Conservation Gap Analysis of Native U.S. Oaks

Species profile: ***Quercus parvula***

Emily Beckman, Ian Pearse, Abby Meyer, Murphy Westwood

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 parvula Greene

Synonyms: *Quercus wislizenii* A. de Candolle **Common Names:** Santa Cruz Island oak, Shreve oak, Tamalpais oak

Species profile co-author: Ian Pearse, Fort Collins Science Center, USGS

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DISTRIBUTION AND ECOLOGY

Three varieties of *Quercus parvula* are currently recognized, all endemic to California, U.S.: *Q. parvula.* var. *parvula* (Santa Cruz Island oak), *Q. parvula* var. *shrevei* (Shreve oak), and *Q. parvula* var. *tamalpaisensis* (Tamalpais oak); though it has recently been asserted that *Q. parvula* var. *tamalpaisensis* is a hybrid between *Q. parvula* and *Q. wislizeni*.[1] Distribution of the Santa Cruz Island oak is limited to Santa Cruz Island and a few coastal localities in Santa Barbara County. It is associated with maritime chaparral and closed-cone pine forests. Shreve oak is the tree-like mainland variety of the shrubby, primarily insular variety. It is endemic to moist woodlands in the outer south-central California Coast Ranges from Santa Barbara County north to Mendocino County and west of the San Francisco Bay region. Tamalpais oak is endemic to Mount Tamalpais, located along the coast just north of San Francisco, growing in several small subpopulations. The USDA PLANTS Database recognizes all three varieties of *Q. parvula*, The Plant List only recognizes its shrevei variety, while Flora North America places all of these taxa in *Q. wislinzeni*.[2,3,4] Genetic evidence points to extensive hybridization between *Q. parvula* and other live oaks in the red oak clade (Sect. Lobatae), including *Q. agrifolia* and *Q. wislizeni*, suggesting more research is needed regarding *Q. parvula* and its distribution.[5]

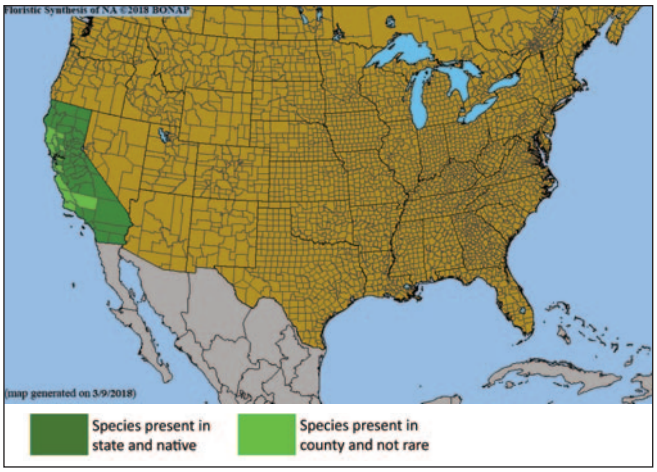


Figure 1. County-level distribution map for *Quercus parvula*. Source: Biota of North America Program (BONAP).[6]

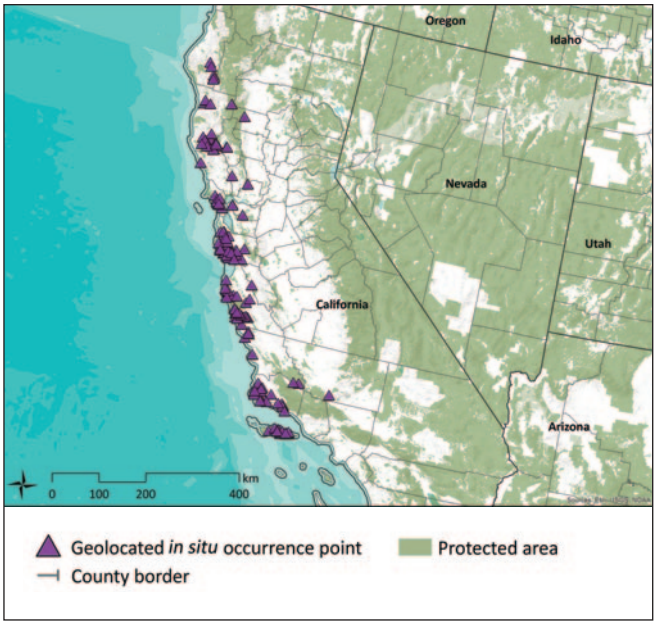


Figure 2. Documented *in situ* occurrence points for *Quercus parvula*. Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[7]

VULNERABILITY OF WILD POPULATIONS

Table 1. Scoring matrix identifying the most severe demographic issues affecting *Quercus parvula*. 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	5
Range/endemism	Extremely small range or 1 location	EOO < 100 km^2 or AOO < 10 km^2 or 2-4 locations	EOO < 5,000 km^2 or AOO < 500 km^2 or 5-9 locations	EOO < 20,000 km^2 or AOO < 2,000 km^2 or 10+ locations	EOO > 20,000 km^2 or AOO > 2,000 km^2	Unknown	5
Population decline	Extreme	>= 80% decline	>= 50% decline	>= 30% decline	None	Unknown	10
Fragmentation	Severe fragmentation	Isolated populations	Somewhat isolated populations	Relatively connected populations	Connected populations	Unknown	5
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	0
Genetic variation/ integrity	Extremely low	Low	Medium	High	Very high	Unknown	-
						Average vulnerability score	5.0
						Rank relative to all U.S. oak species of concern (out of 19)	15

THREATS TO WILD POPULATIONS

High Impact Threats

Human modification of natural systems — disturbance regime modification, pollution, and/or eradication: Death of trees infected trees by sudden oak death has increased fuel loads and potential fire occurrence.[8]

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: Severe drought and multiple forest fires have reduced the size of some *Q. parvula* subpopulations. In 2015, it was estimated that 500 kilometers squared of *Q. parvula* habitat was affected, calculated by superimposing occurrence data points with the California Fire Map.[9,10]

Pests and/or pathogens: In 2002, *Q. parvula* was determined to be affected by sudden oak death, which is caused by the fungus Phytophthora ramorum.[11] At the time of this discovery, the the pathogen covered over 600 kilometers from central California to southern Oregon, and had spread at a faster rate than that of chestnut blight in the early 1900s.[12] Several other studies subsequently demonstrated that *Q. parvula* can die from infection, but that the pathogen cannot sporulate (reproduce) on oaks; instead it requires another host (usually Tanoak or California bay laurel) to persist and spread in the environment (I. Pearse pers. comm., 2018). Since 2002, *P. ramorum* has been found infecting oaks as far south as Santa Barbara County. Most *Q. parvula* subpopulations are found in areas known to be infected.[13] Because *Q. parvula* is a member of the red oak clade (Sect. Lobatae), it also has the potential to be affected by oak wilt and Goldspotted oak borer, the latter of which is currently distributed within the range of *Q. parvula*.[14,15] No serious damage is known to-date, though continued monitoring is necessary.

Moderate Impact Threats

Human use of landscape — residential/commercial development, mining, and/or roads: *Quercus parvula* var. *tamalpaisensis* is an extremely localized endemic known only from the Mount Tamalpais area in Marin County. Some sites are on protected lands owned by the Marin County Water District, where the only threats are disturbance from hiking and perhaps firebreaks. The other sites have unknown ownership and unknown threats. There may be development and other serious threats to some sites since significant portions of the species' range are highly urbanized.[16]

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:	15
Number of plants in *ex situ* collections:	61
Average number of plants per institution:	4
Percent of *ex situ* plants of wild origin:	70%
Percent of wild origin plants with known locality:	77%

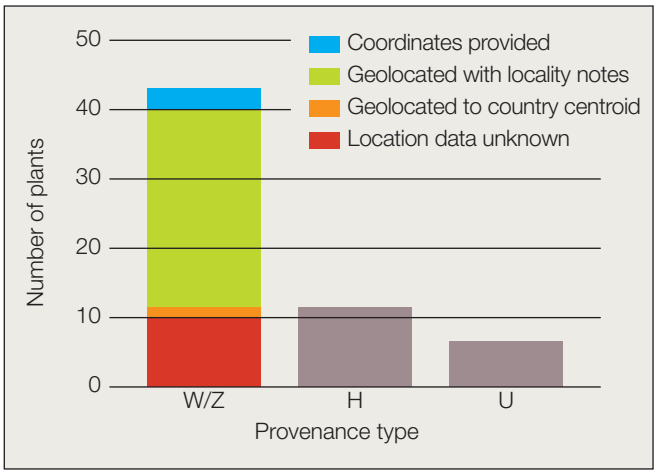


Figure 3. Number and origin of *Quercus parvula* plants in *ex situ* collections. Provenance types: W = wild; Z = indirect wild; H = horticultural; U = unknown.

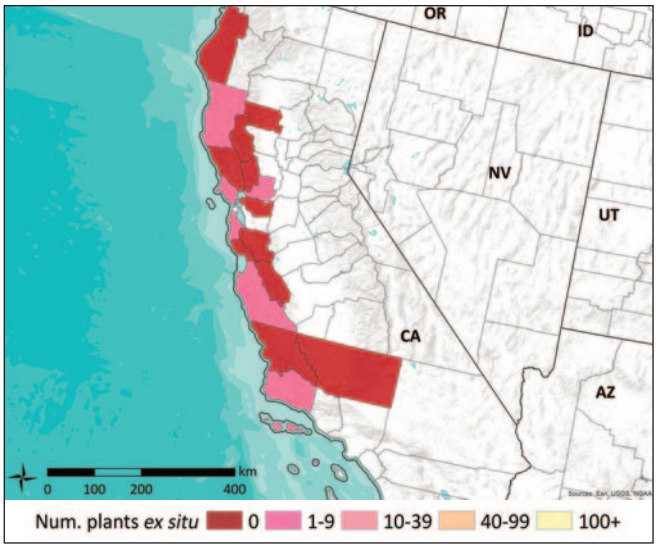


Figure 4. *Quercus parvula* counties of *in situ* occurrence, reflecting the number of plants from each county in *ex situ* collections.

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:	39%
Ecological coverage:	64%

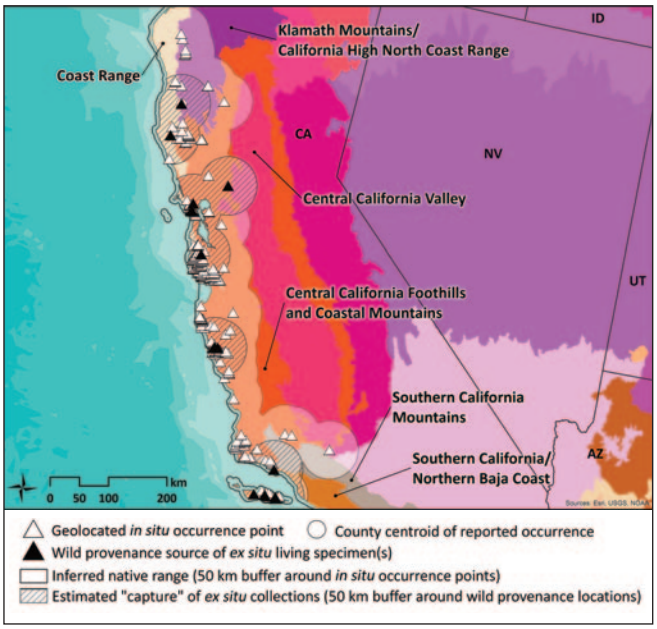


Figure 5. *Quercus parvula in situ* occurrence points and *ex situ* collection source localities. U.S. EPA Level III Ecoregions are colored and labelled.[17] County centroid is shown if no precise locality data exist for that county of occurrence. Email treeconservation@mortonarb.org for information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

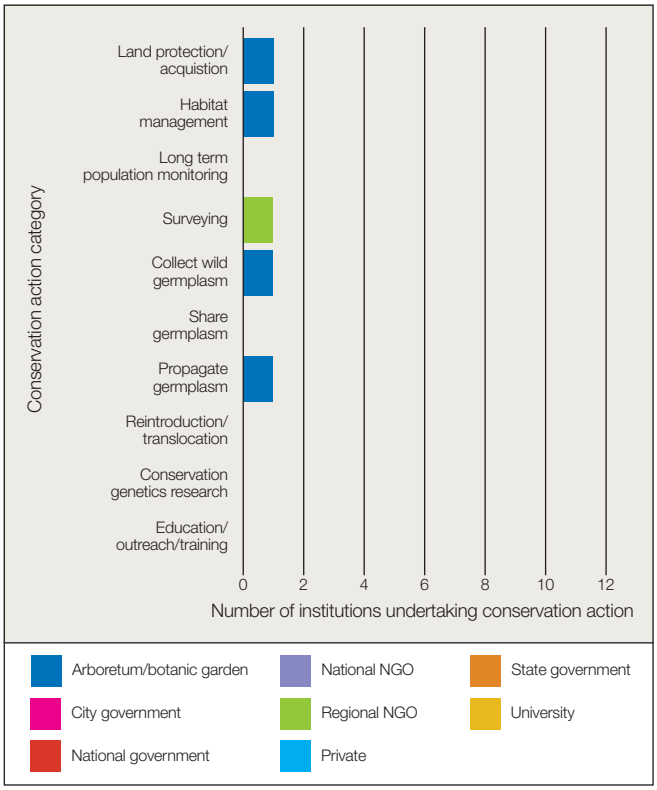


Figure 6. Number of institutions reporting conservation activities for *Quercus parvula* grouped by organization type. One of 252 institutions reported activities focused on *Q. parvula* (see Appendix D for a list of all responding institutions).

Land protection: Within the inferred native range of *Q. parvula*, 33% of the land is covered by protected areas (Figure 7). Much of Santa Cruz Island oak's native distribution is composed of developed urban/suburban areas, rangeland, or unprotected wildland.

In 2016, the East Bay California Native Plant Society encouraged their members to sign a petition to preserve the Richmond Hills, an open space near Wildcat Canyon and San Pablo Dam Road, and prevent development of the land. They argue the land has "potential and documented botanical richness" and that "Northern Maritime Chaparral is a sensitive natural community." *Quercus parvula* var. *shrevei* is listed as one of the rare and unique plant species within the open space, "at it's only location in the East Bay."[18] The Richmond Hills Initiative was successfully adopted, but currently three of the speculative developers are suing the City of Richmond in an attempt to overturn the Initiative. The Sierra Club is helping the City respond to the lawsuits, and a specialist lawyer has been hired.[19] At UC Davis Arboretum Shields Oak Grove, a native *Q. parvula* stand is protected and monitored.[20]

Sustainable management of land: The Oak Woodlands Management Plan for Santa Clara County was adopted in 2005, and includes habitat for *Q. parvula* var. shrevei.[21]

Population monitoring and/or occurrence surveys: *Quercus parvula* var. *parvula* and *Q. parvula* var. *tamalpaisensis* are considered rare by the California Native Plant Society, and therefore their distribution, ecology, and conservation status are tracked as part of the society's Rare Plant Program. They use this information to promote science-based plant conservation in California.[22]

Wild collecting and/or *ex situ* curation: One institution reported this activity in the conservation action questionnaire, but no other details are currently known.

Propagation and/or breeding programs: One institution reported this activity in the conservation action questionnaire, but no other details are currently known.

Reintroduction, reinforcement, and/or translocation: No known initiatives at the time of publication.

Research: The University of California Santa Cruz (UCSC) Forest Ecology Research Plot, located in the UCSC Campus Natural Reserve, contains six hectares of mixed evergreen coastal forest with 8,180 tagged stems. The four dominant species are Douglas fir (*Pseudotsuga menziesii*), Coast live oak (*Quercus agrifolia*), Shreve's oak (*Q. parvula* var. *shrevei*), and Tanoak (*Lithocarpus densiflorus*). This research plot provides an opportunity to follow population dynamics across different soil types, and includes an area that has undergone significant canopy mortality in the last two decades with unknown cause.[23]

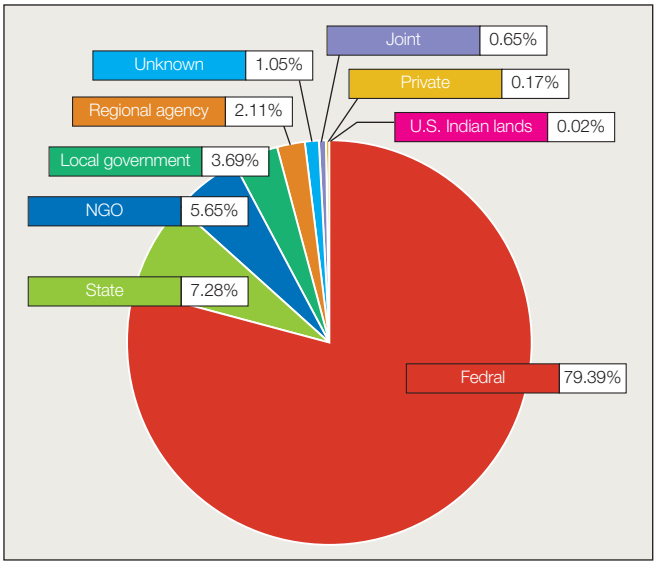


Figure 7. Management type of protected areas within the inferred native range of *Quercus parvula*. Protected areas data from the U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[7]

Through a network of 280 long-term forest monitoring plots, it is known that stands infested with sudden oak death are largely mixed evergreen forests with a specific plant composition of Bay laurel, Coast live oak, Tanoak, Madrone (*Arbutus menziesii*), and Shreve's oak (*Q. parvula* var. *shrevei*). A likely relationship was also uncovered between the pathogen's establishment and fire suppression: the pathogen more commonly establishes in mature stands, which have not been recently burned. These stands can also more easily spread the pathogen, due to increased connectivity stemming from a lack of fire.[13]

Education, outreach, and/or training: 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. parvula* as one of 20 species chosen for plantings. Between 2007 and 2008, the initiative, lead by the non-profit Canopy, collaborated with East Palo Alto City officials to spread the word and recruit partners and volunteers. School groups and community members helped prepare planting sites, plant acorns and seedlings, mulch, weed, and prune to keep the newly planted trees healthy. These volunteers contributed more than 4,000 hours of work. The City maintenance crews have now take over caring for the trees.[24]

The Oak Woodlands Management Plan for Santa Clara County was adopted in 2005 and informs forest management practices, including natural areas with populations of *Q. parvula* var. *shrevei*. Their listed Strategies for Conserving include improving knowledge, increasing outreach and education, promoting pilot projects, providing incentives for landowners, encouraging collaborative action, and planning for oak conservation on public lands.[21] Shipley Nature Center also protects a few young Island scrub oak specimens within their property, and hopes these trees will flourish so visitors can learn about and enjoy them.[25]

Species protection policies: No known initiatives at the time of publication.

Dean Taylor

PRIORITY CONSERVATION ACTIONS

Pressing challenges for the conservation of *Q. parvula* include the prevalence of sudden oak death throughout much of its range as well as habitat loss in coastal California due to development and fire. Preventing the spread of sudden oak death and understanding the degree of natural resistance to the pathogen that exists in *Q. parvula* will help mitigate this threat and clarify its importance. Long-term climate projections for coastal California still contain a great deal of uncertainty due to the importance of the fog layer in this region.

Imminent threat to *Q. parvula* from increased fire disturbance in California may be addressed with studies that track the survival of *Q. parvula* trees and regeneration post-fire. These studies will inform appropriate land management practices within *Q. parvula* habitat. Land owners and managers should be engaged in this process, and education and/or training will likely be an important step in applying research findings towards sustainable management of land. Land protection could also be considered in areas with pressure from development.

The species concept of *Q. parvula* has undergone numerous changes resulting in subspecies and populations that are treated differently by different scientists and conservation organizations. Moving forward, this concept should be tightened through genetic and morphological studies, which will be useful to conservation efforts that wish to preserve genetic resources of this species. The potential for important functional differences among *Q. parvula* populations is high because of the prevalence of disjunct populations such as those on the Channel Islands. Maintaining conservation efforts and *ex situ* collections of these populations can preserve that diversity.

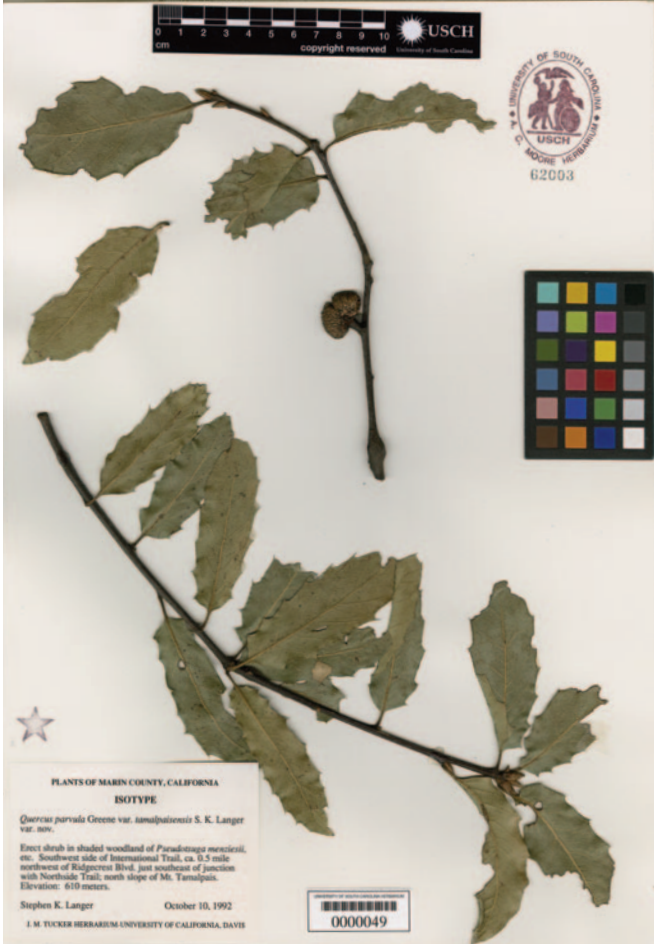
Conservation recommendations for *Quercus parvula*

Highest Priority

- Population monitoring and/or occurrence surveys
- Research (climate change modeling; land management/disturbance regime needs; pests/pathogens; taxonomy/phylogenetics)
- Sustainable management of land

Recommended

- Education, outreach, and/or training
- Land protection
- Wild collecting and/or *ex situ* curation



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