Conservation Gap Analysis of Native U.S. Oaks

Species profile: ***Quercus robusta***

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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 robusta C.H.Müll.

Synonyms: N/A **Common Names:** Robust oak

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Shannon Still

DISTRIBUTION AND ECOLOGY

Quercus robusta, or Robust oak, is believed to be endemic to the Chisos Mountains of southwestern Texas, U.S., and is currently known from a small area in Big Bend National Park. The type locality contains the only confirmed location, but a potential second population was just discovered; more research is necessary to verify this second location (S. Still pers. comm., 2018). There is continued taxonomic debate surrounding the status of this species, with C. H. Müller describing the species in 1934, deeming it a hybrid between *Q. emoryi* and *Q. gravesii* in the mid-20th century, and finally reviewing the case again more recently and concluding Robust oak to be a true species.[1] There is some possibility that *Q. robusta* exists within northern Mexico, but no evidence has yet been found. The species is not present in Valencia and Flores-Franco's 2006 authoritative Fagaceae of Mexico.[2] Robust oak is large compared to other trees within the Chisos Mountains, and is found occupying the lowlands of moist wooded canyons where a creek sometimes flows, around 1,500 meters above sea level. These relatively moist conditions likely account for the species' unique stature. Cottonwoods are found alongside *Q. robusta* in its type locality, and are also rare within the Chisos Mountains; this speaks to the distinctive nature the of site (A. McNeil-Marshall pers. comm., 2018).

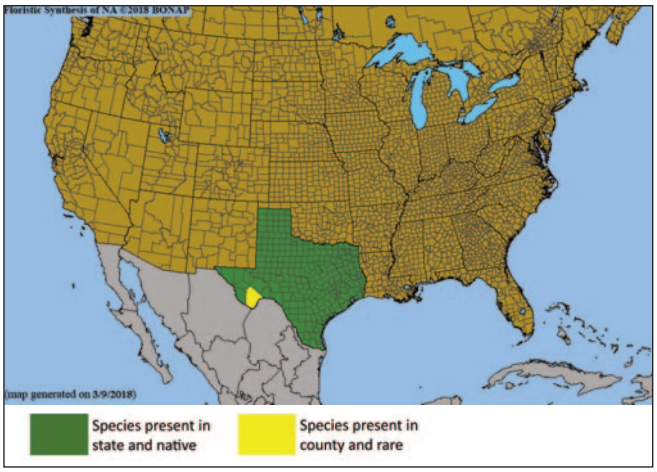

Figure 1. County-level distribution map for *Quercus robusta*. Source: Biota of North America Program (BONAP).[3]

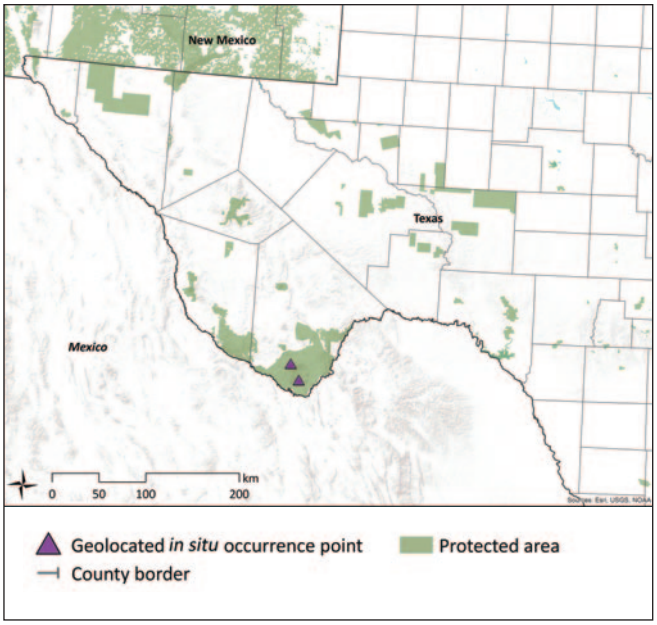

Figure 2. Documented *in situ* occurrence points for *Quercus robusta*. Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[4]

VULNERABILITY OF WILD POPULATIONS

Table 1. Scoring matrix identifying the most severe demographic issues affecting *Quercus robusta*. 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	40
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	40
Population decline	Extreme	>= 80% decline	>= 50% decline	>= 30% decline	None	Unknown	0
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	-
Genetic variation/ integrity	Extremely low	Low	Medium	High	Very high	Unknown	20
						Average vulnerability score	24.0
						Rank relative to all U.S. oak species of concern (out of 19)	2

THREATS TO WILD POPULATIONS

High Impact Threats

Extremely small and/or restricted population: This species is currently verified in only one restricted location, though a second potential population was recently discovered; further research is required to confirm this new location (S. Still pers. comm., 2018).

Moderate Impact Threats

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: Drought, flood, and fire all pose threats, especially since the population could be wiped out by one extreme event (A. McNeil-Marshall pers. comm., 2016).

Genetic material loss — inbreeding and/or introgression: Because this species is rare and occurs with other oak species nearby, hybridization may be a genetic threat; though there is little evidence of a problem currently (S. Still pers. comm., 2018). All known populations are extremely small, making inbreeding in the near future very likely and genetic adaptation through natural selection unlikely.

Low Impact Threats

Human use of landscape — tourism and/or recreation: Within Big Bend National Park, there is some potential threat from human impact during recreational activities (A. McNeil-Marshall pers. comm., 2016).

Human modification of natural systems — invasive species competition: In general, invasive plant species are known to pose a threat to the unique and rare species within Big Bend National Park; no specific impacts to *Q. robusta* have been reported.[5]

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:	2
Number of plants in *ex situ* collections:	2
Average number of plants per institution:	1
Percent of *ex situ* plants of wild origin:	50%
Percent of wild origin plants with known locality:	100%

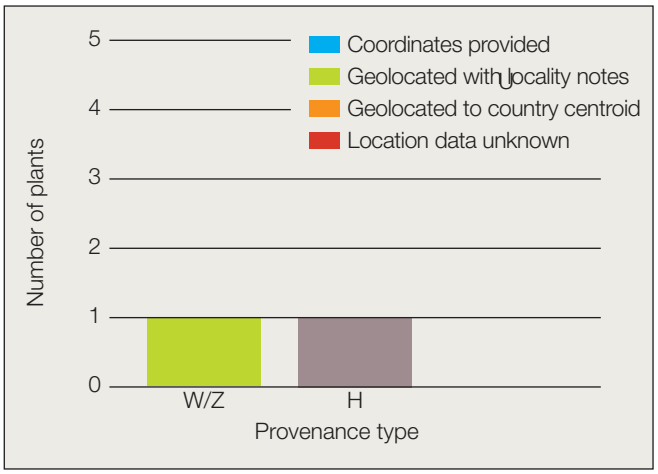

Figure 3. Number and origin of *Quercus robusta* plants in *ex situ* collections. Provenance types: W = wild; Z = indirect wild; H = horticultural; U = unknown.

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:	69%
Ecological coverage:	100%

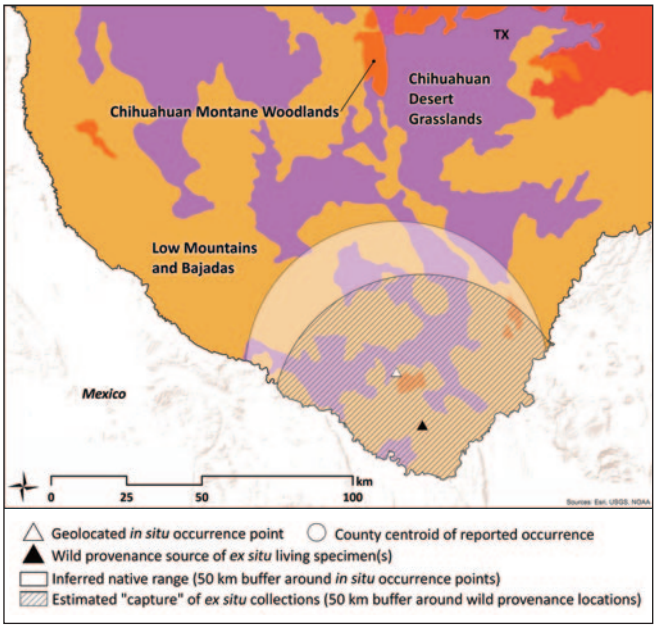

Figure 4. *Quercus robusta in situ* occurrence points and *ex situ* collection source localities. U.S. EPA Level IV Ecoregions are colored and labelled.[6] County centroid is shown if no precise locality data exist for that county of occurrence. Email treeconservation@mortonarb.org for information regarding specific coordinates.

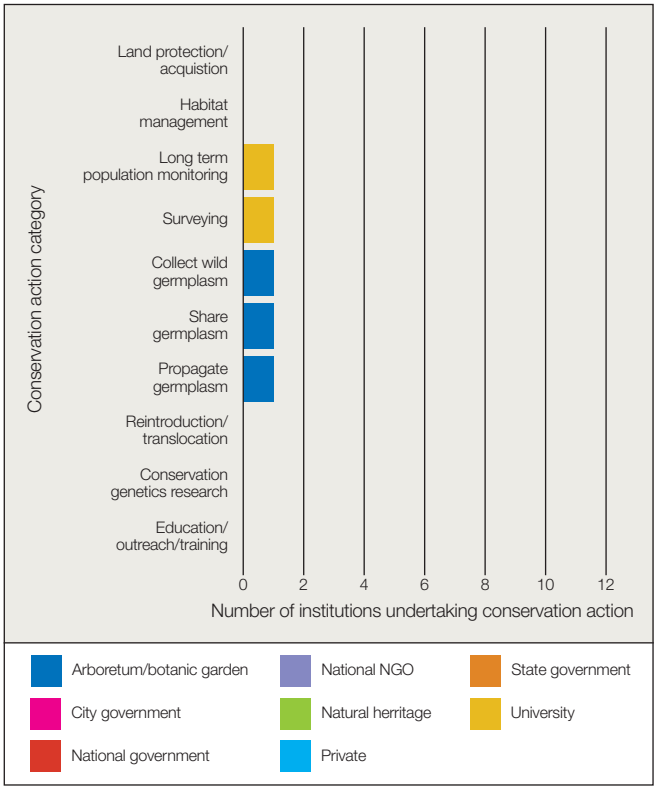

Figure 5. Number of institutions reporting conservation activities for *Quercus robusta* grouped by organization type. Two of 252 institutions reported activities focused on *Q. robusta* (see Appendix D for a list of all responding institutions).

Land protection: Within the inferred native range of *Q. robusta*, 63% of the land is covered by protected areas (Figure 6). However, because this species' distribution is small and well-documented, we know that 100% of the species' potential occurrences within the U.S. are within protected areas.

All known populations of this species are located within Big Bend National Park, providing protection from excess human disturbance. The Park's general management plan also lists *Q. robusta* as outside the areas where current projects may disturb the landscape.[7]

Sustainable management of land: The Ecoregional Conservation Assessment of the Chihuahuan Desert ranks Big Bend Triangle as the area with the highest Irreplaceability Index and 9th highest overall conservation priority out of 39 areas of conservation concern in Texas.[8] The Texas Conservation Action Plan: Chihuahuan Desert and Arizona-New Mexico Mountains Ecoregions Handbook outlines general trends and needs in the region as a whole, including Big Bend National Park, but there is no specific mention of *Q. robusta* outside the "Species of Greatest Conservation Need" list.[9]

Population monitoring and/or occurrence surveys: Although the Texas Parks and Wildlife Department conservation action plan for the Chihuahuan Desert and Arizona-New Mexico mountain regions lists *Q. robusta* as a "Species of Greatest Conservation Need," it is unclear whether population monitoring accompanies this listing.[9] With support from APGA-USFS Tree Gene Conservation Program grants in 2016 and 2018, UC Davis Arboretum & Public Garden led expeditions to visit the species' type locality. It seemed to be in good health. A second potential population was also discovered in 2018, but needs further analysis to confirm its identification as *Q. robusta* (S. Still pers. comm., 2018).[10]

Wild collecting and/or *ex situ* curation: With support from an APGA-USFS Tree Gene Conservation Program grant, an expedition lead by UC Davis Arboretum & Public Garden located the main population of *Q. robusta* in 2016 to collect acorns, but none were present.[10] The Partnership funded a second collecting trip in 2018, which successfully obtained acorns; however, identification is uncertain and the individuals could be *Q. emoryi* x *Q. gracilliformis/gravesii* (A. Black pers. comm., 2018).

Propagation and/or breeding programs: Seeds from the collecting trip in 2018 will be distributed to grow out in cultivation and monitored for purity, and potentially confirmed through genetic characterization in the future (A. Black pers. comm., 2018).

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

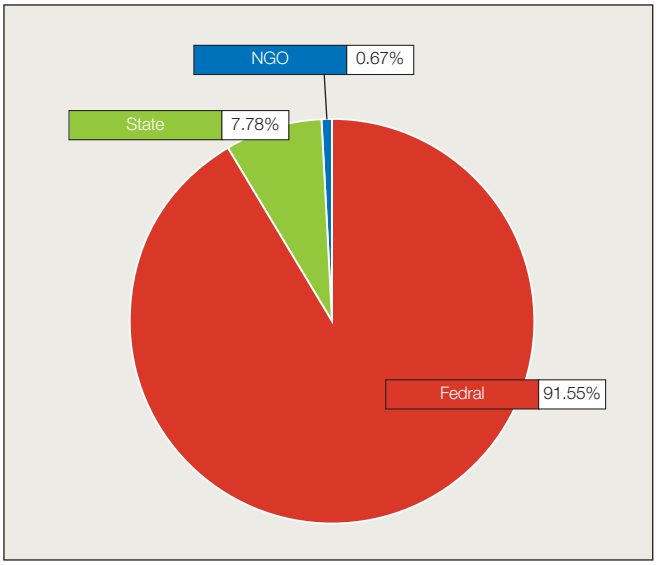

Figure 6. Management type of protected areas within the inferred native range of *Quercus robusta*. Protected areas data from the U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[4]

Research: In 2016, the Australian City of Melbourne completed The city of Melbourne's Future Urban Forest: Identifying vulnerability to future temperatures, which analyzed species currently planted within the city as well as species with possible suitability for urban planting in the future. *Quercus robusta* was analyzed as a tree not currently planted in the City of Melbourne, and was rated as moderately appropriate in low and medium intensity climate projections, and unsuitable in high intensity projections.[11]

Education, outreach, and/or training: No known initiatives at the time of publication.

Species protection policies: In 2009, a petition was submitted to the U.S. Fish and Wildlife Service, to list 475 species in the southwestern U.S. as Threatened or Endangered under the Endangered Species Act. Robust oak was determined to have an inadequate amount of threat information provided in the petition, and was subsequently rejected.[12] In addition to listing species as endangered or threatened, Texas maintains a list of more than 1,300 Species of Greatest Conservation Need (SGCN). These species are "declining or rare and in need of attention to recover or to prevent the need to list under state or federal regulation…[and are] the focus of Texas Parks and Wildlife Department's Texas Conservation Action Plan," but are not provided the same protections as endangered or threatened species. *Quercus robusta* is listed as a SGCN.[13]

PRIORITY CONSERVATION ACTIONS

Robust oak is a little-understood plant whose main conservation gap is the lack of an articulate, comprehensive taxonomic study. There are very little primary data available to help in determining whether this small group of plants, occurring fairly separately from other oaks in the area, should be considered a distinct species or whether it should be placed in the wider context of a *Q. emoryi*-*Q. gravesii* continuum that exists in the Chisos Mountains. Also noteworthy is the very recent discovery of a second population appearing to be *Q. robusta*. If these plants are indeed *Q. robusta*, the number of verified populations, and likely the number of individuals as well, would double. This development would certainly increase the stability of the species. Though, these plants are in close proximity to several other species that are not found in the type locality, giving rise to suspicion regarding their identity.

Physical conservation of this species seems fairly assured given that it is found only within the boundaries of Big Bend National Park. *Ex situ* conservation is the obvious next step in ensuring the longevity and further study of this plant. It will be important to cultivate the species within a wide range of growing sites to determining the extent to which the natural habitat is influencing morphology of the known plants. For instance, it could be discovered whether the distinctive stature of naturally occurring *Q. robusta* is due to increased moisture at its native site. The remoteness of the site makes collection a challenge, especially due to highly sporadic acorn production in the region, although acorns were collected from both localities in 2018. Nonetheless, efforts to collect, distribute, and propagate germplasm should be continued for the purposes of *ex situ* conservation and taxonomic study. Reinforcement and/or translocation could also be considered to further stabilize the species. Public education regarding the unique flora and fauna of the Chisos Mountains could provide further resources for the research and protection of this region; for example, interpretation could be installed at botanic gardens housing these rare species.

Conservation recommendations for *Quercus robusta*

Highest Priority

- Population monitoring and/or occurrence surveys
- Propagation and/or breeding programs
- Research (restoration protocols/guidelines; taxonomy/phylogenetics)
- Wild collecting and/or *ex situ* curation

Recommended

- Education, outreach, and/or training
- Reintroduction, reinforcement, and/or translocation

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