



Conservation Gap Analysis of Native U.S. Oaks

Species profile: *Quercus acerifolia*

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SPECIES OF CONSERVATION CONCERN

CALIFORNIA

Channel Island endemics:
Quercus pacifica, *Quercus tomentella*

Southern region:
Quercus cedrosensis, *Quercus dumosa*,
Quercus engelmannii

Northern region and /
or broad distribution:
Quercus lobata, *Quercus parvula*,
Quercus sadleriana

SOUTHWESTERN U.S.

Texas limited-range endemics
Quercus carmenensis,
Quercus graciliformis, *Quercus hinckleyi*,
Quercus robusta, *Quercus tardifolia*

Concentrated in Arizona:
Quercus ajoensis, *Quercus palmeri*,
Quercus toumeyii

Broad distribution:
Quercus havardii, *Quercus laceyi*

SOUTHEASTERN U.S.

State endemics:
Quercus acerifolia, *Quercus boyntonii*

Concentrated in Florida:
Quercus chapmanii, *Quercus inopina*,
Quercus pumila

Broad distribution:
Quercus arkansana, *Quercus austrina*,
Quercus georgiana,
Quercus oglethorpensis, *Quercus similis*



Quercus acerifolia (E.J.Palmer) Stoyhoff & Hess

Synonyms: *Quercus shumardii* var. *acerifolia* E.J.Palmer **Common Names:** Maple-leaved oak, Maple-leaf oak, Mapleleaf oak

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Deb Brown

DISTRIBUTION AND ECOLOGY

Endemic to the Interior Highlands of the Ouachita Mountains region in west-central Arkansas, U.S., *Quercus acerifolia* is restricted to four counties within the state. Also known as Maple-leaved oak, occurrences of the species are known from Magazine Mountain (Logan County), Sugarloaf Mountain (Sebastian County), Pryor Mountain (Montgomery County), and Porter Mountain (Polk County). *Quercus acerifolia* has an extremely restricted range, occupying a total of seven to 24 kilometers squared.¹ There have also been a few reports of the species in Oklahoma, Georgia, Alabama, and Tennessee, though all cases have appeared to be anomalous individuals not associated with a greater population (M. Lobdell pers. comm., 2018). Within its natural habitat, *Q. acerifolia* grows as a small tree or large shrub, typically three to nine meters tall, and is distinctive due to its palmately lobed leaves resembling those of the Norway maple. Early successional woodland habitats are preferred, especially those with open canopies, dry, rocky ledges, steep slopes, bluff lines, and open glades. Maple-leaved oak occurs most often on xeric sites with thin and rocky soils, but is known to exist in a few mesic, rich soils that have been altered by humans. Co-occurring species include *Q. stellata*, *Juniperus virginiana*, *Carya* spp. and *Fraxinus americana*.^{2,3}

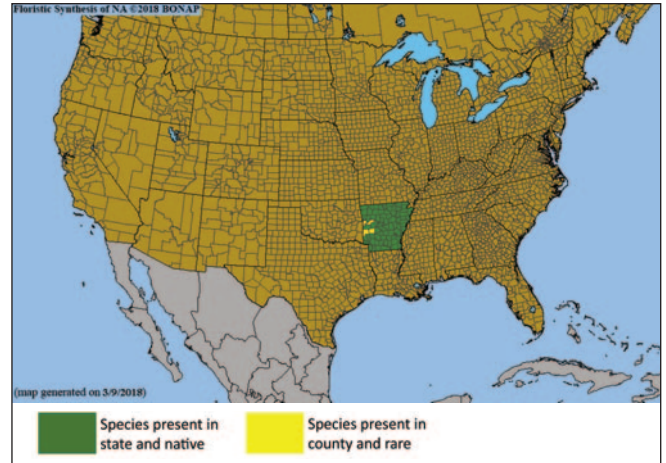


Figure 1. County-level distribution map for *Quercus acerifolia*. Source: Biota of North America Program (BONAP).³

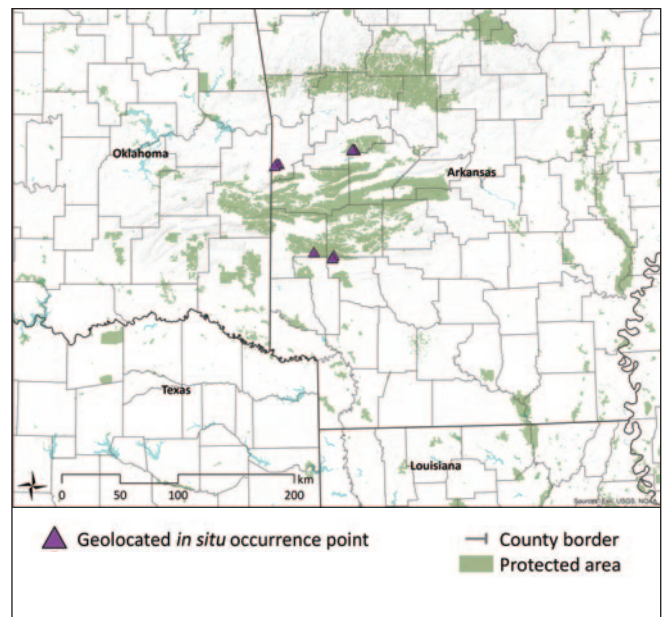


Figure 2. Documented *in situ* occurrence points for *Quercus acerifolia*. Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).⁴

VULNERABILITY OF WILD POPULATIONS

Table 1. Scoring matrix identifying the most severe demographic issues affecting *Quercus acerifolia*. Cells are highlighted when the species meets the respective vulnerability threshold for each demographic indicator. Average vulnerability score is calculated using only those demographic indicators with sufficient data (i.e., excluding unknown indicators).

Demographic indicators	Level of vulnerability						Score
	Emergency Score = 40	High Score = 20	Moderate Score = 10	Low Score = 5	None Score = 0	Unknown No score	
Population size	< 50	< 250	< 2,500	< 10,000	> 10,000	Unknown	10
Range/endemism	Extremely small range or 1 location	E00 < 100 km ² or A00 < 10 km ² or 2-4 locations	E00 < 5,000 km ² or A00 < 500 km ² or 5-9 locations	E00 < 20,000 km ² or A00 < 2,000 km ² or 10+ locations	E00 > 20,000 km ² or A00 > 2,000 km ²	Unknown	20
Population decline	Extreme	>= 80% decline	>= 50% decline	>= 30% decline	None	Unknown	5
Fragmentation	Severe fragmentation	Isolated populations	Somewhat isolated populations	Relatively connected populations	Connected populations	Unknown	20
Regeneration/recruitment	No regeneration or recruitment	Decline of >50% predicted in next generation	Insufficient to maintain current population size	Sufficient to maintain current population size	Sufficient to increase population size	Unknown	10
Genetic variation/integrity	Extremely low	Low	Medium	High	Very high	Unknown	10
Average vulnerability score							12.5
Rank relative to all U.S. oak species of concern (out of 19)							5

THREATS TO WILD POPULATIONS

High Impact Threats

Human use of landscape — residential/commercial development, mining, and/or roads: The subpopulation at Sugarloaf Mountain in Sebastian County, 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. Unrestricted access and recreational use of the site (camping, all-terrain vehicles, deposition of refuse), as well as shale mining activity and electric tower construction, pose moderate threats. The land is also vulnerable to development by future landowners.⁶

Human modification of natural systems — disturbance regime modification, pollution, and/or eradication: Human settlement has suppressed the natural fire regime on Magazine Mountain, resulting in a decline of the early successional open-canopy woodland in which *Q. acerifolia* thrives.²

Moderate Impact Threats

Genetic material loss — inbreeding and/or introgression: The subpopulation on Magazine Mountain seems to be in a bottleneck, perhaps due to low levels of outcrossing.¹

Pests and/or pathogens: Cynipid wasps have recently been reported at the Magazine Mountain subpopulation, and may be impacting acorn production.¹ Because *Q. acerifolia* is a member of

the red oak clade (Sect. *Lobatae*), it also has the potential to be affected by oak wilt, Sudden oak death (SOD), and Goldspotted oak borer.^{7,8,9} No serious damage has been reported to-date, though continued monitoring is necessary. Based on SOD's current distribution in California and the environmental conditions at these locations, models "indicated highest potential for establishment [of SOD] in the southeastern USA;" therefore, Maple-leaved oak is at particular risk should the pathogen spread throughout the Southeast.⁸

Extremely small and/or restricted population: Simply the small range and relatively small population size of *Q. acerifolia* pose moderate threat.

Low Impact Threats

Human use of landscape — tourism and/or recreation: Magazine Mountain has close proximity to recreation areas and campgrounds, but the likelihood of disturbance to *Q. acerifolia* is low due to protection within a state park, which strictly enforces rules regarding threatened and endangered plants.⁶

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: No specific research exists regarding predicted climate impacts on Maple-leaved oak, but its small range and habitat specificity could pose significant challenges in a changing climate.

CONSERVATION ACTIVITIES

In 2017 *Quercus* accessions data were requested from *ex situ* collections. A total of 162 institutions from 26 countries submitted data for native U.S. oaks (Figures 3 and 4). Past, present, and planned conservation activities for U.S. oak species of concern were also examined through literature review, expert consultation, and conduction of a questionnaire. Questionnaire respondents totaled 328 individuals from 252 organizations, including 78 institutions reporting on species of concern (Figure 6).

Results of 2017 *ex situ* survey

Number of <i>ex situ</i> collections reporting this species:	21
Number of plants in <i>ex situ</i> collections:	79
Average number of plants per institution:	4
Percent of <i>ex situ</i> plants of wild origin:	65%
Percent of wild origin plants with known locality:	84%

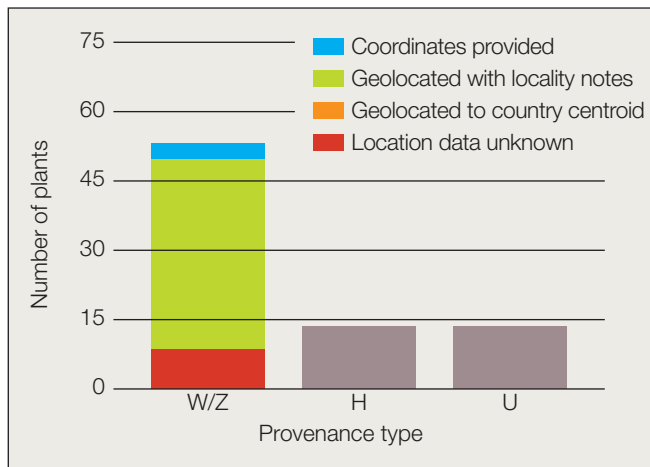


Figure 3. Number and origin of *Quercus acerifolia* plants in *ex situ* collections. Provenance types: W = wild; Z = indirect wild; H = horticultural; U = unknown.

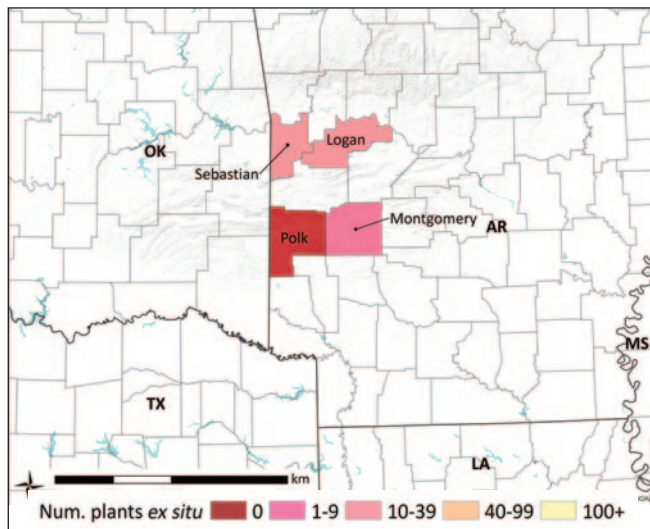


Figure 4. *Quercus acerifolia* counties of *in situ* occurrence, reflecting the number of plants from each county in *ex situ* collections.

A spatial analysis was conducted to estimate the geographic and ecological coverage of *ex situ* collections (Figure 5). Fifty-kilometer buffers were placed around each *in situ* occurrence point and the source locality of each plant living in *ex situ* collections. Collectively, the *in situ* buffer area serves as the inferred native range of the species, or “combined area *in situ*” (CAI50). The *ex situ* buffer area represents the native range “captured” in *ex situ* collections, or “combined area *ex situ*” (CAE50). Geographic coverage of *ex situ* collections was estimated by dividing CAI50 by CAE50. Ecological coverage was estimated by dividing the number of EPA Level IV Ecoregions present in CAE50 by the number of ecoregions in CAI50.

Estimated *ex situ* representation

Geographic coverage:	94%
Ecological coverage:	100%

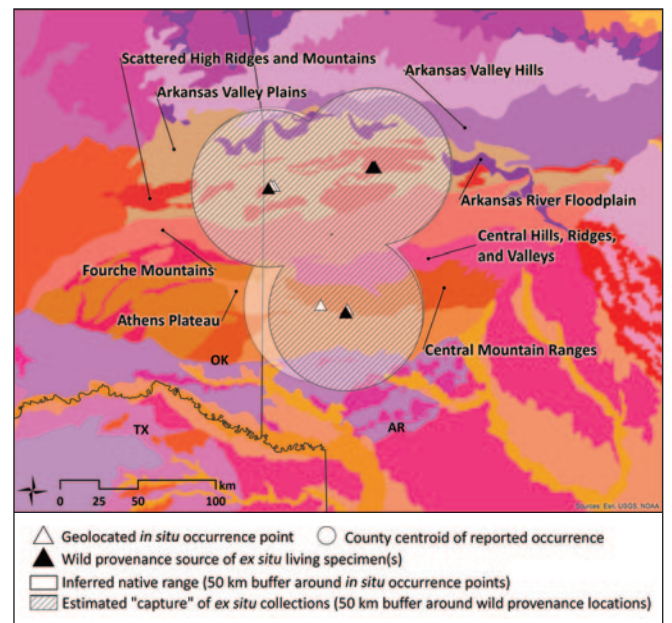


Figure 5. *Quercus acerifolia* *in situ* occurrence points and *ex situ* collection source localities. U.S. EPA Level IV Ecoregions are colored and labeled.¹⁰ County centroid is shown if no precise locality data exist for that county of occurrence. Email treeconservation@mortonarb.org for more information regarding specific coordinates.



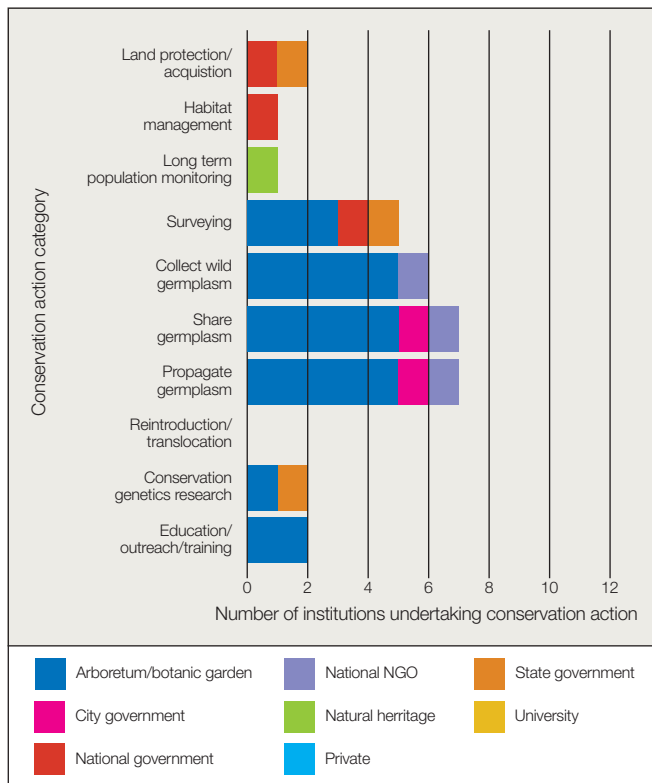


Figure 6. Number of institutions reporting conservation activities for *Quercus acerifolia* grouped by organization type. Thirteen of 252 institutions reported activities focused on *Q. acerifolia* (see Appendix D for a list of all responding institutions).

Land protection: Within the inferred native range of *Q. acerifolia*, 32% of the land is covered by protected areas (Figure 7). However, it is known that three of the four well-documented localities of Maple-leaved oak are within protected areas; although about half of the known number of individuals are located on unprotected land.

Protected areas include Ozark-St. Francis National Forest and Mount Magazine State Park, Ouachita National Forest (Porter Mountain and Pryor Mountain), and Caney Creek National Game Refuge (Porter Mountain); Caney Creek has National Wilderness status. The occurrences within Ouachita National Forest are situated in remote areas with difficult terrain, which further protects them from any kind of human disturbance.¹ Based on USFS spatial data, *Q. acerifolia* could also be represented in other nearby protected areas, including Brush Heap, National Wild and Scenic Cossatot River, National Wild and Scenic Little Missouri River, and Roaring Branch Research Natural Area, which are all federally managed.¹¹

Sustainable management of land: As part of the USDA Forest Service Silviculture Reforestation program, parts of Ouachita National Forest that may overlap with the distribution of *Q. acerifolia* have been burned at least once, in 2006. The Silviculture Reforestation program works to optimize forest vegetation establishment, including planting, seeding, site preparation for natural regeneration, and certification of natural regeneration without site preparation.¹¹

Population monitoring and/or occurrence surveys: The Arkansas Natural Heritage Commission considers *Q. acerifolia* extremely rare in the state based on NatureServe’s vulnerability assessment guidelines. This designation requires the Commission to track the species’ distribution within their biodiversity database.¹² Lead by The Dawes Arboretum, with funding from an APGA-USFS Tree Gene Conservation Partnership grant, three of the four known sites were visited for seed collection in 2017. Due to “unusually heavy rains and more moderate weather than normal,” they found that “trees from all sites displayed excellent vigor judging by recent growth increments.” However, some individuals on Mount Magazine did show “considerable dieback in the upper crowns, [which was] attributed...to heavy shade from overtopping vegetation.”¹³

Wild collecting and/or ex situ curation: With funding from a 2017 APGA-USFS Tree Gene Conservation Partnership grant, The Dawes Arboretum lead an expedition to collect seed from as many individuals as possible within three of the four known Maple-leaved oak sites. Low reproductivity has been documented in the past, so all individuals were examined for possible acorn collection. Six unique accessions were collected, with a total of 2,251 total acorns: Mount Magazine (902 acorns), Porter Mountain (857 acorns), Pryor Mountain (492 acorns; K. Bachtell & M. Ecker pers. comm., 2018). By the end of 2017, 22 gardens had received surplus seeds from one or more of these sites. Living material from Maple-leaved oak was also provided to Dr. Valerie Pence at the Center for Conservation and Research of Endangered Wildlife, Cincinnati Zoo and Botanical Garden. Using cutting-edge techniques to preserve oak germplasm, which cannot be successfully stored in normal seed bank conditions, Pence has preserved germinated seedlings of *Q. acerifolia* through in vitro culture of shoot tips and subsequent long-term liquid nitrogen storage.¹³

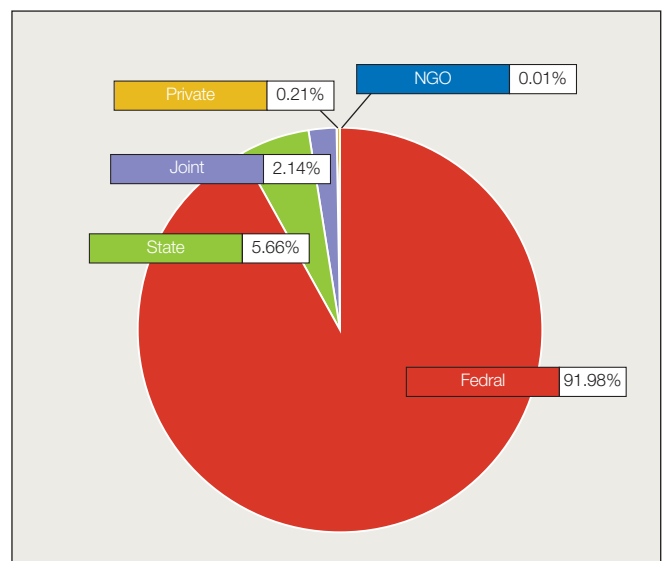


Figure 7. Management type of protected areas within the inferred native range of *Quercus acerifolia*. Protected areas data from the U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).⁵

Propagation and/or breeding programs: After completing wild collecting efforts funded by a 2017 APGA-USFS Tree Gene Conservation Partnership grant, The Dawes Arboretum kept at least five seedlings for their collections, and depending on the number of seedlings produced, remaining seedlings were distributed to other participating institutions when plants reached an appropriate size for shipping. Receiving institutions include: Holden Forest and Gardens, OH; Morris Arboretum of the University of Pennsylvania, PA; The Morton Arboretum, IL; Chicago Botanic Garden, IL; Starhill Forest Arboretum of Illinois College, IL (K. Bachtell pers comm., 2017).¹³

Reintroduction, reinforcement, and/or translocation: No known initiatives at the time of publication.

Research: Through cutting-edge techniques that utilize in vitro culture of shoot tips and subsequent long-term liquid nitrogen storage, Dr. Valerie Pence is working towards long-term preservation of germinated seedlings of *Q. acerifolia* at the Center for Conservation and Research of Endangered Wildlife, Cincinnati Zoo and Botanical Garden.¹³

Education, outreach, and/or training: The Oklahoma City Zoo and Botanical Gardens held an event in conjunction with Endangered Species Day on May 18th, 2008, which included a plant sale with *Q. acerifolia* as a featured species.¹⁴

Species protection policies: The Arkansas Natural Heritage Commission considers *Q. acerifolia* threatened in the state, although no specific protection policies are attached to this designation. Distribution data are used to inform land management planning and the environmental review processes of private developers and public landowners, however the state of Arkansas does not have conservation requirements for land development.¹⁵



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PRIORITY CONSERVATION ACTIONS

Of greatest need with regard to conservation of Maple-leaved oak is a broad and thorough genetic analysis. An understanding of diversity between and within the four traditionally recognized mountaintop populations would be useful to prioritize investigation of protection of the privately owned Sugarloaf Mountain site, as well as to guide further *ex situ* preservation efforts. Furthermore, a genetic study is necessary to answer lingering debate and disagreement on the taxonomic disposition of the species in general. In recent years, oak populations have been documented elsewhere in Arkansas, as well as in Alabama, Georgia, Missouri, Oklahoma, and Tennessee, that are morphologically similar to *Q. acerifolia*, usually in association with rocky woodlands and glades of various geologic substrates and elevations (D. Estes pers. comm., 2018).^{16,17} A thorough assessment of these populations and comparison to the four traditional populations is necessary to determine the true conservation status of the species.

Recognition of *Q. acerifolia* as a threatened species by the Arkansas Natural Heritage Commission is positive for awareness of the species, though the lack of legal protection or status attached to this designation will likely require supplementation with other means in order to ensure long-term viability of the species. The lack of land protection or extensive *in situ* conservation efforts are also problematic. All wild populations should continue to be closely monitored long-term, and land management should be discussed with the respective stakeholders to identify if disturbances such as burning or culling are necessary for the species' successful reproduction. If possible, landowners of the Sugarloaf Mountain site should be engaged to determine if land protection can be pursued; this could include options like conservation easements. Reinforcement and/or translocation should also be considered, especially if specific subpopulations are found to have very low genetic variation. Furthering the *ex situ* conservation of this species through cultivation in botanical gardens, arboreta, or seed orchards should be a priority as well.

Conservation recommendations for *Quercus acerifolia*

Highest Priority

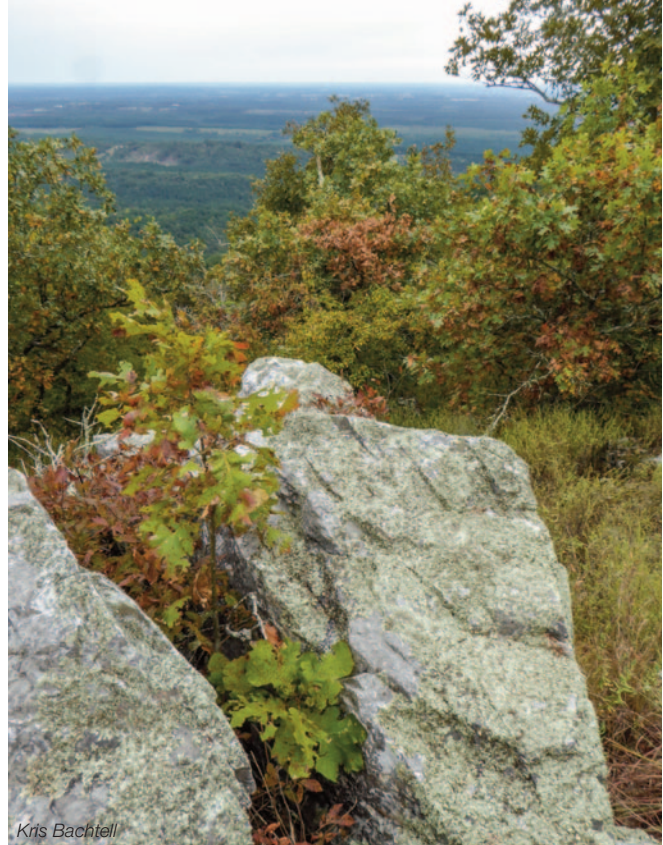
- Research (climate change modeling; demographic studies/ecological niche modeling; pests/pathogens; population genetics; restoration protocols/guidelines; taxonomy/phylogenetics)
- Population monitoring and/or occurrence surveys
- Land protection
- Sustainable management of land

Recommended

- Wild collecting and/or *ex situ* curation
- Reintroduction, reinforcement, and/or translocation
- Education, outreach, and/or training

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