

Conservation Gap Analysis of Native Mesoamerican Oaks

Luz María González-Villarreal



Species profile: *Quercus cualensis*

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CRITICALLY ENDANGERED

Quercus graciliformis
Quercus mulleri

ENDANGERED

Quercus brandegeei
Quercus carmenensis
Quercus cualensis
Quercus cupreata
Quercus delgadoana
Quercus devia
Quercus diversifolia
Quercus dumosa
Quercus engelmannii
Quercus flocculenta

Quercus galeanensis
Quercus hintonii
Quercus hirtifolia
Quercus insignis
Quercus macdougallii
Quercus miquihuanensis
Quercus nixoniana
Quercus radiata
Quercus runcinatifolia
Quercus tomentella

VULNERABLE

Quercus acutifolia
Quercus ajoensis
Quercus cedrosensis
Quercus costaricensis
Quercus gulielmi-treleasei
Quercus hintoniorum
Quercus meavei
Quercus rubramenta
Quercus tuitensis
Quercus vicentensis



THE
CHAMPION
of TREES



Quercus cualensis L.M.González

IUCN Red List Category and Criteria: Endangered B1ab(iii)

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DISTRIBUTION AND BIOLOGY

Quercus cualensis is a local endemic to Jalisco, Mexico first described by Luz María González-Villarreal in 2003 (Figure 1). It grows at an elevation of 1,800–2,300 m above sea level on the peaks of Sierra de Cuale, Municipio Talpa de Allende. It is locally abundant along a 15 km stretch of road between the village of Cuale and the Minas Zimapán. Found among the highest peaks within this mountain range, *Q. cualensis* grows on steep, rocky slopes in acidic soils. It is possible that *Q. cualensis* also inhabits other peaks of the Sierra de Cuale, and this should be a focal region for future botanical surveys. Towards the upper elevation limit of its distribution, *Q. cualensis* is associated with species such as *Pinus ayacahuite*, *Juniperus jaliscana*, and *Agarista villarrealana*. At lower elevations *Q. cualensis* inhabits protected sites within the pine-oak forest where it is found with species such as *Pinus oocarpa*, *Q. elliptica*, *Q. mexiae*, *Bejaria mexicana*, *Arbutus xalapensis* and *Clethra rosei*. A majority of known occurrences of *Q. cualensis* occur within the warm temperate moist forest life zone (Figure 2). (González-Villarreal, 2003)

Quercus cualensis is a small evergreen tree typically 8–10 m high with a short, 20–30 cm diameter trunk. In more exposed locations it is often shrubby and 2–3 m high. The tree has been described as “tortuous” in appearance, with oftentimes crooked and twisted branches. It has a light green crown that easily distinguishes it from other trees within the forest. The leaves are entire, narrowly elliptic or elliptic-lanceolate, and glabrous on both surfaces. The fruit matures biennially. Acorns are elongate-ovoid, 17–22 mm high and 10–15 mm thick. (González-Villarreal, 2003)



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Figure 1. Wild (i.e., *in situ*) occurrence points for *Quercus cualensis*.

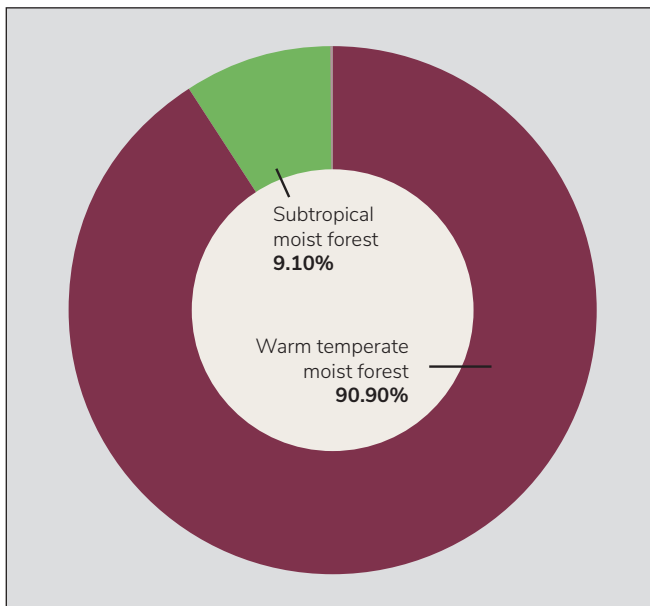


Figure 2. The percentage of wild occurrence points in each Holdridge life zone in which *Quercus cualensis* is distributed.

THREATS TO WILD POPULATIONS

Human use of species — wild harvesting: Unknown.

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: Livestock grazing and illegal pine logging occur within the Sierra de Cuale and Talpa de Allende municipality.

Human use of landscape — residential/commercial development, mining, and/or roads: Copper, zinc, gold, and silver have been mined from the Sierra Madre del Sur for 20 years (1963–1983; González-Villarreal, 2003). A mine has just reopened this past year, and roads have been constructed that pass through the species' distribution. In addition, *Quercus cualensis* grows near the popular tourism destination of Puerto Vallarta, which is experiencing population growth: between 2010 and 2022, the population increased by 14.1% (Gobierno de México, n.d.).

Human use of landscape — tourism and/or recreation: The Sierra de Cuale is experiencing increased urbanization, primarily due to tourism.

Human modification of natural systems: altered fire regime, pollution, eradication: The Vallarta Botanical Garden surveyed the Sierra Cuale region in 2022 where they witnessed significant degradation of the habitat due to arson. During the dry season of 2023, this region experienced one of the worst fire seasons in recent history. Fires occurred primarily in the mountain ranges of western Jalisco, destroying large areas where this species is distributed.

Human modification of natural systems — invasive species competition/disturbance: Unknown.

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: An increase in extreme weather events associated with climate change poses a major threat to *Q. cualensis*. Hurricane Lidia, a powerful category 4 hurricane, made landfall along the pacific coast of Mexico in October 2023 and directly impacted the habitat of *Q. cualensis*, felling many large trees (Cristóbal Sánchez, personal communication, 2023). Within the inferred native range of *Q. cualensis*, the warm temperate moist forest is expected to decrease in area by an average of 71% by the years 2061–2080 relative to current conditions (Good et al., 2024).

Genetic material loss — inbreeding and/or introgression: Unknown.

Pests and/or pathogens: Unknown.

Extremely small and/or restricted population: The known distribution of *Q. cualensis* is highly restricted.



CONSERVATION ACTIVITIES

Once per year between 2017 and 2022, *Quercus* accessions data were requested from ex situ collections globally. A total of 197 institutions from 27 countries submitted data for Mesoamerican oak species, including *Q. cualensis* (Table 1, Figure 3). Past, present, and planned conservation activities for Mesoamerican oak species of concern were also examined through literature review and expert consultation.

A spatial analysis was conducted to estimate the geographic and ecological coverage of ex situ collections using methods adapted from Khoury et al. (2020; Figure 4). Twenty-kilometer buffers were placed around each wild occurrence point as well as the source locality of each plant living in ex situ collections. Collectively, the buffer area around the wild occurrence points represents the inferred native range of the species. The buffer area around ex situ points serves as the native range represented in ex situ collections. Geographic coverage of ex situ collections was estimated by dividing the ex situ buffer area by the area of the inferred native range. Ecological coverage of ex situ collections was estimated by dividing the number of Holdridge life zones present under the ex situ buffer by the number of Holdridge life zones under the inferred native range. The species representativeness ex situ was calculated by counting the number of ex situ institutions that currently have one or more living individuals of wild provenance in their collections, up to a maximum of ten. In order to maintain a consistent scale across all scores, this number was multiplied by ten. All three scores range from 0–100. A final ex situ conservation score was calculated by taking an average of the three scores above. Final scores range from 0–100, with scores near 100 indicating comprehensive ex situ conservation, and scores near 0 indicating poor ex situ conservation (Table 2). As a reference, the threatened Mesoamerican oaks with the highest ex situ conservation scores are *Q. engelmannii* with a score of 76/100, and *Q. brandegeei* with a score of 74/100. There are 10 threatened oaks with final ex situ scores of 10 or less.

Table 1. Results of 2017–2022 ex situ surveys.

Number of ex situ collections reporting this species	1
Number of plants in ex situ collections	4
Average number of plants per institution	4
Percent of ex situ plants of wild origin	100%
Percent of wild origin plants with known locality	100%



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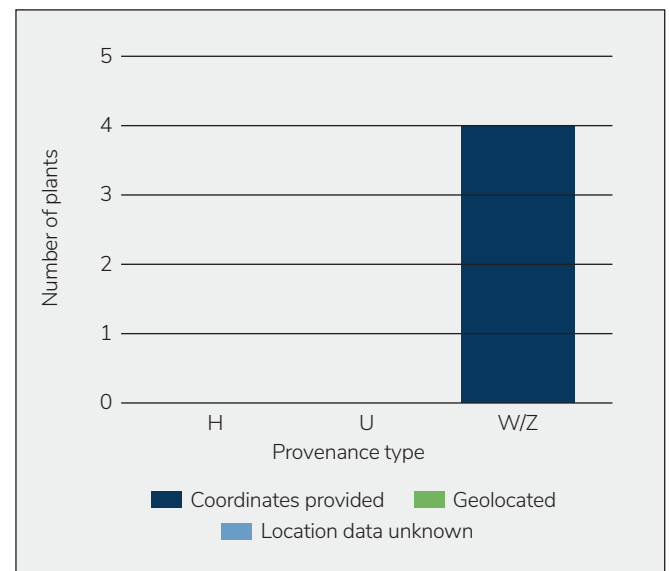


Figure 3. Number and origin of *Quercus cualensis* plants in ex situ collections. Provenance types: H = horticultural; U = unknown; W = wild; Z = propagated from wild.

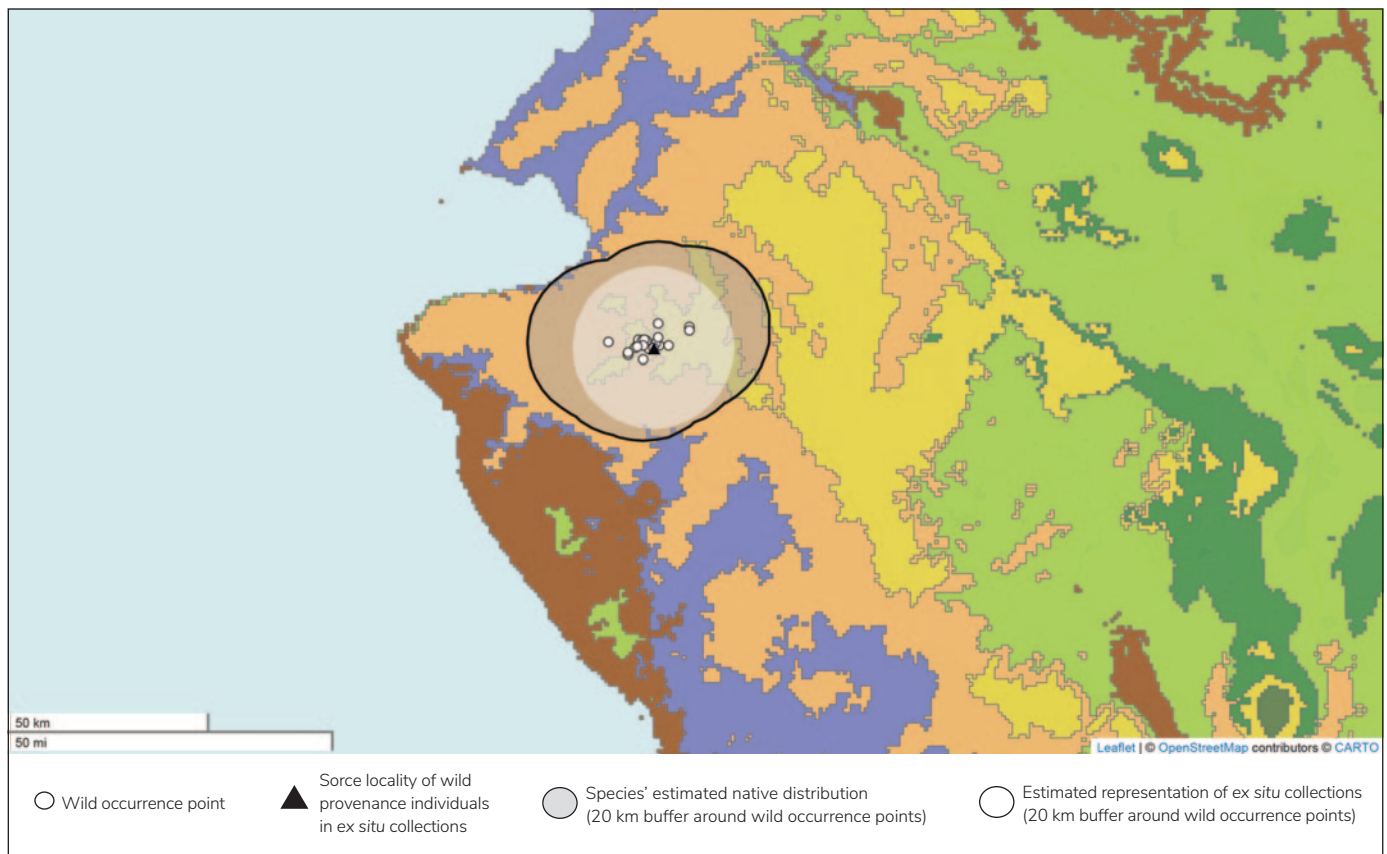


Figure 4. *Quercus cualensis* wild occurrence points and ex situ collection source localities. Colored regions are Holdridge life zones. All ex situ collection source localities are also wild occurrence points.

Table 2. Ex situ conservation scores for *Quercus cualensis* with all scores ranging from 0–100. A final score of 100 indicates comprehensive ex situ conservation, and a score of 0 represents poor ex situ conservation.

Geographic coverage ex situ	57
Ecological coverage ex situ	50
Representation in ex situ collections	10
Final ex situ conservation score	39

Using methods adapted from Khoury et al. (2020), we estimated the degree of representation of *Q. cualensis* in protected areas in order to identify in situ conservation gaps. Wild occurrence points were mapped and overlaid with protected areas from the World Database on Protected Areas (Figure 5; UNEP-WCMC and IUCN, 2023). A twenty-kilometer buffer was placed around each occurrence point to represent the species inferred native range. Geographic coverage *in situ* was estimated by calculating the proportion

of a species inferred native range that is covered by protected areas. Ecological coverage *in situ* was estimated by identifying the Holdridge life zones in the inferred native range as well as the Holdridge life zones in protected areas within the inferred native range and calculating the percentage of life zones that are conserved in protected areas. Species representativeness *in situ* was estimated by calculating the percentage of known occurrence points within the species inferred native range that fall inside protected areas. All three scores range from 0–100. A final conservation score *in situ* was calculated by taking an average of the three scores above. Final scores range from 0–100, with scores near 100 indicating comprehensive *in situ* conservation, and scores near 0 indicating poor *in situ* conservation (Table 3). As a reference, the threatened Mesoamerican oaks with the highest in situ conservation scores are *Q. carmenensis* with a score of 99/100, and *Q. costaricensis* with a score of 94/100. There are two threatened oaks with final in situ scores of 10 or less.

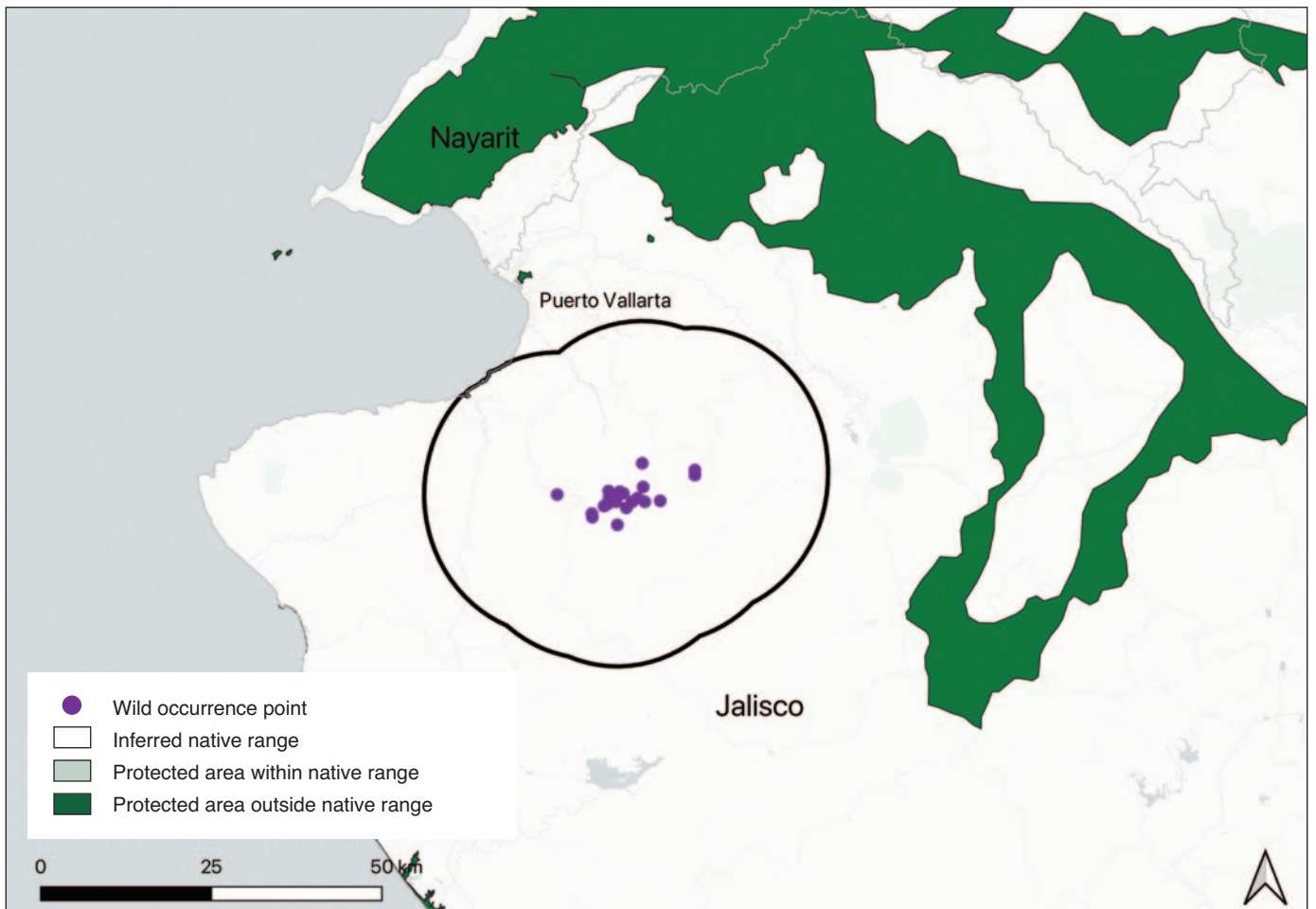


Figure 5. Wild occurrence points and inferred native range of *Quercus cualensis* in relation to protected areas. Protected areas are from Protected Planet (UNEP-WCMC and IUCN, 2023).

Table 3. *In situ* conservation scores for *Quercus cualensis* with all scores ranging from 0–100. A final score of 100 indicates comprehensive *in situ* conservation, and a score of 0 represents poor *in situ* conservation.

Geographic coverage <i>in situ</i>	0
Ecological coverage <i>in situ</i>	0
Species representation in <i>in situ</i> collections	0
Final <i>in situ</i> conservation score	0

Land protection: There are no protected areas within the native range of *Q. cualensis* (Figure 5). In January 2024 a new biosphere reserve was established, the Sierra de Vallejo-Río Ameca, located in the municipalities of Bahía de Banderas and Compostela (state of Nayarit) and in the municipalities of Mascota, Mixtlán, San Sebastián del Oeste and Puerto Vallarta (state of Jalisco). Although this new

protected area is not within the known habitat of *Q. cualensis*, it is an important addition to the region and it is possible that this species could occur here.

Sustainable management of land: Unknown.

Population monitoring and/or occurrence surveys: This is not a conservation activity at the time of publication.

Wild collecting and/or ex situ curation: Seeds were collected from several mother trees as part of a germination trial (Arenas-Navarro, unpublished). Following the conclusion of the experiment in 2018, seedlings were donated to gardens in Mexico. We know of one garden, Ecojardín-UNAM en el Instituto de Investigaciones en Ecosistemas y Sustentabilidad (IIES), that reports living individuals of *Q. cualensis* as a result of the 2018 donation.

Propagation and/or breeding programs: *Quercus cualensis* has been propagated as part of a recent experiment comparing germination rates of oaks growing from humid versus dry environments (Arenas-Navarro, unpublished). The results showed that *Q. cualensis* has a high germination rate.

Reintroduction, reinforcement, and/or translocation: In 2018 the Vallarta Botanical Garden received nine specimens of *Q. cualensis* from researcher Maribel Arenas Navarro and professor Ken Oyama Nakagawa from the National School of Higher Studies Unidad Morelia (ENES-Morelia) of the National Autonomous University of Mexico (UNAM). The trees were planted for restoration purposes in an area near the botanical garden. Unfortunately, factors such as the lack of irrigation during the COVID pandemic (2020–2021) and the recent damage caused by the category 4 Hurricane Lidia (October 2023), directly impacted the seedlings and no surviving plants have been found.

Research: There are two recent studies that investigated leaf and stem functional traits (Arenas-Navarro et al., 2020) as well as wood anatomical traits (Arenas-Navarro et al., 2021) of oak species along an environmental gradient in Jalisco, Mexico, and *Q. cualensis* was among the study species. Funding through the International Oak Society (IOS) for a project titled “Protection and Conservation Actions through the Extinction Risk Assessment Method for Five Endemic Mexican Oak Species” was awarded in 2023. *Quercus cualensis* is among the five target species. The project will include research on the effect of climate change on species distribution and germination rates.

Education, outreach, and/or training: A team led by Dra Maribel Arenas Navarro has discussed current conservation activities related to *Q. cualensis* in schools and the community in Cuale. Stickers, educational materials, and games were shared with students.

Species protection policies: There are currently no species protection policies for *Q. cualensis*.

PRIORITY CONSERVATION ACTIONS

In order to conserve *Q. cualensis*, the conservation activities that should be given the highest priority are:

Wild collecting and/or ex situ curation

According to the results of our ex situ surveys, *Q. cualensis* is currently held in one ex situ collection. This species is restricted to a very small region near the coast in Jalisco that has already seen its habitat directly impacted by hurricanes. Establishing *Q. cualensis* in collections throughout Mexico should be a priority.

Land protection

There are no protected areas within the native range of *Q. cualensis*, and this species is threatened by land use change due to mining, grazing, and rural and urban development. Establishing *Q. cualensis* within protected areas is crucial to conserve this species.



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