Conservation Gap Analysis of Native U.S. Oaks

Species profile: ***Quercus lobata***

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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 ajoensis, Quercus palmeri, Quercus toumeyi

Broad distribution:
Quercus havardii, Quercus laceyi

SOUTHEASTERN U.S.

State endemics:
Quercus acerifolia, Quercus boyntonii

Concentrated in Florida:
Quercus chapmanii, Quercus inopina, Quercus pumila

Broad distribution:
Quercus arkansana, Quercus austrina, Quercus georgiana, Quercus oglethorpensis, Quercus similis

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Quercus lobata Née

Synonyms: *Quercus hindsii* Benth., *Q. hindsiana* Benth. ex Dippel, *Q. longiglanda* Frém., *Q. lyrata* Spreng.
Common Names: Valley oak, California white oak

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Andy Lentz

DISTRIBUTION AND ECOLOGY

Quercus lobata, or Valley oak, is endemic to California, U.S., with a distribution south from Shasta County to the Central Valley, including the foothills and valleys of the Sierra Nevada and Coast Ranges leading to Los Angeles.[1] Due to their naturally wide spacing, current mapping underrepresents occurrences, especially at the southern end of their range in Los Angeles County.[2] They are also found on Santa Cruz and Santa Catalina Islands. *Quercus lobata* is the dominant species in both Valley oak woodland and Valley oak riparian forest. Often, the species is the only tree found within Valley oak woodland, where it lives widely spaced with grasses stretching between each individual. Within the riparian community, Valley oak historically extended one to eight kilometers on each side of major rivers, along with other trees such as Interior live oak, Blue oak, Coast live oak, Black walnut, Sycamore, California bay laurel, White alder, numerous willow species, and Gray pine. These two dominant ecosystems have deep, rich soils that provide some of the best farmland in the world.[3] Valley oak is a deciduous tree that is both flood and drought tolerant, withstanding cool, wet winters and hot, dry summers. It is is reported to be the largest and longest lived oak species in North America, reaching ten to 30 meters tall and 400 to 600 years old, with a rounded, spreading crown.[4,5] The species can occur from sea level to 1,200 meters above sea level.[3] Valley oak also comprises necessary habitat for multiple state-threatened species such as Swanson's hawk, Sandhill crane, and Yellow-billed cuckoo, as well as the federally-threatened Elderberry longhorn beetle.[6]

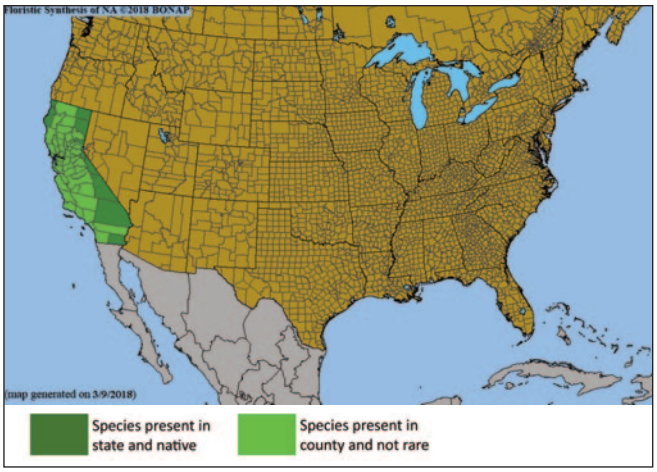

Figure 1. County-level distribution map for *Quercus lobata*. Source: Biota of North America Program (BONAP).[7]

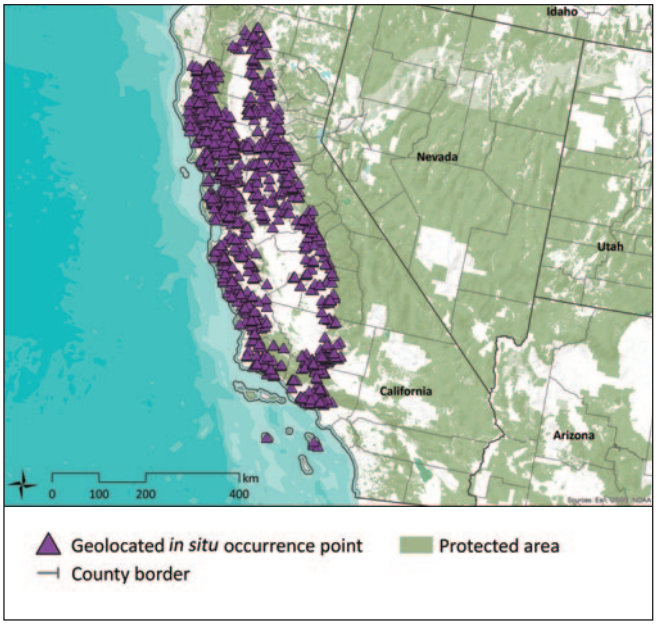

Figure 2. Documented *in situ* occurrence points for *Quercus lobata*. Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[8]

VULNERABILITY OF WILD POPULATIONS

Table 1. Scoring matrix identifying the most severe demographic issues affecting *Quercus lobata*. 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).

Demographic indicators	Level of vulnerability						
	Emergency Score = 40	**High** Score = 20	**Moderate** Score = 10	**Low** Score = 5	**None** Score = 0	**Unknown** No score	**Score**
Population size	< 50	< 250	< 2,500	< 10,000	> 10,000	Unknown	0
Range/endemism	Extremely small range or 1 location	EOO < 100 km² or AOO < 10 km² or 2-4 locations	EOO < 5,000 km² or AOO < 500 km² or 5-9 locations	EOO < 20,000 km² or AOO < 2,000 km² or 10+ locations	EOO > 20,000 km² or AOO > 2,000 km²	Unknown	0
Population decline	Extreme	>= 80% decline	>= 50% decline	>= 30% decline	None	Unknown	20
Fragmentation	Severe fragmentation	Isolated populations	Somewhat isolated populations	Relatively connected populations	Connected populations	Unknown	10
Regeneration/ recruitment	No regeneration or recruitment	Decline of >50% predicted in next generation	Insufficient to maintain current population size	Sufficient to maintain current population size	Sufficient to increase population size	Unknown	20
Genetic variation/ integrity	Extremely low	Low	Medium	High	Very high	Unknown	0
						Average vulnerability score	8.3
						Rank relative to all U.S. oak species of concern (out of 19)	11

THREATS TO WILD POPULATIONS

High Impact Threats

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: Much of *Q. lobata* habitat has been cleared for agriculture. In central California, the loss of large parcels of Valley oaks to vineyard development has fueled heated debates between private landowners and public interest groups. Soil compaction by cattle may be affecting regeneration.[9] It has also been found that oak tree removal increases ranch income through livestock use, though benefits drop after the first few years following removal (J. Wright pers. comm., 2018).[10]

Human use of landscape — residential/commercial development, mining, and/or roads: Over the last 150 years, Valley oaks have been the victims of widespread residential development in lowland areas. Over 90% of Valley oak woodlands have been lost due to conversion to development or agriculture.[9] Where groundwater pumping has drastically lowered the water table, Valley oaks have become slow-growing and haggard.[5] Expanding urban areas have also destroyed many stands in the Coast Ranges.[11]

Human modification of natural systems — disturbance regime modification, pollution, and/or eradication: Remaining stands of Valley oak primarily occur on private lands, and are threatened by fire suppression.[1,9] Hydrologic processes such as periodic, low intensity floods that help maintain this vegetation have also been greatly altered.[11]

Pests and Diseases: Valley oaks are known reproductive hosts for the invasive Polyphagous and Kuroshio shot-hole borers, which carry the symbiotic fungus fusarium that infects the tree. The beetles are spreading north and threatening a larger number of trees.[12]

Moderate Impact Threats

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: Valley oak is likely to experience habitat shifting and contracting due to climate change, leading to a decrease in both the quality and extent of its habitat. The decline of the species will not be consistent across its range, therefore a conservative estimate of 27% decrease in suitable habitat by 2099 has been projected.[13,14] A recent analysis of U.S. tree vulnerability to climate change found *Q. lobata* to be within the lowest climate change vulnerability category based on species-specific traits, as compared to other U.S. trees.[15]

Low Impact Threats

Human modification of natural systems — invasive species competition: Exotic plant species are present within Valley oak woodland and somewhat perturb the ecosystem.[16] Significant threat has not been noted at this time.

Human use of species — wild harvesting: Remaining *Q. lobata* stands primarily occur on private lands, and are sometimes threatened by fuelwood cutting.[1,9]

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 328 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:	44
Number of plants in *ex situ* collections:	1369
Average number of plants per institution:	31
Percent of *ex situ* plants of wild origin:	86%
Percent of wild origin plants with known locality:	99%

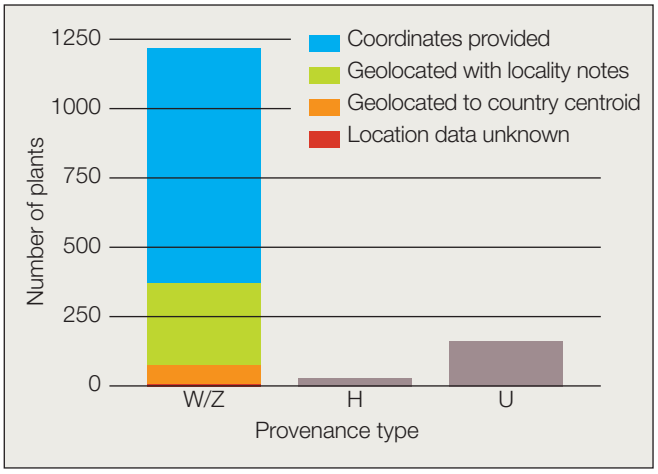

Figure 3. Number and origin of *Quercus lobata* plants in *ex situ* collections. Provenance types: W = wild; Z = indirect wild; H = horticultural; U = unknown.

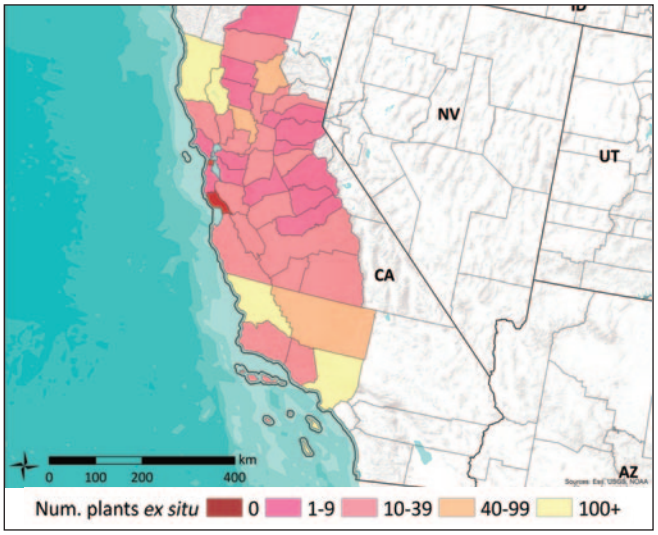

Figure 4. *Quercus lobata* counties of *in situ* occurrence, reflecting the number of plants from each county in *ex situ* collections.

A spatial analysis was conducted to estimate the geographic and ecological coverage of *ex situ* collections (Figure 5). 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*" (CAI50). 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 CAI50 by CAE50. Ecological coverage was estimated by dividing the number of EPA Level IV Ecoregions present in CAE50 by the number of ecoregions in CAI50.

Estimated *ex situ* representation	
Geographic coverage:	91%
Ecological coverage:	95%

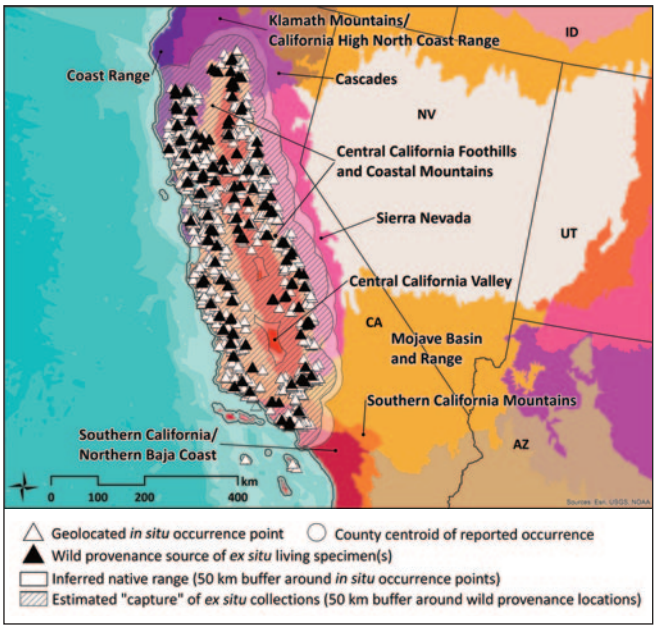

Figure 5. *Quercus lobata in situ* occurrence points and *ex situ* collection source localities. U.S. EPA Level III Ecoregions are colored and labelled.[17] County centroid is shown if no precise locality data exist for that county of occurrence. Email treeconservation@mortonarb.org for information regarding specific coordinates.

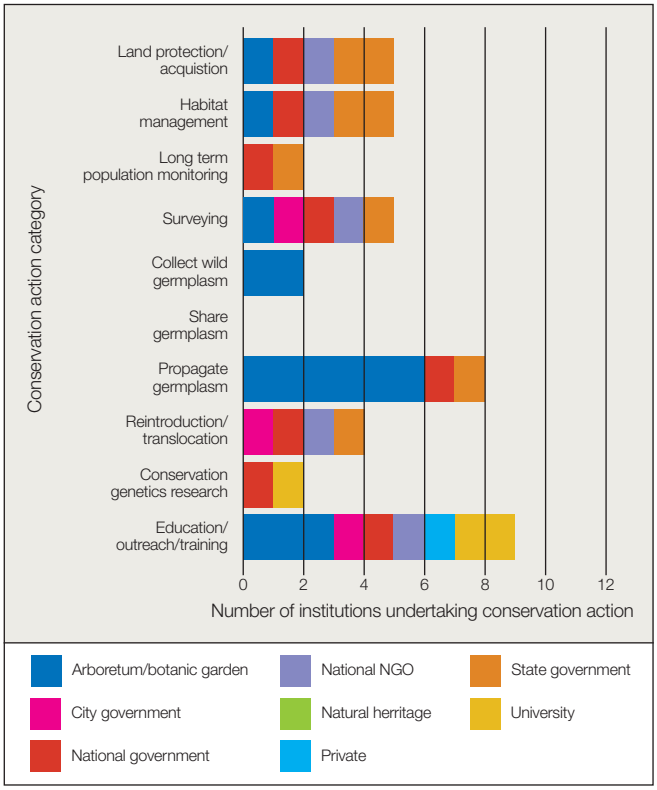

Figure 6. Number of institutions reporting conservation activities for *Quercus lobata* grouped by organization type. Nineteen of 252 institutions reported activities focused on *Q. lobata* (see Appendix D for a list of all responding institutions).

Land protection: Within the inferred native range of *Q. lobata* in the U.S., 35% of the land is covered by protected areas (Figure 7). Although this is not a significant proportion, many counties and communities already work towards the protection of Valley oak on private land. Expansion of protected areas is unlikely, therefore collaboration with stakeholders is key.

Los Angeles County is aiming for no net loss of oak woodlands and has incorporated protections for both individual trees and woodland areas in their General Plan and other supporting land use plans.[18] Many other counties in California also have such goals for expanding protections on private lands through conservation easements and fee acquisition. Multiple federal and state agencies such as the Bureau of Land Management, National Park Service, USDA Forest Service, and California Department of Parks and Recreation are all working towards preservation and expansion of existing valley oak woodlands throughout the state (R. Dagit pers. comm., 2018).

Sustainable management of land: Of the 58 counties in California, roughly half have established protection ordinances or conservation plans to conserve their oak resources, including through proper land management. Los Angeles, Santa Barbara, San Luis Obispo, and Yolo counties have plans that are good examples of these efforts (R. Dagit pers. comm., 2018).[19]

Population monitoring and/or occurrence surveys: Current mapping scales and polygons are available, but routinely miss existing stands of Valley oaks due to the species' low density within a given spatial area, especially in savannah ecosystems.[2]

Wild collecting and/or *ex situ* curation: Since 2011, Wright (USDA Forest Service) and Sork (University of California, LA) have been working to establish a fully-replicated provenance trial from a range-wide collection, representing 95 populations of Valley oak at two outplanting sites: the Institute of Forest Genetics (IFG) in Placerville, California and the USDA-FS Chico Seed Orchard in Chico, California (J. Wright pers. comm., 2017).[20]

Propagation and/or breeding programs: Wright and Sork describe their provenance trial: "Over 10,000 acorns were planted at the Institute of Forest Genetics, PSW, Placerville. 9115 of these acorns germinated, representing an 89% germination rate...In the December 2014, 3500 trees were planted at the IFG site, and in January, 3500 seedlings were outplanted at the GRCC [now the Chico Seed Orchard] in Chico."[20] Height growth has been recorded every year since planting in 2012, and bud burst data have been collected since 2015. Analyses associating growth performance, climate, and each individual's site of origin are ongoing (J. Wright pers. comm., 2018).

Reintroduction, reinforcement, and/or translocation: There is great interest among public and private managers to restore as much Valley oak woodland and riparian forest as possible, and revegetation projects are numerous. Due to heavy acorn and seedling predation, however, mortality of newly-established populations often approaches 100% on project sites. Enclosing plants in a protective device such as wire caging is recommended until tree height exceeds the browse line.[4]

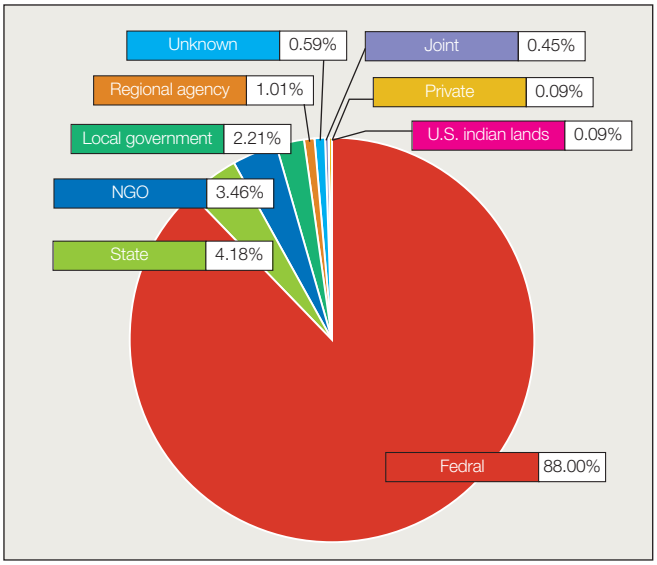

Figure 7. Management type of protected areas within the inferred native range of *Quercus lobata*. Protected areas data from the U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[8]

Research: Ecosystem and landscape level research is limited. To develop a comprehensive conservation plan for Valley oaks, certain critical information is lacking. Knowledge of the species' current range and distribution, and current rates of land conversion are needed to assess loss of habitat. Information on stand structure, population dynamics, and minimum viable population size will help identify conservation priorities.[9]

In response to ongoing fragmentation and loss of Valley oaks due to drought and invasive beetles, Los Angeles County embarked on a collaborative effort with federal, state, and local land agencies to identify potential climate-appropriate areas for restoration and planting. Sites within the Santa Monica Mountains National Recreation Area were studied using remote sensing data, to identify criteria and locations for priority planting sites. Maps and guidance for priority planting and restoration areas are in progress and expected to be available by the end of 2019 (R. Dagit pers. comm., 2018).[21]

Wright and Sork's Valley oak provenance test is dedicated to assessing climate change vulnerability, linking climatic models with population response models, determining seed-zone and seed-transfer guidelines for current and future climates, gathering conservation genomics information, and providing easy access to sites for further research and project development (J. Wright pers. comm., 2017).[22]

Education, outreach, and/or training: The Integrated Hardwood Range Management Program—a partnership among the University of California, California Department of Forestry and Fire Protection, and California Department of Fish and Game, as well as numerous county and local programs—has focused efforts on educating landowners on multiple-use and sustainable-yield practices. Research regarding economic incentives, wildlife relationships, and tree reproduction and regeneration have been shared, and funding has been provided for further research informing an understanding of oak woodland ecology.[9] Wright and Sork's provenance trial provides educational outreach opportunities for students, postdocs, and the general public, as well as specific guidance for resource managers on ecotypic variation in Valley oak survival (J. Wright pers. comm., 2017).

Species protection policies: City and county ordinances often focus on heritage trees and set mitigation standards for removal of trees. Though these efforts are a step in the right direction, they may not result in the long-term survival of *Q. lobata*.[9] With help from Santa Barbara County, a group of citizens formed the Oak Working Group, which produces the basic recommendations that are applied in the Oak Tree Protection and Regeneration Program (adopted in 2003; includes *Q. agrifolia, Q. lobata, Q. douglasii, Q. chrysolepis, Q. kelloggii, Q. wislizenii*). This protection and regeneration program received support from both the agricultural and environmental communities, which is critical to the success of species protection and restoration programs.[23] In 2011, Los Angeles County also adopted an Oak Woodland Conservation Management Plan that provides a comprehensive road map for achieving no net loss of woodlands in the future. The plan outlines specific strategies for conserving the 17 oak species native to the county.[2] Counties throughout California have taken a variety of steps to protect oak woodlands and provide strategies for future preservation through the use of conservation easements, fee acquisition, and other land use planning tools.

PRIORITY CONSERVATION ACTIONS

The biggest challenge to ensuring a future for Valley oaks throughout their range is to increase understanding of current distribution patterns, population demographics, regeneration patterns, and potential response to changes in climate. Ongoing research by Wright and Sork will provide important understanding of genetic variability and guidance for successful restoration efforts. There is also a need for identifying optimal sites where planting can augment currently fragmented, mature, and senescing populations. Additional landscape-level analysis of potential suitable habitat based on projected climate change scenarios is critical to focus restoration efforts throughout the species' range. This analysis of ideal locations for planting, paired with the provenance data being gathered by Wright and Sork, will provide powerful tools for restoration and reforestation. Los Angeles County is tackling this need for the Santa Monica Mountains National Recreation Area in 2018-2019 by building upon the documentation of drought and beetle mortality and using remote sensing data to identify criteria and locations for prioritizing planting sites.[21] Improving protocols for restoration planting and maintenance are also needed, given the challenges of providing water in remote locations. Forward thinking analyses such as these will be needed to direct successful, scientifically sound, and collaborative regeneration efforts for the future. Valley oaks are iconic trees, often optimizing the rural beauty of California, and are much loved by many people. Developing a coordinated, comprehensive plan is the key to longevity of this species, and must include the engagement of all stakeholders in sharing the effort to ensure future generations are able to enjoy these trees.

Conservation recommendations for *Quercus lobata*

Highest Priority

- Reintroduction, reinforcement, and/or translocation
- Research (pests/pathogens; population genetics; reproductive biology/regeneration; restoration protocols/guidelines)

Recommended

- Education, outreach, and/or training
- Population monitoring and/or occurrence surveys
- Sustainable management of land

REFERENCES

1. **Gamen, T., & J. Firman. (2006).** *Oaks 2040: The status and future of oaks in California* (Gen. Tech. Rep. PSW-GTR-217). Retrieved from https://www.fs.fed.us/psw/publications/documents/psw_gtr217/psw_gtr217_603.pdf
2. **Los Angeles County. (2014).** Los Angeles County oak woodlands conservation management plan. Los Angeles, CA: Los Angeles County Oak Woodlands Strategic Alliance. Retrieved from http://planning.lacounty.gov/oakwoodlands
3. **Pavlik, B. M., Muick, P. C., Johnson, S. G., & Popper, M. (1991).** *Oaks of California*. Los Olivos, CA: Cachuma Press, Inc.
4. **NRCS. (n.d.).** Fact sheets & plant guides. PLANTS Database. Retrieved from http://plants.usda.gov/java/factSheet
5. **Tyler, C. M., Kuhn, B., & Davis, F. W. (2006).** Demography and recruitment limitations of three oak species in California. *The Quarterly Review of Biology*, 81(2).
6. **Howard, J. L. (1992).** *Quercus lobata*. In Fire Effects Information System [online]. CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Retrieved from https://www.fs.fed.us/database/feis/plants/tree/quelob/all.html
7. **Kartesz, J. T. (2018).** The Biota of North America Program (BONAP). Taxonomic Data Center, Floristic Synthesis of North America, Version 1.0. Chapel Hill, NC. Retrieved from http://www.bonap.net/tdc
8. **U.S. Geological Survey, Gap Analysis Program (GAP). (2016, May).** Protected Areas Database of the United States (PAD-US). Version 1.4 Combined Feature Class. Retrieved from https://gapanalysis.usgs.gov/padus/data/download/
9. **Standiford, R. B. (2015).** Valley oak conservation. CA: University of California, Oak Woodland Management. Retrieved from http://ucanr.edu/sites/oak_range/Oak_Articles_On_Line/Oak_Woodland_Ecology_and_Monitoring/Valley_Oak_Conservation/
10. **Murphy, A. H., & Berry, L. J. (1973)**. Range pasture benefits through tree removal. *California Agriculture*, 8-9.
11. **NatureServe. (2017).** NatureServe Explorer: An online encyclopedia of life [online]. Version 7.1. Arlington, VA. Retrieved from http://explorer.natureserve.org
12. **Eskalen, A., Kabashima, J., Dimson, M., & Lynch, S. (2018).** *Invasive shot-hole borer and fusarium dieback field guide Identifying Polyphagous and Kuroshio shot-hole borer in California* (ANR Publication 8590). CA: University of California, Agriculture and Natural Resources. Retrieved from https://anrcatalog.ucanr.edu/pdf/8590.pdf
13. **Kueppers, L. M., Snyder, M. A., Sloan L. C., Zavaleta E. S., & Fulfrost, B. (2005).** Modeled regional climate change and California endemic oak ranges. *Proceedings of the National Academy of Sciences of the United States of America, 102*(45), 16281–16286. Retrieved from https://doi.org/10.1073/pnas.0501427102
14. **Sork, V. L., Davis, F. W., Westfall, R., Flint, A., Ikegami, M., Wang, H., & Grivet, D. (2010).** Gene movement and genetic association with regional climate gradients in California valley oak (*Quercus lobata* Nee) in the face of climate change. *Molecular Ecology*, 19, 3806–3823. Retrieved from https://doi.org/10.1111/j.1365-294X.2010.04726.x
15. **Potter, K. M., Crane, B. S., & Hargrove, W. W. (2017).** A United States national prioritization framework for tree species vulnerability to climate change. *New Forests*, 48(2), 275-300. doi:10.1007/s11056-017-9569-5
16. **Morrison, M. L., Block, W. M., & Verner, J. (1991).** Wildlife-habitat relationships in California's oak woodlands: Where do we go from here? *In Wildlife habitat & relationships of hardwood rangelands* (Gen. Tech. Rep. PSW-126). Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. Retrieved from https://www.fs.usda.gov/treesearch/pubs/28406
17. **U.S. EPA Office of Research & Development. (2013, April).** Ecoregions of the Conterminous United States. National Health and Environmental Effects Research Laboratory (NHEERL). Retrieved from ftp://ftp.epa.gov/wed/ecoregions/us/us_eco_l4.zip
18. **Los Angeles County. (2015).** *Los Angeles County 2035 General Plan.* CA: Los Angeles County Department of Regional Planning. Retrieved from http://planning.lacounty.gov/generalplan/generalplan
19. **Yolo County. (2007, January).** *Yolo County oak woodland conservation and enhancement plan*. Woodland, CA: Yolo County Parks and Natural Resources Management Division & Yolo County Planning, Resources, and Public Works Department Retrieved from http://www.yolocounty.org/home/showdocument?id=4040
20. **Mix, A. D., Wright, J. W., Gugger, P. F., Liang, C., & Sork, V. L. (2015).** Establishing a range-wide provenance test in Valley oak (*Quercus lobata* Née) at two California sites. 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. Retrieved from https://www.fs.usda.gov/treesearch/pubs/50010
21. **Dagit, R., Contreras, S., Dauksis, R., Sprykia, A., Queally, N., Foster, K., Nickmeyer, A., Rousseau, N., Chang., E. (2017).** *How can we save our native trees? Drought and invasive beetle impacts on wildland trees and shrublands in the Santa Monica Mountains.* Retrieved from www.rcdsmm.org/wp-content/uploads/2016/04/Drought-and-Invasive-Beetle-impacts-RCDSMM-1.2.18.pdf
22. **Valley Oak Genome Project. (2016).** Valley oak phenology. Retrieved from https://valleyoak.ucla.edu/valley-oak-phenology/
23. **County of Santa Barbara. (2009).** *Santa Barbara County comprehensive general plan: Conservation element — Oak tree protection in the inland rural areas of Santa Barbara County.* Retrieved from http://longrange.sbcountyplanning.org/programs/conservationelement/conservation_element.php