Conservation Gap Analysis of Native U.S. Oaks

Species profile: ***Quercus hinckleyi***

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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 hinckleyi C.H.Müll.

Synonyms: N/A **Common Names:** Hinckley's oak

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Suggested citation: Beckman, E., Rizner Backs, J., Meyer, A., & Westwood, M. (2019). *Quercus hinckleyi* C.H.Müll. In Beckman, E., Meyer, A., Man, G., Pivorunas, D., Denvir, A., Gill, D., Shaw, K., & Westwood, M. *Conservation Gap Analysis of Native U.S. Oaks* (pp. 128-133). Lisle, IL: The Morton Arboretum. Retrieved from https://www.mortonarb.org/files/species-profile-quercus-hinckleyi.pdf

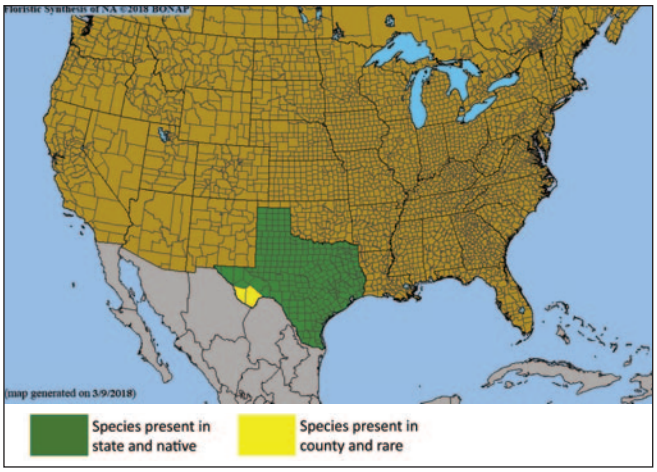

Figure 1. County-level distribution map for *Quercus hinckleyi*. Source: Biota of North America Program (BONAP).[3]

DISTRIBUTION AND ECOLOGY

In the late Wisconsin or early Holocene period, *Quercus hinckleyi*, or Hinckley's oak, was widespread across the more mesic region that we now call the Chihuahuan Desert in western Texas, U.S., and north-central Mexico. Today, over 10,000 years later, this scrub oak exists in a few suitable patches within Presidio County, Texas. *Quercus hinckleyi* has become restricted and isolated as the area's climate moves in an increasingly xeric direction. There remains a chance that pockets of this species still exist within the northern Mexican states of Coahuila and Chihuahua, but no current confirmation exists. Hinckley's oak can be found in the northeastern part of Big Bend Ranch State Park as well as near the town of Shafter, Texas, just northwest of the state park's limits. The distance between these two main sites is about 60 kilometers. Hinckley's oak is found in a dry, subtropical landscape on limestone and sandstone slopes between about 1,000 and 1,400 meters above sea level. It grows as a shrub less than one meter tall and usually forms dense bunches with thick, grey-green leaves that possess a holly-like form. Although this species can reproduce both clonally and sexually, clonal reproduction is much more prevalent. Growth rings on individual aerial stems have been found to show a seven to nine year lifespan. However, the clonal bunches themselves cannot be dated and are simply known to be much older than above-ground individuals, perhaps by thousands of years.[1,2]

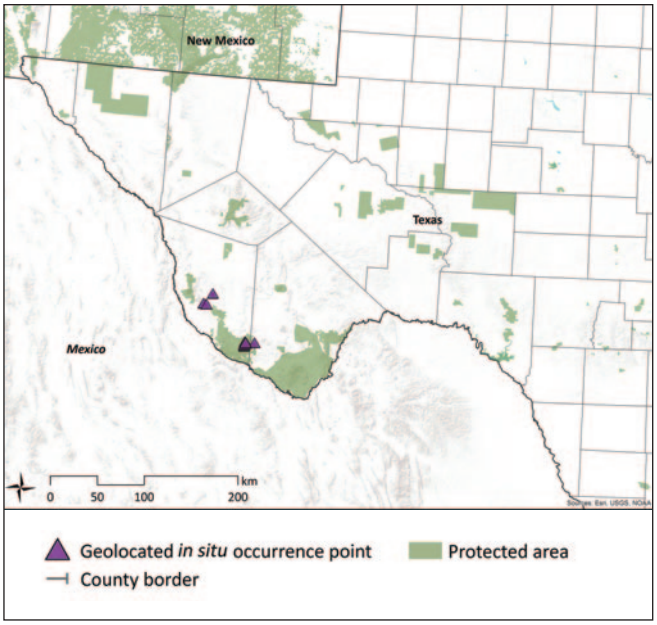

Figure 2. Documented *in situ* occurrence points for *Quercus hinckleyi*. Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[4]

VULNERABILITY OF WILD POPULATIONS

Table 1. Scoring matrix identifying the most severe demographic issues affecting *Quercus hinckleyi*. 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	20
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	20
Population decline	Extreme	>= 80% decline	>= 50% decline	>= 30% decline	None	Unknown	5
Fragmentation	Severe fragmentation	Isolated populations	Somewhat isolated populations	Relatively connected populations	Connected populations	Unknown	20
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	10
Genetic variation/ integrity	Extremely low	Low	Medium	High	Very high	Unknown	10
						Average vulnerability score	14.2
						Rank relative to all U.S. oak species of concern (out of 19)	3

THREATS TO WILD POPULATIONS

High Impact Threats

Extremely small and/or restricted population: There are multiple concerns regarding the small, fragmented range of Hinckley's oak, which magnify through time if not addressed.[1]

Moderate Impact Threats

Human use of landscape — residential/commercial development, mining, and/or roads: It is also possible that land development has caused changes to the environment that hinder the ability of *Q. hinckleyi* to successfully reproduce sexually and recruit saplings.[1] The smaller of the species' two populations, the Shafter site, is within the path of a proposed pipeline (J. Backs pers. comm., 2018).

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: As the climate shifts and landscapes change, *Q. hinckleyi* may have a difficult time adapting, mostly due to its small population size and small amount of sexual regeneration. Although some acorns were found at the larger sites within Big Bend Ranch State Park and there appears to be evidence of recruitment, there is no current evidence of recruitment at the smaller Shafter site. Clonal reproduction prevents continued diversification of genotypes, as well as the species' ability to populate new areas by the natural transportation of acorns. These are both important factors in determining the persistence of species as the climate shifts and landscapes change.[1]

Genetic material loss — inbreeding and/or introgression: Genetic threats should be considered for the smaller of the two subpopulations because the current reproduction method is overwhelmingly clonal; this stunts diversification of genotypes and population of new areas. Too few individuals cannot respond positively to natural selection. It has also been observed that as clones increase in size, flowers become surrounded with more of the same genetic entity and therefore may produce less viable seed.[1] Hybridization with *Q. pungens* and *Q. vaseyana* could also be a possible future threat, but does not seem to be extensive at this time and genetic swamping has not occurred.[5] Recent research also indicates that the effects of hybridization can sometimes be positive rather than negative, so more investigation is needed in this area.[6]

Low Impact Threats

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: It is possible that ranching activities in the area have caused habitat degradation, which hinders the ability of *Q. hinckleyi* to successfully reproduce sexually and recruit saplings.

Human use of landscape — tourism and/or recreation: Within Big Bend Ranch State Park, recreation has the potential to disturb Hinckley's oak populations.

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 (Figure 3). 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 5).

Results of 2017 *ex situ* survey

Number of *ex situ* collections reporting this species:	6
Number of plants in *ex situ* collections:	10
Average number of plants per institution:	2
Percent of *ex situ* plants of wild origin:	20%
Percent of wild origin plants with known locality:	50%

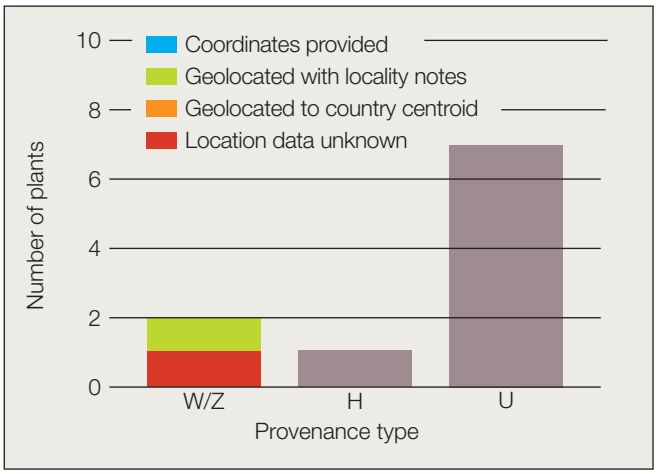

Figure 3. Number and origin of *Quercus hinckleyi* plants in *ex situ* collections. Provenance types: W = wild; Z = indirect wild; H = horticultural; U = unknown.

A spatial analysis was conducted to estimate the geographic and ecological coverage of *ex situ* collections (Figure 4). 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:	50%
Ecological coverage:	100%

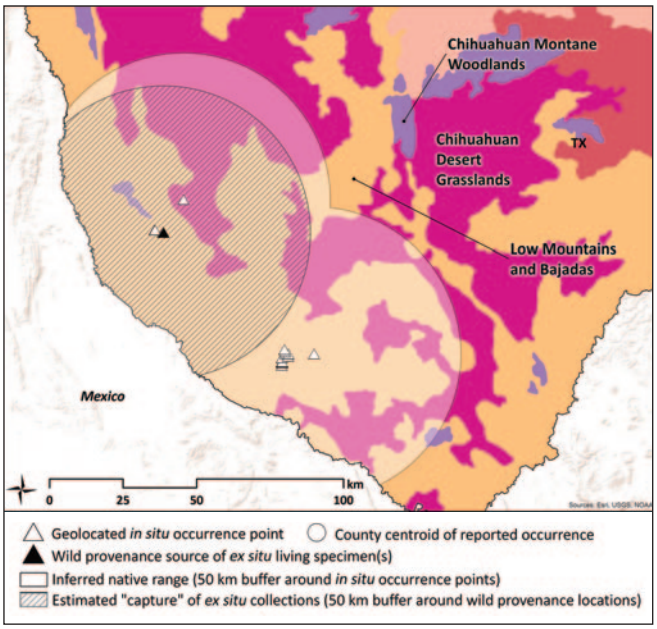

Figure 4. *Quercus hinckleyi in situ* occurrence points and *ex situ* collection source localities. U.S. EPA Level IV Ecoregions are colored and labelled.[7] County centroid is shown if no precise locality data exist for that county of occurrence. Email treeconservation@mortonarb.org for information regarding specific coordinates.

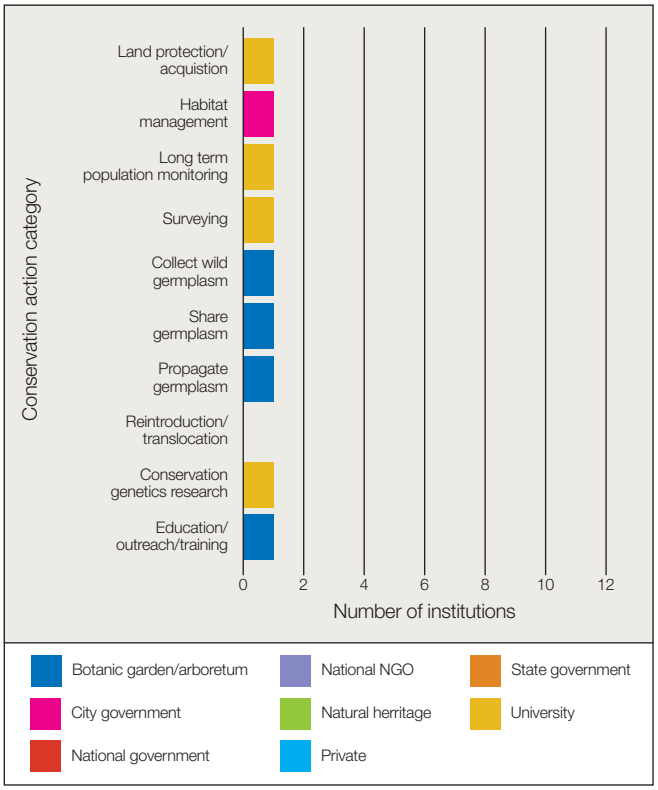

Figure 5. Number of institutions reporting conservation activities for *Quercus hinckleyi* grouped by organization type. One of 252 institutions reported activities focused on *Q. hinckleyi* (see Appendix D for a list of all responding institutions).

Land protection: Within the inferred native range of *Q. hinckleyi* in the U.S., 62% of the land is covered by protected areas (Figure 6). One of the two known Hinckley's oak populations is protected within Big Bend Ranch State Park and the other is on privately owned land. Genetic analysis found the protected population to harbor more diversity (116 unique genotypes), while high clonality was determined at the unprotected Shafter site (seven unique genotypes). The protected site is also more frequently reproducing sexually.[1,5]

Sustainable management of land: The Texas Parks and Wildlife Department's 2012 ecoregions handbook for the Chihuahuan Desert and Arizona-New Mexico Mountains outlines general trends and needs in the region as a whole, including Big Bend Ranch State Park. There is no specific mention of *Q. hinckleyi* outside the "Species of Greatest Conservation Need" list.[8]

Population monitoring and/or occurrence surveys: In accordance with the requirements for species listed on the Endangered Species Act (ESA), a Hinckley Oak Recovery Plan was created upon listing in 1992. This document laid out criteria for removal from the ESA: "attain at least 20 viable self-sustaining populations in at least 4 geographically distinct population centers and attain a total of at least 10,000 individual plants. Demonstrate population viability at recovery levels for 10 consecutive years."[9] Within the species' five year review, which did not occur until 2008, it was found that little new information about *Q. hinckleyi* had been collected and few recovery actions had been implemented.[5] Big Bend Ranch State Park has also performed surveys of *Q. hinckleyi* within other parts of their preserve, but have not yet been successful.[1]

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: Within their 2015 and 2016 research, Backs *et al*. list the fulfillment of three high priority tasks within the recovery plan: #3212 to assess genetic viability and needs, #3231 to determine types of reproduction and contribution to population, and #3213 to assess incidence of (and potential threat from) hybridization with nearby oak species and develop management strategies to address any problems. They found that overall, remnant populations of *Q. hinckleyi* exhibit strong population differentiation, and do not act as fringe pioneers with founder effects or genetic bottlenecks. Backs et al. also used genetic analysis of *Q. hinckleyi* to further understand the potential conservation concern of hybridization and subsequent genetic swamping. It was concluded that although genetic swamping can be a threat to rare species, "it is not always the case, and rather than focusing on hybridization, conservation management may be better served by protecting threatened habitat that may include hybrids. To preserve the *Q. hinckleyi* genetic variability that may be stored in the neighboring oak species, protection of the cryptic *Q. pungens* should be included as part of *Q. hinckleyi's* conservation strategy."[1,6]

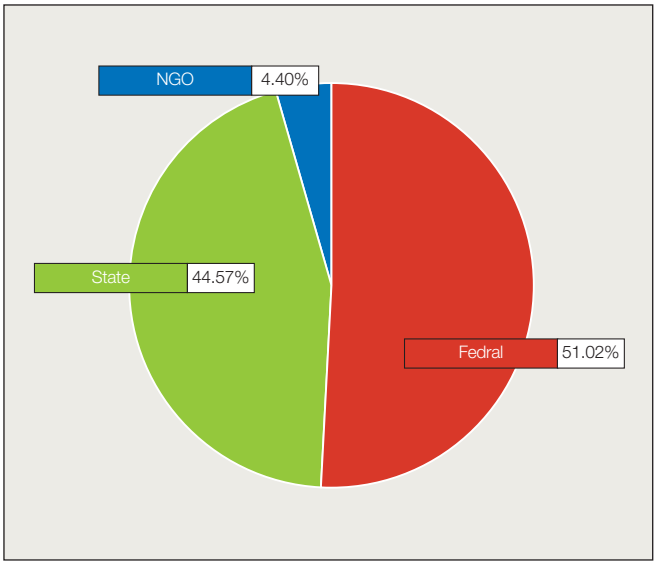

Figure 6. Management type of protected areas within the inferred native range of *Quercus hinckleyi*. Protected areas data from the U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[4]


Emily Griswold

Education, outreach, and/or training: One institution reported this activity in the conservation action questionnaire, but no other details are currently known.

Species protection policies: *Quercus hinckleyi* is the only native U.S. oak protected under the Endangered Species Act, which, by law, triggered the creation of a recovery plan.[9] The species is also considered Threatened by the state of Texas, as overseen by Texas Parks and Wildlife Department's Wildlife Diversity Program. Texas state Threatened or Endangered plants gain protection from humans taking, possessing, transporting, or selling the species.[10]

PRIORITY CONSERVATION ACTIONS

There have been limited conservation initiatives for Hinckley's oak. Although one of its subpopulations is now protected in a state park, recreational use of this area has the potential of threatening its numbers. The other subpopulation, located on private land, is within the path of a proposed pipeline. Climate is projected to become more xeric, which will further stress populations. Protecting surrounding habitat of wild individuals would be an ideal solution, but reality suggests that *ex situ* conservation is critical to the ultimate survival of this species. Although the species itself may appear insignificant, it has survived thousands of years of an increasingly arid environment. The persistence of the genetic adaptations to these conditions may be invaluable in understanding how plants cope with climate change as we are now experiencing it.

Because the species often reproduces clonally, genetic identification is needed to ensure that unique individuals are used for *ex situ* programs. Programs could include hand pollination and translocating genets or, less invasively, ramets of existing plants. Collecting acorns may be possible in some of its locations, but removing these from native habitat then limits survival there through loss of genetic diversification. Removal of acorns should be done with care; propagation programs could play an important role in sustainably distributing Hinckley's oak germplasm among *ex situ* institutions.

Protection of the Shafter site should be considered, as well as subsequent reinforcement and/or reintroduction to increase genetic diversity. Because *Q. hinckleyi* populations are very small and reproduce sporadically, population monitoring should continue on a regular basis to determine if decline is occurring. Finally, public outreach and education on the threats to this endangered species will help to raise awareness of the vulnerability of plant species in general. *Quercus hinckleyi* is a rather charismatic little oak, which has the potential to capture the support of locals, non-profits, and governing bodies alike.

Conservation recommendations for *Quercus hinckleyi*

Highest Priority

- Land protection
- Propagation and/or breeding programs
- Wild collecting and/or *ex situ* curation

Recommended

- Education, outreach, and/or training
- Population monitoring and/or occurrence surveys
- Reinforcement / Reintroduction / Translocation
- Research (climate change modeling; reproductive biology/regeneration; restoration protocols/guidelines)

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