Conservation Gap Analysis of Native

Mesoamerican Oaks


Béatrice Chassé

Species profile: ***Quercus engelmannii***

Kate Good, Lluvia Flores Renteria, Kieran Althaus, Silvia Alvarez-Clare

CRITICALLY ENDANGERED

Quercus graciliformis
Quercus mulleri

ENDANGERED

Quercus brandegeei
Quercus carmenensis
Quercus cualensis
Quercus cupreata
Quercus delgadoana
Quercus devia
Quercus diversifolia
Quercus dumosa
Quercus engelmannii
Quercus flocculenta
Quercus galeanensis
Quercus hintonii
Quercus hirtifolia
Quercus insignis
Quercus macdougallii
Quercus miquihuanensis
Quercus nixoniana
Quercus radiata
Quercus runcinatifolia
Quercus tomentella

VULNERABLE

Quercus acutifolia
Quercus ajoensis
Quercus cedrosensis
Quercus costaricensis
Quercus gulielmi-treleasei
Quercus hintoniorum
Quercus meavei
Quercus rubramenta
Quercus tuitensis
Quercus vicentensis

The Morton Arboretum | THE CHAMPION of TREES
Global Conservation Consortium Oak
CSS TREES Center for Species Survival
Franklinia Foundation

Quercus engelmannii Greene

Common Names, English: Engelmann Oak
IUCN Red List Category and Criteria: Endangered: A3c

Species profile experts: Lluvia Flores Renteria, San Diego State University; Kieran Althaus, The Morton Arboretum, University of Chicago

Suggested citation: Good, K., Flores Renteria, L., Althaus, K., and Alvarez-Clare, S. (2024). *Quercus engelmannii* Greene. In Good, K., Coombes, A. J., Valencia-A, S., Rodríguez-Acosta, M., Beckman Bruns, E., and Alvarez-Clare, S. *Conservation Gap Analysis of Native Mesoamerican Oaks*. (pp. 165-172). Lisle, IL: The Morton Arboretum.

DISTRIBUTION AND BIOLOGY

Quercus engelmannii is native to southern California and northwestern Baja California, Mexico (Figure 1). It occurs as far north as the San Gabriel Mountains outside of Los Angeles, and south to the Ensenada area in Baja California. *Quercus engelmannii* is typically found on flat to slightly sloping land (no more than 5–10%) where water drains rapidly, and grows best in areas with a minimum of 38 cm of annual rainfall and moderate summer temperatures (Henrich, 2014). This amount of rainfall is now atypical throughout the species range. It inhabits valley grasslands, foothill woodlands, and chaparral margins (Beckman et al., 2019). A majority of known occurrence points for this species are in the warm temperate thorn scrub life zone (Figure 2).

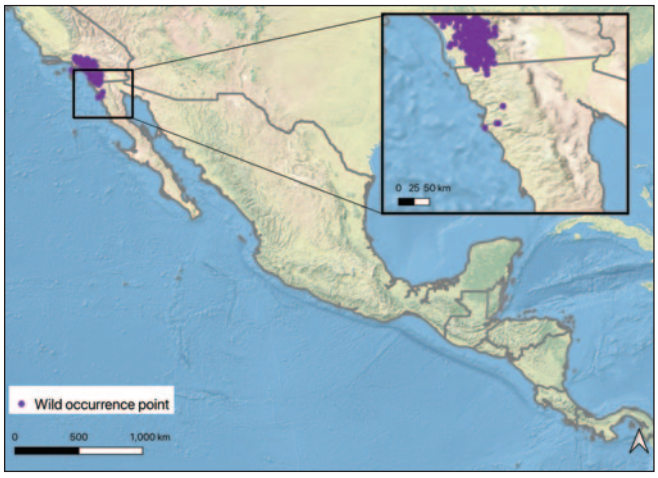

Figure 1. Wild (i.e., *in situ*) occurrence points for *Quercus engelmannii*.

Quercus engelmannii is an evergreen species that grows 5–25 m. Leaves are oblong to obviate and are blue-green in color. Acorns are 15–25 mm, oblong-cylindric to ovoid, and mature in one year (The Jepson Herbarium, 2024). It most closely resembles Arizona White Oak (*Q. arizonica*) and Mexican Blue Oak (*Q. oblongifolia*).

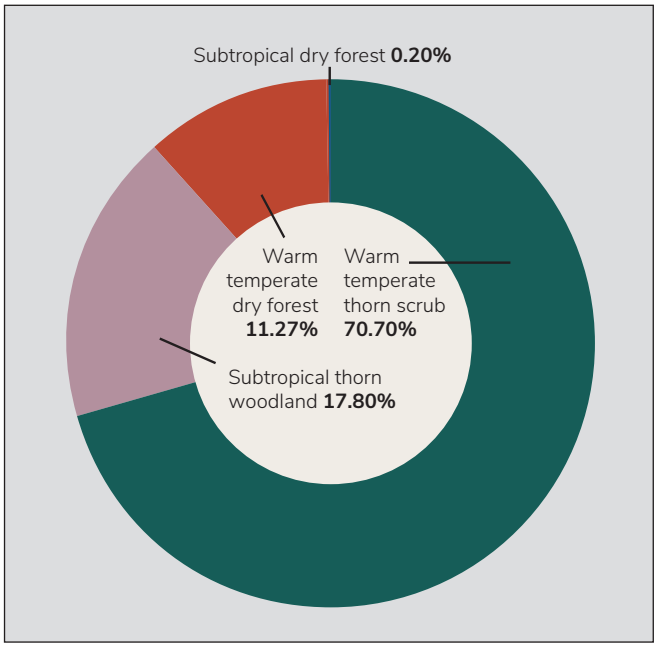

Figure 2. The percentage of wild occurrence points in each Holdridge life zone in which *Quercus engelmannii* is distributed.

THREATS TO WILD POPULATIONS

Human use of species — wild harvesting: This is not currently considered a threat. The acorns of *Q. engelmannii* are edible, but native peoples prefer other species such as *Q. kelloggii* or *Q. agrifolia* since the acorns of *Q. engelmannii* are smaller.

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: In California, extensive historic grazing has caused soil compaction and damage to existing trees (Henrich, 2012). There is also grazing within the species' native range in Mexico, and crop conversion from the growing wine industry in Valle de Guadalupe.

Human use of landscape — residential/commercial development, mining, and/or roads: This species is threatened by rapid development and suburban sprawl in both the United States and Mexico, which has resulted in the loss of individuals and entire populations (Henrich, 2014). The municipality of Ensenada, where this species is found, is one of the fastest growing urban areas in Mexico. Development also causes populations to become fragmented.

Human use of landscape — tourism and/or recreation: This is not considered to be a threat at the time of publication.

Human modification of natural systems — altered fire regime, pollution, eradication: The entire range of *Q. engelmannii* is within areas that are a high risk for human induced wildfire. Within California, a large portion of this species range was burned by two of the largest wildfires in the state's history (Principe, 2015). Fire damage to trees is especially high in chaparral habitat, where Engelmann oak is found (Riordan et al., 2015).

Human modification of natural systems — invasive species competition/disturbance: Engelmann oaks growing on mesas and valley floors often have grassland understories made up of introduced species of genera such as *Bromus*, *Avena*, *Hordeum*, and *Erodium* (Scott, 1990).

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: In the Conservation Gap Analysis of Native U.S. Oaks, Beckman et al. (2019) categorized climate change as a high impact threat to *Q. engelmannii*. A study investigating the impact of climate change on *Q. engelmannii* found that anywhere from 0.16% to 29.6% of suitable habitat will remain by the year 2100, depending on the model projection used (Conlisk et al., 2012).

Genetic material loss — inbreeding and/or introgression: There is evidence of hybridization between *Q. engelmannii* and species of scrub oaks, however this is not currently considered a major threat. Ortego et al. (2012) found low rates of ongoing hybridization in areas of overlapping distribution of *Q. engelmannii* and scrub oaks (*Q. berberidifolia*, *Q. cornelius-mulleri*, *Q. durata* var. *gabrielensis*), and they concluded that hybridization could be promoting the acquisition of favorable alleles that increase the adaptive potential of *Q. engelmannii*. In a recent study, O'Donnell et al. (2021) found evidence of asymmetric gene flow from *Q. berberidifolia* into *Q. engelmannii*. The authors conclude that the timing of the initiation of gene flow between the two species coincides with a shift towards a Mediterranean-type climate in California, and ancient introgression allowed *Q. engelmannii* to persist despite the changing climate.

Pests and/or pathogens: There is recent concern surrounding the impact of Polyphagous and Kuroshio Shot Hole Borers in Southern California. These beetles are a host for several fungus species, including *Fusarium euwallaceae*, *Graphium euwallaceae* and *Paracremonium pembeum*. These fungi cause fusarium dieback disease, which impacts the transportation of water and nutrients to infected trees (UC-IPM, 2024). Other oak borer species have been spotted on Engelmann oak, but only in some very restricted communities on a few individuals (Coleman and Seybold, 2011).

Extremely small and/or restricted population: This is not currently considered a major threat.

CONSERVATION ACTIVITIES

Once per year between 2017 and 2022, *Quercus* accessions data were requested from ex *situ* collections globally. A total of 197 institutions from 27 countries submitted data for Mesoamerican oak species, including *Q. engelmannii* (Table 1, Figure 3). Past, present, and planned conservation activities for Mesoamerican oak species of concern were also examined through literature review and expert consultation.

A spatial analysis was conducted to estimate the geographic and ecological coverage of ex *situ* collections using methods adapted from Khoury et al. (2020; Figure 4). Twenty-kilometer buffers were placed around each wild occurrence point as well as the source locality of each plant living in ex *situ* collections. Collectively, the buffer area around the wild occurrence points represents the inferred native range of the species. The buffer area around ex *situ* points serves as the native range represented in ex *situ* collections. Geographic coverage of ex *situ* collections was estimated by dividing the ex *situ* buffer area by the area of the inferred native range. Ecological coverage of ex *situ* collections was estimated by dividing the number of Holdridge life zones present under the ex *situ* buffer by the number of Holdridge life zones under the inferred native range. The species representativeness ex *situ* was calculated by counting the number of ex *situ* institutions that currently have one or more living individuals of wild provenance in their collections, up to a maximum of ten. In order to maintain a consistent scale across all scores, this number was multiplied by ten. All three scores range from 0–100. A final ex *situ* conservation score was calculated by taking an average of the three scores above. Final scores range from 0–100, with scores near 100 indicating comprehensive ex *situ* conservation, and scores near 0 indicating poor ex *situ* conservation (Table 2). As a reference, the threatened Mesoamerican oaks with the highest ex *situ* conservation scores are *Q. engelmannii* with a score of 76/100, and *Q. brandegeei* with a score of 74/100. There are 10 threatened oaks with final ex *situ* scores of 10 or less.

Table 1. Results of 2017–2022 ex *situ* surveys.

Number of ex *situ* collections reporting this species	32
Number of plants in ex *situ* collections	2,604
Average number of plants per institution	81
Percent of ex *situ* plants of wild origin	9%
Percent of wild origin plants with known locality	71%

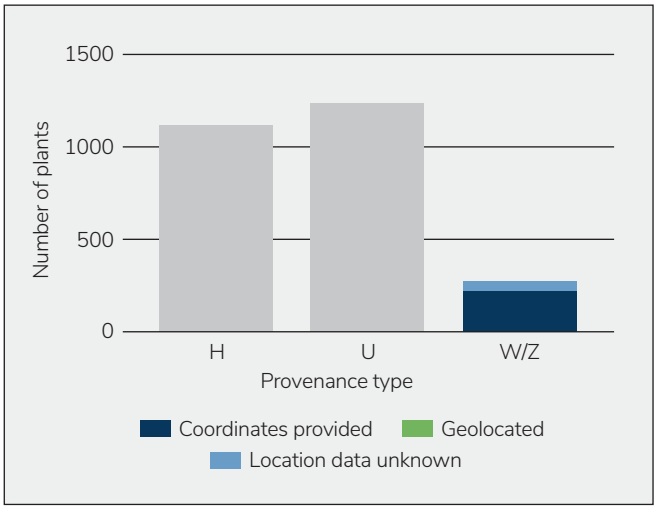

Figure 3. Number and origin of *Quercus engelmannii* plants in ex *situ* collections. Provenance types: H = horticultural; U = unknown; W = wild; Z = propagated from wild.


Béatrice Chassé

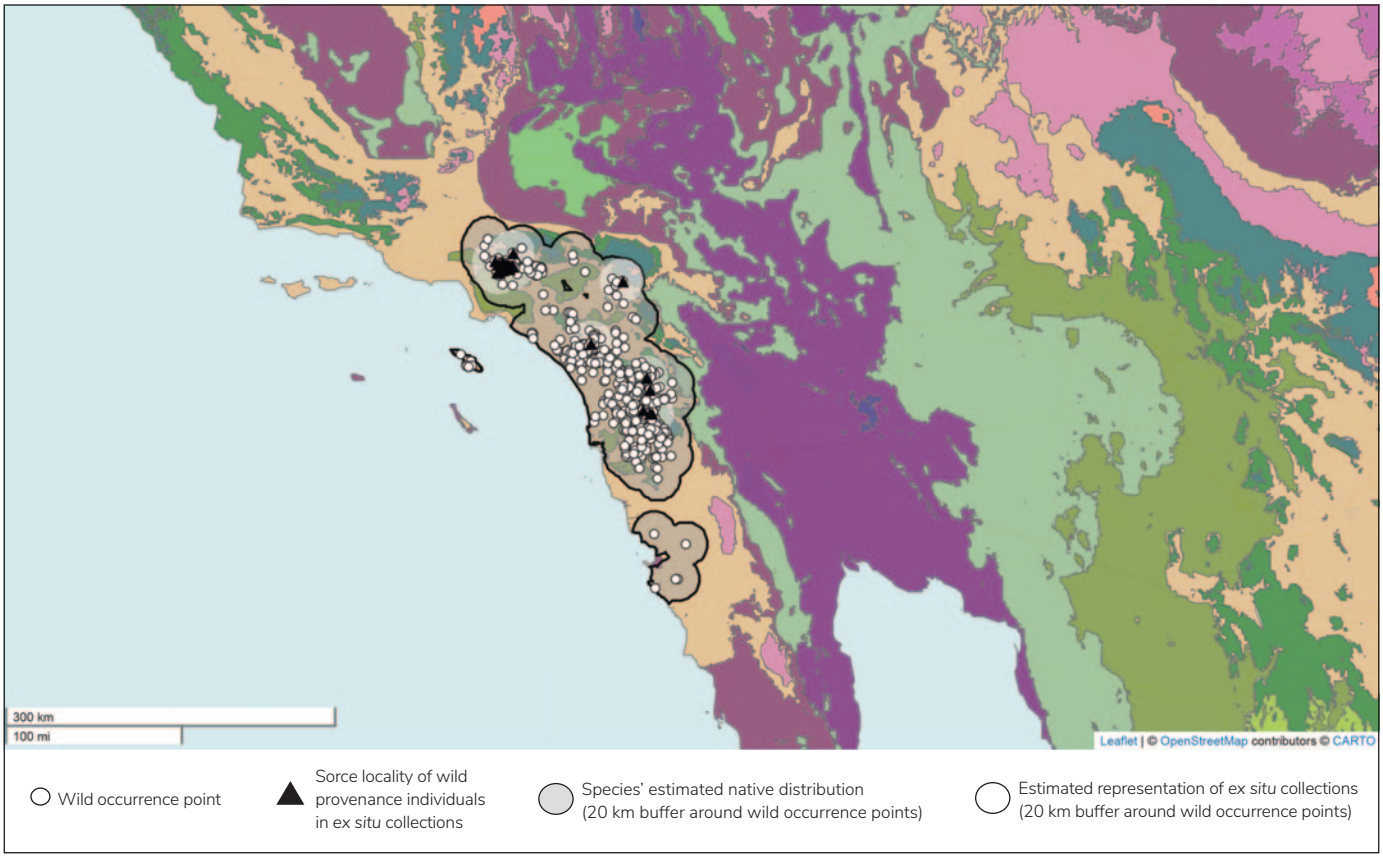

Figure 4. *Quercus engelmannii* wild occurrence points and *ex situ* collection source localities. Colored regions are Holdridge life zones. All *ex situ* collection source localities are also wild occurrence points.

Using methods adapted from Khoury et al. (2020), we estimated the degree of representation of *Q. engelmannii* in protected areas in order to identify *in situ* conservation gaps. Wild occurrence points were mapped and overlaid with protected areas from the World Database on Protected Areas (Figure 5; UNEP-WCMC and IUCN, 2023). A twenty-kilometer buffer was placed around each occurrence point to represent the species inferred native range. Geographic coverage *in situ* was estimated by calculating the proportion of a species inferred native range that is covered by protected areas. Ecological coverage *in situ* was estimated by identifying the Holdridge life zones in the inferred native range as well as the Holdridge life zones in protected areas within the inferred native range and calculating the percentage of life zones that are conserved in protected areas. Species representativeness *in situ* was estimated by calculating the percentage of known occurrence points within the species inferred native range that fall inside protected areas. All three scores range from 0–100. A final conservation score *in situ* was calculated by taking an average of the three scores above. Final scores range from 0–100, with scores near 100 indicating comprehensive *in situ* conservation, and scores near 0 indicating poor *in situ* conservation (Table 3). As a reference, the threatened Mesoamerican oaks with the highest *in situ* conservation scores are *Q. carmenensis* with a score of 99/100, and *Q. costaricensis* with a score of 94/100. There are two threatened oaks with final *in situ* scores of 10 or less.

Table 2. *Ex situ* conservation scores for *Quercus engelmannii* with all scores ranging from 0–100. A final score of 100 indicates comprehensive *ex situ* conservation, and a score of 0 represents poor *ex situ* conservation.

Geographic coverage *ex situ*	27
Ecological coverage *ex situ*	100
Representation in *ex situ* collections	100
Final *ex situ* conservation score	76

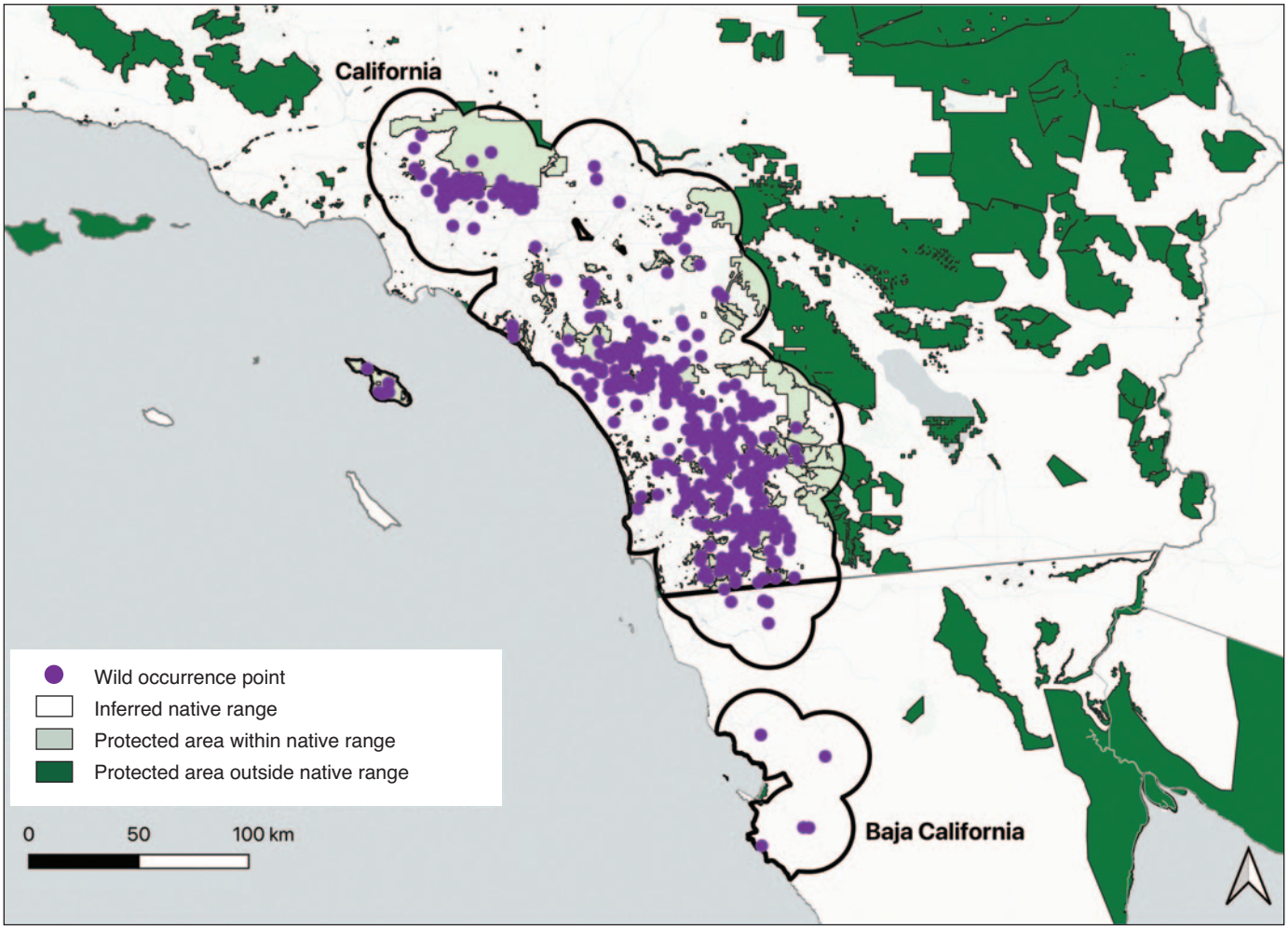

Figure 5. Wild occurrence points and inferred native range of *Quercus engelmannii* in relation to protected areas. Protected areas are from Protected Planet (UNEP-WCMC and IUCN, 2023.

Table 3. *In situ* conservation scores for *Quercus engelmannii* with all scores ranging from 0–100. A final score of 100 indicates comprehensive *in situ* conservation, and a score of 0 represents poor *in situ* conservation.

Geographic coverage *in situ*	16
Ecological coverage *in situ*	88
Species representation in *in situ* collections	13
Final *in situ* conservation score	39

Land protection: Within the inferred native range of *Q. engelmannii*, 16% is in protected areas. However, only 1% of the species range is protected in Mexico (Figure 5). There is one Ramsar site (Estero de Punta Banda, 13 km south of Ensenada) and one National Park (Parque Nacional Constitución de 1857, approximately 80 km east of Ensenada). However, none of the known occurrence points fall within protected land.

Sustainable management of land: The Nature Conservancy actively manages the Santa Rosa Plateau in Riverside County, California, and there is a small population that is managed at the Los Angeles County Arboretum (Henrich, 2014). The United States Forest Service also maintains a study site over a *Q. engelmannii* woodland in the Cleveland National Forest (Scott, 1990). To our knowledge, there is no sustainable management of *Q. engelmannii* habitat in Mexico.

Population monitoring and/or occurrence surveys: The Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) has conducted several surveys for *Q. engelmannii* in Riverside county in 2011, 2016 and 2018, all to record demographics and recruitment at several sites throughout the county. Surveys conducted throughout plots in Riverside County have found extensive recruitment of Engelmann oaks in seven of eleven surveyed sites.

These populations total to approximately 18,000 oak trees. In a 1991 survey, Scott identified 31,512 ha of woodland containing Engelmann oaks in southern California and noted that there were only scattered instances of Engelmann oak south of the Mexican border. To our knowledge, there is no recent population monitoring or occurrence surveys that focus on the Mexican population of this species.

Wild collecting and/or *ex situ* curation: According to the results of our *ex situ* surveys, there are 32 institutions that have reported collections of *Q. engelmannii*. However, there have been no reported collections from the Mexican population.

Propagation and/or breeding programs: Seedlings of *Q. engelmannii* have been propagated in California by organizations such as the L.A. County Arboretum (Henrich, 2012) and Tree of Life Nursery in collaboration with local conservation groups (McCrearey, 2001). However, this is not a known conservation activity in Mexico.

Reintroduction, reinforcement, and/or translocation: *Quercus engelmannii* is planted widely throughout the Los Angeles basin, most notably in Pasadena, and in San Diego as a street tree (City of San Mateo, 2022). In Escondido, California, a retired science teacher has collected and planted 2,500 *Q. engelmannii* acorns and has donated them to local landowners for planting (Zevely, 2024). This is not a known conservation activity in Mexico.

Research: A study on the impact of grasshoppers on seedlings showed that *Q. engelmannii* is not the preferred diet source as it might have lower nutrition to these herbivores compared to *Q. agrifolia* (Dunning et al., 2003). There has also been research on the effects of climate change on *Q. engelmannii*, suggesting that drier conditions and increased fire frequency will cause a dramatic reduction in its abundance (Conlisk et al., 2012; Riordan et al., 2015). The effect of environmental conditions on genetic structure and variability has also been studied (Ortego et al., 2012).

Education, outreach, and/or training: The Global Conservation Consortium for Oak (GCCO) has created species identification guides for Engelmann oak in English and Spanish to assist in searching for wild populations.

Species protection policies: As of the time of publication, *Q. engelmannii* is not listed under the endangered species list protected by the Mexican government NOM-059-SEMARNAT. Its narrow and fragmented distribution as well as the low population density warrants its inclusion. There is a Conservation Action Plan for six species of California oaks, including *Q. engelmannii*, that was recently published following a participatory process with local stakeholders. This plan identifies the most urgent threats facing *Q. engelmannii*, as well as specific actions needed to address each threat with the ultimate goal of rescuing and regenerating the species.

PRIORITY CONSERVATION ACTIONS

In order to conserve *Q. engelmannii*, the conservation activities that should be given the highest priority are:

Land protection

There are currently virtually no protected areas within this species' inferred native range in Mexico. Land protection is especially needed in the chaparral and coastal scrub habitats.

Population monitoring and/or occurrence surveys

There is a need for additional surveying work for this species in Mexico. A challenge is the feasibility of field work along the US-Mexico border. Stakeholders from these two countries should collaborate in order to successfully conserve *Q. engelmannii*.

REFERENCES

Beckman, E., Gaman, T., Meyer, A., and Westwood, M. 2019. *Quercus engelmannii* Greene. In Beckman, E., Meyer, A., Man, G., Pivorunas, D., Denvir, A., Gill, D., Shaw, K., and Westwood, M. *Conservation Gap Analysis of Native U.S. Oaks* (pp. 104-109). Lisle, IL: The Morton Arboretum.

City of San Mateo. 2022. City of San Mateo Street Tree Master Plan: S.M.M.C. 13.40.040. Available at https://www.cityofsanmateo.org/DocumentCenter/View/91512/Street-Tree-Master-Plan. Accessed April 2024.

Coleman, T. W., and Seybold, S. J. 2011. Collection history and comparison of the interactions of the goldspotted oak borer, Agrilus auroguttatus Schaeffer (Coleoptera: Buprestidae), with host oaks in southern California and southeastern Arizona, USA. The Coleopterists Bulletin 65.2 (2011): 93–108. https://doi.org/10.1649/072.065.0224

Conlisk, E., Lawson, D., Syphard, A. D., Franklin, J., Flint, L., Flint, A., and Regan, H. M. 2012. The Roles of Dispersal, Fecundity, and Predation in the Population Persistence of an Oak (*Quercus engelmannii*) under Global Change. *PLoS ONE* 7(5): e36391. doi:10.1371/journal.pone.0036391

Dunning, C. E., Redack, R. A., and Paine, T. D. 2003. Preference and performance of a generalist insect herbivore on *Quercus agrifolia* and *Quercus engelmannii* seedlings from a southern California oak woodland. *Forest Ecology and Management* 17(1-3): 593–603. https://doi.org/10.1016/S0378-1127(02)00187-1

Henrich, J. 2012. The most majestic southern California oak. Pacific Horticulture, 78. Available at https://pacifichorticulture.org/articles/the-most-majestic-southern-california-oak/ Accessed February 2024.

Henrich, J. E. 2014. Growth and Management of a Remnant Stand of Engelmann Oak at Los Angeles County Arboretum & Botanic Garden. Proceedings of the Seventh California Oak Symposium: Managing Oak Woodlands in a Dynamic World. Pages 157-164.

Khoury, C. K, Carver, D., Greene, S. L., and Frances, A. 2020. Crop wild relatives of the United States require urgent conservation action. PNAS 117(52): 33351–33357. https://doi.org/10.1073/pnas.2007029117

McCreary, D. D. 2001. Regenerating rangeland oaks in California. Oakland, CA: University of California, Agriculture and Natural Resources. Available at https://anrcatalog.ucanr.edu/pdf/21601e.pdf. Accessed February 2024.

O'Donnell, S. T., Fitz-Gibbon, S. T., and Sork, V. L. 2021. Ancient introgression between distantly related White Oaks (*Quercus* sect. *Quercus*) shows evidence of climate-associated asymmetric gene exchange. *Journal of Heredity* 112(7): 663–670. https://doi.org/10.1093/jhered/esab053

Ortego, J., Riordan, E. C., Gugger, P. F., and Sork, V. L. 2012. Influence of environmental heterogeneity on genetic diversity and structure in an endemic southern Californian oak. *Molecular Ecology* 21(13): 3210–3223. https://doi.org/10.1111/j.1365-294X.2012.05591.x

Principe, Z. 2015. Influence of fire on Engelmann oak survival – patterns following prescribed fires and wildfires. In Proceedings of the seventh California oak symposium: managing oak woodlands in a dynamic world (Gen. Tech. Rep. PSW-GTR-251). Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Riordan, E. C., Gillespie, T. W., Pitcher, L., Pincetl, S. S., Jenerette, G. D., and Pataki, D. E. 2015. Threats of future climate change and land use to vulnerable tree species native to Southern California. *Environmental Conservation* 42(2): 127–138. doi:10.1017/S0376892914000265

Scott, T. A. 1990. Conserving California's rarest white oak: the Engelmann oak. *Fremontia* 18: 26–29.

Scott, T. A. 1991. The distribution of Engelmann oak (*Quercus engelmannii*) in California. In R. B. Standiford (Ed.), Proceedings for symposium on oak woodland and hardwood rangeland management. (pp. 351–359) General Technical Report PSW-126. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

The Jepson Herbarium. 2024. "*Quercus engelmannii*". Jepson eFlora: Taxon page. Available at https://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=40590. Accessed May 2024.

UC-IPM. 2024. Polyphagous Shothole Borer and Kuroshio Shothole Borer. Available at https://ipm.ucanr.edu/agriculture/avocado/polyphagous-shot-hole-borer-and-kuroshio-shot-hole-borer/. Accessed January 2024

UNEP-WCMC and IUCN. 2023. Protected Planet: The World Database on Protected Areas (WDPA) [Online] Cambridge, UK. Available at www.protectedplanet.net. Accessed 2023.

Zevely, J. 2024. "Escondido man collects 2,500 acorns in hopes of saving the Engelmann Oak". CBS8. Available at https://www.cbs8.com/article/news/local/zevely-zone/escondido-man-collects-2500-acorns-in-hopes-of-saving-the-engelmann-oak/509-f5e45849-bf65-49d3-b9dd-1256db14a3e9. Accessed May 2024.