

# Conservation Gap Analysis of Native Mesoamerican Oaks



Maricela Rodríguez Acosta

## Species profile: *Quercus hirtifolia*

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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*

# *Quercus hirtifolia* M.L.Vázquez, S.Valencia & Nixon

Common Names, Spanish: Encino negro

IUCN Red List Category and Criteria: Endangered: B1ab(iii)+2ab(iii)

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## DISTRIBUTION AND BIOLOGY

*Quercus hirtifolia* is found in the southern part of the Sierra Madre Oriental, Mexico, in the states of Puebla, Veracruz, and Hidalgo, where it forms small, allopatric populations (González-Espinosa et al., 2011; Figure 1). There is also a 1983 collection of this species in Veracruz five km northeast of Teocelo that is not shown in Figure 1 and should be verified. *Quercus hirtifolia* inhabits oak-pine forest and cloud forests, and is associated with species such as *Fagus grandifolia* subsp. *mexicana*, *Q. corrugata*, *Q. delgadoana* and *Q. meavei* (Valencia-A, 2017). It occurs on steep slopes at an elevation of 2,000–2,400 m (Vázquez et al., 2004). A majority of known occurrences are within two Holdridge life zones: warm temperate moist forest and warm temperate dry forest (Figure 2).

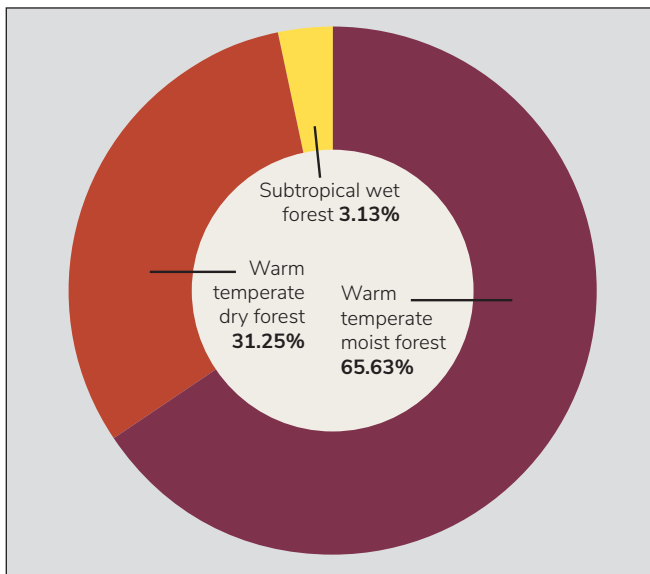


**Figure 1.** Wild (i.e., *in situ*) occurrence points for *Quercus hirtifolia*.



It is a shrub or a small tree, growing 3–15 m tall (Vázquez et al., 2004). The fruit of *Q. hirtifolia* matures annually, with a peduncle up to 2.5 cm long (Vázquez et al., 2004). These features distinguish *Q. hirtifolia* from other red oaks in the region, which typically have fruit that matures biennially with a much shorter peduncle.





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

## THREATS TO WILD POPULATIONS

**Human use of species — wild harvesting:** Wood is collected locally on a small scale for fuel. Local people in humid and cold areas prefer oaks for firewood as it is considered of high quality. In Hidalgo the cutting of large trees such as *Q. delgadoana* or *Q. meavei* is very common, as the large trunks are used in house construction and the smaller branches are sold as firewood. This causes a change in the microhabitat where *Q. hirtifolia* grows.

**Human use of landscape — agriculture, silviculture, ranching, and/or grazing:** The surrounding landscape is used mainly for silviculture, where pines are typically planted in preference to oaks. *Quercus hirtifolia* often grows on very steep slopes not suitable for agriculture or forestry. However, agriculture does threaten this species' habitat as water is diverted from streams to cultivate potatoes.

**Human use of landscape — residential/commercial development, mining, and/or roads:** Sand mines are frequently observed along the roads in this part of the Sierra Norte in Puebla. Recently there are projects to develop clay mines in areas of well-preserved private forest.

**Human use of landscape — tourism and/or recreation:** Trout fishing is a popular recreational activity within the native range of *Q. hirtifolia*, and there are several trout farms along the rivers. There has also been recent construction of cabins for ecotourism recreational parks.

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

**Human modification of natural systems — invasive species competition/disturbance:** Some areas suitable for *Q. hirtifolia* have been modified by planting pines. *Pinus patula*, and more recently *P. greggii*, have been planted extensively in habitats suitable for *Q. hirtifolia*.

**Climate change — habitat shifting, drought, temperature extremes, and/or flooding:** *Quercus hirtifolia* grows very well along rivers and areas of high humidity, and is especially affected by drought. Within the inferred native range of *Q. hirtifolia*, the warm temperate moist forest is expected to decrease in area by an average of 85% by the years 2061–2080 relative to current conditions (Good et al., 2024).

**Genetic material loss — inbreeding and/or introgression:** Three populations have been clearly defined by genetic studies (González Rodríguez et al., 2022). In some areas, particularly near Honey in Puebla, there is extensive hybridization with *Q. acherdophylla*.

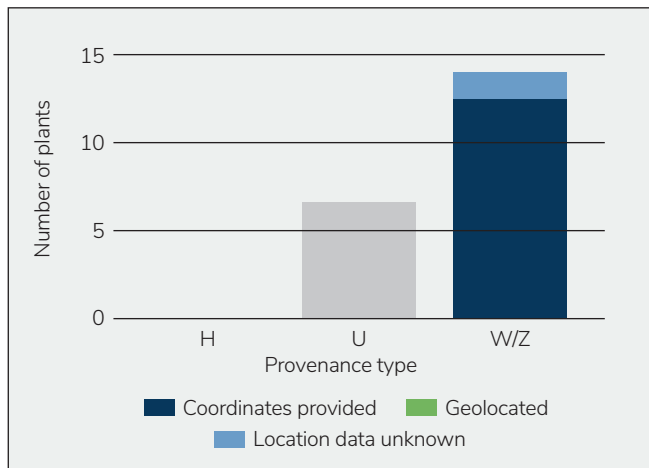
**Pests and/or pathogens:** Unknown. It is possible that one of the populations of *Q. hirtifolia* growing with *Q. acherdophylla* in Honey, Puebla shows signs of a disease caused by a fungus, however this needs to be investigated further.

**Extremely small and/or restricted population:** Populations are very well distributed in their range, and a major threat is forest fragmentation. There are two cases where the population seems to be very small: one in Teziutlan and the other in Hueytamalco. Genetic studies are necessary to determine the diversity of these populations.

## 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. hirtifolia* (Table 1, Figure 3). Past, present, and planned conservation activities for Mesoamerican oak species of concern were also examined through a 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



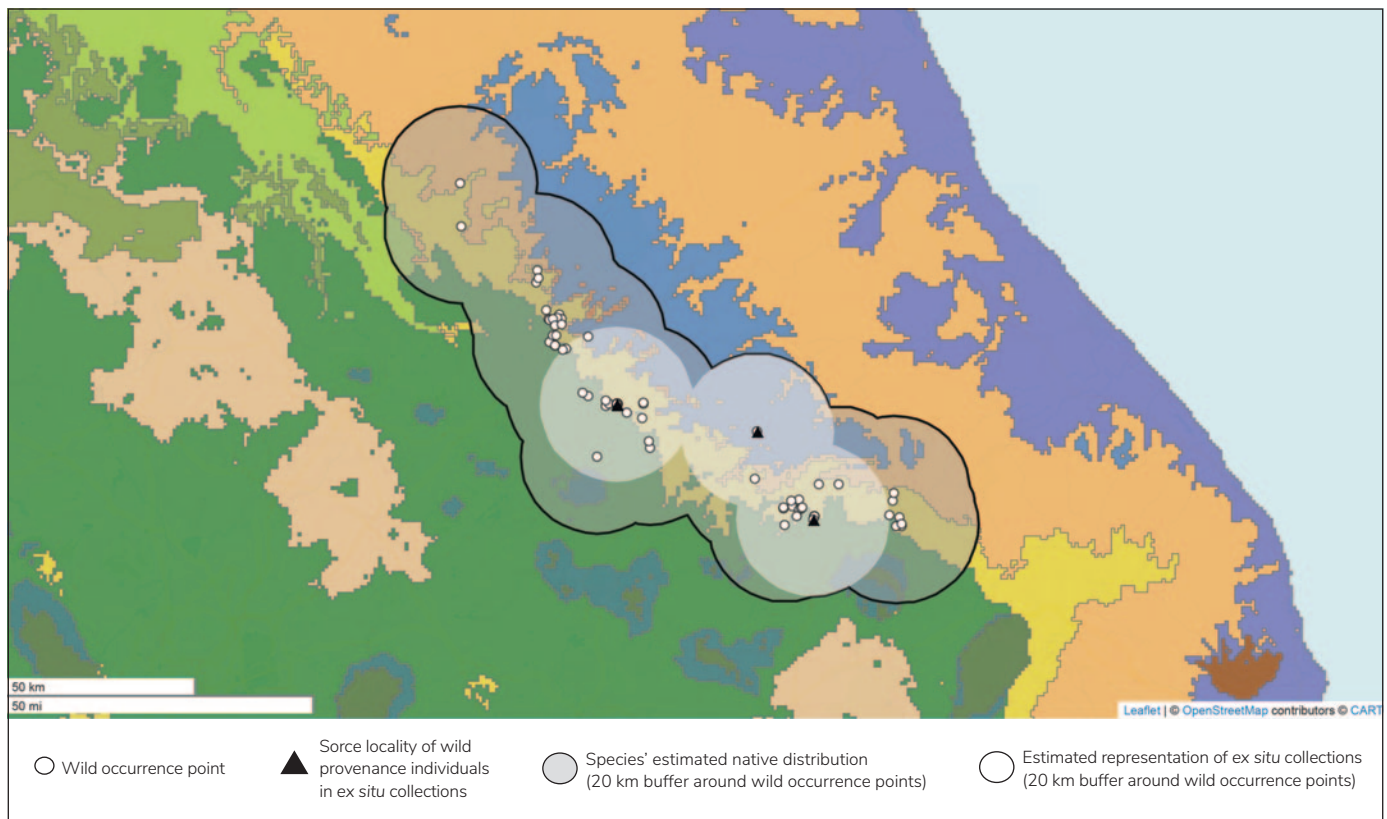
**Figure 3.** Number and origin of *Quercus hirtifolia* plants in ex situ collections. Provenance types: H = horticultural; U = unknown; W = wild; Z = propagated from wild.

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

Number of ex situ collections reporting this species	10
Number of plants in ex situ collections	21
Average number of plants per institution	2
Percent of ex situ plants of wild origin	67%
Percent of wild origin plants with known locality	86%

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.





**Figure 4.** *Quercus hirtifolia* 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.

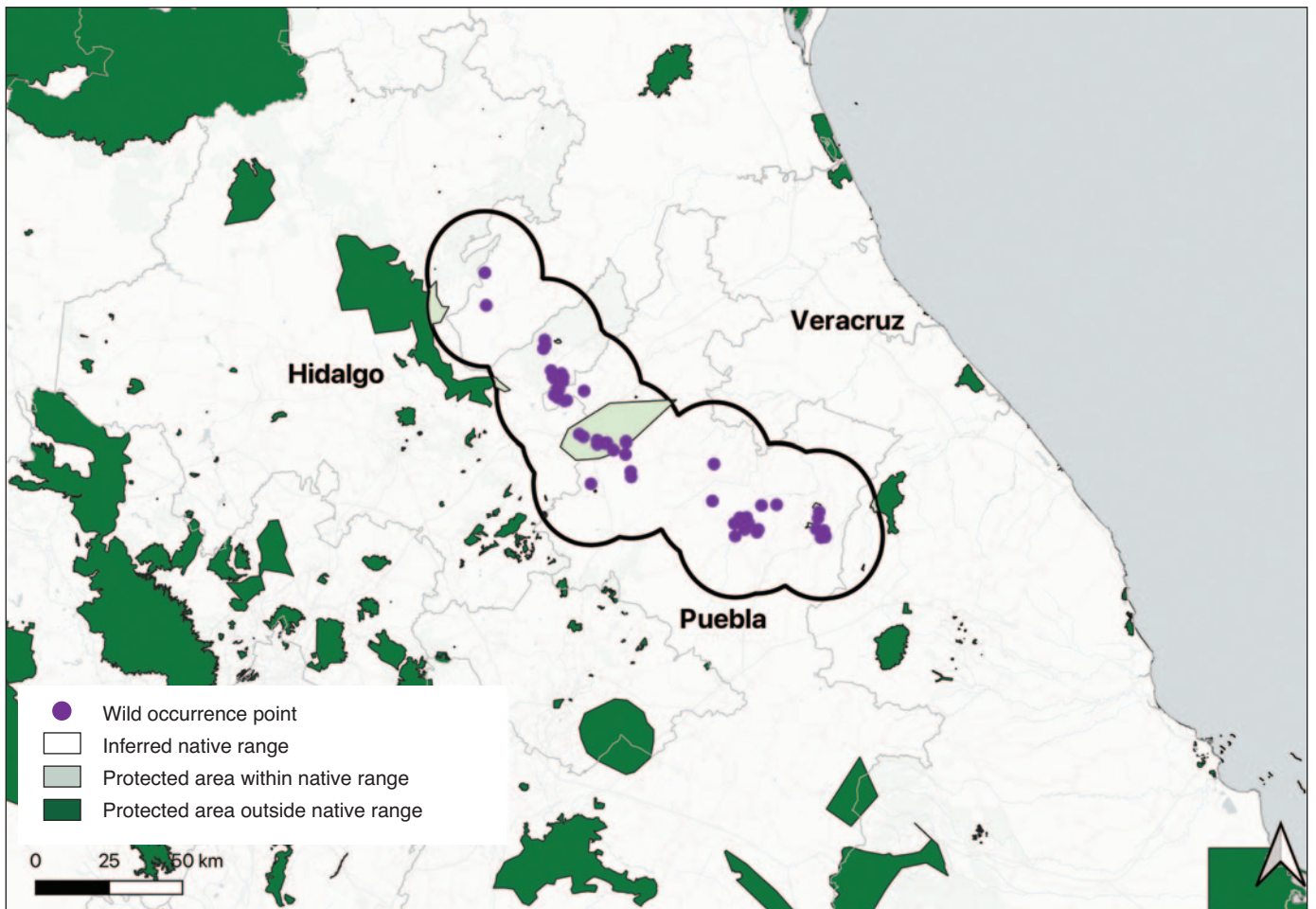
**Table 2.** Ex situ conservation scores for *Quercus hirtifolia* with all scores ranging from 0–100. A final score of 100 indicates comprehensive ex situ conservation, and a score of 0 represents poor ex situ conservation.

Geographic coverage ex situ	40
Ecological coverage ex situ	88
Representation in ex situ collections	60
Final ex situ conservation score	62

Using methods adapted from Khoury et al. (2020), we estimated the degree of representation of *Q. hirtifolia* 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 hirtifolia* in relation to protected areas. Protected areas are from Protected Planet (UNEP-WCMC and IUCN, 2023).

**Table 3.** *In situ* conservation scores for *Quercus hirtifolia* 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>	6
Ecological coverage <i>in situ</i>	75
Species representation in <i>in situ</i> collections	15
Final <i>in situ</i> conservation score	32

**Land protection:** Within the inferred native range of *Q. hirtifolia*, 6% is within protected areas (Figure 5). Protected areas include the Sistema de Represas y Corredores biológicos de la Cuenca Hidrográfica del Río Necaxa, a Ramsar Site, Wetland of International Importance.

**Sustainable management of land:** There is no visible management of land apart from that observed in Ejecayan in las Truchas Ejecayan, Zacapoaxtla.

**Population monitoring and/or occurrence surveys:** Puebla Botanic Garden (JBU-BUAP) has been surveying the distribution of this species and has found a very restricted distribution.

**Wild collecting and/or ex situ curation:** JBU-BUAP has collected from three populations and has developed an ex situ collection for conservation purposes. According to the results of our ex situ surveys, this species is in 10 ex situ collections.

**Propagation and/or breeding programs:** As a part of the “Safeguarding Threatened Tropical Montane Cloud Forest Oaks in Mesoamerica” project funded by the Franklinia Foundation, seed was collected in 2022 and 2023, and nearly 2,000 plants were grown in the greenhouse located in the Zacapoaxtla site.

**Reintroduction, reinforcement, and/or translocation:** In 2023, 850 small plants were planted in the Zacapoaxtla area *in situ* to reinforce the population in Ejecayan. Additional seedlings are currently growing in the nursery to be planted in 2024.

**Research:** Studies on genetic diversity of *Q. hirtifolia* have been done in nine populations, showing that there is more diversity within populations than between populations (González Rodríguez et al., 2022). However, more research is needed.

**Education, outreach, and/or training:** A floristic guide has been produced to inform the community about the local flora and their uses. These guides are an opportunity to inform the general public about the importance of *Q. hirtifolia* conservation. Also, training on propagation of oaks, including *Q. hirtifolia*, has been held in Ejecayan.

**Species protection policies:** There are currently no species protection policies for *Q. hirtifolia*. An Action Plan meeting is expected to be held in the near future to create a conservation strategy for this species in all of its potential distribution.

## PRIORITY CONSERVATION ACTIONS

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

### Land Protection

Currently less than 10% of *Q. hirtifolia*'s native range is within protected areas.

### Propagation and/or breeding programs

There is an active propagation program for *Q. hirtifolia*. Continuing this program, including providing training in correct propagation techniques, must be a priority for the future.

### Reintroduction, reinforcement, and/or translocation

Seedlings are currently growing in a nursery to be planted *in situ* in 2024.

### Propagation and/or breeding programs

Although this species is relatively well represented in ex situ collections, there should be an effort to collect from throughout the species' native range and continue to develop ex situ collections across Mexico

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