Conservation Gap Analysis of Native U.S. Oaks

Species profile: *Quercus carmenensis*
Emily Beckman, Shannon M. Still, 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 australina,
    - Quercus georgiana,
    - Quercus oglethorpensis, Quercus similis
Quercus carmenensis C.H.Müll.

Synonyms: N/A  Common Names: Del Carmen oak, Mexican oak, Sierra del Carmen oak

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Contributors: Adam Black, Peckerwood Garden; Andrew McNeil-Marshall, Lady Bird Johnson Wildflower Center, The University of Texas at Austin


DISTRIBUTION AND ECOLOGY

Quercus carmenensis, also known as Del Carmen oak, is only recorded in the U.S. within Brewster County in southwestern Texas, and is originally known from the Sierra del Carmen region in Coahuila, Mexico. Michael Powell made the first U.S. collections of Q. carmenensis in 1982, on the slopes of Casa Grande Peak within the Chisos Mountains of Big Bend National Park. In 1991, Powell documented the species at a second location in the park, Laguna Meadows, and specimens were also verified by Billy Turner. However, since their discovery, attempts to find the species at either site have been inconclusive (S. Still pers. comm., 2018). Although, on a recent collecting trip seeking Q. carmenensis in its documented Texas location, experts could not confidently identify the species; this calls into question the species’ occurrence in the U.S. If Del Carmen oak is not present in the U.S., original documentation could have misidentified the species, or hybridization with Q. intricata and/or Q. grisea have diluted Q. carmenensis individuals past clear identification. Oak hybridization is rampant in the region and correctly identifying species is quite difficult (A. Black pers. comm., 2018). Photos of what could be Q. carmenensis have been provided. Ideal environmental factors for Q. carmenensis include shallow soils and shrublands or woodlands of high intermountain valleys, 2,000 to 2,500 meters above sea level, especially slopes with north or northwest facing exposures. The species is typically a shrub, one-half to two meters tall, but on better sites can grow to be a small tree, reaching 12 meters high, with a maximum height of about 15 meters, and trunk diameter of 0.75 meters wide (S. Still pers. comm., 2018).

Figure 1. County-level distribution map for the U.S. distribution of Quercus carmenensis. Source: Biota of North America Program (BONAP).²

Figure 2. Documented in situ occurrence points for the U.S. distribution of Quercus carmenensis. Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).³
VULNERABILITY OF WILD POPULATIONS

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

<table>
<thead>
<tr>
<th>Demographic indicators</th>
<th>Level of vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Emergency</td>
</tr>
<tr>
<td>Population size</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>Range/endemism</td>
<td>Extremely small range or 1 location</td>
</tr>
<tr>
<td>Population decline</td>
<td>Extreme</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>Severe fragmentation</td>
</tr>
<tr>
<td>Regeneration/recruitment</td>
<td>No regeneration or recruitment</td>
</tr>
<tr>
<td>Genetic variation/integrity</td>
<td>Extremely low</td>
</tr>
</tbody>
</table>

Average vulnerability score 12.0

Rank relative to all U.S. oak species of concern (out of 19) 6

THREATS TO WILD POPULATIONS

High Impact Threats

Genetic material loss — inbreeding and/or introgression: If the species is present in the U.S., regular hybridization with Q. intricata and/or Q. grisea is highly likely, threatening the genetic integrity of Q. carmenensis (A. Black pers. comm., 2018).

Extremely small and/or restricted population: If present in the U.S., Del Carmen oak has a very restricted range and only a few individuals have been documented over the past 30 years during multiple surveys. Recent visits to the putative sites in the Chisos Mountains have been inconclusive (S. Still pers. comm., 2018).

Moderate Impact Threats

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: Quercus carmenensis does occur in the Maderas Del Carmen Flora and Fauna Protection Area in Mexico, however a combination of communal land use for agriculture and grazing, as well as private land holdings, still exist in much of the Sierra del Carmen region. These land uses may pose future threats to the species. Extensive grazing activity has also altered the hydrology of streams and groundwater in the region, which could impact the vitality of Q. carmenensis.

Low Impact Threats

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 this threat has not yet been recorded for Q. carmenensis.

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

<table>
<thead>
<tr>
<th>Data point</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ex situ collections</td>
<td>1</td>
</tr>
<tr>
<td>Number of plants in ex situ</td>
<td>2</td>
</tr>
<tr>
<td>Average number of plants per</td>
<td></td>
</tr>
<tr>
<td>institution</td>
<td>2</td>
</tr>
<tr>
<td>Percent of ex situ plants of</td>
<td>100%</td>
</tr>
<tr>
<td>wild origin</td>
<td></td>
</tr>
<tr>
<td>Percent of wild origin plants</td>
<td>100%</td>
</tr>
<tr>
<td>with known locality</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic coverage</td>
<td>0%</td>
</tr>
<tr>
<td>Ecological coverage</td>
<td>0%</td>
</tr>
</tbody>
</table>

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

Figure 4. Quercus carmenensis in situ occurrence points and ex situ collection source localities within the United States. U.S. EPA Level IV Ecoregions are colored and labelled. 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.
Land protection: Within the inferred native range of *Quercus carmenensis* in the U.S., 62% 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.

If present in the U.S., populations of *Q. carmenensis* are completely within Big Bend National Park, and well protected from human impact. The Critical Ecosystem Partnership Fund also defines Madrean Pine-Oak Woodlands of Mexico as a biodiversity hotspot, which could incentivise further protection.\(^7\)

Sustainable management of land: The Ecoregional Conservation Assessment of the Chihuahuan Desert ranks Big Bend Triangle with the highest Irreplaceability Index and 9th highest overall conservation priority out of 39 areas of conservation concern in Texas.\(^4\) Big Bend Triangle is currently the only potential location of Del Carmen oak in the U.S. The 2012 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; there is no specific mention of *Q. carmenensis* outside the “Species of Greatest Conservation Need” list.\(^5\)

Population monitoring and/or occurrence surveys: A vegetation survey was conducted in the Sierra del Carmen in 1997 and within Big Bend National Park in 1998. *Quercus carmenensis* was on the plant checklist used for the surveys.\(^9\) There have been three visits to the Chisos Mountains since 2016 to find and collect *Q. carmenensis* germplasm. Two teams were able to find some plants that could be *Q. carmenensis*, but identification of the individuals is uncertain and there is question as to the validity of the species’ presence in the Chisos Mountains at locations visited (S. Still pers. comm., 2018).\(^10\)

Wild collecting and/or ex situ curation: Members of the International Oak Society completed a fruitful *Q. carmenensis* collecting trip in 2010 within the Sierra del Carmen of Coahuila, Mexico.\(^11\) In 2017, an expedition worked to collect the species in southwestern Texas, to no avail. The next year, with support from the APGA-USFS Tree Gene Conservation Program, a second collecting trip was executed, and still no individuals were confidently identified. No acorns were present on individuals that bared the most similarity to *Q. carmenensis*, but germplasm was collected for ex situ growth and study (S. Still pers. comm., 2018).\(^10\)

Propagation and/or breeding programs: No known initiatives at the time of publication.

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

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

**Figure 6.** Management type of protected areas within the inferred native range of *Quercus carmenensis*. Protected areas data from the U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).\(^3\)
Research: The Ecoregional Conservation Assessment of the Chihuahuan Desert also outlines areas needing conservation research within *Q. carmenensis*’ range. They emphasize the role of site-specific conservation planning and “implementation of creative strategies to abate such threats as altered hydrology of streams and groundwater, poor grazing practices, and invasive animals and plants,” which require working at multiple scales and sustaining partnerships with stakeholders such as multi-generation ranching landowners.4

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

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 carmenensis* is listed as a SGCN.12

**PRIORITY CONSERVATION ACTIONS**

Del Carmen oak appears to be in a good position for ample conservation due to its protection within Big Bend National Park. However, there are only two putative populations documented, and difficulties in identification of the Chisos Mountain populations create uncertainty as to whether the species is extant in the U.S. Despite a few trips to the region since 2016 to search for *Q. carmenensis*, the species has still not been verified in the Chisos Mountains. The species may still be present in the region, but it is possible there are fewer individuals or that they have hybridized with other taxa in the area, becoming more difficult to identify. Molecular research should be conducted to compare the samples taken in the U.S. in August 2018 with verified samples of *Q. carmenensis* from Mexico. It would be useful to revisit populations in the Sierra del Carmen mountains of Mexico to compare with live individuals found putatively in the U.S. Further wild collecting efforts in Mexico should also be carried out to secure more germplasm in ex situ collections. Propagation followed by reinforcement and/or translocation could be considered if populations are not currently sustainable.

**Conservation recommendations for Quercus carmenensis**

**Highest Priority**
- Population monitoring and/or occurrence surveys
- Research (taxonomy/phylogenetics)
- Wild collecting and/or ex situ curation

**Recommended**
- Propagation and/or breeding programs
- Reintroduction, reinforcement, and/or translocation
REFERENCES


