Conservation Gap Analysis of Native

Mesoamerican Oaks


M. Socorro González-Elizondo

Species profile: ***Quercus radiata***

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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
Fondation Franklinia

Quercus radiata Trel.

Common Names, Spanish: Cucharillo, encino cucharillo, encino roble, roble, encino
IUCN Red List Category and Criteria: Endangered: B2ab(iii)

Species profile expert: M. Socorro González-Elizondo, CIIDIR Durango, Instituto Politécnico Nacional

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DISTRIBUTION AND BIOLOGY

Quercus radiata is restricted to the southern zone of the Sierra Madre Occidental, in western Mexico (Figure 1). It occurs in the mountains of southern Durango, northern Jalisco, and adjacent Nayarit and Zacatecas, primarily within the warm temperate dry forest (Spellenberg and Bacon, 1996; Figure 2). Although this species was recorded in six Holdridge life zones, it is estimated that upwards of 95% of all occurrences are within the warm temperate dry forest, and the remaining 5% in subtropical dry forest (M. Socorro González-Elizondo, personal communication, 2024). *Quercus radiata* has a limited geographic range and a low density within that range.


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This species is a tree 2–8(–10) m tall. It occurs at 2,000–2,850 m asl, in open stands with other oaks and pines in rather sterile pale gray igneous soil (Spellenberg and Bacon, 1996). In areas of very shallow, whitish soil and outcrops of withish or weathered rust rhyolite *Q. radiata* is mainly associated with *Pinus lumholtzii* (González-Elizondo et al., 2012) and sometimes also with *Pinus teocote*, *Quercus* spp., *Arbutus* spp., *Juniperus durangensis*, *J. deppeana*, *Arctostaphylos pungens*, *Comarostaphylis* spp. and *Garrya wrightii*.

Quercus radiata is a black oak (section Lobatae) in the subsection Racemiflorae due to the presence of racemose infructescence. Once considered as a synonym of *Q. urbani* (McVaugh, 1974), a species of the Southern Sierra Madre, from which *Q. radiata* differs mainly in lacking the dense persistent tomentum of trichomes with intertangled branches that almost obscure the underleaf surface. It is closely related to *Q. tarahumara*, a northernmost representative of the group that differs mainly in having short and crowded infructescence and and usually denser glandular trichomes and denser tomentose pubescence on the underleaf (Spellenberg et al., 1995). Both *Q. radiata* and *Q. tarahumara* have big, almost orbicular to broadly obovate or pandurate, sparsely tomentose leaves, the underleaf with abundant amber or golden brown vermiform trichomes often coalescent in dark globules of glandular excrescence (Spellenberg et al., 1995). The common names encino hueja and encino jumate recorded by Valencia-A and Flores-Franco (2006) for *Q. radiata* belong to some other species of the Racemiflorae.

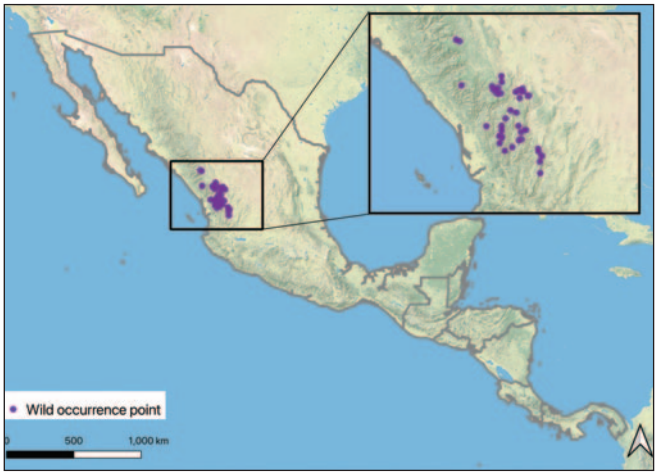

Figure 1. Wild (i.e., *in situ*) occurrence points for *Quercus radiata*.

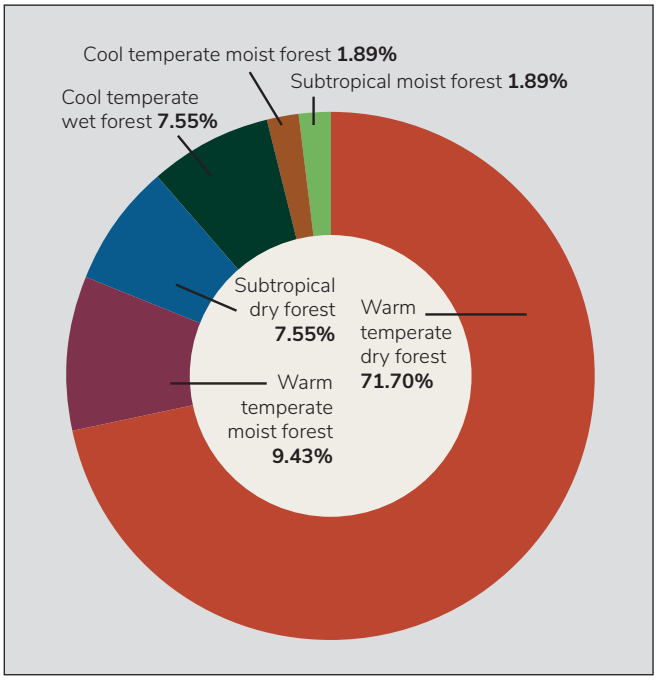

Figure 2. The percentage of wild occurrence points in each Holdridge life zone in which *Quercus radiata* is distributed.

THREATS TO WILD POPULATIONS

Human use of species — wild harvesting: *Quercus radiata* is occasionally used as a source for firewood.

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: This is a hardy species that is adapted to shallow and poor soils, and for that reason, it is not particularly subject to heavy exploitation.

Human use of landscape — residential/commercial development, mining, and/or roads: Roads cutting through some of the populations may affect the species.

Human use of landscape — tourism and/or recreation: This is not currently considered a threat. The areas where *Q. radiata* occurs are not subject to tourism or recreation activities.

Human modification of natural systems — altered fire regime, pollution, and/or eradication: This is not currently considered a threat.

Human modification of natural systems — invasive species competition/disturbance: This is not currently considered a threat. However, with more research it is possible that *Dodonaea viscosa* may later be found, as it is already invading populations of other local trees (e.g., *Pinus cembroides*, *Q. eduardi*, *Q. huicholensis* and *Q. resinosa*).

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: While there are not yet records of habitat shifting to higher elevations as a result of drought and temperature extremes, as for several other species in the region, these threats may affect *Q. radiata* too. Within the inferred native range of *Q. radiata*, the warm temperate dry forest is expected to decrease in area by an average of 29% by the years 2061–2080 relative to current conditions (Good et al., 2024).

Genetic material loss — inbreeding and/or introgression: *Quercus radiata* has been considered as of possible hybrid origin between *Q. jonesii* and *Q. conzattii* or *Q. urbani* (Vázquez and Nixon, 2013). Recent data (McCauley and Oyama, 2020) indicate that the last two species do not occur in the Sierra Madre Occidental and that their names were mistakenly applied to *Q. huicholensis* and *Q. pennivenia*, respectively. Therefore, if the hybrid origin hypothesis were to be accepted, the putative parents of *Q. radiata* would be *Q. jonesii* and *Q. pennivenia*. Sporadic hybrids occur with *Q. eduardi* and *Q. jonesii*, and only two mixed and introgressed populations have been recorded (Spellenberg and Bacon, 1996), one involving *Q. radiata* and *Q. jonesii* and the other with *Q. radiata* and *Q. huicholensis*. Field observations indicate that most of the populations of *Q. radiata* are stable and uniform (González-Elizondo et al., 2012).

Pests and/or pathogens: This is not currently considered a threat.

Extremely small and/or restricted population: This is not currently considered a threat. The populations are small but not particularly 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. radiata* (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.


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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

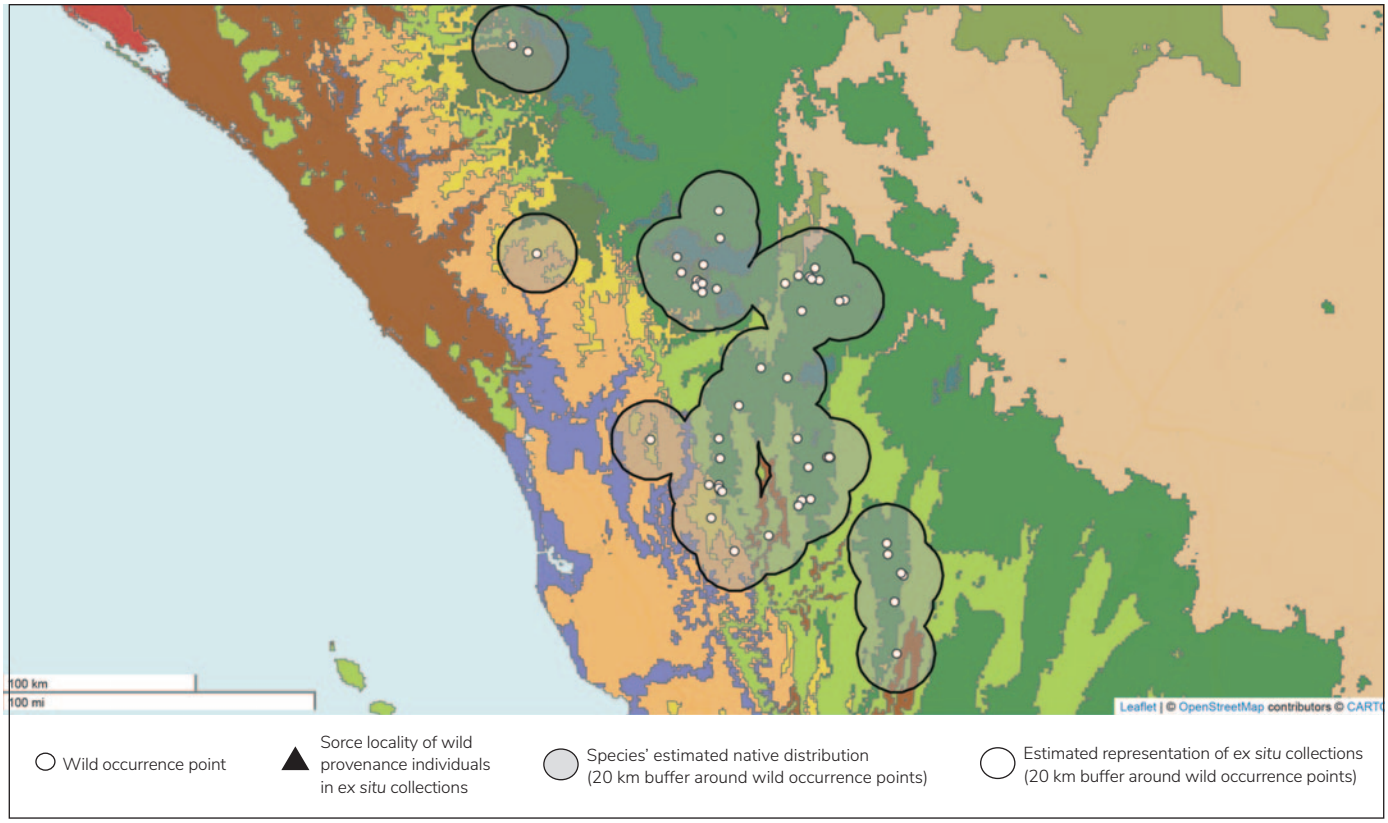

Figure 3. *Quercus radiata* wild occurrence points and ex *situ* collection source localities. Colored regions are Holdridge life zones. All ex *situ* collection source localities are also wild occurrence points.

Table 2. Ex *situ* conservation scores for *Quercus radiata* 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. radiata* 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.

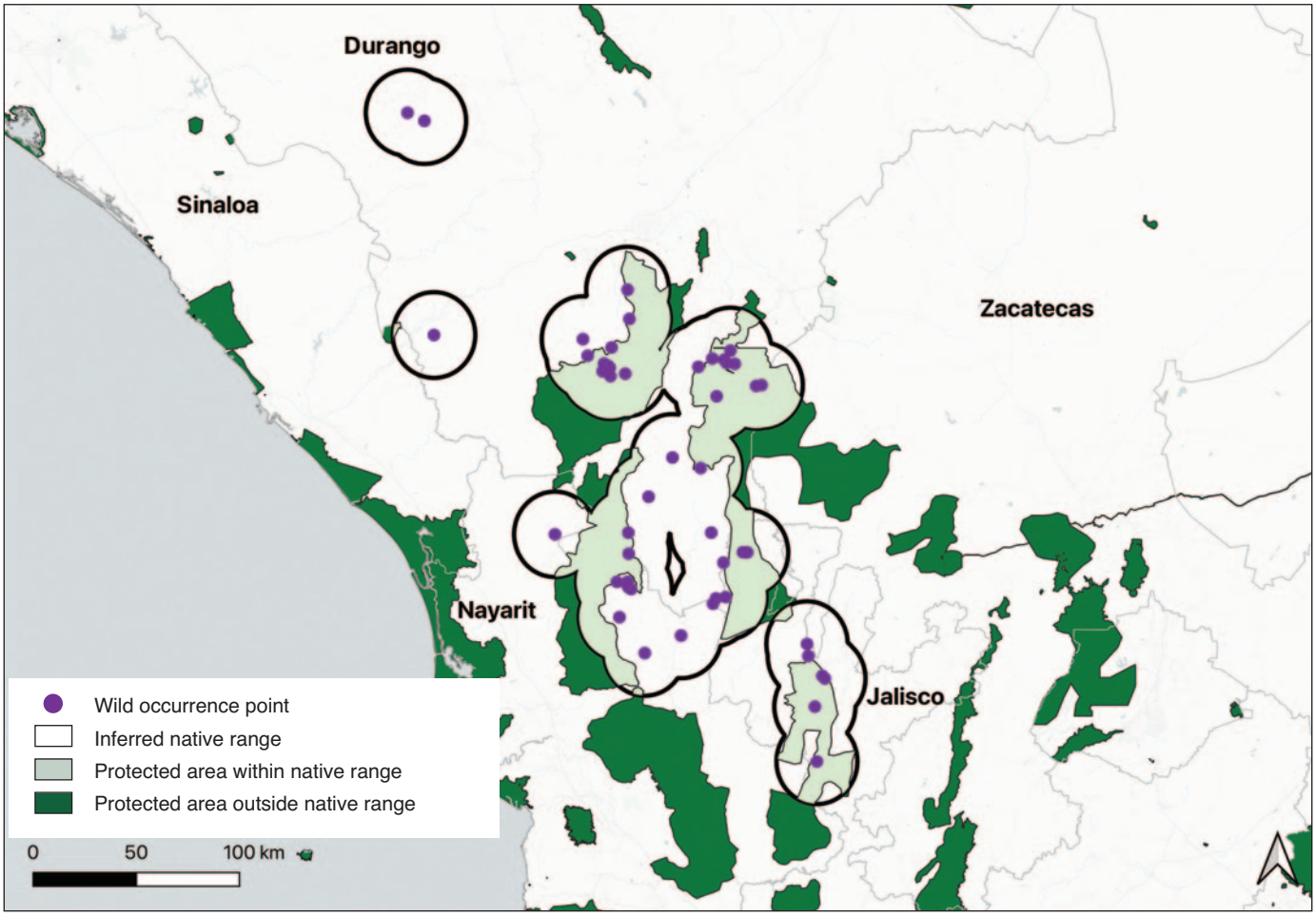

Figure 4. Wild occurrence points and inferred native range of *Quercus radiata* in relation to protected areas. Protected areas are from Protected Planet (UNEP-WCMC and IUCN, 2023.

Table 3. *In situ* conservation scores for *Quercus radiata* 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*	36
Ecological coverage *in situ*	100
Species representation in *in situ* collections	55
Final *in situ* conservation score	64

Land protection: Within the inferred native range of *Q. radiata*, 36% is within protected areas (Figure 4), most of which are in zones of national designation: La Michilía Biosphere Reserve and the National Protected Area "Área de Protección de Recursos Naturales Cuenca Alimentadora del Distrito Nacional de Riego 043" which is in the states of Durango and Nayarit.

Sustainable management of land: Communal lands (ejidos) and private properties are subject to management programs based on sustainability goals, but those are general, not species specific. There is a collaboration between Pronatura Noroeste and La Michilía Biosphere Reserve management with a goal of mitigating the effects of human activities in the reserve (Pronatura Noreste, 2020).

Population monitoring and/or occurrence surveys: A network of long-term forest observational studies is being developed in Mexico. A few of those sites include *Q. radiata*.

Wild collecting and/or ex situ curation: This species is not currently held in any *ex situ* collections. Collection of herbarium samples, mainly for taxonomic studies, have been made by researchers of different institutions. There has been no seed collection.


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Propagation and/or breeding programs: This is not a conservation activity at the time of publication.

Reintroduction, reinforcement, and/or translocation: There is no data on reintroduction, reinforcement, and/or translocation efforts for this species.

Research: To the best of our knowledge, there is little to no research focused on Q. *radiata* specifically. Floristic and ecological research on the flora and vegetation of Sierra Madre Occidental is being carried out, but not specifically on this species. The same regarding a current taxonomic and ecological inventory for the oaks occurring in Sierra Madre Occidental.

Education, outreach, and/or training: There are currently no conservation, outreach, or training programs for this species

Species protection policies: Protection policies are applied on the natural protected areas, but are not species specific for Q. *radiata*.

PRIORITY CONSERVATION ACTIONS

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

Education, outreach, and/or training

It is a priority to work with the inhabitants of the region in order to provide them with appropriate outreach material that emphasizes the concepts of environmental care and protection of the natural communities. Some populations of Q. *radiata* are found within original people's communal lands, mainly O'dam (Southeastern Tepehuan), Audam (Southwestern Tepehuan) and Wixárika (Huichol), besides the populations located in mestizos' properties and ejidos.

Research

Taxonomic research of Q. *radiata* and its potential genetic exchange with other red oaks, as well as on its particular environmental preferences, potential threats, and reproductive biology would help to construct a theoretical basis for its conservation.


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REFERENCES

González-Elizondo, M. S., González-Elizondo, M., Tena Flores, J. A., Ruacho González, L., and López Enríquez, I. L. 2012. Vegetación de la Sierra Madre Occidental, México. Una Síntesis. *Acta Botanica Mexicana* 100: 351–403.

Good, K., Coombes, A. J., Valencia-A, S., Rodríguez-Acosta, M., Beckman Bruns, E., and Alvarez-Clare, S. 2024. *Conservation Gap Analysis of Native Mesoamerican Oaks*. Lisle, IL: The Morton Arboretum.

Khoury, C. K, Carver, D., Greene, S. L., and Frances, A. 2020. Crop wild relatives of the United States require urgent conservation action. *PNAS* 117(52): 33351–33357.

McCauley, R. A. and Oyama, K. 2020. A re-evaluation of taxonomy in *Quercus* section Lobatae subsection Racemiflorae (Fagaceae), resurrection of the name *Q. pennivenia* and description of a new taxon, *Q. huicholensis*. *Phytotaxa* 471(3): 247–257.

McVaugh, R. 1974. Flora Novo-Galiciana. *Contributions from the University of Michigan Herbarium* 12(1): 1–93.

Pronatura Noreste. 2020. Creation of the management plan in La Michilia, Duragno underway. Available from https://pronatura-noroeste.org/en/creation-of-the-management-program-in-la-michilia-durango-underway/. Accessed February 2024.

Spellenberg, R., Bacon, J. R., and Breedlove, D. E. 1995. A new species of *Quercus* (Fagaceae, sect. Lobatae, group Racemiflorae) from the Sierra Madre Occidental, Mexico. *Madroño* 42(1): 26–33.

Spellenberg, R. and Bacon, J. R. 1996. Taxonomy and distribution of a natural group of black oaks of México (*Quercus* section Lobatae subsection Racemiflorae). *Systematic Botany* 21(1): 85–99.

UNEP-WCMC and IUCN. 2023. Protected Planet: The World Database on Protected Areas (WDPA) [Online] Cambridge, UK. Available at www.protectedplanet.net. Accessed 2023.

Valencia-A, S., and Flores-Franco, G. 2006. Catálogo de autoridad taxonómica del género Quercus, Fagaceae en México. Herbario FCME. Facultad de Ciencias. Universidad Nacional Autónoma de México. Bases de datos SNIB-CONABIO, proyecto CS008. México, D. F. Available at https://www.snib.mx/iptconabio/resource?r=SNIB-CS008&request_locale=pt

Vázquez, M. L. and Nixon, K. C. 2013. Taxonomy of *Quercus crassifolia* (Fagaceae) and morphologically similar species in Mexico. *Brittonia* 65(2): 208–227.