The Red List of US Oaks

Diana Jerome, Emily Beckman, Lisa Kenny, Katherine Wenzell,
Chai-Shian Kua, Murphy Westwood

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Quercus palustris *(K Kohout)*

Contents

Quercus imbricaria *(Matt Lobdell)*

Quercus macrocarpa *(Ed Hedborn)*

Foreword

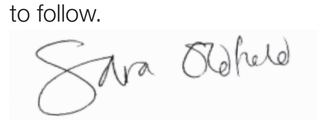
Trees are essential for our well-being but are under threat worldwide. Cataloguing the plight of tree species is a major first step in securing conservation action for priority species. This report on the conservation status of oaks in the US is a vital contribution to the tree conservation literature and a reminder of the need for urgent action.

The Morton Arboretum is a globally renowned champion of trees. Plant scientists at the Arboretum model and inspire a commitment to supporting collaborative oak research and conservation worldwide. As part of this commitment, a global assessment of the conservation status of oaks is underway as a contribution to the Global Tree Assessment (GTA). The GTA is the first comprehensive attempt to Red List all trees using IUCN methodology with results expected by 2020.

Globally there are around 60,000 tree species. The oak genus *Quercus* has an estimated 450 species. Oaks are important flagships for conservation with their huge ecological and cultural importance. For this report, 91 oak species have been assessed with 16 identified as threatened according to the IUCN Red List Categories and Criteria and 75 recorded as non-threatened. This information is also made available through the IUCN Red List of Threatened Species (iucnredlist.org), adding significantly to the global knowledge base.

The 16 species of threatened oaks of the US are clear priorities for conservation action. Included in this report are brief overviews of the work underway by Morton Arboretum scientists and their partners to support oak conservation. There is, for example, a story of seed collection and conservation genetic studies for the Endangered Shinnery Oak, *Quercus havardii*; this shrubby oak reproduces clonally and faces threats from habitat loss due to increasing agriculture, urbanization, and oil and gas drilling. There is also information on the study of conservation genetics of oaks, and other tree taxa, to develop scientifically informed *ex situ* collection strategies.

A combination of conservation action for oaks in their natural habitats and *ex situ* conservation in well-managed collections should ensure that no oak species becomes extinct. This report shows what can be done using the best available information as a starting point. I thank all involved in the oak assessment and hope the inspirational work of the scientists at The Morton Arboretum will serve as an example for many other arboreta to follow.



Sara Oldfield
Chair of the IUCN/SSC Global Tree Specialist Group

Quercus alba *(Ed Hedborn)*

Executive summary

Quercus ellipsoidalis *(Deb Brown)*

The IUCN Red List is an objective system for assessing the extinction risk of a species based on past, present, and projected threats. In 2007 the IUCN/SSC Global Tree Specialist Group published The *Red List of Oaks* which included 175 of the roughly 450 species of worldwide oaks (genus *Quercus*). Of those 175 species 67 of them are found inside the US, but around one third of the US's species were not evaluated.

In 2015 The Morton Arboretum established a partnership with the Global Tree Specialist Group to assess all oak species by 2020, including reassessments of the species in the 2007 publication, starting with the 91 species native to the United States. All assessments are submitted for publication on the IUCN red list of threatened species, available at http://www.iucnredlist.org/.

The 2017 version of *The Red List of US Oaks* includes not only the results and summaries of those assessments, but also information on conservation actions and initiatives that aim to understand and maintain oak diversity in the US.Examples include The US Native Oak Conservation Gap Analysis and the IMLS-funded project Safeguarding Our Plant Collections, which will inform best practices for *in situ* and *ex situ* oak conservation.

Of the 91 native US oak species, 20 are of conservation concern including 16 that reach the threshold for one of the threatened categories of Vulnerable, Endangered or Critically Endangered and 4 that fall into the Near Threatened category. Generally species richness of oaks increases from north to south in the United States, with Texas having 48 native species, the highest number of any state. California contains the highest number of oak species of conservation concern (nine species), followed by Texas and Alabama, both with five oak species of concern. Southern California represents a threatened oak diversity hotspot and is of critical importance for focusing conservation efforts. Some of the major threats to oak species in the US include both native and non-native pests and diseases, problems caused by changing climate such as drought, changes to landscape through fire and fire suppression, residential and commercial development, and land use change due to agriculture.

Quercus muehlenbergii *(Ed Hedborn)*

Quercus garryana *(Matt Lobdell)*

This report establishes the need for in situ conservation, management, and ecological restoration of oak habitat, as well as enhanced *ex situ* collections of threatened oaks. By prioritizing species of need *The Red List of US Oaks* can help maximize the impact of conservation actions, especially when working with limited resources. *The Red List of US Oaks* identifies key threats to oaks, stimulates research and conservation action for oak species in the United States, and contributes to the global effort to complete threat assessments for all tree species by 2020.

Introduction

Oaks (*Quercus* spp.) are keystone species in a wide range of ecosystems around the world, including oak-pine forests and cloud forests in Mexico, and subtropical broad-leaved evergreen forests in Southeast Asia. Oaks are trees or shrubs, generally distributed through the northern hemisphere. There are an estimated 450 species of oaks worldwide, with centers of diversity in Southeast Asia and Mexico (Nixon 1997; Manos et al. 1999; Valencia-A. 2004; le Hardÿ de Beaulieu and Lamant 2010). Globally, oaks are ecologically valuable for promoting terrestrial biodiversity, performing critical ecosystem functions, and providing food and habitat for countless species of animals (Miller and Lamb 1985; Menitsky 2005; le Hardÿ de Beaulieu and Lamant 2010). The US oak species represent an amazing amount of morphological and ecological diversity due to the broad range of habitat types and climates that are found in the country.

In North America, native oak species are host to 534 different species of Lepidoptera (moths and butterflies), making *Quercus* the most ecologically valuable plant genus for that insect group (Tallamy and Shropshire 2009). Oaks also have economic importance; oak timber is used for the production of furniture, wine and whisky barrels, and commercial charcoal and firewood. However, oaks are threatened with extinction worldwide and oak-dominated ecosystems are declining (Oldfield and Eastwood 2007; Fahey *et al*. 2012). Furthermore, oak acorns cannot be easily seed banked through conventional preservation methods of low temperature and humidity, so effective long term *ex situ* conservation of threatened oak species must be through living collections of genetically diverse, wild-collected trees of known provenance – a challenging undertaking for such large, long-lived trees. Their longevity and slow growth rates also make them particularly susceptible to the effects of a rapidly changing climate, which will likely lead to dramatic shifts in suitable habitat within the next 50 years (Potter *et al*. 2017). Entire oak ecosystems have been in decline in the United States for the past century. The causes of this decline are still not fully understood, but are thought to include fire suppression, increased consumption of acorns by growing mammal populations, herbivory of seedlings, introduced pests, and climate change (Lorimer, 2003).

In 2007, Oldfield and Eastwood published *The Red List of Oaks*, the first global threat assessment for the genus. The report included 67 of the 91 native US oak species. Since then, substantial advances have been made in areas such as oak taxonomy, phylogenetics, population genetics, and species distribution modeling. Furthermore, many new threats have been identified. In light of this new research and in response to the global threats facing oak species, The Morton Arboretum, Botanic Gardens Conservation International (BGCI), and Fauna & Flora International (FFI) launched the Global Oak Conservation Partnership in 2015 as part of the Global Trees Campaign (GTC).

Quercus rubra *(Deb Brown)*

One of the Global Oak Conservation Partnership objectives is to update and expand *The Red List of Oaks of 2007* to identify the species of greatest conservation concern, in order to set conservation priorities within the genus. To achieve this objective, the Arboretum is working with the IUCN/SSC Global Tree Specialist Group (GTSG) under the auspices of the Global Tree Assessment, an initiative to complete conservation assessments for all tree species by 2020 (Newton *et al*. 2015). The *Red List of US Oaks of 2017* represents the culmination of the first phase of this global species prioritization project.

Global Tree Assessment

GTA
GLOBAL TREE ASSESSMENT

Despite the importance of trees, many are threatened by over-exploitation and habitat destruction, as well as by pests, diseases, drought and their interaction with global climate change. In order to estimate the impact of such threats to trees there is an urgent need to conduct a complete assessment of the conservation status of the world's tree species – the Global Tree Assessment.

The Global Tree Assessment aims to provide conservation assessments of the entire world's tree species by 2020. The assessment will identify those tree species that are at greatest risk of extinction. The goal of the Global Tree Assessment is to provide prioritization information to ensure that conservation efforts are directed at the right species so that no tree species becomes extinct.

The Global Tree Assessment is an initiative led by BGCI and the IUCN/SSC Global Tree Specialist Group. Work is ongoing to develop an even more extensive global collaborative partnership, involving the coordinated effort of many institutions and individuals. These steps will enable the Global Tree Assessment to achieve its 2020 target. For more information on the GTA, see Newton *et al*., 2015.

The Red List of US Oaks

Methods

Taxonomy

The species list for this evaluation was compiled by comparing The Plant List (2013), NatureServe (2015), Flora of North America (1997), The USDA PLANTS Database (2017), and the Oak Names Checklist (2010). When these sources disagreed the majority and/or expert opinion was used. Oak taxonomy is of continued debate and additional information from regional oak experts and recent taxonomic literature was used when necessary and available.

Conservation assessment

Conservation assessments were conducted following the IUCN Red List of Threatened Species Categories and Criteria version 3.1 (IUCN, 2001, Appendix C). Assessments were compiled using IUCN's Species Information Service (SIS), which is a web-based database for storing and managing IUCN conservation assessments. Information was collected on each species including distribution, population size and trends, habitats and ecology, threats, uses, and any existing conservation actions. Evidence for assessments was obtained through published and unpublished literature review, national and regional floras, botanic garden and herbarium collections, and extensive consultation with experts. Much of the species distribution data was found using Global Biodiversity Information Facility (GBIF: http://www.gbif.org/), an open data source that pulls together specimen occurrence data from institutions around the world. Geospatial Conservation Assessment Tool (GeoCAT: http://geocat.kew.org/) was used to calculate the area of occupancy (area occupied by species) and extent of occurrence (spatial spread of a species) (Chapman, 2005). In order to gather the most accurate and up to date information for Red List assessments, The Morton Arboretum hosted a one-day Red List training and assessment review workshop associated with the International Oak Society conference in October, 2015. The experts who have provided information for this report are listed in Appendix B.

Using this information, each species was assigned to a conservation category: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), or Data Deficient (DD). CR, EN, and VU are considered "threatened" categories (Fig. 1). Species that do not reach the threatened category thresholds, but are close to or are likely to qualify for a threatened category in the near future are considered NT. For the purpose of this report, we consider threatened and NT species to be "of conservation concern". Near Threatened species, along with threatened species, need monitoring and/or conservation action to maintain their populations and prevent future decline. LC species are not considered threatened, and the category can include widespread species as well as rare but stable species. The category DD is used when there is inadequate information to assess its risk of extinction based on distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking.

A species may qualify as threatened (CR, EN, and VU) under any of five possible criteria: A) Population reduction; B) Small geographic range; C) Small population size and decline; D) Very small or restricted population; or E) Quantitative analysis. Assessors are encouraged to evaluate each species using all five criteria, but thresholds for only one criterion are required for placement in threatened category. Using the precautionary principle, the criterion (or criteria) under which a species qualifies as most threatened dictates the final threat category.

Every species in this report was evaluated at the global scale, including species whose ranges extend beyond the geopolitical borders of the United States. In accordance with IUCN regulations, all assessments were reviewed by a member of the GTSG and, in most cases, also by an oak expert.

Quercus nigra *(Matt Lobdell)*

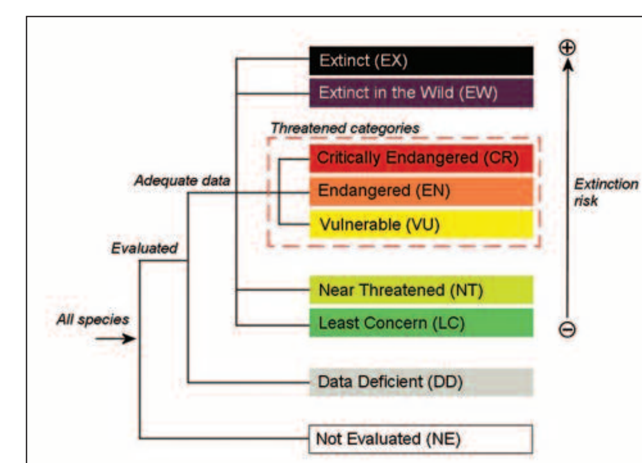


Fig 1. Structure of the IUCN Red List categories (version 3.1) (Credit: IUCN)

Results and evaluation

Quercus alba *(Ed Hedborn)*

Threat status

This report marks the first complete evaluation of all native US oak species, including 24 species that had never previously been assessed. The results of the global assessment for all 91 native US *Quercus* species are summarized in Table 1. Sixteen species (18%) are threatened with extinction (CR, EN, or VU). Four additional species are assessed as Near Threatened. These species almost reach the threshold that would categorize them as threatened or have imminent threats that could cause them to become threatened very quickly. Together, the Near Threatened and threatened species are considered "of conservation concern" and represent 22% of all US oaks. The three species assessed as Data Deficient may or may not be threatened, but no conclusion could be reached due to taxonomic uncertainty and/or lack of data. The majority of *Quercus* taxa in the US are assessed as Least Concern. These species often have large distributions and are not at a high risk of extinction.

Red List category	Number of species
Extinct	0
Extinct in the Wild	0
Critically Endangered	3
Endangered	9
Vulnerable	4
Near Threatened	4
Data Deficient	3
Least Concern	68
Total US Species	**91**

Table 1. Summary of conservation assessments for US species of Quercus.

IUCN Criteria	Number of Threatened Species (Percent)
Criterion A	2 (12.5%)
Criterion B	10 (62.5%)
Criterion C	4 (25%)
Criterion D	0
Criterion E	0
Total US Species	**16**

Table 2. The five Red List criteria and the number of threatened Quercus assessments assessed under each.

Criteria used

To assess a species as threatened all five criteria should be examined, although the threshold for only one criterion must be met for a species to be considered threatened. Sufficient data is often not available to apply more than one criterion to a species. The majority of threatened oak species were only able to be assessed using criterion B, which considers geographic range size (Table 2). Georeferenced point data is often the most readily available and robust data to be found, especially for plant taxa. This reflects the dependence of many conservation assessments on herbarium collection data for measures of area of occupancy and extent of occurrence.

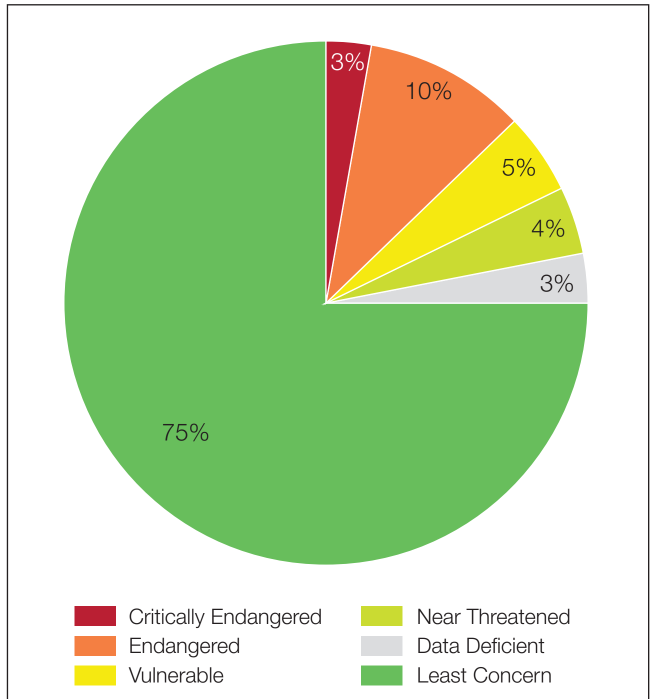


Fig 2. Summary of conservation assessments for US species of Quercus.

Box 1: Application of Climate Change Modeling to the IUCN Red List

The IUCN criteria aim to identify the symptoms of endangerment instead of the causes; this way they are applicable when the cause of threat to a species is unknown. However, complex processes, such as climate change, require special consideration when applying the Red List criteria.

Bioclimatic envelope modeling is often used to predict how species distributions will change across a landscape under climate change conditions. These models use observation records, present day climate data, and climate change projections to predict the potential range of a species under different climate scenarios. In order to use current occurrence data to predict potential species distributions, it must be assumed that the species currently occurs only where the conditions are most suitable and never occurs in less-than-suitable habitat. This is an unrealistic assumption, especially for oaks, whose distribution often lags behind habitat changes due to their long life cycles.

Models require accurate and robust occurrence records as well as environmental variables that are ecologically relevant to the taxon. For a Red List assessment to apply climate change modeling directly under the Categories and Criteria, change in suitable habitat is used as a proxy for population size reduction under Criterion A3c or A4c (Appendix C). While a decline in habitat is correlated to population decline, as well as loss of genetic diversity (Rivers *et al*. 2014), the two do not necessarily have a 1:1 relationship. Population decline due to the loss of habitat quality depends on population density, as well as the species ability to persist or adapt to less than ideal conditions.

Red List assessments which use bioclimatic models should take into account relevant life history traits that may influence species distribution and range changes. For this report, most assessments claiming climate change as a major threat cited Potter and Hargrove (2013) and Potter *et al*. (2017). The model applied in the second paper integrated the output of exposure to climate change with evaluations of the potential for each species to withstand climate change due to either adaptation or persistence in unsuitable habitats. The study ranked tree species by three vulnerability dimensions: (1) Exposure to climate change, which included projected area change by 2050 and distance to future habitat; (2) sensitivity to the threat, which included rarity, area of distribution, dispersal ability, and disturbance tolerance; and (3) adaptability to the threat, which included regeneration, genetic variability, and ecological

Quercus arkansana *(VU) would have been assessed as EN with direct application of climate change modeling* *(Murphy Westwood)*

requirements. While this model is robust, due to uncertainties in the relationship between habitat and population decline, as well as the climate change bioclimatic envelope assumptions used, these results were not applied directly to the Red List Categories and Criteria Instead, the climate change models were used as evidence of major threat to a species.

Had the results from climate change modeling been applied directly, this report would have expressed a drastic increase in the number of threatened species. Species identified in Potter *et al*. (2017) as being a priority in at least two vulnerability categories are listed below along with their potential threat category had the results been used to directly apply the Red List Categories and Criteria. These species are identified in their final Red List evaluation as at risk due to climate change.

IUCN Criteria	Without Climate Modeling	Direct Application of Climate Modeling
CR	3	4
EN	9	21
VU	4	9
NT	4	5
DD	3	3
LC	68	49

Comparison of the number of species in each Red List category with and without direct application of climate change modeling. Species that would fall into a threatened category are indicated as such in the species accounts.

Box 2: American oaks in an evolutionary context
By Andrew L. Hipp, The Morton Arboretum

Oaks arrived in North America approximately 45 million years ago (McIntyre, D.J. 1991), and the major groups of oaks were distinct from one another by at least 33 million years ago (Daghlian & Crepet, 1983). These major groups are:

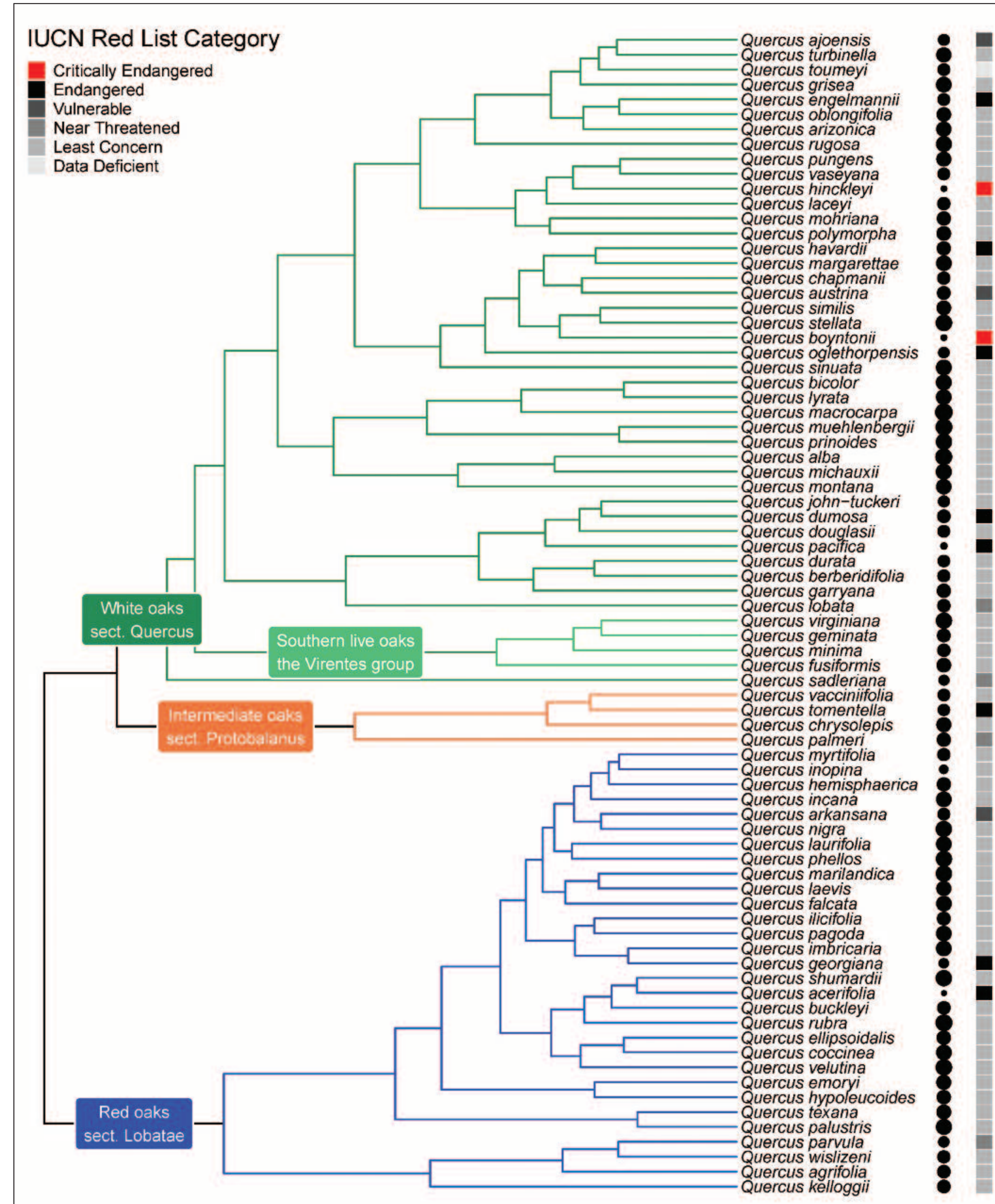
- **Red oaks**, ***Quercus* section *Lobatae***, characterized by biennial acorns and leaves with bristles at the tips of the lobes or, for unlobed leaves, the leaf tip;
- **Intermediate oaks**, ***Quercus* section *Protobalanus***, characterized by a dense, golden-colored woolly covering of hairs on the acorn cap; and
- **White oaks**, ***Quercus* section *Quercus***, which have annual acorn development and lack the bristle tips and woolly pubescence of the other two groups.

Here we present a phylogenetic tree based on DNA sequence data gathered from across the oak genome (Hipp *et al*. 2014; Hipp, Andrew L. *et al.* In prep; McVay et al. 2017). This phylogenetic tree is a portrayal of our understanding of the history of one portion of the Tree of Life: the genus *Quercus*. The branches of the Tree of Life, referred to as clades, are useful to us both because they are the currency by which we document and communicate about biodiversity and because they record evolutionary events that shape the world we live in. The transition of plants onto land, the angiosperm flower, and the oak acorn all define clades that make human life as we know it possible. A tree-of-life based view of evolutionary history forms the basis of the classification we use when we talk about oaks.

The oak phylogenetic tree also informs our understanding of the evolution of traits that shape oak-dominated plant communities and oak ecological interactions. The traits that make oaks important to us have evolved on the tree of life; these traits are passed down from parent to offspring in oak evolution, making phylogenetic trees a practical tool for predicting ecological interactions. For example, in the Figure below we show an estimate of geographic range for each species inferred from specimen records reported by the GBIF (Chapman, 2005). Geographic range is a Red List criterion that we could estimate fairly objectively for all species on our phylogeny. Species tend to be more closely related to other species of comparable geographic ranges, and when we analyze these data using two common statistical methods (Blomberg, Garland, & Ives, 2003; Pagel, 1999), we find that statistical analysis supports the evidence of our eyes: close relatives are significantly more similar to each other than we expect if we were just drawing range sizes at random. Range size is an emergent property that American oak species tend to have in common with their ancestors and close relatives.

But threat takes many forms, and so the conservation rankings as assessed using the IUCN Red List process are not themselves well predicted by the phylogeny: three types of statistical tests (Blomberg et al. 2003; Fritz & Purvis, 2010; Pagel, 1999) implemented in several different ways suggest that the oak Red List categories ignore evolutionary history, even if some of the traits underlying them are well predicted by phylogeny. Thus phylogeny may be helpful in predicting how vulnerable species are when the traits underlying that vulnerability evolve in predictable ways (e.g. Willis, Ruhfel, Primack, Miller-Rushing, & Davis, 2008). The oaks, as a well-studied group from both ecological and phylogenetic perspectives, may be particularly suited to assessing the degree to which phylogeny can fill in for a lack of knowledge about species biology in making conservation assessments.

The image on the right is a phylogenetic tree based on restriction-site associated DNA sequencing (RAD-seq) from (Hipp, Andrew L. *et al*. In prep). Thirteen red-listed species have not been evaluated phylogenetically and are consequently not shown on this tree. Colored squares at the tips indicate IUCN Red List category for each species. Black dots at the tips indicate relative range size: range size was log-transformed and rescaled to make the differences easier to see (this has no effect on statistical analyses presented in the text); points represent a range of sizes from a minimum of 1.25 × 103 m^2 (*Quercus acerifolia*) to a maximum of 7.08 × 106 m^2 (*Q. macrocarpa*). Data and scripts used to generate this figure and perform analyses are located at https://github.com/andrew-hipp/oak-redlist-phylogeny-2017.



Geographic analysis

Of the 91 *Quercus* species with a native range within the United States, 41 are endemic, occurring only in the US. Twelve species reach north into Canada and 38 species cross the border into Mexico, including two species that extend further south into Central America. *Quercus muehlenbergii* is the only species to span Canada, the US, and Mexico. Within the US, the number of oak species per state (species richness) increases from north to south (Fig. 3). Idaho is the only state within the contiguous US without any native oaks; Alaska and Hawaii also lack native oak species. The state with the highest species richness is Texas, with 48 native oaks. Texas sits at the confluence of several different ecoregions and habitat types, contributing to its high level of oak diversity. The trend of high species richness in the south is also true for oak species of concern. There are in fact no species of conservation concern in most of the northern states. The state with the highest number of species of concern is California, with nine species. Most of these species are found in Southern California, with six species of concern found in Santa Barbara County, including the Channel Islands (Fig. 4). This can be attributed to many factors including, but not limited to, the high species diversity in California as well as the relatively recent description of some species. Until the beginning of the 21st century many species of California's shrubby white oak were all known as "*Quercus dumosa*" and were thought to be widespread. It was only after the species were correctly identified that their rarity was uncovered (Backs, 2014).

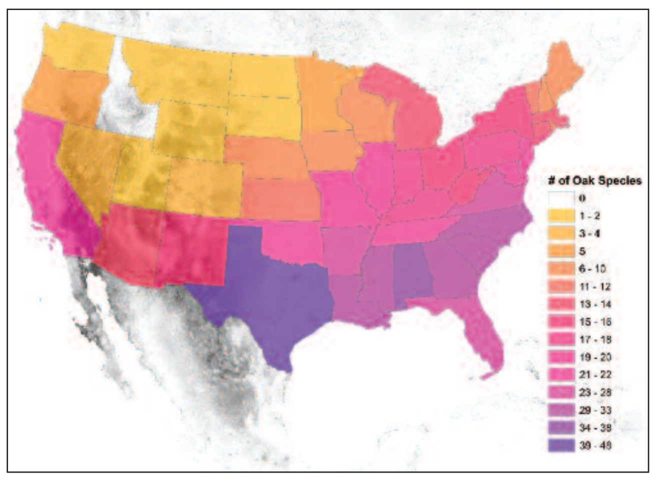


Fig 3. Quercus species richness by state in the US.

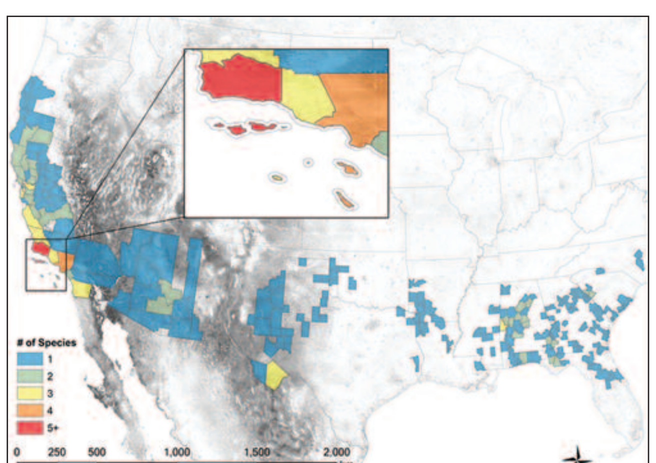


Fig 4. Distribution of US Quercus species of conservation concern (i.e. threatened and Near Threatened species) by county.

Quercus montana *(Ed Hedborn)*

Major threats

The most common threats to *Quercus* species in the US are shown in Figure 5. Threats were coded using the IUCN classification scheme (IUCN, 2012). Many species assessed as Least Concern have threats, but these threats do not affect their population size enough to warrant moving them to a threatened category. The top major threats to oak species in the US tend not to cluster geographically; instead they are pervasive across the country. The most common threat for not-threatened species is habitat shifting and alteration due to climate change; this is also the most common threat for *Quercus* species overall (Box 1). The most common threat to species of concern is fire and fire suppression (Box 3). Problematic species and diseases are split into native, non-native invasive, and species of unknown origin. These categories include threats due to pest species (Box 4), competitive species, and species that are able to hybridize with the oak of interest (Case study 1).

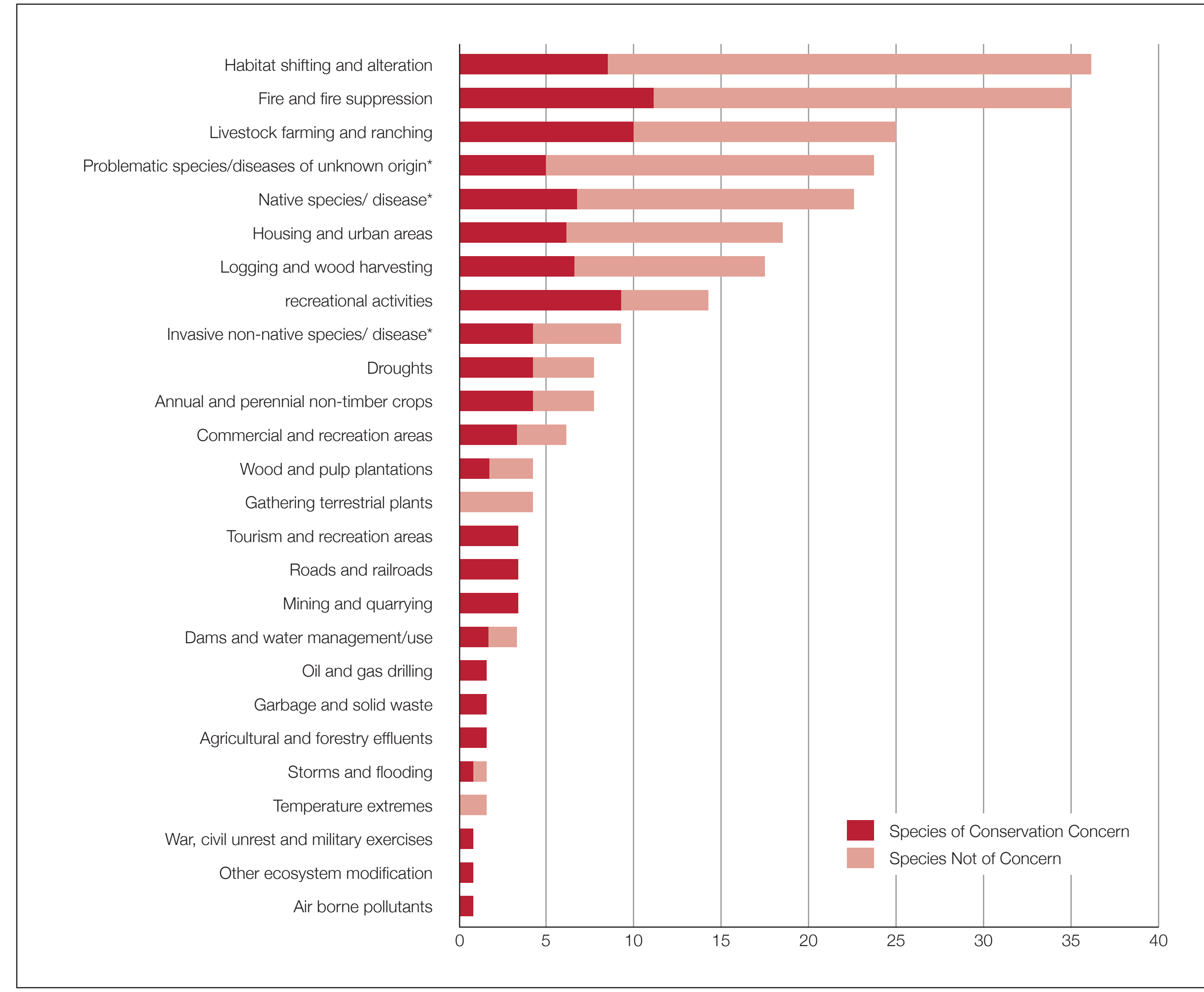


Fig 5. Major threats to Quercus species in the US, using the IUCN threat classification system.
** includes threats due to pest species, competitive species, and species that are able to hybridize with the oak of interest.*

Oak Wilt, one example of a common threat, is a disease caused by the invasive fungus *Ceratocystis fagacearum* and is a threat to many species including *Quercus muelenbergii, Quercus velutina*, and *Quercus montana*. A major threat to *Quercus* species in Southern California is frequent hybridization with other native white oaks. Although hybridization does not cause large population declines, it can lead to introgression and genetic swamping for the rarer species, and makes taxonomic distinctions difficult in the field, thus hindering the conservation of these populations (Fryer. 2012). Other problematic species are herbivores; browsing from mammals such as White-Tailed Deer (*Odocoileus virginianus*) and Mule Deer (*Odocoileus hemionus*) is a common threat for oaks species across the US.

Quercus oglethorpensis *(Matt Lobdell)*

Box 3: Oak Fire Ecology

By Christy Rollinson, The Morton Arboretum

Changes in fire regimes over the past century have been linked to changes in oak distributions across the United States. Oaks in North America are widely associated with moderate fire regimes in terms of both frequency and severity. Thick bark at maturity and well-developed root systems as seedlings help many oaks survive fires that kill off many fire-intolerant competitors. Oaks are also often moderately shade intolerant and unable to persist under a dense canopy, instead relying on high-light conditions created by periodic disturbances to successfully regenerate and ascend into the canopy.

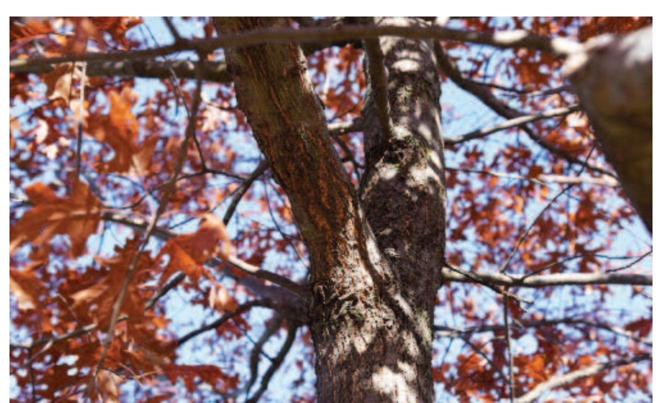
Widespread, active fire suppression in the United States has altered the natural disturbance regimes of many ecosystems and the effect this has on oak distributions varies regionally (Nowacki and Abrams 2008). In the eastern U.S., reduced burning has lead to the proliferation of shade-tolerant and fire-intolerant species such as maples that often characterize forests further north. However, a reduction in high-severity, stand-replacing fires in ponderosa pine forests in the West and longleaf pine in the South are allowing some oak species such as gambel's oak (*Quercus gambelii*) to encroach into historically pine-dominant areas. In the Midwest, transitions in fire frequency and severity were thought to structure the ecotones among prairies, oak savannas, and closed-canopy woodlands.

In recent years, land managers have increasingly reintroduced fire into the landscape through controlled burns, often in combination with selective harvesting to create canopy gaps, to attempt to restore the disturbance regimes historically responsible for determining oak species distributions (Brose *et al*. 2001). However, managers face several challenges in this

Quercus gambelii *habitat after fire* *(Ed Hedborn)*

process and the success of controlled burning for promoting oak regeneration has been mixed (McEwan *et al*. 2011). Although robust fire histories have been generated for much of the western US through tree rings, the historical frequency and severity of fire in the eastern US is less clear. In the western US, fire scars on surviving or dead trees have allowed the creation of multi-century fire history reconstructions with information on the timing, extent, and severity of fires. However, due to logging activity and faster decay rates, these old fire scar records are challenging to generate for the eastern half of the country. Some fire information can be gained through sediment charcoal in bogs and lakes, but these centennial-scale averages are difficult to translate into management practices. The timing of fire can also have a large impact on vegetation communities and influence the success of controlled burning for promoting oak regeneration. For example, a late spring burn may be hotter and more effective in reducing competitors for oak seedlings than an early spring burn. However, in management, the optimal timing of a burn for oak regeneration must be weighed against containment risks and other impacts on human activities in the area.

Quercus marilandica *(Deb Brown)*



Quercus velutina *(Deb Brown)*

Box 4: An ongoing threat to oak trees: Oak Decline

By Bruce D. Moltzan, US Forest Service

Quercus arizonica *(Hilary Cox)*

Oak decline is a broad term that encompasses a variety of biotic or abiotic stresses that impact the health of oak trees. Oak decline can occur across the entire range of US oaks in regions that have poor or no management, continual over harvesting, burning, grazing, and other non-sustainable forest stewardship practices. This condition worsens under episodic droughts and the advancing age of many oaks, resulting in an ever-growing number of dead and dying oaks. Damage from oak declines reduce acorn production, degrade timber value and create a higher risk of wildfires, as well as increased danger from toppling trees.

The most frequent outbreaks of oak decline have been in southern New England, the Middle Atlantic States, and the Southeastern States. Decline occurs most frequently among red (*Quercus rubra*), scarlet (*Q. coccinea*), pin (*Q. palustris*), and black oak (*Q. velutina*) and to a lesser extent among white (*Q. alba*) and chestnut oak (*Q. montana*). Many of these trees have managed to survive under less than ideal conditions. These stands are often crowded with large numbers of trees that are at least 70- to 80-years-old. Under prolonged drought, a multitude of stresses can gain advantage over the tree's defenses to the point where only dwarfed, sparse foliage, and thinning canopies remain. Branches in the upper crown die back from the tips as tree growth is reduced over multiple years. Various diseases and insects attack these weakened trees and, in time, the combination of stressors take their toll and the tree dies.
The disease agents involved in oak decline are often Armillaria and Hypoxylon fungi. The most common insects involved include the red oak borers, carpenter ants, and two-lined chestnut borers. These damage agents are native to North America. Most of the time, Armillaria acts as a decomposer, decaying coarse, woody debris that has fallen to the forest floor. When trees become stressed or wounded, this fungus can act as an aggressive parasite, attacking vulnerable root systems of stressed trees. Water uptake is reduced and enhanced in drought stressed soils. This causes the progressive branch die-back in the canopy creating pockets of oak mortality across broad landscapes.

The red oak borer is a reddish brown beetle that deposits its young larvae on the oak bark surface, which then chew through the bark and into the tree where they spend the next two years creating large diameter tunnels in the heartwood of the tree. These burrows further disrupt tree vigor increasing tree susceptibility to oak decline. Insects such as the two-lined chestnut borer tunnel in the outer sapwood just under the bark. Their tunnels wind around the trunk of the tree, disrupting the flow of food, nutrients and minerals.

Droughts and the resulting effects on oak forests are expected to continue in the future, but good management practices can help forests withstand these stresses. Preventing oak decline can be accomplished by sustaining the health and vigor of trees by increasing the diversity of tree species on the landscape, selecting species appropriate for the conditions of the site, and removing poorly-formed trees and trees with unhealthy crowns. Active management plans that restore and maintain the appropriate species on appropriate sites will improve forest health and reduce the need for drastic management intervention in the future.

adapted from: Lawrence, R., Moltzan, B. and Moser, W. K.: 2002, 'Oak decline and the future of Missouri's forests', Missouri Cons. 63, 11–18.

Conclusions and conservation recommendations

The Red List of US Oaks directly contributes to achieving the objectives of the Global Tree Assessment and greatly advances the collective knowledge of the state of the country's native *Quercus* species. This report identified that nearly one-quarter of US oak species that are of conservation concern (Threatened or Near Threatened). The majority of these species are concentrated in the south and the west. This pattern of species richness is also found for all US *Quercus* species. Conservation resources can be maximized by focusing on certain hotspot counties in Alabama, Texas, and California. Threats such as changing fire regimes, changing land use from farming and ranching, and problems from both native and invasive species have high negative impacts on threatened and non-threatened oak populations. Habitat alteration due to climate change will be a serious threat in the near future and land managers, as well as garden collection curators, should begin planning now.

The global assessments of US *Quercus* species can be used to guide further action by identifying high priority species in need of conservation action and drawing attention to areas that lack research. There are many initiatives already underway that use the Red List of Threatened Species to direct their actions.

US Native Oak Conservation Gap Analysis

Additional *ex situ* (cultivated) conservation of *Quercus* species within living collections is critical because oak acorns do not survive the conditions of a conventional seed bank (low temperature and humidity). It is essential to preserve oak genetic diversity through the development of living collections that are fully representative of each species' natural range. In light of this, BGCI-US and The Morton Arboretum are conducting a conservation gap analysis for native U.S. oaks, with support from the United States Forest Service and the Stanley Smith Horticultural Trust. This analysis incorporates *ex situ* collections data, *in situ* health and distribution of wild populations, as well as oak conservation programs and stakeholders. Using spatial and statistical analyses, the study is forming a complete understanding of gaps and needs for protecting threatened US oaks. This knowledge will be used to determine priority species and populations for implementing highest impact conservation actions. The protection of threatened species should be paired with programs aimed at increasing awareness and environmental education. The long term survival of natural habitats requires the involvement of local communities. Capacity building of these communities to protect local habitats will help to safeguard the future of global biodiversity.

Oaks of the Americas Conservation Network

The Oaks of the Americas Conservation Network (OACN) was born out of the International Workshop on Oak Conservation held in March 2016 in Morelia, Mexico as a collaborative effort between The Morton Arboretum, the National Autonomous University of Mexico (UNAM), and University of Minnesota, in partnership with BGCI and FFI. OACN is a consortium of researchers and conservationists at universities, botanical gardens, arboreta, NGOs and government agencies working to conserve threatened oak species throughout the Americas, with a focus on Latin America as a global hotspot for oak diversity. In an attempt to take an integrated approach to oak conservation in Mexico and Central America, OACN pursues research and conservation projects that span a variety of species, audiences, and methodologies. These projects involve international collaboration across different sectors to maximize the efficiency and effectiveness of the activities. Together these projects will forge new partnerships, strengthen the network of engaged conservationists in an oak diversity hotspot, build knowledge and capacity, and result in direct conservation action for several rare and threatened species of oak.

The US Native Oak Conservation Gap Analysis uses the *Red List of US Oaks* as the starting point for a deeper evaluation of the *ex situ* and in situ conservation gaps facing each threatened US species. The Institute of Museum and Library Services project *Safeguarding our Plant Collections* seeks to improve *ex situ* collections of threatened tree species, including oaks, through increased genetic diversity. Developing *ex situ* living collections of *Quercus* species is especially urgent because oak acorns cannot survive in a conventional seed bank. Collections that are fully representative of a species' natural range are essential in capturing the genetic diversity of oaks. Although oaks cannot be seed banked traditionally, there have been efforts towards nontraditional techniques of preserving plant material such as cryopreservation of oak germplasm (Kramer *et al*. 2012; Walters *et al*. 2016). This research is an important step in ensuring the preservation of oaks and other recalcitrant species.

While threatened taxa are obviously high priority candidates for conservation action, Data Deficient taxa require more research effort to improve our knowledge of taxonomy, population trends, threats, and range size. Without this information species will lack a clear conservation status, leaving them vulnerable to further degradation. Near Threatened species are also often overlooked, but they represent an opportunity to implement high impact species monitoring, where potentially minimal management can keep a species from becoming threatened. Near Threatened, along with Vulnerable species are more likely to still be important components of their ecosystems and communities as they have had fewer decline. Therefore, any conservation action taken will likely have more significant impact on the health of those communities.

Quercus stellata *(Deb Brown)*

The global assessment of *Quercus* species is just beginning; this report covers only 91 of the estimated 450 species of oak worldwide. The next phase of the global oak assessment will focus on Mexico, the country with the highest diversity of oak species, and Central America. The Oaks of the Americas Conservation Network (OACN) was created to further international collaboration on the research and protection of oaks in this region. This network, and the research and resources its experts produce, will be critical to completing the conservation assessments for *Quercus* species in Mexico and Central America.

As information continues to be gathered and applied to the Red List, it is clear that many species, habitats, and communities need protection. This report not only contributes to the goal of global assessments for all tree species, it also works to raise public awareness of threatened species and the importance of preventing global biodiversity loss. The assessments published in this report as well as future assessments of *Quercus* species should be used to assist conservation efforts for these species and inform decisions affecting their future existence and management.

Safeguarding our Plant Collections

By: Sean Hoban and Emma Spence,
The Morton Arboretum

One major criteria used to measure the value of an *ex situ* collection is genetic diversity. High genetic diversity gives a species the evolutionary capacity to evolve in the future, the ability to survive in a variety of possible reintroduction sites, and higher resilience to disturbances like heat waves. High genetic diversity in keystone species like trees can even help make entire ecosystems more stable. But how can a collector or curator ensure that an *ex situ* collection has high genetic variation?

The Federally-funded project, *Safeguarding our Plant Collections*, (IMLS National Leadership Grant MG-30-16-0085-16) is now examining *ex situ* conservation effectiveness, based on biological factors of the target plants. Specifically, it seeks to determine how we should sample species having different traits. Several gardens (Montgomery Botanical Center, Arnold Arboretum, Chicago Botanic Garden, The Morton Arboretum, National Tropical Botanic Garden) will develop collection strategies for threatened species, including two endangered oaks- Boynton's post oak (*Quercus boyntonii*) and Georgia oak (*Quercus georgiana*). This analysis will reveal how much of the overall genetic variation of the species is successfully preserved in collections.

In essence, this is a measure of conservation success for botanic gardens. These results can also highlight additional locations and amount of seed that should be collected for these threatened species for *ex situ* placement. This will be a major step in helping ensure that *ex situ* collections will have high value and utility for conservation, making the best conservation impact with limited time, money, space, and personnel.

Case studies

Hybridization and species boundaries: do oaks believe in free love?

By Chuck Cannon, The Morton Arboretum

Hybridization poses a challenge for the Red List in multiple ways. First, commonly occurring spontaneous hybrids have often been described in the taxonomic literature, adding a layer of confusion to Red List policies, which only recognize species, not hybrids. Secondly, in large species complexes, interspecies gene flow may be rampant and backcrosses between hybrids and their ancestral species frequent, species boundaries are difficult to define, both conceptually and geographically. These species boundaries are a necessary first step in a Red List assessment.

Oaks are notorious for being relatively unpicky in their choice of mates. Oak pollen is abundantly dispersed by the wind in the spring, and the onus falls on the mother tree to filter out all of these windswept suitors. Mother trees will occasionally accept pollen from other species, resulting in hybrid offspring.

Quercus bicolor *(Ed Hedborn)*

So, if oak trees hybridize between two different species, why do we still call them distinct species? The answer is surprisingly simple: because we can still recognize a red oak (*Q. rubra*) from a pin oak (*Q. palustris*) and a swamp white oak (*Q. bicolor*) from a bur oak (*Q. macrocarpa*). Scientists consistently find that morphologically, genetically, and ecologically, oaks form distinct species that nonetheless hybridize. While don't know exactly how oaks retain their species identities, the exchange in genes between species is not random and rarely involves those alleles (different gene copies) that make oak species distinct (Hipp, 2015).

Even though we don't expect hybridization to cause complete merger of oak species, pervasive gene flow even among "good" species might nonetheless erode biodiversity and dilute the ecological adaptiveness of each species. This has substantial impact on the ability of conservationists to conduct directed conservation action. Additionally, some worry that rare species may become 'swamped' by more common and successful species, as is the case with some populations of endangered *Q. georgiana*. The sheer imbalance in numbers, the argument would go, dooms the rare species to genetic dilution by the common species. Scientists are gathering data to assess this risk. While the jury is still out, preliminary work appears to suggest that hybridization prevails in cases where individual trees are embedded in a matrix of other species. Where rare species persist primarily as cohesive populations, we suspect that hybridization does not pose a significant biodiversity risk for oaks.

Hybridization in oaks may, on the other hand, play a helpful role in maintaining oak biodiversity, increasing the ability of oak species to adapt to changing environments. There are at least two ways this might work. First, hybrid individuals may fill newly arising niches in a changing environment, creating a new species. In oaks, there is evidence that this may well have been the route by which the widespread species *Quercus gambelii* arose. Second, as oak species appear to maintain their genetic identity even as they retain the ability to exchange genes, they may form an adaptive 'syngameon', an interbreeding group of species, which results in enhanced evolutionary potential of each species. Such a mechanism may enable oaks to rapidly adapt to climate change. Since oak trees can live for centuries, and climate can change dramatically over just decades, the climate is always changing rapidly from the perspective of oaks. Possibly the best way to deal with this situation is to believe a bit in free love.

Conservation genetics of *Quercus havardii*, a threatened arid-adapted shrub oak

By Sean Hoban, Chuck Cannon and Drew Duckett, The Morton Arboretum

Quercus havardii is a shrubby (typically ~50 cm tall) desert oak occurring in mixed sagebrush and grassland communities, sand dunes, and sandy plains in northwest Texas, western Oklahoma, and southern New Mexico, and a disjunct portion of the range in Utah and Arizona (Gucker 2006). The disjunct range has unresolved taxonomic status: some consider it a varietal form (havardii var. tuckeri or welshii), and others do not. Hybridization is observed in the eastern margins of its range where it meets post oak (*Q. stellata*), and in the western margins where it meets Gambel oak (*Q. gambelii*), and hybrid populations can produce tremendous variation in growth form and phenotype.

Shinnery oak is a foundational species, stabilizing sand dunes with its extensive root system; sometimes it is the only species found in deep sand dunes (Peterson and Boyd 1998). A shinnery oak stand or 'motte' often refers to a single clonal individual. Shinnery mottes provide excellent habitat for wildlife, particularly game birds, deer, and antelope. It is very drought tolerant due to specialized leaf and root adaptations. These traits may be of interest for ecological restoration, research and tree breeding. Most populations are small (<10 acres) and isolated, though a few larger populations (hundreds of acres) are known. It is important forage for many wildlife species, and is the main habitat of the lesser prairie chicken and dunes-sagebrush lizard, species listed as VU by IUCN.

This species is threatened by habitat loss due to increasing agriculture, urbanization, and oil and gas drilling. Landowners will often remove *Q. havardii* because it can be poisonous to livestock. Most *Q. havardii* habitat occurs on private rangeland, increasing its threat exposure. An additional threat is possibly low genetic variation due to highly clonal propagation - an unusual trait among US oak species. Seedlings are rarely observed even though acorns are abundant, so long-term population viability is uncertain. Regeneration from seedlings might occur only under special favorable circumstances in this typically harsh habitat.

Prior to 2015, shinnery oak was only protected in 1 public botanic garden, and the source for *ex situ* seed was entirely from Texas populations. In 2016, The Morton Arboretum, funded by the US Forest Service, and with the assistance of many local collaborators as well as the American Public Gardens Association, sampled from 39 populations and collected ~1700 seeds. Collections covered the entire range of

Clonal Quercus havardii *in the foreground (Sean Hoban)*

the species, including high altitude and low rainfall areas. This new *ex situ* collection is much more representative of the species' range and will likely bring useful new genetic material and new traits into collections. The seed was distributed to 11 institutions where its unusual habit can now be seen and appreciated by visitors and researchers. In sum, the species is now secure ex situ, being represented from many locations across its range, in multiple botanic gardens.

The Morton Arboretum is conducting several conservation genetic studies of this species. A primary question is the degree to which shinnery oak spreads via cloning. It is suspected that the species can live for hundreds of years and thus distinct clumps may have once been connected underground but may not be connected now. It is not known how large one plant can be. This is a key gap for conservation assessment, because it is currently not possible to definitively state the population size. By examining clonality at many sites, one can also understand what aspects of the environment might make shinnery oak become more clonal (e.g. soil type, less rainfall). Although clonal propagation does decrease genetic variation, it might help a species survive for a long time in a harsh environment, or to spread in locations where it is rare for a seedling to survive. Finally, it is not known to what degree shinnery oak populations have declined over time, but it has been speculated that in the past shinnery oak was more common and populations were more connected during wetter climates. Answering these questions through genetic analysis will inform the conservation strategy for this important and unusual oak species.

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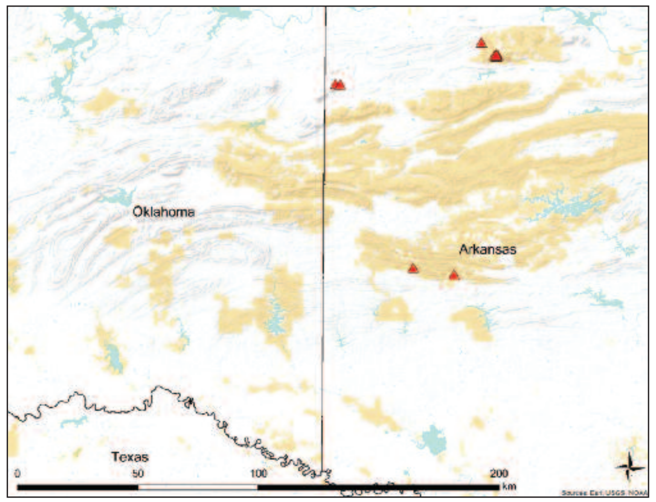
SPECIES ASSESSMENTS

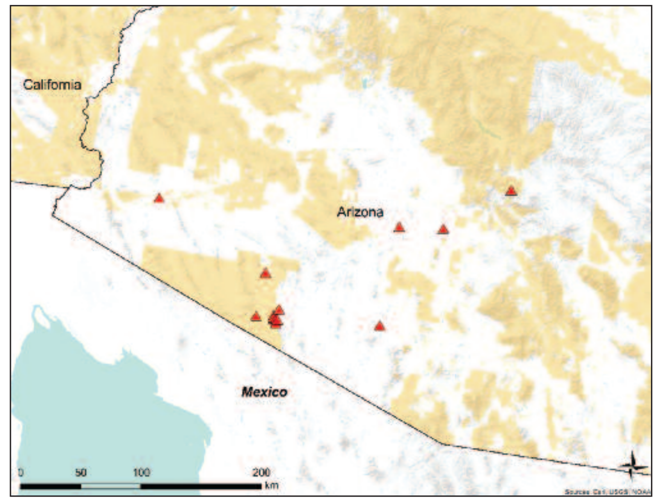
Species evaluated as threatened:

Quercus acerifolia (E.J.Palmer) Stoynoff & Hess
EN B1ab(iii)+2ab(iii)
AR



Maple-leaved Oak grows as a small tree or large shrub; typically three to nine meters tall. It is distinctive due to its palmately lobed, maple-like leaves. Only four occurrences of Maple-leaved Oak are currently known in the Ouachita Mountains of Arkansas. Primary threats to Maple-leaved Oak are land use change and degradation, potential destruction of habitat and scientific specimen collection. The subpopulation at Sugarloaf Mountain, which holds more than half of the total number of individuals, lies on privately owned land where no protective status or conservation agreement exists as of 2003. Following Western settlement of the area, changes to the ecology of Magazine Mountain (where the second largest and best-documented occurrence is found) have disrupted the disturbance regime of the site. Suppression of fire has led to a decline in the early successional open-canopy woodland in which *Quercus acerifolia* thrives. The total population is believed to number fewer than 600 individuals, with just a few dozen to a few hundred individuals per locality. Its distribution is extremely restricted with an extent of occurrence of 3,520 km^2 and an area of occupancy of between 7 km^2 and 24 km^2. Due to its highly restricted geographic range and small population size, combined with its small number of locations and the ongoing degradation of its habitat, *Quercus acerifolia* is considered Endangered.
Assessor(s): Wenzell, K., Kenny, L. & Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 70, 117, 172, 215, 218, 238, 241, 286

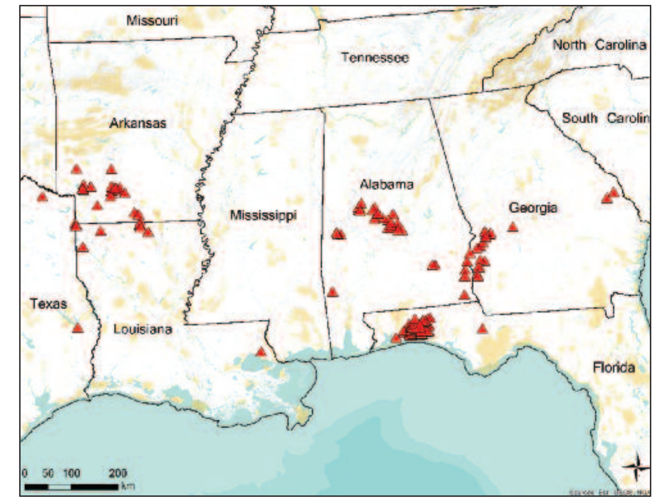
Quercus ajoensis C.H.Müll.
VU B2ab(iii)
AZ, NM, MX-BJ, BS



Quercus ajoensis is a spreading, evergreen shrub that reaches up to 2 to 3 meters in height. *Quercus ajoensis* grows in moist canyon bottoms, on grassy slopes, and at the bases of high north-facing canyon walls. The only genetically distinct individuals of *Quercus ajoensis* occur in the Ajo Mountains of Arizona and the most Northwestern parts of Mexico. It has a limited geographic range and is generally a rare species. In Mexico, the species has been virtually uncollected since the first half of the 20th century. Historic occurrences in New Mexico, Colorado, and Yuma County Arizona are hybrids or extremely introgressed with Quercus turbinella. Introgression has also been found in the Ajo mountains population; additionally *Q. ajoensis* is susceptible to desiccation due to the long term drought in Arizona. *Quercus ajoensis* could be considered Endangered as the area of occurrence found using the available herbarium collection data is low enough to pass the Endangered threshold for criteria B2 (AOO 84 km^2). However there has been very little sampling of *Q. ajoensis*, especially in its Mexican population, therefore a more conservative assessment of Vulnerable is being used. That being said, the taxon is part of a poorly understood species complex which requires taxonomic revision.
Assessor(s): Kenny, L., Wenzell, K. & Jerome, D.
Reviewer(s): Oldfield, S.
Refs: 20, 31, 68, 70, 146, 172, 182, 220, 257, 269

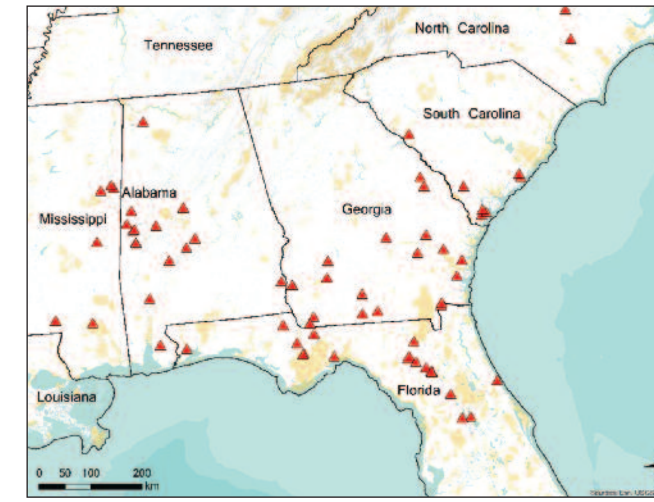
Legend: * Presence uncertain CAN: Canada MX: Mexico Protected Areas Location

Quercus arkansana Sarg.
VU B2ab(ii,iii,v)
AL, AR, FL, GA, LA, TX



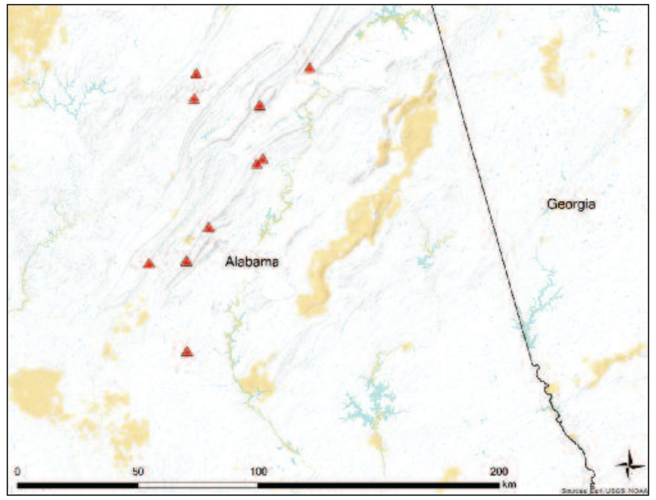
Arkansas Oak, a small- to medium-sized shade-loving tree, can reach heights of 15 m but is often much smaller, about one to eight meters in height. This species favors fine loamy sand and other well-draining sandy soils. Restricted to the Coastal Plain of the southeastern United States, Arkansas Oak is a likely relict species that occurs sporadically in isolated stands. Despite its wide range from Georgia to eastern Texas (with an estimated extent of occurrence of roughly 345,000 km^2), its small, fragmented occurrences give it a restricted area of occupancy of about 1,000 km^2. Throughout the majority of its range, *Q. arkansana* occurs in small subpopulations many occurrences holding only a few (one to five) to a few dozen individuals. This species is severely fragmented, with most subpopulations too isolated to allow for seed dispersal between occurrences. Threats from commercial logging, conversion of habitat to pine plantations, and unfavorable land management continue to drive declines in habitat quality and population size. Private land ownership of many sites and introgression from more common red oaks (particularly in light of this species' ecology and sporadic distribution) pose additional threats to Arkansas Oak. *Quercus arkansana* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L., & Jerome, D.
Reviewer(s): Rivers, M.C.
Contributor(s): Beckman, E.
Refs: 10, 21, 70, 71, 73, 80, 101, 114, 115, 117, 172, 179, 82, 189, 196, 199, 214, 248, 266

Quercus austrina Small
VU B2ab(ii,iv,v)
AL, AR*, FL, GA, MS, NC*, SC



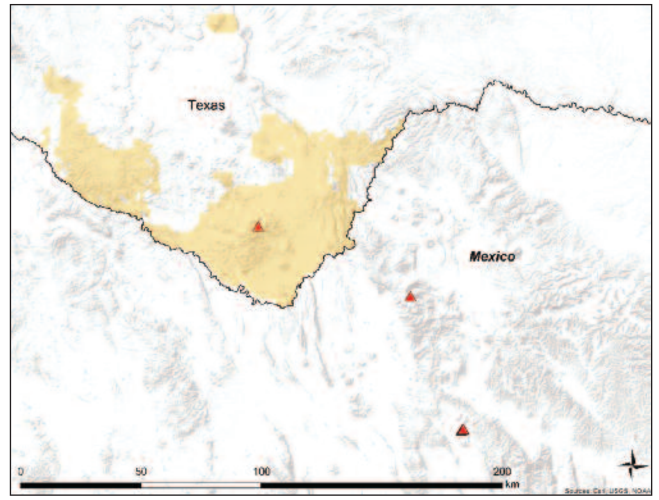
Bluff Oak is a relatively small tree, typically reaching about 20 meters in height. Most remaining *Q. austrina* are found on the flat tops of wooded bluffs and nearby ravines which edge streams throughout the Southeastern Coastal Plain. Its range is largely restricted by its habitat specificity and rarity. Isolated occurrences sprinkle the woods of the sandy, mesic coastal plains where regeneration is difficult. *Quercus austrina* is endemic to the Southeastern Coastal Plain of the United States, ranging from the coasts of North Carolina, South Carolina, and Florida, to southern Georgia, central Alabama, eastern Mississippi, and Arkansas (historically). Its native altitude range is 0 to 200 meters above sea level. 1,500 km^2 was used as a reasonable, if not slightly high, estimate for area of occupancy. *Q. austrina* faced large amounts of land clearing for agriculture as well as extensive logging in the 19th and first half of the 20th centuries. In the last 50 years land conversion has generally slowed within the species' remaining habitat patches, but stress from recreational activities within protected areas, accelerating climate change, and factors not yet understood create enough disturbance that regeneration is little to none at most sites. Continuing decline is therefore projected for the population as older trees die and are not replaced, leading to disappearance of the smallest, isolated subpopulations. The majority of localities occupied by Bluff Oak only contain a few individuals and exist more than 50 km from the nearest separate patch. These subpopulations cannot support themselves without human management, and exhibit the species' current severe fragmentation. Therefore, *Q. austrina* is assessed as Vulnerable under Criterion B2.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Contributor(s): Lobdell, M., Lance, R., Phelps, D. & Black, A.
Refs: 11, 35, 53, 59, 62, 65, 70, 107, 111, 135, 202, 231, 262, 267, 275, 278, 285

Quercus boyntonii Beadle
CR C2a(ii)
AL, TX (Extinct Post- 1500)



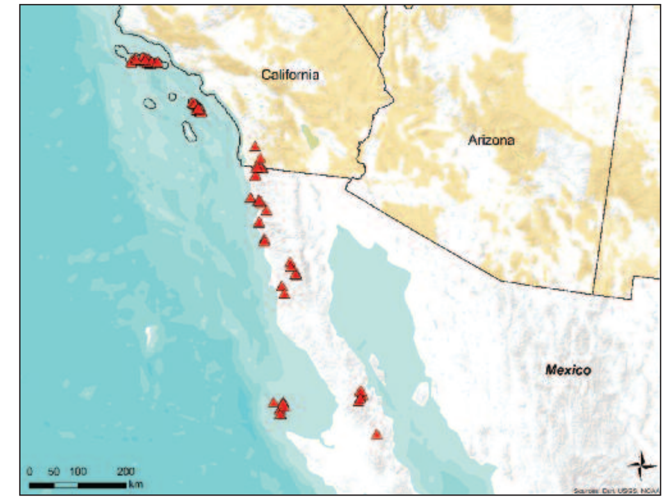
Quercus boyntonii is rare with a restricted occurrence in the southern parts of the United States. This species is known to occur on the summit of Lookout Mountain in Etowah County, Alabama. Additionally, *Q. boyntonii* is historically known from Angelina County, Texas. Very little research exists on a quantified population prior to the extirpation of this species in Texas. There have been no insights as to this species' generation length. This species has an extent of occurrence of 4,157 km^2. The most pervasive issue that threatens *Q. boyntonii* is urban development. As *Q. boyntonii* grows on rock outcrops, the habitat is not necessarily conducive for development; however, threats that are associated with development such as ATV use, trash disposal and cutting for firewood are of biggest concern. In 2010, 13 known sites in Alabama were found to contain the species with roughly 200 individuals in total, both immature and mature. Under criteria D, this species would fall into the Endangered category. However, with subpopulation being extirpated in Texas, it can be said that this species has now been reduced to one subpopulation in Alabama, since occurrences in Alabama are situated close enough in proximity to one another for gene flow and exchange to still be plausible. With continuing decline and all individuals in one subpopulation, this species qualifies for a higher listing under criterion C. Under criterion C this species qualifies as Critically Endangered.
Assessor(s): Kenny, L., Wenzell, K. & Beckman, E.
Reviewer(s): Rivers, M.C.
Refs: 70, 117, 172, 197

Quercus carmenensis C.H.Müll.
EN B1ab(iv)
TX, MX-CU



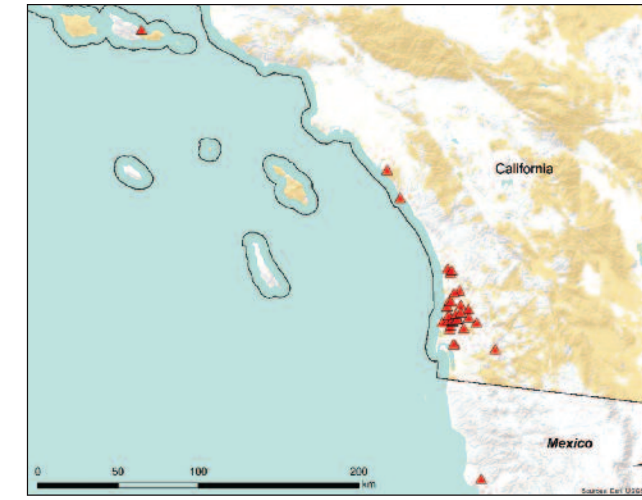
This species is only known from the Sierra del Carmen region in Coahuila, Mexico and the Chisos Mountains in Texas. It is considered to be threatened in Texas and of conservation concern in Mexico. Quantitative information on the population of this species does not exist, though observations of subpopulations in Texas describe no more than a few thousand individuals to occur and in Coahuila only few trees have been confirmed. With all occurrence data mapped, including the subpopulation in Texas where introgression is apparent, this species' extent of occurrence is estimated to be 1,792 km^2, meeting the threshold for the Endangered category. This species also only has three locations, with one in Texas and two within the mountains of Mexico, separated by a major road. This species does occur in the Maderas Del Carmen Flora and Fauna Protection Area, however, a combination of communal land use for agriculture and grazing as well as private land holdings continue to exist within the boundaries of the Sierra del Carmen region, which may pose future threats for this species. Throughout the Chisos Mountains, this species' restricted range poses a threat to its vitality, and only a few individuals have been positively identified over the past 30 years during multiple surveys. The most vibrant subpopulation observed within the Chisos, at the Laguna Meadows site, is confirmed to be hybridising regularly with *Q. intricata* and therefore may be experiencing a threat to its integrity. If introgression continues with the Texas subpopulation on Chisos Mountains, the number of true *Q. carmenensis* subpopulations will be reduced. This species is therefore given a listing of EN B1ab(iv).
Assessor(s): Kenny, L., Wenzell, K. & Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 70, 117, 126, 172, 182, 201, 274

Quercus cedrosensis C.H.Müll.
VU B2ab(ii,iii,v)
CA, MX-BJ, BS*



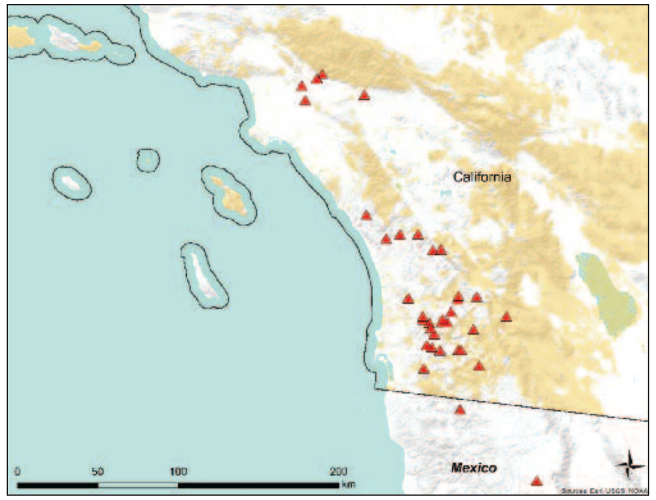
Quercus cedrosensis occurs in in the northern half of Baja California (Mexico), and on Cedros Island located off the west coast of the peninsula. Recent discoveries have also documented a small population near the Otay Mountains (California, USA) just north of the border with Mexico. *Quercus cedrosensis* has a fairly large range, but a small number of isolated subpopulations. It has an area of occupancy between 200 km^2 and 2,000 km^2. In southern California, as well as northern parts of Baja California (Las Californias Region), this species is threatened by habitat loss due to land use changes. These changes include road construction, Border Patrol activities, and urban and rural development. Southern California occurrences are 0.5-1.5 meters from the Mexican border, making these localities very sensitive to "security" issues. This area is closely surveillance by U.S. authorities for illegal immigration issues and a triple fence was erected, destroying part of the vegetation of this region. Traffic control infrastructure was more recently implemented further implicating the survival of other specimens of this shrub oak. From 2004-2014 in the Las Californias region alone, about 435 km^2 area has been attributed to direct habitat loss; half of that lost compromises rare communities. Effects of these losses include habitat fragmentation, unnatural fire regimes, clearing/logging, and habitat type conversions. Though quantified population information does not exist for this species threats continue to drive declines in area of occupancy, habitat quality, and the number of subpopulations. Based on these factors *Quercus cedrosensis* is considered Vulnerable.
Assessor(s): Kenny, L., Wenzell, K. & Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 38, 39, 66, 146, 166, 168, 176, 236, 281

Quercus dumosa Nutt.
EN B2ab(ii,iii,iv,v)
CA, MX- BJ



Until the beginning on the 21st century, the species name "*Quercus dumosa*" referred to many species of shrubby white oaks in California. The majority of these species are found in southern California within close geographical proximity to one another, but generally do not occur in mixed stands. *Quercus dumosa* is known to be rare and in decline, facing compounding past and future threats. The most pervasive threat to Coastal Sage Scrub Oak is human development along the coast leaving very little intact habitat. Past misclassification of other *Quercus* species as 'dumosa' likely hindered possible conservation initiatives during times of extreme human development since the rarity of this species had not yet been discovered. Altered fire regimes, due to both human influence and climate change impacts, are also believed to be a source of some threat. The extent of occurrence (EOO) is calculated to be about 12,500 km^2 and area of occupancy (AOO) is 620 km^2. Only three locations remain for *Q. dumosa*: one cluster in far southern California, another near Laguna Beach, and a final location further north near Santa Barbara. The Laguna Beach location is facing the most stress currently, and may be lost to development. Using Criterion B, the EOO places Coastal Sage Scrub Oak in the Vulnerable category, while the AOO leads to an assessment of the species as Endangered. The AOO, extent of habitat, number of locations, and the number of mature individuals are all projected to continue declining if no changes occur regarding the trajectory of current threats.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Contributor(s): Meyer, E. & McIntyre, P.
Refs: 24, 31, 38, 39, 46, 70, 78, 84, 132, 172, 185, 217, 223

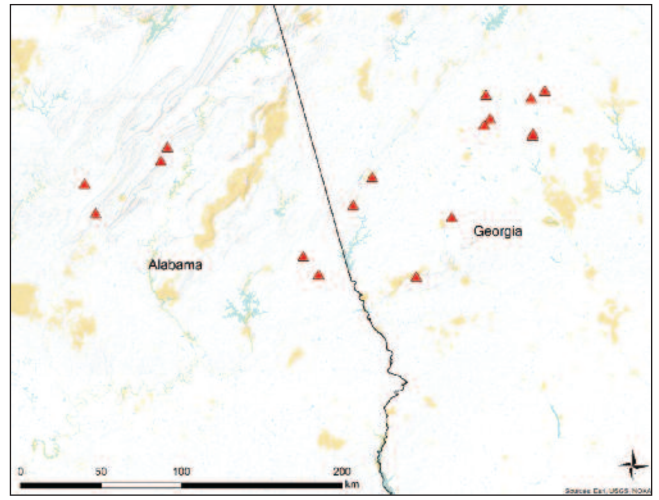
Quercus engelmannii Greene
EN A3c
CA,MX- BJ



Quercus engelmannii is a rare oak of California and Baja California with particular habitat requirements. The current natural population of Engelmann Oak is scattered among restricted habitats which maintain at least fifteen inches of rainfall per year, rare instances of frost, and moderate summer temperatures. There are many current threats to *Q. engelmannii*, such as fragmentation due to suburban sprawl and human induced wildfires. The 2003 Cedar Fire burned approximately 53% of monitored trees within the Santa Ysabel Open Space Preserve. This preserve is within the Black Mountain region, where the vast majority of the population of *Q. engelmannii* is located.

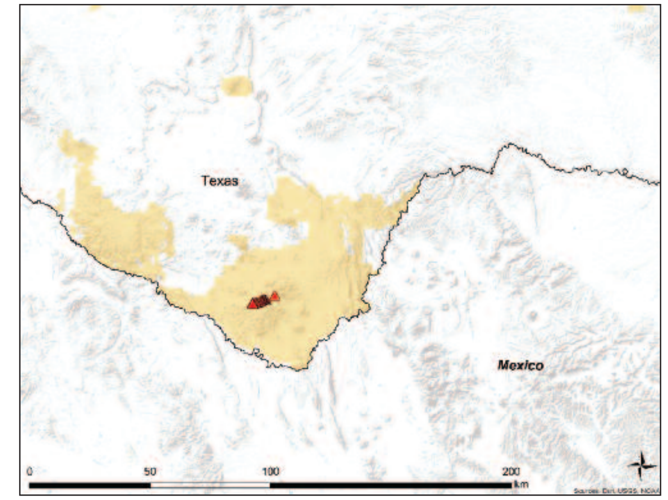
With an area of occupancy of approximately 1,200 km^2, continuing decline based on various ways of measuring, and only two locations, *Q. engelmannii* can be classified as Vulnerable under B2. The species can also be assessed as Vulnerable A2c. The 1998 Red List publication listed this species as A1c, but it is now believed that some of the causes of past reduction such as land use and development have not ceased. Recent studies have projected a greater population decline in the future due to continuously shifting and unpredictable climates. A dynamic species distribution model (suitable habitat prediction) was combined with a stochastic, stage-based metapopulation model (prediction of population trajectories), to found that the possible effects of shifting dispersal, fire, and masting values caused a 33 to 61 percent decline in total population by the year 2100. Taking a slightly generous approach, a 50 percent decline falls roughly between these two predicted extremes. This places *Q. engelmannii* in the Endangered category under A3c.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 22, 36, 38, 50, 70, 79, 119, 123, 125, 145, 163, 174, 180, 203, 205, 243, 264

Quercus georgiana M.A.Curtis
EN B2ab(i,ii,iii,iv,v)
AL, GA, NC*, SC*



Abundant at only a few localities, Georgia Oak is restricted to small occurrences on isolated granite outcrops in the Piedmont Plateau of the southeastern United States. This species is believed to have an area of occupancy of 72-272 km^2. Georgia Oak is known from three counties in Alabama and 14 counties in Georgia. Historic occurrences in South Carolina are now considered extirpated, and a single occurrence in North Carolina is considered eradicated due to heavy introgression and non-viable subpopulation size. Throughout its restricted range, occurrences of *Q. georgiana* are small and geographically isolated. However, despite the geographic distance between occurrences, a recent molecular analysis of the species' genetic diversity revealed evidence of gene flow and low genetic isolation between subpopulations, suggesting these occurrences are not genetically isolated enough to be considered severely fragmented. However, this apparent gene flow could be a relict of past interconnectedness, and negative consequences of fragmentation may still remain to be seen. This study sampled approximately 25 individual trees each from nine occurrences in Georgia and Alabama (suggesting the population size is at least greater than 225 individuals). Notably, two subpopulations in Georgia were not sampled because trees were infrequent or not positively identifiable, indicating that these occurrences may be declining and/or suffering from introgression. Additional threats to Georgia Oak include drought, climate change, as well as soil compaction and trampling from tourism and recreation, particularly at Stone Mountain, a popular recreation site where the plant was first discovered.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 8, 28, 41, 70, 79, 83, 110, 117, 140, 142, 172, 187, 244, 249, 253

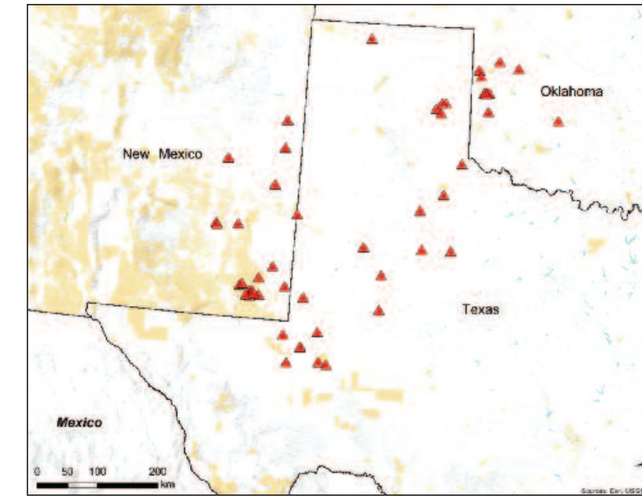
Quercus graciliformis C.H.Müll.
CR C2a(ii)
TX, MX-CI*, CU*



Quercus graciliformis (Slender Oak) is a unique and isolated oak, with a small, specialized habitat. It grows within dry, oak woodlands lining the canyon floors of the Chisos Mountains, and is especially known to be present in areas with a high water table. Only one population (Blue Creek Canyon, Brewster County, Texas) has been verified and well-documented, with one other nearby area recorded but needing further research (Juniper Springs). All reported locations of Slender Oak within Mexico cannot be considered accepted at this time due to taxonomic confusion. More than one misidentification has been discovered in the last few decades, as older herbarium specimens are studied again, which has raised overall doubts as to the accuracy of past identifications within Mexico. Using only the Chisos Mountains of Texas localities, the Area of Occupancy is calculated to be 24 km^2. The total number of known mature individuals rests around 100 or more, but this needs field confirmation. Continuing decline in population size, extent of occurrence, and area of occupancy are not currently evident, but it has been observed that recruitment rates will lead to a population decline in the future if no changes occur.

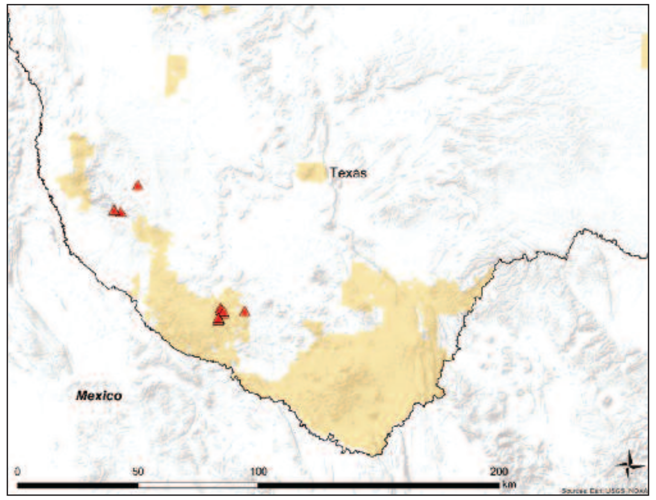
Under Criterion B2, Q. graciliformis falls within the Endangered category. But, because there are less than 250 mature individuals total, continuing decline projected, 90-100% of verified mature individuals in one subpopulation, this species is Critically Endangered under Criterion C2.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S
Contributor(s): McNeil-Marshall, A.
Refs: 6, 31, 70, 103, 121, 175, 197, 201

Quercus havardii Rydb.
EN A2bc
NM, OK, TX, UT*



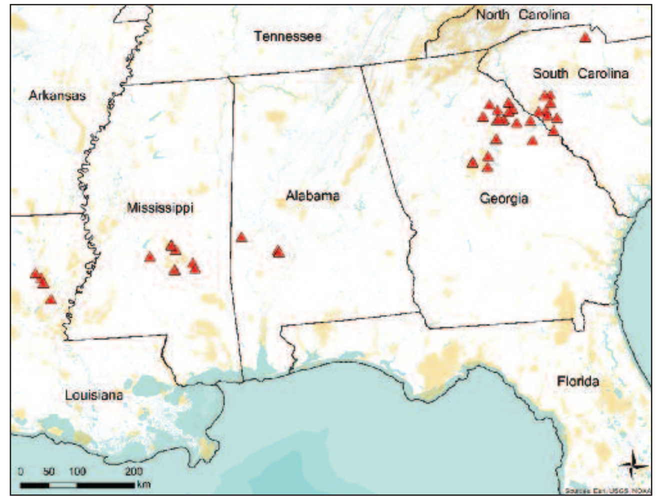
Quercus havardii defines Sand Shinnery communities and has historically occupied five to seven million acres of the Southern Great Plains. It occurs primarily underground, with only one-tenth of the plant standing 0.6 to 0.8 meters above ground level. This species extensive underground system of horizontal stems extends 5 to 6 m below the surface, which supports and stabilizes the dynamic dune system. *Quercus havardii* reproduces almost exclusively via underground rhizomes, which makes distinguishing individuals within subpopulations difficult. Percentage population decline can be calculated using an estimated density of 6.07 distinct individuals per acre, historic range area, and the percentage of that range lost due to human disturbance for Shinnery Oak subpopulations in New Mexico, Oklahoma, and Texas. There is, however, some question surrounding the definition of an individual due to the clonal nature of the species, as well as corresponding generation length. Here we use genets, rather than above-ground shoots, as an 'individual,' to reflect the population size of this mostly clonal species. *Quercus havardii* contains individual clonal systems that carry the same genetic makeup and can date back as far as hundreds to thousands of years. However, individual shoots live no longer than 15 years. To include a lifespan over thousands of years would severely overestimate this species longevity. Sexual reproduction is still possible for *Q. havardii*, although rare. Considering multiple estimates for the average lifespan of above-ground shoots, a generation length of between 11 and 15 years is concluded. The percent population reduction was calculated using an 11, 15, and 100- year generation length and then averaged across the three values; resulting in a value of 58.3%. This average reduction qualifies *Q. havardii* for Endangered under criteria A2.
Assessor(s): Kenny, L., Wenzell, K. & Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 55, 57, 76, 95, 117, 159, 167, 194, 229, 238, 261, 283

Quercus hinckleyi C.H.Müll.
CR C2a(ii)
TX, MX - CI*, CU*



Quercus hinckleyi is an ancient species that has persisted through extensive ecological pressure. It is still fighting for survival today, and existing threats have become even greater through human impact. Hinckley's Oak can be found in the northeast part of Big Bend Ranch State Park as well as near Shafter, Texas, just northwest of the state park's limits. Acorn production has been observed at the Shafter site, but there is no evidence of sapling recruitment there. While there is more evidence of sexual reproduction (through acorns) at the Big Bend Ranch State Park sites, the limited numbers of individuals there present barriers to population growth. If this trend continues, it is likely the population will decline further. The oak's extent of occurrence (380 km^2) and area of occupancy (30 km^2) both fall within the Endangered category under Criterion B, with a probable continuing decline in area of occupancy, extent and quality of habitat, and the number of mature individuals, due to immediate anthropogenic effects as well as predicted climate change. But the species also has a population size of approximately 123 genetically distinct individuals split between two main subpopulations (Shafter and Solitario), with between 90 and 100 percent of the individuals located in the Solitario subpopulation. This brings the threat status to Critically Endangered within Criterion C.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Contributor(s): Backs, J.
Refs: 23, 25, 31, 259, 260

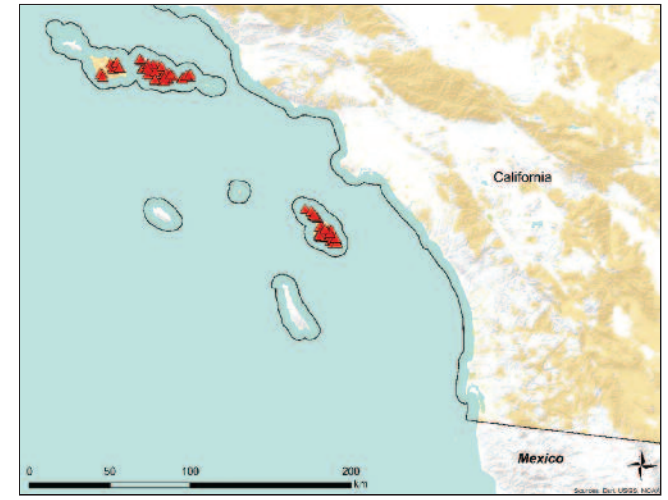
Quercus oglethorpensis W.H.Duncan
EN C2a(i)
AL, GA, LA, MS, SC



Quercus oglethorpensis has a patchy distribution in southern US, with an estimated area of occupancy between 500 and 2,000 km^2, and the potential of severe fragmentation, if more data is gathered regarding population size and density. It is believed currently that land-use changes pose that largest threat to *Q. oglethorpensis*, but most areas that could be cleared for agriculture, silviculture, or urban development have already been converted, leaving wetter areas or road-side occurrences remaining. From 1940 to 1990, about 10% of known *Q. oglethorpensis* trees were lost to habitat destruction and disease. Dry-season fires pose a further concern, since Oglethorpe Oak seedlings and saplings are fire-intolerant. Many ongoing and potential threats, as well as evidence of little recruitment, point to a continuing trend of population decline, even if levels of destruction have reduced since mid-20th century. These qualifications would place the species within the Vulnerable category of Criterion B2.

Looking at the current knowledge of population size, the number of mature individuals remaining can be estimated at 1000, with less than 250 mature individuals in each subpopulation. These values fall within the requirements for Endangered C2a(i). Since this is the higher of the two possible threat levels, the species is assessed as Endangered due to a small population size consisting of small, isolated subpopulations.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Contributor(s): Wood, J. & Lobdell, M.
Refs: 31, 45, 48, 79, 98, 150, 151, 172, 202, 227

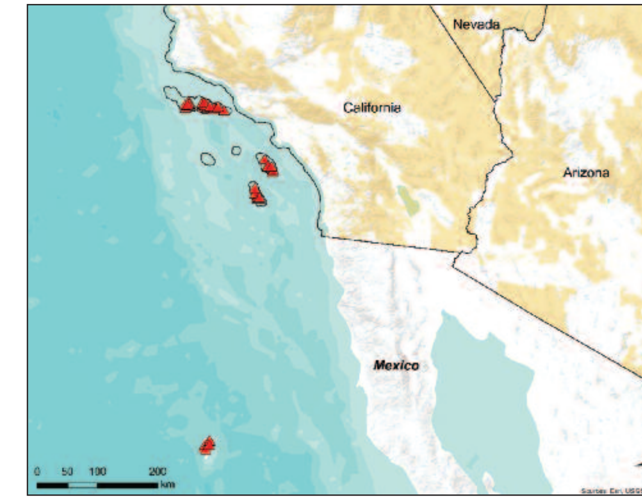
Quercus pacifica Nixon & C.H.Müll.
EN B1ab(v)
CA



Quercus pacifica is a rare oak species, endemic to three of the California Channel Islands: Santa Cruz, Catalina, and Santa Rosa. Between 1943 and 2005 31% of the west end of Catalina Island's oak habitat had been lost. Little is known about the population declines before 1943 and no predictions can be made to the future, therefore population decline over three generations has not been calculated.

The extent of occurrence for Island Scrub Oak is approximately 3,800 km^2, and the species has between one and three locations, which places it into the Endangered category under criterion B1. But, since most data is island-specific and was taken at different times into the past, it is unknown whether the entire population is currently continuing to experience decline. It is likely that habitat restoration and replanting of saplings have offset any continued decrease in the total number of both immature and mature individuals, but available information points to continued decline in the number of mature individuals presently, as the new generation catches up to the older generation which experienced extensive disturbance and dieback. Because of this population lag, *Q. pacifica* is listed as Endangered under criterion B1ab(v). Due to ongoing conservation efforts and ongoing improvements in the species' vitality due to the removal of some key threats, recovery of *Quercus pacifica* is promising as the newly planted generation matures.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 24, 56, 70, 117, 137, 138, 139, 192, 193

Quercus tomentella Engelm.
EN B2ab(i,ii,iv,v)
CA, MX-Guadalupe I.



Quercus tomentella is found only on the Channel Islands (Santa Rosa, Santa Cruz, Anacapa, Santa Catalina, and San Clemente) off the coast of California and Guadalupe Island off the coast of Mexico. Population disturbance has been evident on the Channel Islands since the increase of agriculture and ranching, which caused dramatic vegetative changes by the late 1800s and early 1900s, as supported by records of increased non-native plant species. Each island has a slightly different story to tell, involving varying degrees and types of habitat cover affected by agricultural use and destruction from introduced sheep, goats, and pigs. In 1997, the Catalina Island Conservancy began a restoration program and successfully removed all feral goats and pig. With the successful removal of introduced herbivores in the late 20th century, subpopulations of *Q. tomentella* on the United States' Channel Islands are likely increasing slowly; or, in the least, these subpopulations are stable at present. This species of oak has an area of occurrence of between 200 and 250 km^2 and a maximum number of locations at 5. Due to these factors *Quercus tomentella* has been listed as Endangered, under criterion B2ab(i,ii,iv,v).
Assessor(s): Beckman, E. & Jerome, D.
Reviewer(s): Oldfield, S.
Contributor(s): Ashley, M.
Refs: 7, 31, 33, 54, 70, 79, 100, 118, 124, 149, 157, 191, 213

Species evaluated as near threatened:

Quercus lobata Née
NT
CA
Although it has an extensive estimated extent of occurrence of nearly 280,000 km^2, *Quercus lobata* suffers from fragmentation and declining habitat due to agricultural and urban expansion. *Quercus lobata* comprises necessary habitat for multiple state-threatened species such as Swanson's Hawk, Sandhill Crane, and Yellow-billed Cuckoo, as well as the federally-threatened Elderberry Longhorn Beetle. The most extensive Valley Oak woodlands and savannas now exist in Coast Range valleys. Valley Oak is also likely to experience habitat shifting and contracting due to climate change leading to a decrease in both the quality and the extent of its habitat. Projections for this decline vary. Due to the high degree of nuclear genetic variation in *Quercus lobata*, the decline of the species will not be consistent across its range therefore a conservative estimate of 27% decrease in suitable habitat by 2099 is being used. Using this projection *Quercus lobata* is Near Threatened under A3c.
Assessor(s): Beckman, E. & Jerome, D.
Reviewer(s): Oldfield, S.
Contributor(s): Kaproth, M.
Refs: 31, 37, 63, 112, 144, 155, 172, 186, 191, 198, 209, 210, 258, 267, 273

Quercus palmeri Engelm.
NT
AZ, CA, NM, MX- BJ
Palmer oak is relatively sparsely populated throughout its range, with a higher concentration of individuals located further south within the coastal Transverse and Peninsular Ranges. *Q. palmeri* generally occupies lower elevations. It generally takes the form of a shrub or small tree, between 1 and 3 meters tall, but can reach up to 6 meters. Although *Quercus palmeri* does not fall into any of the threatened categories currently, some concerns should be noted. Continuing declines due to commercial development, fragmentation, human impacts, climate change, etc. could quickly lead to classification as threatened, depending on rates of decline. The worst-case estimate of area of occupancy is 2,800 km^2, and future population reduction predictions are very likely at least 30% within three generations based on knowledge of trends seen for other similar *Quercus* species within its range. Because current and specific data is lacking, Palmer's Oak is listed as Near Threatened as it approaches thresholds for multiple criteria (A3c and B2b(ii,iii)).
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Contributor(s): Kaproth, M.
Refs: 31, 70, 79, 99, 136, 158, 172, 191, 217, 222, 284

Quercus parvula Greene
NT
CA
The Santa Cruz Island Oak is limited to Santa Cruz Island and a few coastal localities in Santa Barbara County, California. In 2007 *Quercus parvula* var. *parvula* was assessed as EN B1ab(ii,iii)+2ab(ii,iii) and *Quercus parvula* var. *tamalpaisensis* as EN B2ab(i). The variety *Quercus parvula* var. *shrevei* was not assessed. These previous assessments were based on small localized populations and threats such as habitat degradation and grazing. In this species-level assessment, the same threats remained for all three varieties. However, Quercus parvula is facing additional threats such as Sudden Oak Death, severe drought conditions and the increased forest fires in 2015. It almost qualifies for a threatened listing under criterion B2, because of its small area of occupancy and continuing decline, but does not qualify because the species occurs at more than ten locations and the population is not severely fragmented. Field surveys are required to determine the impacts of the recent droughts and fires on this species.
Assessor(s): Kua, C.-S.
Reviewer(s): Oldfield, S.
Contributor(s): Kaproth, M.
Refs: 70, 75, 89, 104, 117, 123, 134, 143, 172, 182, 191, 212

Quercus sadleriana R. Br. ter
NT
CA, OR
Although *Q. sadleriana* has an extent of occurrence of 14,000 km² which could qualify the species as Vulnerable, this oak species is not currently reaching any of the other requirements to be assessed under Criterion B1. This is mostly due to its presence in large, nationally-protected forests. The species may be facing continuing decline in its subpopulations due to development and recreational activities even within protected areas, but there is no current and substantial evidence for a continuing decline of the population as a whole; more research is necessary to determine if Vulnerable would be a more accurate assessment of *Q. sadleriana*. In the interim the species is listed as Near Threatened as it almost qualifies for a threatened listing under criterion B1 and is clearly dependent on ongoing conservation efforts to protect it.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Contributor(s): Kaproth, M.
Refs: 31, 70, 117, 123, 170, 172, 183, 228

Species evaluated as data deficient:

Quercus robusta C.H.Müll.
DD
TX, MX*
Quercus robusta is believed to be endemic to the Chisos Mountains range of southwest Texas, and currently known from one small area in Big Bend National Park. There is continued taxonomic debate surrounding the status of this species, with C. H. Muller describing the species in 1934, deeming it a hybrid between *Q. emoryi* and *Q. gravesii* in the mid-20th century, and finally reviewing the case again more recently and concluding Robust Oak to be a true species. Because there is not yet agreement regarding the taxonomic status of *Q. robusta*, more research will be necessary before a full assessment is possible. This leaves the species within the Data Deficient category. If species status is further supported, the species would very likely fall into the Critically Endangered category under criterion D, with less than 50 individuals remaining.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Contributor(s): McNeil-Marshall, A.
Refs: 31, 70, 72, 172, 184, 197, 268

Quercus tardifolia C.H.Müll.
DD
TX*, MX-CU*
Quercus tardifolia is only agreed to be found in Big Bend National Park, and is currently under taxonomic debate. Many believe the tree is a rare hybrid occurrence of Q. gravesii and either *Q. hypoxantha* or *Q. arizonica* At this time, there are known to be less than 50 mature individuals, which would place *Q. tardifolia* within the Critically Endangered category under criterion D. But due to the high level of taxonomic uncertainty and lack of field exploration, research and consensus must precede a final Red List assessment. Therefore Chisos Mountains Oak is listed as Data Deficient.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Contributor(s): McNeil-Marshall, A.
Refs: 31, 70

Quercus toumeyi Sarg.
DD
AZ, NM, TX* MX-CI, SO
Toumey Oak exists as a shrub or small tree within oak woodlands, pine-oak forests, and chaparral. It is a dominant species within evergreen broad-leaved shrublands, especially on rocky, dry slopes. Toumey Oak is found in southwest Arizona and from central western Chihuahua and adjacent Sonora northward. Locality data from Mexico is sparse, and taxonomic confusion with *Q. barrancana* creates further uncertainty, especially regarding the southern range of *Q. toumeyi*. With the data currently available, this species is considered stable in Arizona, but due to the insufficient data on the density of the Mexican population and the lack of information on threats to *Quercus toumeyi*, this species is currently considered Data Deficient.
Assessor(s): Beckman, E. & Jerome, D.
Reviewer(s): Oldfield, S.
Contributor(s): Kaproth, M
Refs: 31, 32, 70, 172, 216, 235, 267, 269

Species evaluated as least concern:

Quercus agrifolia Née
CA, MX-BJ
Located on the western coast of the United States, Coast Live Oak can be found from Mendocino County in north-central California southward to northern Baja California, Mexico. It is the dominant tree in California's southern and central coastal oak woodlands, and populates the chaparral phase of the southern oak woodland as a shrub. Although *Quercus agrifolia* faces threats in certain localities, especially from human development and sudden oak death, it covers a wide range and has not experienced a significant decline, nor is it believed to face future rapid decline.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 52, 79, 117, 161, 172, 191, 240, 263, 267

Quercus alba L.
AL, AR, CT, DE, DC, FL, IL, IN, IA, KS,KY, LA, ME, MD, MA, MI, MN, MS, MO, NE, NH, NJ, NC, OH, PA, RI, SC, TN TX, VT, VA; CAN-ON, QC
Quercus alba is very widespread in its distribution that encompasses the eastern half of the United States reaching as far west as the Missouri River, from the Gulf Coast extending as far as southern parts of Canada. Wood of *Quercus alba* is strong and durable; it is arguably North America's most valuable hardwood species. *Quercus alba* has experienced a decline in many parts of its range due to land-use changes. The decreases in disturbance regimes, including fire suppression in the eastern U.S. during the 20th century, appears to be important causal factors in oak decline seen throughout the region. Though a decline in parts of its range has been documented, it is not believed to approach the threshold for any threatened category.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Rivers, M.C.
Refs: 3, 4, 5, 85, 92, 117, 238, 282

Quercus arizonica Sarg.
AZ, NM, TX; MX-BS, CU, DG, NL, SI, SO
Quercus arizonica is distributed from central Arizona to southwestern New Mexico and can grow at elevations from 1,505-2,200 m asl. Scattered subpopulations occur in western Texas as well as northern Mexico from the state of Coahuila westward to Baja California Sur. This species is widespread and occurs regularly throughout the northern part of its range. Subpopulations are scattered in southern and eastern parts of its range, making this species of concern in Mexico. Potential future threats do exist in light of its scattered subpopulations; however, on a global scale these are not considered significant threats at present.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 117, 147, 172, 190, 269

Quercus berberidifolia Liebm.
CA, MX-BJ
Quercus berberidifolia extends from Shasta and Humboldt Counties in northern California to northern Baja California in Mexico, and is also present on the Channel Islands. California Scrub Oak is an important browse species for deer, with its low growth form creating easily-reached branches. It is the most common shrubby oak in central and southern California, with a large range, extensive habitat available, and few current threats other than some decline due to hybridization with other Californian white oaks.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 70, 78, 79, 117, 191, 267

Quercus bicolor Willd.
AL, CT, DE, DC, IL, IN,IA, KS, KY, LA, ME, MD, MA, MI, MO, NB, NH, NJ, NY, NC, OH, PA, RI, SC, TN, VT, VA, WV, WI; CAN-NS, ON, QC
Quercus bicolor is a widespread species. It occurs in a variety of soils in swamp forests of river bottoms, stream-sides, depressions, borders of ponds, lakes, and swamps and moist peaty flats. This species also occurs on moist slopes and poorly drained uplands. It is slow growing and can live up to 300 years or more; at maturity it is known to reach 20-30 m. Quercus bicolor is used for furniture, cabinets, veneers, interior finishing and flooring. Q. bicolor has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 2).
Assessor(s): Kenny, L., Wenzell, K. & Jerome, D.
Reviewer(s): Oldfield, S.
Contributor(s): Rivers, M.C.
Refs: 31, 47, 93, 118, 130, 154, 165, 196, 199, 200, 233

Quercus buckleyi Nixon & Dorr
OK, TX
Buckley Oak, endemic to the Edwards Plateau in the south-central United States and occurs abundantly in the upland woodlands of this region. Despite reports of poor regeneration and oak wilt, declines are not known to be impacting the population across the range. *Quercus buckleyi* is considered a co-dominant species of these mixed woodland communities throughout the Edwards Plateau. These mixed woodlands form important breeding habitat for the Golden-cheeked Warbler (*Setophaga chrysoparia*) and Black-capped Vireo (*Vireo atricapilla*).
Assessor(s): Wenzell ,K. & Kenny, L.
Reviewer(s): Oldfield, S.
Contributor(s): Rivers, M.C.
Refs: 31, 47, 92, 117, 129, 153, 164, 195, 198, 199, 232

Quercus chapmanii Sarg.
AL, FL, GA, SC
Quercus chapmanii occurs in dry, xeric habitats of sandy ridges and coastal dunes throughout most of Florida, coastal Alabama and Georgia, in addition to the southern portion of South Carolina. It is common in sandhill and scrub, but is often most abundant in scrubby flatwoods. There is no information available on a quantified population size for this species; however, its extent of occurrence is estimated at 312,029 km^2. Its large range and its abundance suggest a large population, which is not believed to qualify for any threatened category.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Rivers, M.C.
Refs: 2, 9, 73, 117, 172, 238

Quercus chihuahuensis Trel.
TX; MX-AG, CI, DG, JA, NE, NL, QA, SL, SI, SO, ZT
This species occurs in parts of northern and central Mexico. Some research has noted the presence of a two small relict subpopulations between 400-2,000 m asl in southwest Texas, in the mountains just across the Rio Grande. The relict subpopulations in Texas occur in Hudspeth County within the Quitman and Eagle Mountains, but the viability of the two subpopulations is unknown and extensive introgression with *Q. grisea* and *Q. arizonica* has been noted. Raising livestock is the most predominate and continuing threat, although it is not enough to reach the threshold of a threatened category.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 1, 70, 117, 146, 224

Quercus chrysolepis Liebm.
AZ, CA, NV, NM, OR; MX-BJ
Canyon Oak's growth form and other characteristics can vary greatly, which allows it to live in a variety of natural settings. Quercus chrysolepis has native presence in Oregon, Nevada, Arizona, New Mexico and Baja California, Mexico, but is most populous throughout California, where it is found in virtually every mountain range in the state. Canyon Oak provides cover for many species of mammals, birds, reptiles, amphibians and invertebrates.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 79, 117, 191, 251, 267

Quercus coccinea Münchh.
AL, AR, CT, DE, DC, GA, IL IN, KY, ME, MA, MI*, MO, NH, NJ, NY, NC, OH, PA, RI, SC, TN, VT, VA, WV, WI*
Scarlet Oak has a wide geographic distribution throughout the central-eastern United States. It is a fast-growing large tree that can reach heights above 30 m. The common name, Scarlet Oak, is derived from the vibrant red color of its autumn foliage. *Quercus coccinea* is used as commercial lumber and is planted as an ornamental tree, due to its attractive autumn foliage. This species is susceptible to a number of Red Oak diseases, particularly Oak Wilt, caused by the fungus *Ceratocystis fagacearum*. Oak Wilt can kill an infected Scarlet Oak in as little as one month, but notable declines to the population of Scarlet Oaks have not been reported at present.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 31, 42, 70, 117, 172, 238, 266

Quercus cornelius-mulleri Nixon & K.P.Steele
CA; MX-BJ
This species is a known common species throughout parts of its range of southern California and northern Baja California. It faces one known threat, based on recreational uses within its habitat, but the full effects are not well understood at present. The estimated extent of occurrence is 33,202 km^2, close to the Vulnerable threshold and potentially falling into the Near Threatened category based on criterion B. However, with no known threats to be considered significant at present or declines, criterion B cannot be applied. With its drought resistant qualities and deeply tapped root system, it is thought to be secure and thriving throughout its range.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 70, 108, 109, 117, 146, 176, 177, 178, 188, 226

Quercus depressipes Trel.
TX; MX- CI, DG, GJ, HI, JA, NL, QA, SL, SI, SO, TM, ZT
Quercus depressipes is limited to very high altitudes of the central and northern Sierra Madre Occidental. Only one subpopulation of *Quercus depressipes* occurs in the US; it can be found on the highest portion of Mt. Livermore in trans-Pecos Texas. *Quercus depressipes* is a shrub that often forms thickets and is a dominant and abundant species where is found. The threats to this species are largely unknown and there are no accounts of decline therefore it can be assumed that the population is stable.
Assessor(s): Jerome, D.
Reviewer(s): Oldfield, S.
Refs: 31, 61, 70, 152, 172, 182, 206

The Red List of US Oaks

Quercus douglasii Hook. & Arn.
CA
Blue Oak is very common within its range and dominates nearly half of California's oak woodlands, with Blue oak woodland covering 8% of California's total land area. Although *Quercus douglasii* faces low recruitment rates due to a variety of factors that are not well understood, this species currently occupies a sufficient area and is present in a variety of habitat types. It avoids intense pressure from development and agriculture, due to its growth on poor soils and slopes, and very hot, dry regions. More research is required to understand possible reduction in recruitment and if population size is being significantly reduced.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 78, 79, 90, 117, 191, 204, 237, 258

Quercus durata Jeps.
CA
Quercus durata has a large range and is fairly widespread (the extent of occurrence is 195,000 km^2). It is found in serpentine soils, which are low in calcium, nitrogen and phosphorous, but high in magnesium and several other toxic minerals. As a serpentine endemic that has adapted to the nutrient poor soil with high toxic metal levels, competition with other species is limited. Although there are several threats facing Leather Oak currently, such as direct land use change and unnatural fire frequency, in the majority of cases the intensity is unknown and the effects will likely only be seen over a long period of time.
Assessor(s): Kua, C.-S.
Reviewer(s): Oldfield, S.
Contributor(s): Kaproth, M.
Refs: 38, 70, 117, 131, 141, 191, 195

Quercus ellipsoidalis E. J. Hill
IL, IN, IA, MI, MN, MO, ND, OH, WI; CAN-ON
Hill's Oak is a medium to large tree, reaching 20 m and rarely up to 40m at maturity. *Quercus ellipsoidalis* grows on dry, sandy soils though occasionally on mesic slopes and uplands. The wood of Hill's Oak is heavy and used for furniture, flooring and fuel. Hill's Oak occurs fairly commonly throughout its range in the Western Great Lakes Region, somewhat scattered but abundant when present. *Q. ellipsoidalis* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell , K., Kenny, L. & Jerome, D.
Reviewer(s): Oldfield, S.
Refs: 31, 70, 79, 117, 172, 173, 198, 199, 238, 266

Quercus emoryi Torr.
AZ, NM, TX; MX-CI, CU, DG, NL, SO, TM, ZT
Quercus emoryi has a large range and is widespread, occurring as the codominant species in many of its habitats such as pine-oak, Madrean evergreen, and open oak woodlands, as well as interior chaparral, semidesert grasslands and savannas. Cattle grazing is common in oak woodlands where Emory Oak codominates, and conversion of pine-oak woodlands and chaparral stands to grassland for livestock has been common through Emory Oak's range. However, it seems this practice of clearing habitat for rangeland is slowing, at least in the United States. Fire suppression as well as recreational activities threatens Emory Oak as human populations increase in southern Arizona. *Q. emoryi* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Beckman, E., & Jerome, D.
Reviewer(s): Oldfield, S.
Refs: 31, 70, 79, 91, 117, 190, 198, 199, 216

Quercus falcata Michx.
AL, AR, DE, DC, FL, GA, IL, IN, LA, MD, MS, MO, NJ, NY, NC, OH PA, SC, TN, VA, WV
Southern Red Oak is a common upland species throughout its wide geographic range. *Quercus falcata* is a medium to large tree, reaching 30 m at maturity; occasionally up to 45 m. Southern Red Oak inhabits dry upland sites with sandy or clay loam soils. This species is a common component of mixed hardwood-conifer forests in the Piedmont plateau of the southeastern United States. It is harvested for lumber, which is used for general construction and furniture. *Quercus falcata* is highly susceptible to Oak Wilt, but no impacts to the total population of Southern Red Oak have been reported.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 34, 31, 70, 79, 117, 172, 238, 266, 267

Quercus fusiformis Small
OK, TX; MX- CU, NL, TM
Quercus fusiformis is distributed in Oklahoma and Texas, US and south to Tamaulipas in Mexico. In Mexico it is only a dominant species in a small (230 km^2) area of the country and the species is vulnerable to the anthropogenic destruction of Mexican habitats. The extent of its northern range in Texas is threatened by oak wilt. The threats facing this species are not likely to cease, but the rates of decline due to habitat change in Mexico are unknown and currently the threat of oak wilt alone is low enough to keep *Q. fusiformis* out of a threatened category.
Assessor(s): Kenny, L. & Jerome, D.
Reviewer(s): Oldfield, S.
Refs: 15, 16, 17, 18, 19, 31, 64, 70, 74, 127, 146, 156, 238, 287

Quercus gambelii Nutt.
AZ, CO, NV, NM, TX, UT, WY; MX-CI, CU, SO
Gambel Oak is a tree-shrub with good drought tolerance, generally dominating the brushy region between a lower elevation pine-juniper zone and an aspen or Ponderosa Pine zone above. *Quercus gambelii* covers a large area, has no current threats and exists in many areas it has been found to suppress other native ground cover.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 65, 79, 117, 230, 267

Quercus garryana Douglas ex Hook.
CA, OR WA; CAN-BC
Quercus garryana stretches inland along the Pacific Coast, boasting the longest north-south distribution among the western oaks. Its range reaches from southeastern British Columbia, Canada, to southern California, United States. It is the only native oak in British Columbia and Washington, and the dominant one in Oregon. With close-grained, strong and hard lumber, Oregon White Oak is considered one of the best fuels for home heating and gathers top prices. This species is also used for fence posts, furniture, cabinets and interior finish. The straight trunk with mostly upright main limbs makes it easy to use with standard harvest and processing techniques.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 79, 117, 191, 239, 267

Quercus geminata Small
AL, FL, GA, LA, MS, NC, SC
This species is found in southeastern United States, along the coastal plain of Louisiana east to North Carolina and south throughout most of peninsular Florida, where is it dominant and abundant. Its known extent of occurrence is estimated to be well over 250,000 km^2. There are no known threats impacting the survival of this species. It is assessed here as Least Concern on the basis of its distribution, abundance and lack of known threats.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 77, 117, 162, 172, 238

Quercus gravesii Sudw.
TX; MX- CI, CU, NL
Quercus gravesii is a dominant species in pinyon-juniper-oak and mixed conifer woodland; it is found in moderate densities in mesic woodlands at high elevations on moist sites. *Quercus gravesii* is found in moderate densities in Mexico and throughout the valleys and high elevation areas of the Davis, Glass, Chianti, and Chisos mountains of Big Bend National Park. While it is currently thought to be stable further information should be gathered regarding fragmentation and land-use change to determine the intensity of future threats.
Assessor(s): Jerome, D.
Reviewer(s): Oldfield, S
Refs: 31, 67, 70, 102, 113, 128, 200, 225, 254, 274

Quercus grisea Liebm.
AZ,CO, NM, TX; MX-AG, CI, CU, DG, GJ, HG, JA, NL, QA, SL, SO, VZ, ZT
Quercus grisea has a very large range; it is known to be of limited distribution within some areas of its range. *Quercus grisea* can grow anywhere from two to fifteen meters tall. Its growth form varies from a tree with one trunk to a clonal shrub. It is best known as a low-growing form in open savannas, however *Q. grisea* also grows within oak, pine-oak and pinyon-juniper woodlands. Overall abundance of Grey Oak is unknown and many areas have been degraded due to agriculture, livestock grazing and firewood harvest, and continue to face threats. *Q. grisea* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Kenny, L., Wenzell, K., Beckman, E. & Jerome, D
Reviewer(s): Oldfield, S
Refs: 31, 44, 70, 96, 146, 190, 198, 199, 216

Quercus hemisphaerica Bartram ex Willd.
AL, FL, GA, LA, MS, NC, SC, TX, VA
Darlington Oak is a semi-evergreen tree, fast-growing and relatively short-lived. It is widespread throughout the coastal plain of the southeastern United States and the population is considered stable. Darlington Oak's regular production of a large acorn crop makes it an important food source for many wildlife species, including squirrels, wild turkeys and white-tailed deer. Darlington Oak is used for firewood and planted as an urban shade tree in the south due to its fast growth and semi-evergreen habit.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 27, 34, 31, 42, 70, 79, 117, 172, 238, 256, 266

Quercus hypoleucoides A.Camus
AZ, NM, TX; MX- CI, CU, SO
Quercus hypoleucoides exists over a wide area, and its growth at high elevations and within denser forests generally protects the species from disturbance due to urbanization, agriculture and livestock browsing. The subpopulation in Texas is likely under threat due to fragmentation and isolation. This does not affect the overall status of this species since Texas is not part of its main range.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 70, 79, 106, 117, 172, 216, 234

Quercus ilicifolia Wangenh.
CT, DE, KY*, ME, MD, MA, NH, NJ, NY, NC, PA, RI, VT, VA, WV; CAN-ON
Scrub Oak is an important co-dominant of sand barren communities in the northeastern United States, additionally extending into sandy barren and mountainous habitats through the mid-Atlantic region into southern Ontario. Though the sand barren communities it characterizes are increasingly rare (threatened by fire suppression and disrupted disturbance regimes), *Quercus ilicifolia* is locally abundant within its sizeable range (with an extent of occurrence of 546,000 km^2). *Q. ilicifolia* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 70, 95, 117, 172, 199, 208, 211, 238, 266

Quercus imbricaria Michx.
AL, AR, CT, DE, DC, IL, IN, IA, KS, KY, LA, MA, MI, MS, MO, NJ, NY, NC, OH, PA, TN, VA, WV
Shingle Oak is common throughout its wide geographic distribution throughout the central-eastern United States. Shingle Oak is a medium-sized tree, typically reaching 20 m at maturity. This species prefers well-drained soils, though it can grow in a range of habitats, from moderately dry uplands to mesic bottomlands and stream beds. *Quercus imbricaria* is known to be susceptible to Oak Wilt, though this disease has not yet caused any serious declines to the total population. *Q. imbricaria* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 70, 82, 117, 198, 199, 238, 266

Quercus incana Bartram
AL, AR, FL, GA, LA, MS, NC, OK, TX, VA
Bluejack Oak is widespread throughout the coastal plain of the southeastern United States. Bluejack Oak grows as a shrub or small tree, typically reaching 10 m in height. The common name derives from the bluish hue of its leaves. The Longleaf Pine sandhill communities (with which Bluejack Oak is associated) are threatened by disruption of the native disturbance regime, namely through suppression of fire. Extended fire suppression has been reported to lead to decreases in *Quercus incana*, though these declines are currently minor in scale and do not affect the species as a whole. *Q. incana* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 70, 81, 101, 117, 172, 198, 199, 238, 242, 266

Quercus inopina Ashe
FL
Sandhill Oak is endemic to the state of Florida in the extreme southeastern US. Despite its restricted range and the historic and ongoing declines to the upland scrub habitat it occupies, *Quercus inopina* dominates large areas of upland scrub, including those within protected areas. Given its local abundance on protected lands, *Q. inopina* is currently considered of Least Concern.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 31, 58, 70, 105, 117, 172, 238, 266, 280

Quercus intricata Trel.
TX; MX- CI, CU, DG, NL, SL, TM, ZT
Quercus intricata is a clonal evergreen shrub that is abundant in Coahuila, Mexico and is a co-dominant species in many communities where it occurs. It is known in the US only from two localities: a population in the Chisos Mountains and another in the Eagle Mountains of west Texas. Its population density and threats are largely unknown, but the species is generally secure. While *Q. intricata* is vulnerable to the habitat degradation of the Chihuahuan Desert region, the effects will likely be seen only over a long period of time.
Assessor(s): Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 70, 79, 113, 130, 172, 207, 216, 255, 272

Quercus john-tuckeri Nixon & C.H. Müll.
CA
Quercus john-tuckeri is endemic to California where it is a dominant species in many of central California's oak woodlands. It is a drought-resistant evergreen shrub that can grow from three to five meters in height. Tucker's Oak is a dominant species on xeric, desert slopes of coastal range chaparral. Details of its population density and the impact of threats to its habitat are largely unknown, but the species is generally secure.
Assessor(s): Jerome, D
Reviewer(s): Oldfield, S.
Refs: 40, 31, 70, 116, 122, 245

Quercus kelloggii Newb.
CA, OR; MX-BJ
Quercus kelloggii is found in mountainous areas away from the immediate coast, from central Oregon southward through California to Baja California, Mexico. Although California Black Oak faces competition from more shade-tolerant trees in some areas due to fire suppression, and could face pressure in the future from harvesting for lumber and other wood products, this species currently seems to be secure when examining its entire range. More studies are needed to understand the long-term impacts of threats to *Q. kelloggii*, but current information points to substantial recruitment in the foreseeable future.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 79, 117, 160, 191, 209, 267

Quercus laceyi Small
TX; MX-CI, NL, TM
This species occurs in Texas, USA and Mexico. It is a dominant species in parts of Texas. It is the defining species of woodlands on steep rocky upper slopes of most or all of the canyons systems. It becomes a bit scarce in the western part of its Texas range due to increasing aridity. It is also scarce in the eastern part of its range, near Hays and Llano counties. *Quercus laceyi* is often found associated with limestone outcrops, woodland, and riparian zones among mixed stands of ash, basswood and other oaks. *Q. laceyi* has been flagged as a species whose range may be impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Facilitators/Compilers: Kenny, L. & Wenzell, K.
Refs: 31, 70, 101, 117, 172, 199, 238

Quercus laevis Walter
AL, FL, GA, LA, MS, NC, SC, VA
Turkey Oak is abundant on dry sandy uplands throughout the Coastal Plain of the southeastern United States. This species has an extent of occurrence of over 830,000. Conversion of sandhill communities to pine plantations requires removal of understory species, often including Turkey Oak. Additionally, Quercus laevis is susceptible to Oak Wilt and other common Red Oak pests. Despite these factors, however, Turkey Oak remains abundant within its range. *Q. laevis* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 34, 31, 70, 81, 117, 129, 172, 198, 199, 238, 266

Quercus laurifolia Michx.
LC
AL, AR, FL, GA, LA, MS, NC, SC, TX, VA
Swamp Laurel Oak occurs widely throughout the coastal plain of the Southeastern United States, with an extent of occurrence of over 1,770,000 km^2. *Quercus laurifolia* is susceptible to Oak Leaf Blister (Taphrina caerulescens), as well as other common Red Oak pests and pathogens. However, no reports of widespread decline affecting the population are currently available. With no reports of major population decline across its wide distribution, *Quercus laurifolia* appears to be stable and is of Least Concern.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 31, 42, 70, 81, 117, 172, 238, 266

Quercus lyrata Walter
AL, AR, DE, DC, FL, GA, IL, IN, KY, LA, MD, MS, MO, NJ, NC, OK, SC, TN, TX, VA
This species has a fairly wide distribution, with an extent of occurrence of well over 1,500,000 km^2. This species is found on poorly drained, alluvial, clayey soils mainly on southern river flood plains. It is most prevalent on low lying clay or silty clay flats in first bottoms and terraces of the larger streams. It is a large and slow growing tree, usually reaching a height of 24 m but has been known to reach heights up to 47 m. It provides habitat and its acorns supply mast for wildlife. *Quercus lyrata* is quite tolerant of flooding and grows slowly on poorly drained flood plains. *Q. lyrata* has been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Facilitators/Compilers: Kenny, L. & Wenzell, K.
Refs: 31, 117, 129, 172, 182, 198, 199, 233, 238

Quercus macrocarpa Michx.
AL, AR, CT, DE, DC, IL, IN, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NB, NJ, NY, NC, ND, OH, OK, PA, RI, SD, TN, TX, VT, VA, WV, WI, WY; CAN-AL, MB, NB, ON, QC, SK
This species is noted for having the largest distribution of all the North American oak species, growing naturally throughout much of the north-central United States and the eastern Great Plains. Its range extends farther north into south-central and southeastern Canada, reaching into northern areas as well. Overall, conversion of land to agricultural use, livestock introductions and active fire suppression are cited as the primary reasons for reduced fire frequencies and the subsequent loss of *Q. macrocarpa* habitats. *Quercus macrocarpa* has declined on savannas and prairies due to grazing and fire suppression, specifically. Where fire suppression is prevalent, these communities may instead be replaced by more shade-tolerant maple-basswood forests.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 92, 95, 117, 172, 182, 219, 238

Quercus margarettae (Ashe) Small
AL, AR, FL, GA, LA, MS, NC, OK, SC, TX
Quercus margarettae is found in many states across the east-central and southeastern United States. This species is known to grow on deep sands and gravels, often in dense woods as understory or in open scrubland and pine barrens. It is a small tree reaching a maximum height of up to 12 meters. Its population is presumed to be large due to its wide distribution *Q. margarettae* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 70, 92, 117, 172, 182, 198, 199

Quercus marilandica (L.) Münchh.
AL, AR, DE, DC, FL, GA, IL, IN, IA, KS, KY, LA, MD, MS, MO, NE, NJ, NY, NC, OH, OK, PA, SC, TN, TX, VA, WV
Blackjack Oak is a common, widely distributed species, with a range extending over 2,700,000 km^2. *Quercus marilandica* is a small to medium tree, sometimes growing as a shrub with a low, round crown. A member of the Red Oak group, this species is slow-growing and relatively short-lived, typically reaching five to 15 meters in height at maturity. Blackjack Oak is considered a dominant or co-dominant species over much of its extensive range, suggesting a large population.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 31, 42, 70, 81, 117, 172, 238, 266

Quercus michauxii Nutt.
AL, AR, DC, FL, GA, IL, IN, YT, LA, MD, MS, MO, NJ, NC, OK, SC, TN, TX, VA
The range of *Quercus michauxii* covers east-central and eastern parts of the United States. Wood from *Q. michauxii* is commercially useful for lumber in all kinds of construction, for agricultural implements, cooperage, fence posts, baskets and fuel. Acorns from *Q. michauxii* serve as mast for various species of birds and mammals. *Quercus michauxii* also provides cover for birds, mammals, and reptiles, some of which are threatened species in the southern wetland ecosystems.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 34, 117, 165, 172, 182

Quercus minima (Sarg.) Small
AL, FL, GA, LA, MS, NC, TX
Although this species occupies a narrow habitat range and is uncommon in a large portion of its range (southeastern coastal plain), this species is frequent throughout Florida. This species can be found on coastal plains, pine rocklands, mesic flatwoods, scrubby flatwoods, sandhills and dry prairie. Sandhills, the major habitat for *Q. minima*, are threatened due to land use changes for development. In addition to development, fire suppression has been a major contributor in the decline of sandhill ecosystems, although declines have not been enough to push *Q. minima* to a threatened category.
Assessor(s): Wenzell, K., Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 117, 172, 182, 238, 288

Quercus mohriana Buckley ex Rydb.
NM, OK, TX; MX-CU
The range covers an area northward from Coahuila, Mexico, into the Trans-Pecos region of Texas eastward onto the Edwards Plateau and northward along the "breaks" of the plains into the Panhandle of Texas, reaching into parts of New Mexico and Oklahoma. This species grows on limestone hills and slopes. Its extension into the Great Plains region is entirely dependent upon Cretaceous outcrops or upon the exposure of limestone strata of Permian age resulting from the erosion of the plains by drainage systems. Due to the scattered nature of subpopulations, this species could be vulnerable to threats in the future. However, there are no threats known to affect this species at present. Further research is recommended to determine the population size of this species within its natural range.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 117, 172, 182, 238, 288

Quercus montana Willd.
AL, CT, DE, DC, GA, FL, IL, IN, KY, LA, ME, MD, MA, MI, MS, NH, NJ, NY, NC, OH, PA, RI, SC, TN, VT, VA, WV
Quercus montana has a wide distribution across eastern United States. This species typically grows in mixed hardwood and conifer forest communities, often on rocky slopes, and may form a full or only partial canopy. It is an important species of eastern upland deciduous and coniferous forests and may occur in pure stands. Chestnut Oak wood is cut and utilized as white oak lumber. Due to its susceptibility to many diseases and insects, potential future threats exist, but these are not considered significant at present. *Quercus montana* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 42, 69, 70, 117, 133, 153, 172, 198, 199

Quercus muehlenbergii Engelm.
AL, AR, CT, DE, DC, FL, GA, IL, IN, IA, KS, KY, LA, MD, MA, MI, MS, NE, NJ, NM, NY, NC, OH, OK, PA, SC, TN, TX, VT, VA, WV, WI; CAN-ON; MX-CI, CU, NL, TM
Quercus muehlenbergii is the only oak species to cross the United States, Canada and Mexico. This species is localized throughout its range and seems dependent upon soil type and pH above six. This species is threatened by fire, to a certain extent. Severe wildfire kills saplings and small pole-size trees but these re-sprout. Fire scars serve as entry points for decay-causing fungi, and the resulting decay can cause serious losses. Oak Wilt attacks *Q. muehlenbergii* and usually kills the tree within two to four years, but no significant declines have been reportex. *Q.muehlenbergii* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Kenny, L. & Wenzell. & Jerome, D
Reviewer(s): Rivers, M.C.
Refs: 34, 31, 117, 172, 182, 198, 199, 238

Quercus myrtifolia Willd.
AL, FL, GA, MS, NC, SC
Myrtle Oak occurs commonly along the coastal plain of the southeastern United States, with an extent of occurrence of approximately 323,000 km^2. This species occurs in mixed yellow pine-hardwood stands and is abundant in oak scrub communities along with *Q. incana*, *Q. marilandica* and others. This species provides food and cover for numerous wildlife species, including the federally threatened Florida Scrub Jay (*Aphelocoma coerulescens*), which relies on these oak scrub habitats of peninsular Florida. With no reports of major population decline across its wide distribution, *Quercus myrtifolia* appears stable.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S
Refs: 31, 70, 81, 117, 172, 238, 266, 280

Quercus nigra L.
AL, AR, DE, DC, FL, GA, KY, LA, MD, MS, MO, NJ, NC, OK, SC, TN, TX, VA
Water Oak is widespread throughout the southeastern United States, extending from the Atlantic and Gulf Coastal Plains, south from New Jersey to Florida and eastern Texas, and north along the Mississippi Valley into Missouri and Kentucky. This species is associated with bottomland forests, mesic alluvial sites and occasionally upland slopes where soil remains moist. Water Oak prefers well-drained silty clay or loamy soils and is weakly to moderately tolerant of seasonal flooding. The population is considered stable, with no reports of major decline.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 31, 42, 70, 81, 117, 172, 238, 266

Quercus oblongifolia Torr.
AZ, NM, TX; MX-BS, CI, CU, DG, SO
Mexican Blue Oak grows as both a shrub and a tree, ranging from five to 10 meters tall. It is dominant within mid-elevation oak woodlands, forming both pure and mixed stands. *Quercus oblongifolia* currently has a large range and is recorded as widespread within many of the areas where it occurs. Distribution and threats in Mexico are less known, but no serious and extensive threats seem to be present.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 70, 79, 117, 190, 216, 267

Quercus pagoda Raf.
AL, AR, DE, DC, FL, GA, IL, IN, KY, LA, MD, MS, MO, NJ*, NC, OK, SC, TN, TX, VA
Cherrybark Oak is common throughout the southeastern United States, with an extent of occurrence of over 1,400,000 km^2. Quercus pagoda is a large deciduous tree, typically growing to 40m. Cherrybark Oak is one of the largest, fastest-growing and hardiest of the red oaks of the southern US. *Quercus pagoda* produces exceptional quality wood that makes it highly valuable as a timber species, as does its large size and fast growth. Like many species in the Red Oak group, *Quercus pagoda* is susceptible to Oak Wilt. However, no reports of widespread population decline are currently available. *Q. pagoda* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 42, 70, 117, 172, 198, 199, 238, 266, 267

Quercus palustris Münchh.
AR, CT, DE, DC, GA, IN, IA, KS, KY, MD, MA, MI, MS, MO, NE, NJ, NY, NC, OH, OK, PA, RI, SC, TN, VT, VA, WV, WI; CAN-ON
Pin Oak is widespread throughout the central eastern United States and into Canada, with an extent of occurrence of 2,045,000 km^2. Pin Oak is a large tree, typically reaching 25 m in height, known for small dead branches (pins) that persist on the trunk and distinctive downward-angled lower branches. Pin Oak is susceptible to Oak Wilt and other common pests and pathogens of the Red Oak group in the eastern US. However, no reports of widespread population decline are available. *Q. palustris* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Rivers, M.C.
Refs: 31, 42, 70, 81, 117, 154, 172, 198, 199, 238, 266

Quercus phellos L.
AL, AR, CT, DE, DC, FL, GA, IL, KY, LA, MD, MS, MO, NJ, NY, NC, PA, SC, TN, TX, VA
Willow Oak is a common lowland species throughout its wide range with an extent of occurrence of roughly 2,395,000 km^2. Willow Oak is a large deciduous tree (to 40 m) with a straight, slender trunk, round crown and narrow willow-like leaves. *Quercus phellos* is a good source of lumber and pulpwood. Additionally, this species is widely planted as an ornamental and shade tree, particularly because its shallow root system allows it to be transplanted easily. Willow Oak produces a large crop of acorns very regularly (nearly every year) making it an important source of food for wildlife.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 31, 42, 70, 81, 117, 172, 238, 266

Quercus polymorpha Schltdl. & Cham.
TX; MX- CI, CU, GJ, HI, JA, EM, MH, MR, NL, OA, PU, SL, SI, TM, VZ; Guatemala, Honduras
Quercus polymorpha is a small or medium-sized subevergreen tree. *Quercus polymorpha* has a large range in Mexico, a single population in Texas, as well as scattered populations in Guatemala and Honduras. *Quercus polymorpha* is heavily used as a source of firewood, coal, and construction wood in Mexico. It has been previously listed as threatened by the Red List of Guatemalan Trees and the Red list of Mexican Cloud Forests Trees, however due to its widespread population and limited information on its population density *Quercus polymorpha* is currently considered Least Concern.
Assessor(s): Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 43, 60, 70, 79, 88, 94, 172, 199, 207, 255, 276

Quercus prinoides Willd.
AL, AR, CT, DE, GA, IL, IA, KS, LA, ME, MD, MA, MI, MN, MO, NH, NJ, NY, NC, OK, PA, RI, TN, TX, VT, VA, WV, WI; CAN-ON
Quercus prinoides is found across most of the eastern and central parts of the United States, though it is thinly spread over much of its range. It is a fairly small tree reaching a maximum height of 7.6 meters. It is found on dry rocky soils such as sandstone or shale outcrops associated with oak-pine types. *Q. prinoides* has been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 49, 101, 172, 182, 199, 238

Quercus pumila Walter
AL, FL, GA, MS, NC, SC
Quercus pumila grows as a small shrub, deciduous or tardily so, that reaches about one meter in height. This species is strongly clonal, producing shoots from a stolon or “runner,” from which its common name “runner oak” is derived. It is found on dry sandy to loamy soils of pine flatwoods, oak-pine scrub, savannas and ridges. Adapted to fire, this species resprouts quickly with increased acorn production once burned. Runner Oak is distributed throughout the southeastern Atlantic and Gulf Coastal Plains of the United States, with an estimated extent of occurrence of roughly 576,000 km^2.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 31, 70, 117, 172, 238, 266, 267, 279

Quercus pungens Liebm.
AZ, NM, TX; MX-CI, CU, DG, NL, SL, TM
Quercus pugens occurs in open shrub lands on dry sites or in closed canopy woodlands on more moist sites. It is a small tree that reaches three meters in height. It has been documented to be widespread throughout the Edwards Plateau region in Texas and has a distinct presence in the Chihuahuan Desert region. Subpopulations become more scattered in southern parts of this species range, in parts of northern Mexico. Due to the scattered nature of subpopulations in southern parts of its range, potential future threats exist. However, these potential future threats are not considered significant as they will not impact the survival of the entire species.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 70, 117, 172, 190, 238

Quercus rubra L.
LC
AL, AR, CT, DE, DC, GA, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, NE, NH, NJ, NY, NC, OH, OK, PA, RI, SC, TN, VT, VA, WV, WI; CAN-NB, NS, ON, PE, QC
Northern Red Oak occurs widely throughout much of eastern North America and is a canopy dominant in many communities across this range, spanning an extent of occurrence of over 4,150,000 km^2. *Quercus rubra* is the most valuable timber species of all the red oaks. Its heavy, strong wood is widely used for furniture, flooring and construction. Oak decline has been reported to have impacted Northern Red Oaks toward the southern extent of the range (in Missouri, Arkansas and central Appalachia). However, these impacts are not widespread and not likely to significantly reduce *Q. rubra's* robust population in the near future.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 31, 70, 79, 97, 117, 172, 238, 250, 266

Quercus rugosa Née
AZ, NM, TX; MX- AG, BS, CH, CI, CU, CL, CX, DG, GJ, GR, HG, JA, EM, MH, MR, NA, NL, OA, PU, QA, SL, SI, SO, TM, TL, VZ, ZT; Guatemala, Honduras
Quercus rugosa has a large range in Mexico with a few subpopulations reaching into Texas, New Mexico, and Arizona in the USA; it also southward into Guatemala, and Honduras. It is a co-dominant species in many oak, pine-oak, and conifer forests in Mexico. *Quercus rugosa* is used as fuel in the form of firewood and coal. *Quercus rugosa* is threatened by disturbance caused by human settlement, illegal logging in Cloud Forests and recurrent fires in cold conifer forest chaparrals. However these threats are not known to be severe enough to push *Quercus rugosa* into a threatened category.
Assessor(s): Jerome, D.
Reviewer(s): Oldfield, S.
Refs: 30, 31, 60, 79, 86, 129, 172, 186, 199, 255, 271

Quercus shumardii Buckley
AL, AR, FL, GA, IL, KS, KY, LA, MD, MI, MS, MO, NE, NY, NC, OH, OK, PA, SC, TN, TX, VA, WV; CAN-ON
Shumard Oak occurs widely throughout central- and southeastern North America, with an extent of occurrence of nearly 2,520,000 km^2. *Quercus shumardii* is one of the larger southern red oaks, reaching 35-45 m at maturity. Shumard Oak displays an open, wide-spreading crown with trunks becoming buttressed with age. The wood of *Quercus shumardii* is close-grained, strong and heavy and is considered of superior quality to that of other red oaks, including *Q. rubra*. It is used for furniture, cabinets, interior finishing and lumber. *Q. shumardii* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Rivers, M.C.
Refs: 31, 70, 81, 117, 172, 198, 199, 238, 242, 266

Quercus similis Ashe
AL, AR, GA, LA, MS, SC, TX
Quercus similis is a common tree of the rich, moist bottomlands of the east Texas' pineywoods and gulf prairies and marshes. It is a moderate to large tree that can reach maximum height between 25-33 metres. Given the widespread distribution among southeastern parts of the United States *Quercus similis* is assumed to have a currently large population. *Q. similis* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Kenny, L., Wenzell, K. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 70, 117, 172, 182, 198, 199, 238

Quercus sinuata Walter
AL, AR, FL, GA, LA, MS, NC, OK, SC, TX; MX-CU, NL, TM
Quercus sinuata has two varieties: var. *sinuata* and var. *breviloba*. *Quercus sinuata* var. *sinuata* occurs from North Carolina and Florida, west to Oklahoma and Texas; var. *breviloba* occurs on the Edwards Plateau southward into parts of Mexico, along the eastern side of the Sierra Madre Oriental. The two variations of *Q. sinuata* differ in habitat, range, and growth forms. *Quercus sinuata* var. *breviloba* prefer limestone soils and can grow from a shrub to a small tree, reaching heights of 16 metres; *Q. sinuata* var. *sinuata* prefer moist bottomlands and riparian habitats and grows larger, reaching heights of 29 meters. This species has been described as regularly occurring throughout its range
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 70, 117, 172, 182, 238

Quercus stellata Wangenh.
AL, AR,CT, DE, DC, FL, GA, IL, IN, IA, KS, LA, MD, MA, MS, MO, NJ, NY, NC, OH, OK, PA, RI, SC, TN, TX, VA, WV
This species has a wide range and occurs regularly throughout, forming pure stands in parts of its range. This species is slow-growing and lives up to 300-400 years. In good environmental conditions, *Q. stellata* may grow up to 26 meters in height. This species is most common at 900 m asl and is rarest at 1,500 m asl. This is a valuable timber species because the wood is very durable and classified as moderately to very resistant to decay. It is used for railroad ties, mine, timbers, flooring, siding, planks, construction timbers and fence posts.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 34, 42, 117, 172, 182

Quercus texana Buckley
AL, AR, IL, KY, LA, MS, MO, OK, TN, TX
Nuttall Oak is distributed throughout the lower Mississippi River Valley of the southern United States, with an extent of occurrence of more than 700,000 km^2. Nuttall Oak is a good candidate for planting as a shade tree, as it tolerates a range of conditions and stresses. Like many species in the Red Oak group, *Quercus texana* is susceptible to Oak Wilt.Though this disease is of concern in Texas, no reports of widespread decline affecting the total population are currently available. *Q. texana* has also been flagged as a species whose range may be severely impacted by climate change as projected by ecological niche modeling (Box 1).
Assessor(s): Wenzell, K., Kenny, L. & Jerome, D
Reviewer(s): Oldfield, S.
Refs: 31, 70, 82, 117, 172, 198, 199, 238, 266, 267

Quercus turbinella Greene
AZ, CA, CO, NV, NM, TX, UT; MX-BJ, CI, SO
Quercus turbinella inhabits semiarid, lower elevation areas of chaparral, shrub deserts, oak woodlands and oak-pine forests. It frequently coexists with pines, junipers and manzanitas, and is the dominant shrub in Arizona chaparral, frequently covering up to 50% of the shrub cover at such sights. Sonoran Scrub Oak can grow on shallow, broken soils. The acorns are eaten by a variety of birds, as well as Mule Deer. *Quercus turbinella* covers a large area in southwestern United States, extending slightly into Mexico.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 31, 70, 79, 117, 191, 216, 246, 267

Quercus vacciniifolia Kellogg
CA, NV, OR
Located at higher elevations than any other oak species in California, *Quercus vacciniifolia* is a shrub that grows at altitudes of 150 to 2,900 m asl. Fire suppression and logging-related impacts continue to threaten the integrity of mixed conifer-hardwood forest, of which Huckleberry Oak is a member. However, this shrub is mainly of concern because of its abundance and therefore, aids in the spread of surface and crown fires. Reducing the density of *Q. vacciniifolia* is even recommended in some areas. Although *Q. vacciniifolia* faces some threats that could become more intense in the future, it is currently a common member of the understory across its range.
Assessor(s): Beckman, E.
Reviewer(s): Oldfield, S.
Refs: 13, 26, 31, 65, 79, 117, 123, 191, 267

Quercus vaseyana Buckley
TX; MX-CI, CU, NL, TM
Quercus vaseyana is widespread throughout Trans-Pecos Texas; it is also found in west-central Texas and northeastern Mexico. It is a dominant species in Edwards Plateau Limestone Savanna and Woodland was well as Edwards Plateau Limestone Shrubland. Vasey Oak is extremely drought tolerant, and grows on limestone or igneous soils in the western Edwards Plateau and Trans-Pecos. Deer, squirrels, wild turkeys and other wildlife feed on the acorns.
Assessor(s): Jerome, D.
Reviewer(s): Oldfield, S.
Refs: 6, 14, 31, 51, 67, 70, 120, 172, 207, 238, 274, 277

Quercus velutina Lam.
AL, AR, CT, DE, DC, FL, GA, IL, IN, KS, KY, LA, ME, MD, MA, MI, MS, NE, NH, NJ, NY, NC, OH, OK, PA, RI, SC, TN, TX, VT, WV, WI; CAN-ON
Black Oak is a common upland species throughout eastern-central North America, spanning an extent of occurrence of over 3,500,000 km^2. Black Oak bark contains high levels of tannins, which were once extracted for use in tanning leather. This species is valuable as a timber species and is cultivated as a shade tree. *Quercus velutina* is susceptible to Oak Wilt and has been impacted by oak decline (particularly following stressing factors like gypsy moth defoliation and drought). However, no reports of major decline across the distribution are currently available, and Black Oak remains secure at this time.
Assessor(s): Wenzell, K. & Kenny, L.
Reviewer(s): Oldfield, S.
Refs: 31, 42, 70, 81, 117, 172, 238

Quercus viminea Trel.
AZ; MX- AG, CI, DG, GJ, JA, NA, SL, SI, SO, ZT
Quercus viminea is found throughout Mexico's Sierra Madre Occidental. It has a large range with an Extent of Occurrence estimated at 509800 km^2. It is fairly common and widespread in the eastern and north-central Sky Islands of Sonora. The only record of *Q. viminea* in the USA is from a few sightings in the Patagonia Mountains in Arizona. *Quercus viminea* often grows in the mid to upper oak woodland zone and sometimes into the pine/oak woodland. It is closely related to *Q. emoryi*, with which it introgresses. *Quercus viminea* is used for construction in rural houses and firewood in Mexico.
Assessor(s): Jerome, D.
Reviewer(s): Oldfield, S.
Refs: 12, 31, 70, 79, 87, 172, 216, 255, 270

Quercus virginiana Mill.
AL, FL, GA, LA, MS, NC, SC, CA, TX, VI
This species is reported to be common across its range, especially throughout the entirety of Florida and Louisiana where it is generally the dominant species. Acorns of *Q. virginiana* are sweet and sought after by many birds and mammals. *Quercus virginiana* is a valuable timber species; with tough dense wood it is suitable for construction, shipbuilding and firewood. Though oak decline is problematic for this species in Texas, there are no reported range wide threats impacting upon the survival of this species.
Assessor(s): Kenny, L. & Wenzell, K.
Reviewer(s): Oldfield, S.
Refs: 117, 148

Quercus wislizeni A.DC.
CA; MX-BJ
Two varieties of *Quercus wislizeni* are currently recognized: *Quercus wislizeni.* var. *wislizeni* (the typical variety of Interior Live Oak) and *Quercus wislizeni*. var. *frutescens* (scrub Interior Live Oak). *Quercus wislizeni* (often incorrectly spelled *wislizenii*) inhabits dry slopes of interior valleys, often in association with the white oak *Q. douglasii*. Many wildlife species consume Interior Live Oak acorns, including bears, mule deer, squirrels, other rodents, acorn woodpeckers, scrub jays, and band-tailed pigeons. *Quercus wislizeni* is a common species in California. The projected loss of its habitat is currently from development is the most immediate threat facing this species, but it is under the threshold for *Q. wislizeni* to be considered threatened.
Assessor(s): Jerome, D.
Reviewer(s): Oldfield, S.
Refs: 29, 31, 78, 129, 171, 176, 186, 198, 252

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Appendix A:

Full list of evaluated *Quercus* and Red List category: listed by Red List category

Scientific Name	Red List Category
Quercus boyntonii	CR
Quercus graciliformis	CR
Quercus hinckleyi	CR
Quercus acerifolia	EN
Quercus carmenensis	EN
Quercus dumosa	EN
Quercus engelmannii	EN
Quercus georgiana	EN
Quercus havardii	EN
Quercus oglethorpensis	EN
Quercus pacifica	EN
Quercus tomentella	EN
Quercus ajoensis	VU
Quercus arkansana	VU
Quercus austrina	VU
Quercus cedrosensis	VU
Quercus lobata	NT
Quercus palmeri	NT
Quercus parvula	NT
Quercus sadleriana	NT
Quercus robusta	DD
Quercus tardifolia	DD
Quercus toumeyi	DD
Quercus agrifolia	LC
Quercus alba	LC
Quercus arizonica	LC
Quercus berberidifolia	LC
Quercus bicolor	LC
Quercus buckleyi	LC
Quercus chapmanii	LC
Quercus chihuahuensis	LC
Quercus chrysolepis	LC
Quercus coccinea	LC
Quercus cornelius-mulleri	LC
Quercus depressipes	LC
Quercus douglasii	LC
Quercus durata	LC
Quercus ellipsoidalis	LC
Quercus emoryi	LC
Quercus falcata	LC
Quercus fusiformis	LC
Quercus gambelii	LC
Quercus garryana	LC
Quercus geminata	LC
Quercus gravesii	LC
Quercus grisea	LC

Scientific Name	Red List Category
Quercus hemisphaerica	LC
Quercus hypoleucoides	LC
Quercus ilicifolia	LC
Quercus imbricaria	LC
Quercus incana	LC
Quercus inopina	LC
Quercus intricata	LC
Quercus john-tuckeri	LC
Quercus kelloggii	LC
Quercus laceyi	LC
Quercus laevis	LC
Quercus laurifolia	LC
Quercus lyrata	LC
Quercus macrocarpa	LC
Quercus margarettae	LC
Quercus marilandica	LC
Quercus michauxii	LC
Quercus minima	LC
Quercus mohriana	LC
Quercus montana	LC
Quercus muehlenbergii	LC
Quercus myrtifolia	LC
Quercus nigra	LC
Quercus oblongifolia	LC
Quercus pagoda	LC
Quercus palustris	LC
Quercus phellos	LC
Quercus polymorpha	LC
Quercus prinoides	LC
Quercus pumila	LC
Quercus pungens	LC
Quercus rubra	LC
Quercus rugosa	LC
Quercus shumardii	LC
Quercus similis	LC
Quercus sinuata	LC
Quercus stellata	LC
Quercus texana	LC
Quercus turbinella	LC
Quercus vacciniifolia	LC
Quercus vaseyana	LC
Quercus velutina	LC
Quercus viminea	LC
Quercus virginiana	LC
Quercus wislizeni	LC

The Red List of US Oaks

Full list of evaluated *Quercus* and Red List category: listed alphabetically

Scientific Name	Red List Category
Quercus acerifolia	EN
Quercus agrifolia	LC
Quercus ajoensis	VU
Quercus alba	LC
Quercus arizonica	LC
Quercus arkansana	VU
Quercus austrina	VU
Quercus berberidifolia	LC
Quercus bicolor	LC
Quercus boyntonii	CR
Quercus buckleyi	LC
Quercus carmenensis	EN
Quercus cedrosensis	VU
Quercus chapmanii	LC
Quercus chihuahuensis	LC
Quercus chrysolepis	LC
Quercus coccinea	LC
Quercus cornelius-mulleri	LC
Quercus depressipes	LC
Quercus douglasii	LC
Quercus dumosa	EN
Quercus durata	LC
Quercus ellipsoidalis	LC
Quercus emoryi	LC
Quercus engelmannii	EN
Quercus falcata	LC
Quercus fusiformis	LC
Quercus gambelii	LC
Quercus garryana	LC
Quercus geminata	LC
Quercus georgiana	EN
Quercus graciliformis	CR
Quercus gravesii	LC
Quercus grisea	LC
Quercus havardii	EN
Quercus hemisphaerica	LC
Quercus hinckleyi	CR
Quercus hypoleucoides	LC
Quercus ilicifolia	LC
Quercus imbricaria	LC
Quercus incana	LC
Quercus inopina	LC
Quercus intricata	LC
Quercus john-tuckeri	LC
Quercus kelloggii	LC
Quercus laceyi	LC

Scientific Name	Red List Category
Quercus laevis	LC
Quercus laurifolia	LC
Quercus lobata	NT
Quercus lyrata	LC
Quercus macrocarpa	LC
Quercus margarettae	LC
Quercus marilandica	LC
Quercus michauxii	LC
Quercus minima	LC
Quercus mohriana	LC
Quercus montana	LC
Quercus muehlenbergii	LC
Quercus myrtifolia	LC
Quercus nigra	LC
Quercus oblongifolia	LC
Quercus oglethorpensis	EN
Quercus pacifica	EN
Quercus pagoda	LC
Quercus palmeri	NT
Quercus palustris	LC
Quercus parvula	NT
Quercus phellos	LC
Quercus polymorpha	LC
Quercus prinoides	LC
Quercus pumila	LC
Quercus pungens	LC
Quercus robusta	DD
Quercus rubra	LC
Quercus rugosa	LC
Quercus sadleriana	NT
Quercus shumardii	LC
Quercus similis	LC
Quercus sinuata	LC
Quercus stellata	LC
Quercus tardifolia	DD
Quercus texana	LC
Quercus tomentella	EN
Quercus toumeyi	DD
Quercus turbinella	LC
Quercus vacciniifolia	LC
Quercus vaseyana	LC
Quercus velutina	LC
Quercus viminea	LC
Quercus virginiana	LC
Quercus wislizeni	LC

Appendix B:

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Quercus falcata *(Deb Brown)*

Appendix C:

IUCN Red List Categories & Criteria

EXTINCT (EX)
A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time-frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW)
A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time-frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN)
A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)
A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)
A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)
A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD)
A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)
A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

The Criteria for Critically Endangered, Endangered and Vulnerable

CRITICALLY ENDANGERED (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing an extremely high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥ 90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   a. direct observation
   b. an index of abundance appropriate to the taxon
   c. a decline in area of occupancy, extent of occurrence and/or quality of habitat
   d. actual or potential levels of exploitation
   e. the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥ 80% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥ 80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥ 80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 100 km^2, and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at only a single location.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. area, extent and/or quality of habitat
      iv. number of locations or subpopulations
      v. number of mature individuals.
   c. Extreme fluctuations in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. number of locations or subpopulations
      iv. number of mature individuals.

2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at only a single location.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. area, extent and/or quality of habitat
      iv. number of locations or subpopulations
      v. number of mature individuals.
   c. Extreme fluctuations in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. number of locations or subpopulations
      iv. number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:

1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
   a. Population structure in the form of one of the following:
      i. no subpopulation estimated to contain more than 50 mature individuals, OR
      ii. at least 90% of mature individuals in one subpopulation.
   b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a very high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥ 70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   a. direct observation
   b. an index of abundance appropriate to the taxon
   c. a decline in area of occupancy, extent of occurrence and/or quality of habitat
   d. actual or potential levels of exploitation
   e. the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥ 50% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥ 50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥ 50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 5000 km2, and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at no more than five locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. area, extent and/or quality of habitat
      iv. number of locations or subpopulations
      v. number of mature individuals.
   c. Extreme fluctuations in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. number of locations or subpopulations
      iv. number of mature individuals.

2. Area of occupancy estimated to be less than 500 km2, and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at no more than five locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. area, extent and/or quality of habitat
      iv. number of locations or subpopulations
      v. number of mature individuals.
   c. Extreme fluctuations in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. number of locations or subpopulations
      iv. number of mature individuals.

C. Population size estimated to number fewer than 2500 mature individuals and either:

1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
   a. Population structure in the form of one of the following:
      i. no subpopulation estimated to contain more than 250 mature individuals, OR
      ii. at least 95% of mature individuals in one subpopulation.
   b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥ 50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   a. direct observation
   b. an index of abundance appropriate to the taxon
   c. a decline in area of occupancy, extent of occurrence and/or quality of habitat
   d. actual or potential levels of exploitation
   e. the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥ 30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥ 30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥ 30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km^2, and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at no more than 10 locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. area, extent and/or quality of habitat
      iv. number of locations or subpopulations
      v. number of mature individuals.
   c. Extreme fluctuations in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. number of locations or subpopulations
      iv. number of mature individuals.

2. Area of occupancy estimated to be less than 2000 km2, and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at no more than 10 locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. area, extent and/or quality of habitat
      iv. number of locations or subpopulations
      v. number of mature individuals.
   c. Extreme fluctuations in any of the following:
      i. extent of occurrence
      ii. area of occupancy
      iii. number of locations or subpopulations
      iv. number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:

1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
   a. Population structure in the form of one of the following:
      i. no subpopulation estimated to contain more than 1000 mature individuals, OR
      ii. all mature individuals are in one subpopulation.
   b. Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:

1. Population size estimated to number fewer than 1000 mature individuals.

2. Population with a very restricted area of occupancy (typically less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

The Red List of

US Oaks

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