Conservation Gap Analysis of Native U.S. Oaks

Species profile: ***Quercus arkansana***

Emily Beckman, Patrick Thompson, Abby Meyer, Murphy Westwood

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 toumeyi

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*

The Morton Arboretum®
BOTANIC GARDENS CONSERVATION INTERNATIONAL
FOREST SERVICE U.S. DEPARTMENT AGRICULTURE
FAUNA & FLORA INTERNATIONAL

Quercus arkansana Sarg.

Synonyms: *Quercus caput-rivuli* Ashe **Common Names:** Arkansas oak

Species profile co-author: Patrick Thompson, Donald E. Davis Arboretum, Auburn University
Contributors: Michael MacRoberts, Biology Department, Louisiana State University in Shreveport; **Jason Singhurst,** Nongame and Rare Species Program, Texas Parks and Wildlife Department; **Wayne T. Barger,** Alabama Department of Conservation and Natural Resources; **Jared Chauncey,** Missouri Botanical Garden; **Gerould Wilhelm,** Conservation Research Institute

Suggested citation: Beckman, E., Thompson, P., Meyer, A., & Westwood, M. (2019). *Quercus arkansana* Sarg. In Beckman, E., Meyer, A., Man, G., Pivorunas, D., Denvir, A., Gill, D., Shaw, K., & Westwood, M. *Conservation Gap Analysis of Native U.S. Oaks* (pp. 62-67). Lisle, IL: The Morton Arboretum. Retrieved from https://www.mortonarb.org/files/species-profile-quercus-arkansana.pdf

DISTRIBUTION AND ECOLOGY

Quercus arkansana, or Arkansas oak, is endemic to the southeastern U.S., with a distribution stretching from Georgia to eastern Texas. The species' range generally follows the Gulf Coastal Plain and avoids the Mississippi River Delta. Despite its historic commonality across this large range, the species is now thought to be restricted to isolated populations where it usually occurs sporadically, sometimes making up only 5-10% of woody vegetation at sites in its eastern range. However, a few sites do remain with hundreds of individuals[1]. Limited recent surveys in the species' western range have located it in multiple degraded sites, and it is expected to exist in other similar unknown locations where it is inconspicuous and unsurveyed. These types of degraded areas are widespread in east Texas, west Louisiana, and southwest Arkansas, and provide potential for the discovery of new localities (M. MacRoberts pers. comm., 2018). Healthy sites are typically composed of fine loamy sand or other well-draining sandy soils, mesic pine or southern hardwood forests, and topography such as sandhills, steepheads, or stream heads. Arkansas oak is a small tree found in the shady understory, reaching from one to eight meters in height, but has been seen to reach 15 meters.[1]

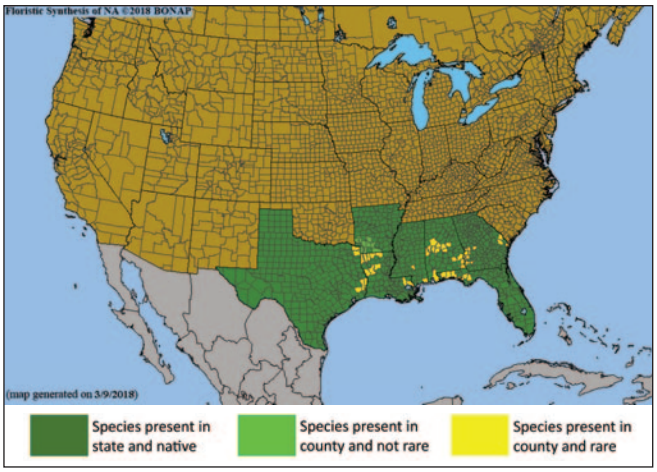

Figure 1. County-level distribution map for *Quercus arkansana*. Source: Biota of North America Program (BONAP).[2]

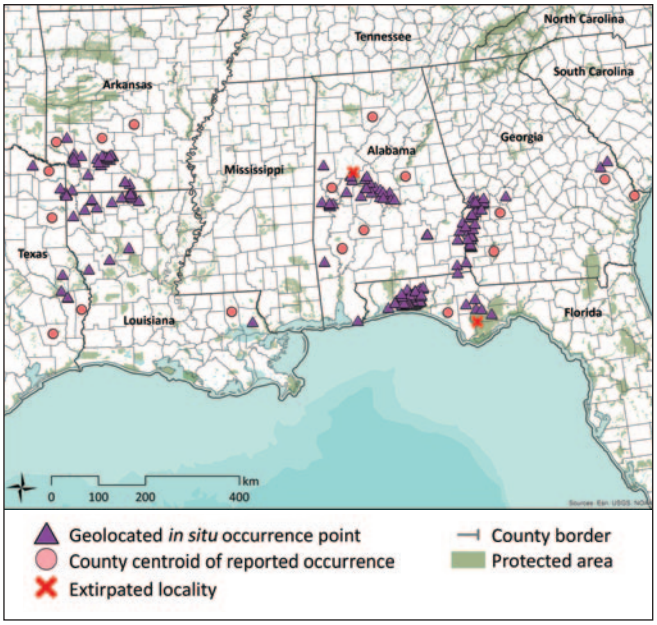

Figure 2. Documented *in situ* occurrence points for *Quercus arkansana.* Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[3]

VULNERABILITY OF WILD POPULATIONS

Table 1. Scoring matrix identifying the most severe demographic issues affecting *Quercus arkansana*. 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						
	Emergency Score = 40	**High** Score = 20	**Moderate** Score = 10	**Low** Score = 5	**None** Score = 0	**Unknown** No score	**Score**
Population size	< 50	< 250	< 2,500	< 10,000	> 10,000	Unknown	5
Range/endemism	Extremely small range or 1 location	EOO < 100 km^2 or AOO < 10 km^2 or 2-4 locations	EOO < 5,000 km^2 or AOO < 500 km^2 or 5-9 locations	EOO < 20,000 km^2 or AOO < 2,000 km^2 or 10+ locations	EOO > 20,000 km^2 or AOO > 2,000 km^2	Unknown	5
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	9.2
						Rank relative to all U.S. oak species of concern (out of 19)	10

THREATS TO WILD POPULATIONS

High Impact Threats

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: Detrimental impacts of commercial forestry practices such as timber harvest and prescribed burns have destroyed several known stands of *Q. arkansana*, and continue to threaten small, scattered occurrences. Some threat remains from conversion of habitat to pine plantations.[4]

Human use of landscape — residential/commercial development, mining, and/or roads: Habitat deterioration and destruction by residential and commercial development has been this species' largest threat in the past, and may continue to be. Arkansas oak is mostly distributed on privately owned areas, though many habitat remnants seem unlikely to be developed due to unsuitable landscape type (J. Chauncey pers. comm., 2017).

Human modification of natural systems — disturbance regime modification, pollution, and/or eradication: Management of *Q. arkansana's* habitat is often directed at restoring populations of other rare plants and animals, which can be incompatible with the oak's needs. Some populations in central Alabama have been removed while restoring longleaf pine habitat and a large population in southwestern Alabama experienced losses due to management aimed at promoting Gopher tortoise.[1]

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: Recent reports of occurrences in Alabama have noted dieback of trees, with unusual drought suggested as a cause.[1] In an analysis of tree species vulnerability to climate change, *Q. arkansana* was ranked in the highest risk class based on climate change exposure, sensitivity, and low adaptive capacity.[5]

Moderate Impact Threats

Human modification of natural systems — invasive species competition: Two patches of the invasive Chinese wisteria (*Wisteria sinense*) were found during visits to Fort Benning, Georgia. These invasives were able to colonize the area due to erosion.[6]

Genetic material loss — inbreeding and/or introgression: Introgression with more widespread red oaks (Sect. Lobatae) is possible, and this species is particularly susceptible due to its fragmented distribution (J. Chauncey pers. comm., 2017). Increased introgression between *Q. arkansana* and *Q. nigra* was documented at the western edge of *Q. arkansana's* range.[7]

Low Impact Threats

Pests and/or pathogens: Because *Q. arkansana* is a member of the red oak clade it can be affected by oak wilt, Sudden oak death (SOD), and Goldspotted oak borer.[8,9,10] No serious damage has been reported to-date, though monitoring is necessary. Based on environmental conditions in SOD's current California distribution, models "indicated highest potential for establishment [of SOD] in the southeastern USA."[9]

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 *ex situ* collections reporting this species:	28
Number of plants in *ex situ* collections:	129
Average number of plants per institution:	5
Percent of *ex situ* plants of wild origin:	79%
Percent of wild origin plants with known locality:	98%

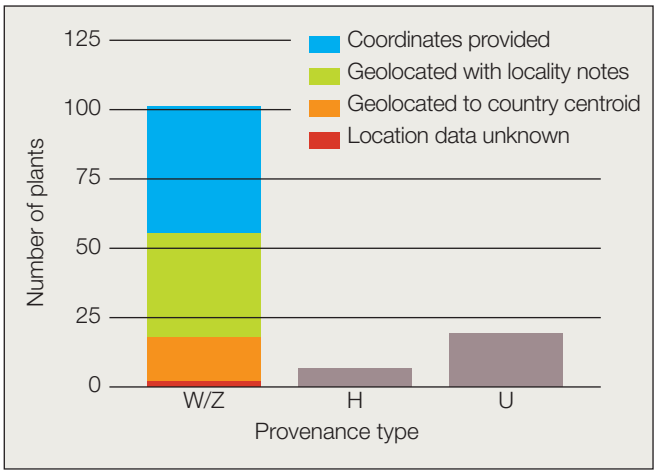

Figure 3. Number and origin of *Quercus arkansana* plants in *ex situ* collections. Provenance types: W = wild; Z = indirect wild; H = horticultural; U = unknown.

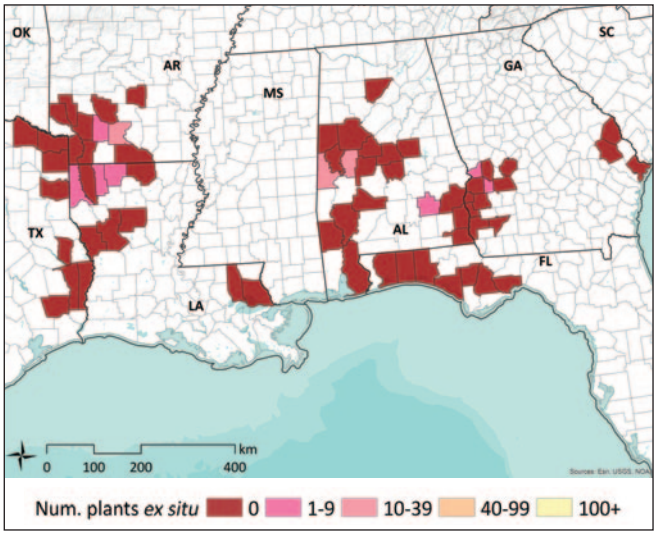

Figure 4. *Quercus arkansana* counties of *in situ* occurrence, reflecting the number of plants from each county in *ex situ* collections.

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:	24%
Ecological coverage:	34%

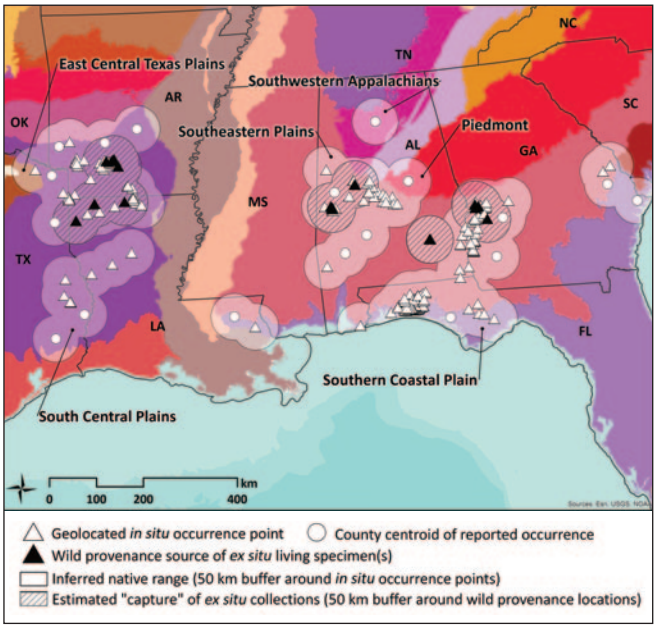

Figure 5. *Quercus arkansana in situ* occurrence points and *ex situ* collection source localities. U.S. EPA Level III Ecoregions are colored and labelled.[11] County centroid is shown if no precise locality data exist for that county of occurrence. Email treeconservation@mortonarb.org for information regarding specific coordinates.

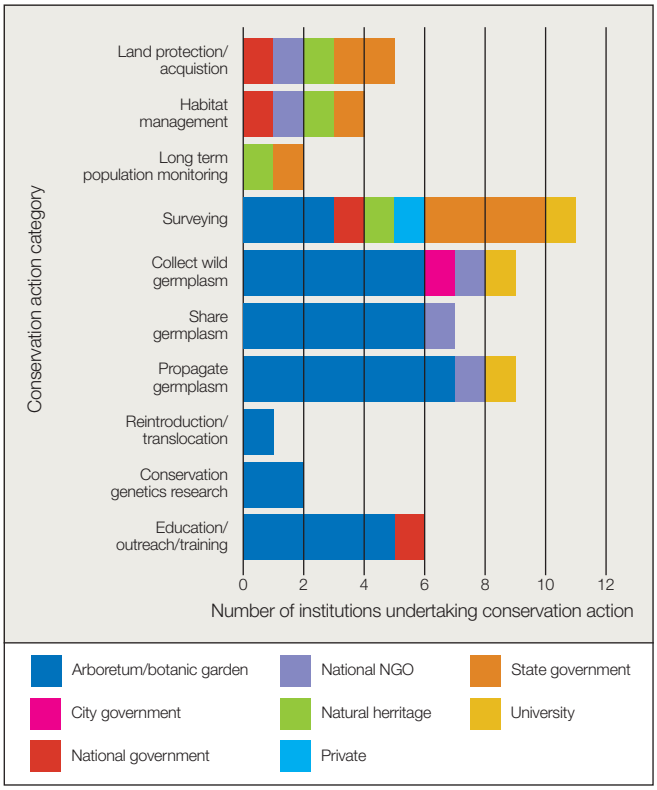

Figure 6. Number of institutions reporting conservation activities for *Quercus arkansana* grouped by organization type. Twenty-four of 252 institutions reported activities focused on *Q. arkansana* (see Appendix D for a list of all responding institutions).

Land protection and/or acquisition: Within the inferred native range of *Q. arkansana*, only 10% of the land is covered by protected areas (Figure 7). While some of these areas contain large, healthy populations, many are not managed optimally for *Q. arkansana* and are unlikely to provide long term protection to the species.

There are two Arkansas Oak Natural Areas, one is a 200 acre plot in Nevada County, Arkansas, owned by the Arkansas Natural Heritage Commission, and the the other is a 673 acre natural area owned by the US Army Corps of Engineers, created specifically to protect *Q. arkansana* in Bossier Parish, Louisiana. The Louisiana area includes two plant community types—mixed hardwood pine forest and stream forest—which provide habitat for Arkansas oak on sandy ridges, knolls, and a bayou bank. The species is thought to be common throughout, though a recent expedition only located heavily shaded *Q. marilandica* (M. MacRoberts pers. comm., 2018).[12] Little River Bottoms in Arkansas also provides protected habitat for *Q. arkansana* through its 18,000 contiguous acres of bottomland hardwood forest. The majority of the tract is privately owned by hunting clubs and land trusts, with smaller portions owned by the Arkansas Natural Heritage Commission or Arkansas Game and Fish Commission.[13] Caddo Black Bayou Preserve in Caddo Parish, Louisiana, is owned by The Nature Conservancy and houses a sandy woodland area dominated by *Q. incana*, *Q. stellate* var. *margaretta*, and *Q. arkansana*. The protected area covers 656 acres, which have a variety of rare plant species, and is surrounded by pine plantations, oil and gas sites, and rural residential areas.[14] The area is currently degraded ecologically (M. MacRoberts pers. comm., 2018).

The Talladega National Forest Oakmulgee District in Alabama completed a Biological Evaluation (BE) for the Longleaf Ecosystem Restoration Project in 2005, in compliance with the Forest Service Manual. The evaluation reported *Q. arkansana* within their project area and determined there to be possible effects on the species, though likely only beneficial.[15] *Quercus arkansana* also occurs at Pike County Pocosin, a site owned and managed by Forever Wild, a land trust operated by the Alabama Department of Conservation and Natural Resources. The population is known by the land managers and discussions of augmenting the population by outplanting propagules grown by AU Davis Arboretum are underway (W. T. Barger pers. comm., 2017). Fred Gannon Rocky Bayou State Park in Georgia has a robust population in a maritime hammock habitat.[16]

Longleaf Ridge Phase II is a conservation easement in Jasper County, Texas, which was acquired by Texas A&M Forest Service in 2017. The area will permanently protect nearly 5,500 acres of sustainably managed timberland in East Texas. A natural Arkansas oak community was documented in a ten acre area within the easement, with immature oaks observed most abundantly, including thousands of trees dominating the understory (J. Singhurst pers. comm., 2018).[17]

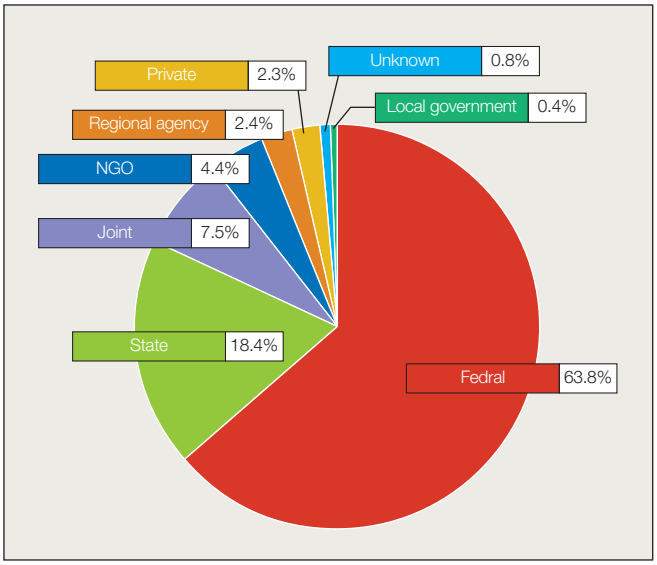

Figure 7. Management type of protected areas within the inferred native range of *Quercus arkansana*. Protected areas data from the U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[2]

Sustainable management of land: National Forests in Alabama are managed for pine, which could conflict with *Q. arkansana's* needs, but the species is protected where possible.[1] Upper Ouachita National Wildlife Refuge works to conserve and restore Arkansas oak habitat, and the Central Sandhills and Miller County Sandhills sites prescribe ecological fire regimes and stem thinning to encourage *Q. arkansana* health and regeneration.[18,19] Eglin Air Force Base, Florida, and Fort Benning, Georgia, hold thousands of trees in healthy subpopulations and protect the plants through an effective land management program.[1] Within the Caddo Black Bayou Preserve, The Nature Conservancy is "focusing its efforts on restoring and enhancing remnant western xeric sandhill plant communities by reintroducing fire as an ecological process."[14]

Population monitoring and/or occurrence surveys: The Integrated Natural Resources Management Plan for Fort Benning, Georgia, prescribes regular monitoring of both erosion and invasive plants within the Unique Ecological Area (UEA). Missouri Botanical Garden and Auburn University received a 2017 APGA-USFS Tree Gene Conservation Partnership grant that provided resources to scout populations of *Q. arkansana* across Alabama, Florida, and Georgia in both the summer and fall. Populations in Alabama and west Georgia were visited multiple times between summer and fall to gauge population health, acorn maturity, acorn drop, and leaf drop (J. Chauncey pers. comm., 2017).

Wild collecting and/or *ex situ* curation: With funding from the 2017 APGA-USFS Tree Gene Conservation Partnership grant, the Missouri Botanical Garden led the collection of propagules across Alabama, Florida, and Georgia. Twenty-eight individuals were sampled, resulting in the collection of 281 viable acorns.[16]

Propagation and/or breeding programs: Funding from the 2017 APGA-USFS Tree Gene Conservation Partnership grant also provided resources to propagate *Q. arkansana* for *ex situ* conservation. Acorns are being propagated at the Missouri Botanical Garden and grown out to the appropriate size for distribution. Seven project partner institutions, representing a large geographic and climatic range, will receive seedlings for addition to their collections.[16]

Reintroduction, reinforcement, and/or translocation: One institution reported this activity in the conservation action questionnaire, but no other details are currently known.

Research: The Native Plant Network Propagation Protocol Database provides information about established propagation techniques specific to *Q. arkansana*.[18] Because *Q. caput-rivuli*, currently a synonym of *Q. arkansana*, may deserve species status, further biosystematics examination should be carried out regarding the issue (J. Wilhelm pers. comm., 2018). Leaf samples collected during the 2017 expedition are stored in the Missouri Botanical Garden DNA bank, awaiting sequencing by additional collaborators.[16]

Education, outreach, and/or training: A joint restoration project between The Conservation Fund, USDA Forest Service, and U.S. Fish and Wildlife Service, entitled Restoring a Forest Legacy at Upper Ouachita National Wildlife Refuge, supports environmental education and interpretation in areas inhabited by *Q. arkansana*.[19] These efforts could have an especially meaningful impact if efforts can focus on Arkansas oak.

Species protection policies: *Quercus arkansana* is protected as a Threatened species by the Florida Department of Agriculture and Consumer Services, as decided by the Florida Endangered Plant Advisory Council. Texas maintains a list of more than 1,300 Species of Greatest Conservation Need (SGCN) that are "declining or rare and in need of attention to recover or to prevent the need to list under state or federal regulation". *Quercus arkansana* is listed as a SGCN.[21]

PRIORITY CONSERVATION ACTIONS

Arkansas oak is a widespread, cryptic species susceptible to numerous threats outlined in this review. One challenge presented by its evasive nature is that it is largely unknown within its range and can be easily overlooked or mistaken for common oak species. In addition to further occurrence surveys, the species should be highlighted in outreach efforts to increase awareness within the general public. This is especially important in the species' southeastern range, because the vast majority of land is privately owned and forestry is a major part of the regional economy.

Preserving and appropriately managing areas where these rare trees grow is also key to avoiding extinction. For *Q. arkansana*, fire frequency and intensity are important management factors. Increased census and survey work, coupled with long term monitoring, should also be carried out; these data will allow for quantification of the effects of climate change on this species, which will be paramount in aiding and informing future conservation work.

Finally, an evaluation of the genetic diversity within the remaining known populations will be necessary for creating an informed conservation plan for *Q. arkansana*. If there are hotspots for genetic diversity within the range, efforts to conserve those plants *in situ* and *ex situ* can receive priority. Regardless of genetic diversity, small and isolated populations are under increased pressure of genetic swamping from other red oaks. Efforts such as those executed by the 2017 APGA-USFS Tree Gene Conservation Partnership grant should be repeated until acorn production captures a significant amount of viable seed. Of the 26 trees collected in 2017, only 3 yielded more than 10 acorns.[16] Replicating this work would establish a greater understanding of mast year frequency for the species and further document issues affecting seed viability, such as infestations of acorn weevil. If infrequent acorn production is a limiting factor, research regarding vegetative propagation through stem cuttings and/or tissue culture could be of great conservation value. Propagated plants can be secured in *ex situ* collections, and used to augment *in situ* populations in order to reduce introgression and genetic swamping pressures.

Conservation recommendations for *Quercus arkansana*

Highest Priority

- Education, outreach, and/or training
- Population monitoring and/or occurrence surveys
- Sustainable management of land
- Wild collecting and/or *ex situ* curation

Recommended

- Land protection
- Population monitoring and/or occurrence surveys
- Reintroduction, reinforcement, and/or translocation
- Research (climate change modeling; demographic studies/ecological niche modeling; land management/disturbance regime needs; pests/pathogens; population genetics; restoration protocols/guidelines)

REFERENCES

1. **Jerome, D., Wenzell, K., & Kenny, L. (2017).** *Quercus arkansana*. The IUCN Red List of Threatened Species 2017: e.T30953A88108282. Retrieved from http://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T30953A88108282.en
2. **Kartesz, J. T. (2018).** The Biota of North America Program (BONAP). Taxonomic Data Center, Floristic Synthesis of North America, Version 1.0. Chapel Hill, NC. Retrieved from http://www.bonap.net/tdc
3. **U.S. Geological Survey, Gap Analysis Program (GAP). (2016, May).** Protected Areas Database of the United States (PAD-US). Version 1.4 Combined Feature Class. Retrieved from https://gapanalysis.usgs.gov/padus/data/download/
4. **Hunt, D. (1986).** Distribution of Quercus arkansana in Georgia. Castanea, 51(3), 183-187. Retrieved from https://www.jstor.org/stable/4033385
5. **Potter, K. M., Crane, B. S., & Hargrove, W. W. (2017).** A United States national prioritization framework for tree species vulnerability to climate change. New Forests, 48(2), 275-300. doi:10.1007/s11056-017-9569-5
6. **Directorate of Public Works Environmental Management Division. (2014).** *Integrated natural resources management plan*. Fort Benning, GA. Retrieved from http://www.benning.army.mil/Garrison/DPW/EMD/Content/PDF/4%20-%20Fort%20Benning%202014%20INRMP%20Revision_Final%20Draft.pdf
7. **Hunt, D. M., MacRoberts, M. H., & MacRoberts, B. R. (1995).** The status of *Quercus arkansana* Sarg. (Fagaceae) in Texas. Phytologia, 79(1), 22-24. Retrieved from http://biostor.org/reference/167651
8. **Canadian Food Inspection Agency (2019).** *Bretziella fagacearum* (previously known as *Ceratocystis fagacearum* (Oak Wilt) - Fact Sheet. Retrieved from http://www.inspection.gc.ca/plants/plant-pests-invasive-species/diseases/oak-wilt/fact-sheet/eng/1325629194844/1325632464641
9. **Kluza, D. A., Vieglais, D. A., Andreasen, J. K., & Peterson, A. T. (2007).** Sudden oak death: geographic risk estimates and predictions of origins. *Plant Pathology*, 56(4), 580-587. doi:10.1111/j.1365-3059.2007.01602.x
10. **Colman, T. W., Jones, M. I., Smith, S. L., Venette, R. C., Flint, M. L., & Seybold, S. J. (2017).** Goldspotted Oak Borer. Forest Insect & Disease Leaflet 183. U.S. Department of Agriculture, Forest Service. Retrieved from https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3833276.pdf
11. **U.S. EPA Office of Research & Development. (2013, April).** Level IV Ecoregions of the Conterminous United States. National Health and Environmental Effects Research Laboratory (NHEERL). Retrieved from ftp://ftp.epa.gov/wed/ecoregions/us/us_eco_l4.zip
12. **Jones, J. (2007, June).** Natural Areas Registry Update. *Louisiana Natural Areas Registry*, 4(4). Baton Rouge, LA: Louisiana Department of Wildlife and Fisheries. Retrieved from http://www.wlf.louisiana.gov/sites/default/files/natural_area_newsletter-june_2007.pdf
13. **Audubon. (n.d.).** Important bird areas: Little River Bottoms, Arkansas. Retrieved from https://www.audubon.org/important-bird-areas/little-river-bottoms
14. **The Nature Conservancy. (n.d.).** Louisiana Caddo Black Bayou Preserve: Discover one of the rarest ecological communities in the Upper West Gulf Coastal Plain ecoregion.
15. **Ragland, C. O., & Shores, J. (Eds.). (2005).** *Longleaf ecosystem restoration project, Talladega National Forest - Oakmulgee District: Final environmental impact statement.* National Forests in Alabama, Forest Service, U.S. Department of Agriculture.
16. **Chauncey, J., & Gunn, D. (2017).** *APGA-USFS Tree Gene Conservation Partnership grant report: 2017 scouting/collecting trip,* Quercus arkansana *and* Aesculus parviflora.
17. **Texas A&M Forest Service. (n.d.).** Newsroom: Longleaf Ridge phase II. Beaumont, TX. Retrieved from https://tfsweb.tamu.edu/content/article.aspx?id=28422
18. **Pearson, S. (2008).** *2007 state wildlife grant: Implementing state wildlife action plan startegies in the West Gulf Coastal Plain Sandhill oak--Shortleaf pine forest and woodlands to benefit CWCS Species of Concern.* AR: The Nature Conservancy. Retrieved from https://www.wildlifearkansas.com/materials/ProjectReports/T26-12%20Sandhill%20pine%20forest%20and%20woodland%20FINAL.pdf
19. **The Conservation Fund. (2016).** *Restoring a forest legacy at Upper Ouachita National Wildlife Refuge: A forestland restoration partnership between the US Fish and Wildlife Service and The Conservation Fund's Go Zero® program, project implementation report.* Contributions from United States Fish and Wildlife Service & TerraCarbon LLC.
20. **Baskin, J. M., & Baskin, C. J. (2001).** Propagation protocol for production of container (plug) *Quercus arkansana* Sarg. plants. Forest Service, US Department of Agriculture. Retrieved from https://rngr.net/renderNPNProtocolDetails?selectedProtocolIds=fagaceae-quercus-2014
21. **Texas Parks and Wildlife Department. (n.d.).** Species of Greatest Conservation Need. Retrieved from https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/tcap/sgcn.phtml