. Three main genetic clusters emerged, suggesting that local environmental conditions can influence spatial genetic structure, “even in species with high potential for gene flow and relatively small distribution ranges.”