Conservation Gap Analysis of Native

Mesoamerican Oaks

Species profile: ***Quercus mulleri***

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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

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Global Conservation Consortium Oak
CSS TREES Center for Species Survival
Franklinia Foundation

Quercus mulleri Martínez

IUCN Red List Status: Endangered B1ab(iii,v)+2ab(iii,v); C2a(ii)

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DISTRIBUTION AND BIOLOGY

Quercus mulleri is only known from two locations: the Sierra Sur region of Oaxaca, Mexico and the Sierra Madre de Chiapas (Figure 1). Originally thought to be a microendemic species of Oaxaca, a population with morphological characteristics that are related to *Q. mulleri* was recently discovered in Chiapas. The distribution of *Q. mulleri* is restricted and fragmented. The population in Oaxaca is very small, and confined to just a few acres of land (Wenzell and Kenny, 2015). The Chiapas population is in the biosphere reserve El Triunfo. However, the identity of the population of Chiapas needs to be confirmed, because only digital images of these populations are known. Originally described in 1953, this species was thought to be extinct after it had not been documented for sixty years (González-Espinosa et al., 2011). It was then "re-discovered" near the town of San Pedro Sosoltepec in Oaxaca in 2011 when it was used as the subject of a population genetic study (Pingarroni, 2011). It occurs at an elevation of 1,000–1,850 m asl (Wenzell and Kenny, 2015), and all known occurrence points are within three Holdridge life zones: subtropical moist forest, warm temperate moist forest, and subtropical wet forest (Figure 2).

Quercus mulleri is a small to medium tree, reaching a height of 12–15 and sometimes up to 20 m. Leaves are narrowly lanceolate and long acuminate, light green to dull grayish-green in color. Acorns are ovoid, 14 mm long by 9 mm wide. (Martínez, 2023)

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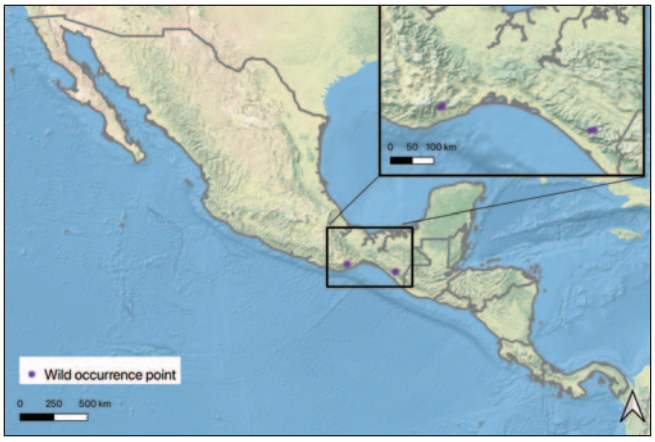

Figure 1. Wild (i.e., *in situ*) occurrence points for *Quercus mulleri*.

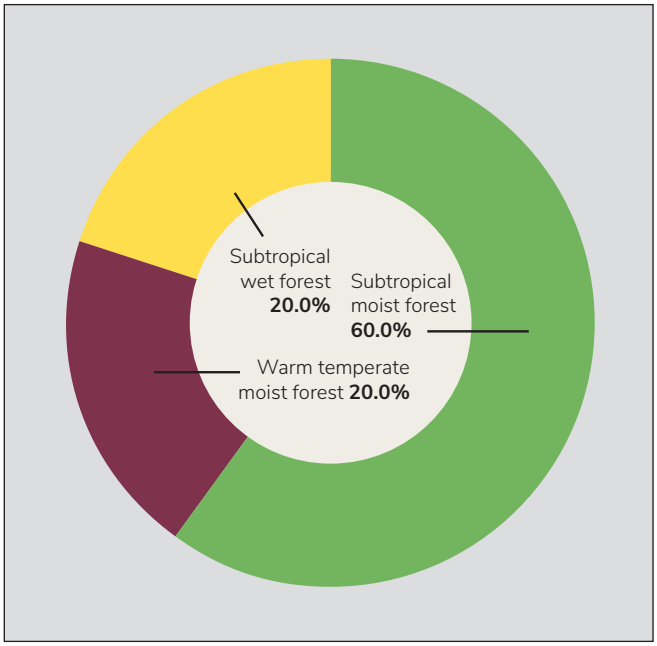

Figure 2. The percentage of wild occurrence points in each Holdridge life zone in which *Quercus mulleri* is distributed.

THREATS TO WILD POPULATIONS

Human use of species — wild harvesting: *Quercus mulleri* is harvested for firewood. It is often extracted from the forests because it is considered of little value.

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: There is agriculture, silviculture, and grazing in the region where this species grows, resulting in a significant loss of forest cover.

Human use of landscape — residential/commercial development, mining, and/or roads: Unknown.

Human use of landscape — tourism and/or recreation: Unknown.

Human modification of natural systems — altered fire regime, pollution, eradication: Unknown.

Human modification of natural systems — invasive species competition/disturbance: In the distribution area of *Q. mulleri*, reforestation with different *Pinus* species is favored.

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: The low number of individuals of *Q. mulleri*, the alteration of the distribution area (due to agricultural, forestry, and livestock activities), as well as the increase in temperature and decrease in humidity due to climate change can deteriorate the health of remaining trees of this species and lead to their death.

Genetic material loss — inbreeding and/or introgression: There is relatively low genetic diversity of *Q. mulleri* compared to species with a wider distribution. There is evidence for high genetic flow between populations and individuals in this species.

Pests and/or pathogens: Unknown.

Extremely small and/or restricted population: The species has a microendemic distribution and small size of only three populations in the state of Oaxaca. Residents in San Pedro Sosoltepec have observed low production of acorns in reproductive years and years with no production.

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. mulleri* (Table 1). 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 3). 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	0
Number of plants in ex *situ* collections	NA
Average number of plants per institution	NA
Percent of ex *situ* plants of wild origin	NA
Percent of wild origin plants with known locality	NA


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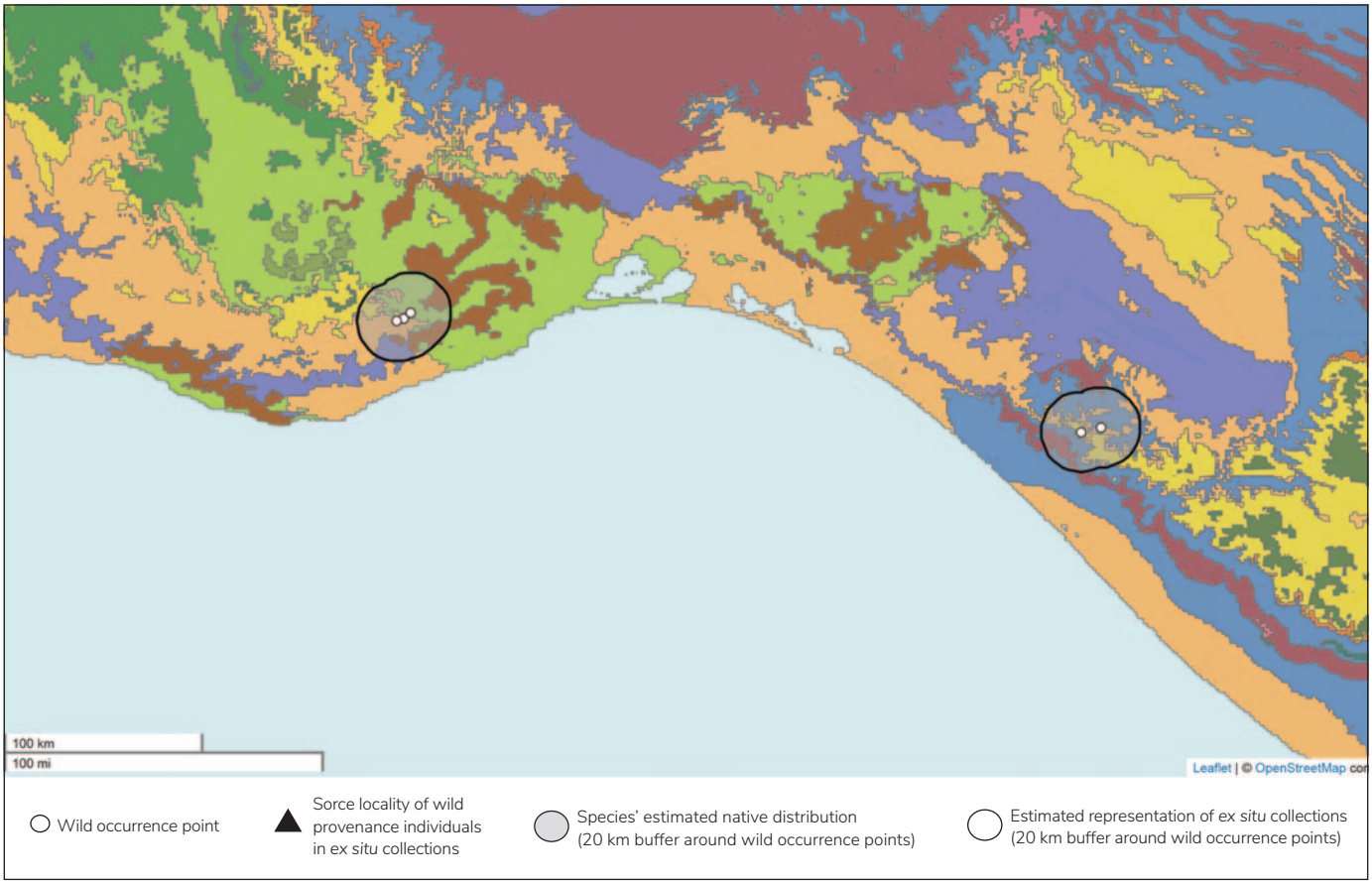

Figure 3. *Quercus mulleri* wild occurrence points and ex *situ* collection source localities. Colored regions are Holdridge life zones.

Table 2. *Ex situ* conservation scores for *Quercus mulleri* 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*	0
Ecological coverage ex *situ*	0
Representation in ex *situ* collections	0
Final ex *situ* conservation score	0

Using methods adapted from Khoury et al. (2020), we estimated the degree of representation of Q. *mulleri* 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 4; 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.

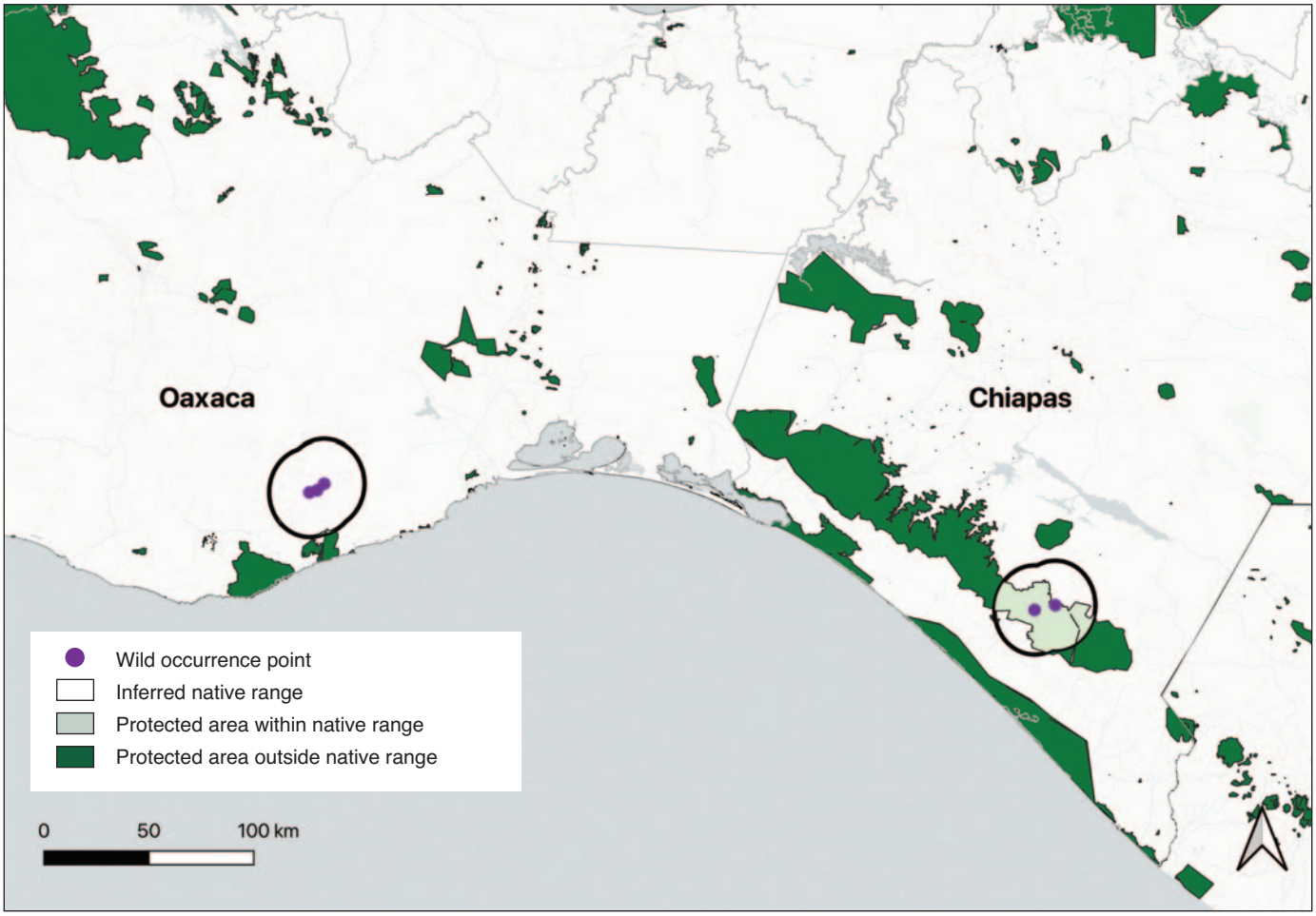

Figure 4. Wild occurrence points and inferred native range of *Quercus mulleri* in relation to protected areas. Protected areas are from Protected Planet (UNEP-WCMC and IUCN, 2023).

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Table 3. *In situ* conservation scores for *Quercus mulleri* 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 *in situ*	27
Ecological coverage *in situ*	63
Species representation in *in situ* collections	40
Final *in situ* conservation score	43

Land protection: Within the inferred native range of *Q. mulleri*, 27% is within protected areas (Figure 4). The Oaxaca population is not protected, and although the Chiapas population is in El Triunfo, a Biosphere Reserve, more work is needed to confirm its identity.

Sustainable management of land: All biosphere reserves in Mexico, such as El Triunfo, are required to have a management plan, which regulates activities in the area and ensures that objectives of the reserve are achieved.

Population monitoring and/or occurrence surveys: Unknown.

Wild collecting and/or *ex situ* curation: This is not a known conservation activity at the time of publication. According to the results of our *ex situ* surveys, there are no *ex situ* collections of this species.

Propagation and/or breeding programs: Unknown.

Reintroduction, reinforcement, and/or translocation: Unknown.

Research: Two genetic studies have been done on populations of *Q. mulleri*, where the species was found to have low to intermediate levels of genetic diversity (Pingarroni et al., 2020; Martínez, 2023). The study by Martínez (2023) also investigated land use change in the towns of San Pedro Sosoltepec and San Pablo Topiltepec from the Sierra Sur region of Oaxaca, Mexico where the species is found. Their results showed a 11.92% decrease in forest cover between 1979 and 2022.

Education, outreach, and/or training: This is not a known conservation activity.

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

PRIORITY CONSERVATION ACTIONS

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

Land protection

Quercus mulleri is a species with few populations and individuals. The highest priority conservation activity should be land protection before any other action, to avoid further loss.

Education, outreach, and/or training

Information should be shared with the local community so they can contribute to the protection of this species. Oaks are often unwanted forest elements because they are considered to have low economic value compared to pines, and they tend to be eliminated to favor pines.

Research

Information on biology (e.g., reproduction and masting time) and ecology are unknown, and are the basis for possible restoration.

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