Conservation Gap Analysis of Native U.S. Oaks

Species profile: ***Quercus graciliformis***

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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 graciliformis C.H.Müll.

Synonyms: *Quercus canbyi* Cory & Parks, *Q. graciliformis* var. *parvilobata* C.H.Müller
Common Names: Graceful oak, Slender oak, Chisos oak

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Adam Black

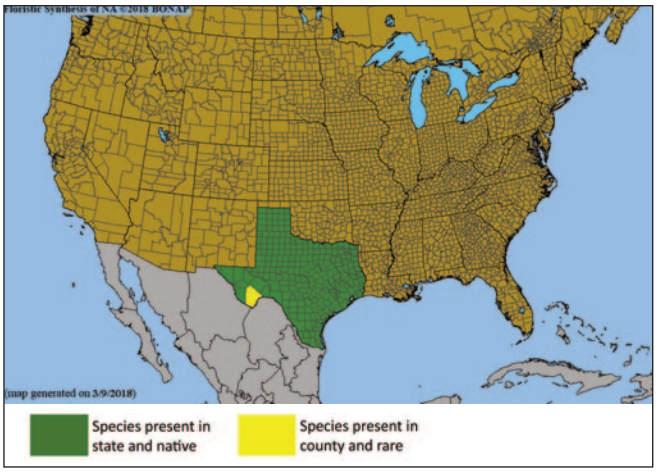

Figure 1. County-level distribution map for the U.S. distribution of *Quercus graciliformis*. Source: Biota of North America Program (BONAP).[4]

DISTRIBUTION AND ECOLOGY

Occurrences of *Quercus graciliformis*, or Graceful oak, have only been verified in an extremely limited range within the Chisos Mountains of western Texas, U.S. Some reports of the species have been documented in the Mexican states of Coahuila, Nuevo Leon, and Tamaulipas, but consensus as to their identify as *Q. graciliformis* has not yet been reached by the botanic community.[1] It is possible Graceful oak also occurs in Chihuahua, Mexico, since there may be suitable habitat, but no extensive searches have yet been completed. Using only verified localities (points from the Chisos Mountains in Brewster County, Texas), *Q. graciliformis* occupies approximately 24 kilometers squared.[2] Past taxonomic confusion with *Q. canbyi* and *Q. gravesii* have also called into question the species' status, though most botanists now accept Graceful oak as a true species. However, some Mexican taxonomists still categorize *Q. graciliformis* as a synonym to *Q. canbyi*.[3] It is difficult to distinguish *Q. graciliformis* from *Q. canbyi*, but the former produces fruit that matures in two years, while the latter only requires one year for fruit maturation. For this report *Q. graciliformis* will be treated as a unique species due to important morphological differences and general agreement on taxonomic status, though more research is necessary. Graceful oak is a small, semi-evergreen tree, reaching eight meters tall, and is named for its skinny, arching branches. It grows in dry oak woodlands, which line the canyon floors of the Chisos Mountains (A. McNeil-Marshall pers. comm., 2016).

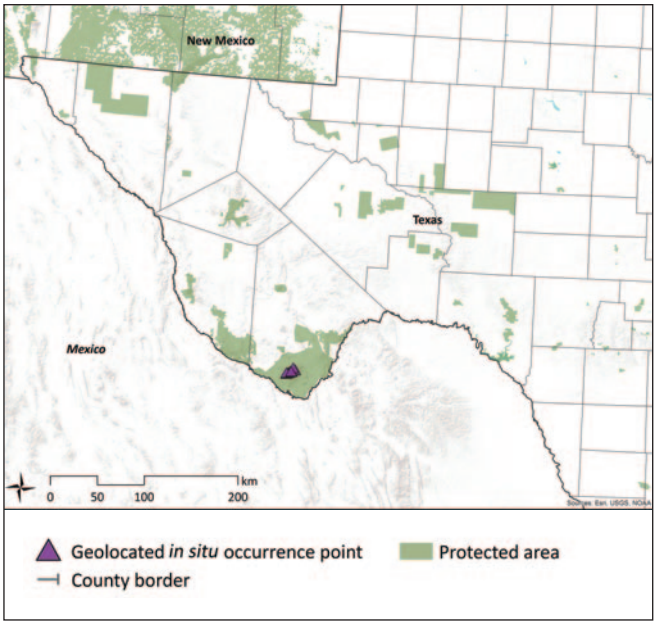

Figure 2. Documented *in situ* occurrence points for the U.S. distribution of *Quercus graciliformis*. Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[5]

VULNERABILITY OF WILD POPULATIONS

Table 1. Scoring matrix identifying the most severe demographic issues affecting *Quercus graciliformis*. 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	40
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	0
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: With *Q. graciliformis*' key subpopulation inhabiting one relatively narrow canyon, a single intense fire event could do extensive damage. It is thought that this species will resprout after fire like most oaks, but an intense burn would certainly be a severe threat to at least one generation (A. McNeil-Marshall pers. comm., 2016).

Moderate Impact Threats

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: Changing climate could create conditions for extreme drought and fire (A. McNeil-Marshall pers. comm., 2016).

Genetic material loss — inbreeding and/or introgression: There are reports of *Q. graciliformis* hybridizing with *Q. emoyri,* but this does not seem to be an extensive threat currently.[6] The species is also unlikely to adapt under environmental change due to its very small population size.

Low Impact Threats

Human use of landscape — residential/commercial development, mining, and/or roads: There is possible threat of residential water withdrawals lowering the high water table supporting this species, although this has not yet been recorded on the ground (A. McNeil-Marshall pers. comm., 2016).

Human use of landscape — tourism and/or recreation: Since the known population is entirely held within Big Bend National Park, the only direct anthropomorphic threat is recreational activities. This is not likely to severely damage the population, but Blue Creek Canyon Trail does cut through the most vibrant and well-known subpopulation.[7]

Human modification of natural systems — invasive species competition: Invasive plant species pose a significant threat to the unique and rare species within Big Bend National Park, but severe threat has not yet been witnessed for *Q. graciliformis*.[8]

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). 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:	13
Number of plants in *ex situ* collections:	108
Average number of plants per institution:	8
Percent of *ex situ* plants of wild origin:	84%
Percent of wild origin plants with known locality:	100%

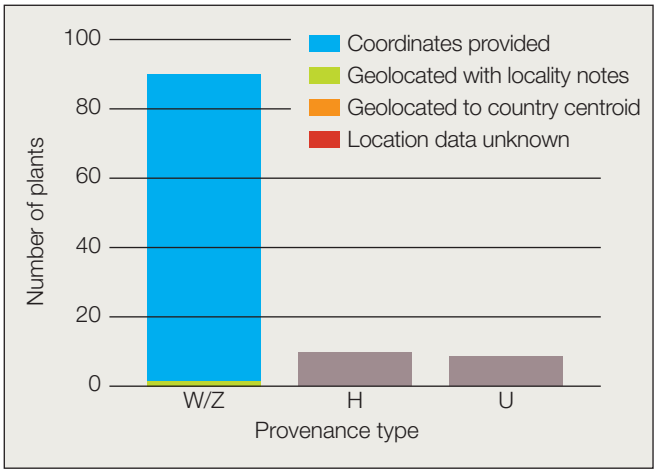

Figure 3. Number and origin of *Quercus graciliformis* plants in *ex situ* collections. Provenance types: W = wild; Z = indirect wild; H = horticultural; U = unknown.

A spatial analysis was conducted to estimate the geographic and ecological coverage of *ex situ* collections (Figure 4). Only the native U.S. distribution of the species was considered in this analysis, due to availability of ecoregion maps. 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:	92%
Ecological coverage:	100%

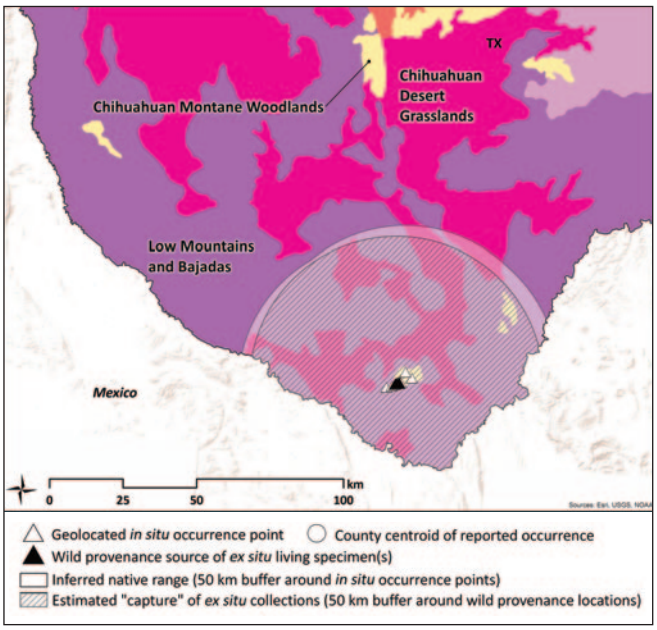

Figure 4. *Quercus graciliformis in situ* occurrence points and *ex situ* collection source localities within the United States. U.S. EPA Level III Ecoregions are colored and labelled.[9] County centroid is shown if no precise locality data exist for that county of occurrence. Email treeconservation@mortonarb.org for more information regarding specific coordinates.

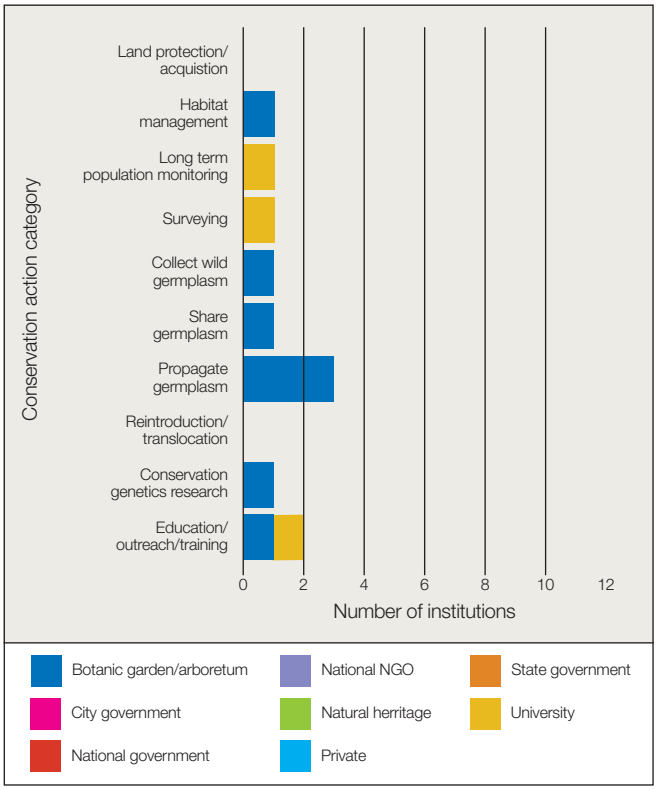

Figure 5. Number of institutions reporting conservation activities for *Quercus graciliformis* grouped by organization type. Seven of 252 institutions reported activities focused on *Q. graciliformis* (see Appendix D for a list of all responding institutions).

Land protection: Within the inferred native range of *Q. graciliformis*, 65% 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 protected within Big Bend National Park.

Sustainable management of land: Big Bend National Park's general management plan lays out park-wide goals, including restoration of native plant and animal populations damaged by past human disturbance, continuation of natural processes that support native plants and animals, and protection of genetic diversity of native plant and animal populations.[10] The Park's fire management plan gives a brief history of management as well as current actions. Surveys in the 1940s and 1960s found that fire should be reintroduced to the system, but "limited resources and cautious administrators led to continued suppression of most natural ignitions." A prescribed fire program was implemented in 1980 with the goal of protecting developments. This program has burned 2,080 acres in 25 years, and also lead to the realization that natural fires should be allowed to burn when possible "to reduce fuels and to burn where they occurred historically." Maps in the report show no occurrence of fire within the area containing *Q. graciliformis*.[11] This could be a good thing for the species, but the role of fire is not well understood for Graceful oak. The Texas Parks and Wildlife Department 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 National Park, but there is no specific mention of *Q. graciliformis* outside the "Species of Greatest Conservation Need" list.[12]

Population monitoring and/or occurrence surveys: Within the general management plan for Big Bend National Park, *Q. graciliformis* has been found within a Project Area, but determined unlikely to be affected by proposed actions.[10] With support from APGA-USFS Tree Gene Conservation Partnership grants, UC Davis Arboretum & Public Garden visited the type locality of Graceful oak in 2016 and 2018. A lesser-known location was also visited in 2018, and the expedition believes to have located *Q. graciliformis* in an area that had not been verified in many years (S. Still pers. comm., 2018).[13]

Wild collecting and/or *ex situ* curation: Funded by the APGA-USFS Tree Gene Conservation Partnership and lead by UC Davis Arboretum & Public Garden, a 2016 expedition collected more than 400 *Q. graciliformis* acorns total, with 30 to 60 acorns from each individual located.[13] UC Davis Arboretum & Public Garden also collected ten acorns in 2017, which they shared with two other gardens for *ex situ* preservation. The APGA-USFS Tree Gene Conservation Program supported another collecting expedition in 2018, which gathered what participants believe to be *Q. graciliformis* acorns from a location that is not yet represented in *ex situ* collections (S. Still pers comm., 2018).

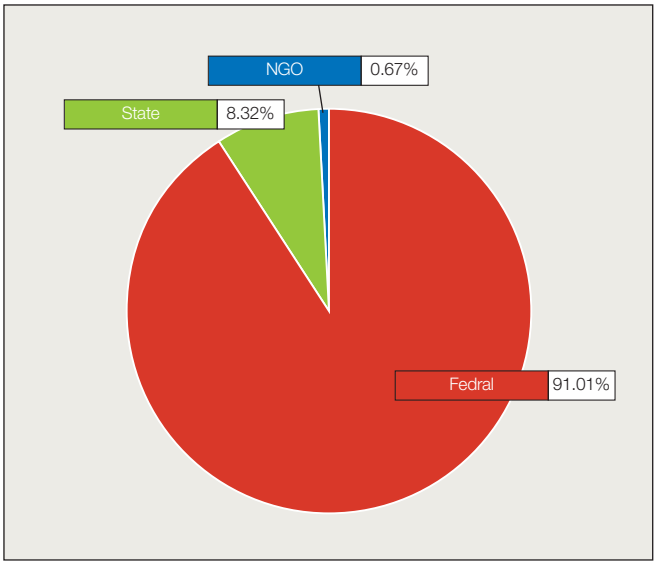

Figure 6. Management type of protected areas within the inferred native range of *Quercus graciliformis*. Protected areas data from the U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[5]


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Propagation and/or breeding programs: Acorns from the 2016 collecting trip were distributed for propagation at four partner institutions: Lady Bird Johnson Wildflower Center, Chihuahuan Desert Botanical Garden and Nature Center, Boyce Thompson Arboretum, and Bartlett Tree Research Laboratories and Arboretum.[13] Acorns collected in 2017 are in propagation at UC Davis Arboretum, The Morton Arboretum, and Boyce Thompson Arboretum, for planting within *ex situ* collections. The 2018 trip also collected acorns, which are in propagation (S. Still pers. comm., 2018).

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

Research: One institution reported conservation genetics research in the conservation action questionnaire, but no other details are currently known.

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

Species protection policies: 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 graciliformis* is listed as a SGCN.[14]

PRIORITY CONSERVATION ACTIONS

It would seem that Graceful oak is in a position to be well conserved in its current location within Big Bend National Park. More survey work should be done in the Chisos Mountains to locate and study other populations. A lesser-known location was visited in 2018 and the expedition believes to have located *Q. graciliformis* in a population that had not been verified in many years. If this is indeed a population of *Q. graciliformis*, it is not nearly as morphologically uniform as the Blue Creek Canyon population, displaying a wider range of leaf size and overall plant size and habit. The population at Blue Creek Canyon should also be surveyed to better understand the extent of its area and number of individuals. These data will help determine if this population is static or dynamic in growth. It will be important to have a baseline of information for this species to see how changes in climate affect its range and habitat. Reinforcement and/or translocation should be considered to prevent a single extreme event from wiping out all populations, and could be urgent if populations are determined to be shrinking.

Due to recent *ex situ* collecting efforts, all known populations are now represented in living collections. Further scouting and possible genetic analysis to identify other populations should be accompanied by representation of those locations in *ex situ* collections. Continued study is warranted to illuminate the nature of genetic crossing and the role this plays in species survival in what is essentially an isolated ecosystem. *Quercus graciliformis* should also be further promoted as a unique Texas-endemic native plant. Overall more interest should be cultivated in the oaks of the floristically unique Chisos Mountains and Big Bend region, which houses many flora facing various levels of imperilment.

Conservation recommendations for *Quercus graciliformis*

Highest Priority

- Population monitoring and/or occurrence surveys
- Reintroduction, reinforcement, and/or translocation

Recommended

- Population monitoring and/or occurrence surveys
- Education, outreach, and/or training
- Propagation and/or breeding programs
- Research (climate change modeling; demographic studies/ecological niche modeling; population genetics; restoration protocols/guidelines; taxonomy/phylogenetics)
- Wild collecting and/or *ex situ* curation

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