Conservation Gap Analysis of Native U.S. Oaks

Species profile: ***Quercus georgiana***

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*

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Quercus georgiana M.A.Curtis

Synonyms: N/A **Common Names:** Georgia oak

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Guy Sternberg

DISTRIBUTION AND ECOLOGY

Quercus georgiana, or Georgia oak, occurs on isolated granite outcrops and flat-rocks in the Piedmont Plateau of the southeastern U.S., including locations in Georgia and Alabama.[1] In Alabama, *Q. georgiana* can also be found on sandstone outcrops of the Ridge and Valley Province, and more frequently in the margins and surrounding woodlands associated with these outcrops (P. Thompson pers. comm., 2018).[2] Historically, the species was also found along the North Carolina-South Carolina border and further east in South Carolina, but these populations are believed to be extirpated or contain too few individuals to be considered viable. Even within its narrow habitat, Georgia oak is uncommon, and considered abundant in few localities. It is currently known to occupy about 72 kilometers squared, with a maximum of 272 kilometers squared.[3] *Quercus georgiana* thrives in dry oak-pine forests that are found atop granite slabs in the Piedmont. Soil depths at one site, Arabia Mountain, are reported to be only 50 to 100 centimeters. Georgia oak is a small tree, usually multi-stemmed and typically growing eight to 15 meters in height.[4]

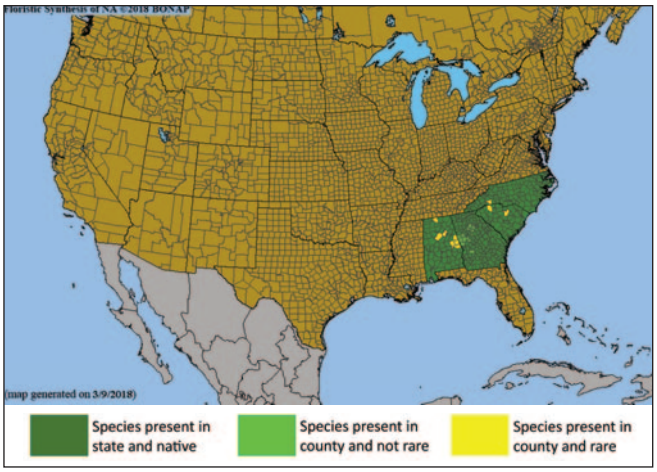

Figure 1. County-level distribution map for *Quercus georgiana*. Source: Biota of North America Program (BONAP).[5]

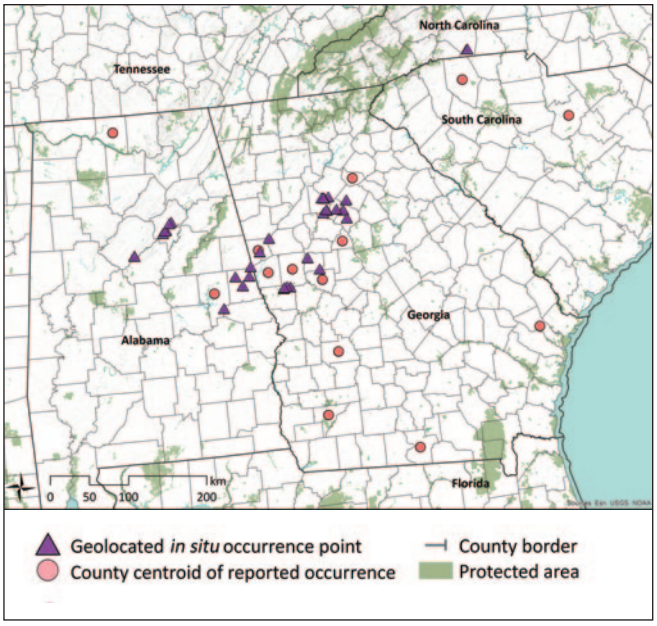

Figure 2. Documented *in situ* occurrence points for *Quercus georgiana.* Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[6]

VULNERABILITY OF WILD POPULATIONS

Table 1. Scoring matrix identifying the most severe demographic issues affecting *Quercus georgiana*. 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	10
Range/endemism	Extremely small range or 1 location	EOO < 100 km² or AOO < 10 km² or 2-4 locations	EOO < 5,000 km² or AOO < 500 km² or 5-9 locations	EOO < 20,000 km² or AOO < 2,000 km² or 10+ locations	EOO > 20,000 km² or AOO > 2,000 km²	Unknown	10
Population decline	Extreme	>= 80% decline	>= 50% decline	>= 30% decline	None	Unknown	10
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	11.7
						Rank relative to all U.S. oak species of concern (out of 19)	7

THREATS TO WILD POPULATIONS

High Impact Threats

Climate change — habitat shifting, drought, temperature extremes, and/or flooding: Climate change may prove a serious threat to *Q. georgiana*, since the species is confined to intermittent "soil islands" on granite outcrops in the Piedmont, which have little connectivity to allow migration. Drought is also a threat, given the species' occurrence on very thin soils (50-100cm deep at some sites) that provide little access to groundwater. *Quercus georgiana* also displays many of the life history traits associated with vulnerability to climate change: limited dispersal ability, slow reproductive rates, specialized habitat requirements, and restricted distribution and rarity.[7,8]

Moderate Impact Threats

Human use of landscape — agriculture, silviculture, ranching, and/or grazing: In the past, land use changes have posed a large threat to *Q. georgiana* habitat, but most areas suitable for agriculture or silviculture have already been cleared; this leaves wetter areas or roadside occurrences remaining (R. Lance pers. comm., 2017).[9]

Human use of landscape — residential/commercial development, mining, and/or roads: *Quercus georgiana* faces significant threat from human development of land and fragmentation (R. Lance pers. comm., 2017).

Human modification of natural systems — disturbance regime modification, pollution, and/or eradication: Fire has been suppressed due to human habitation in the Pine Mountain Range of west-central Georgia, where it is a key component of the ecosystem.[10]

Genetic material loss — inbreeding and/or introgression: For occurrences with especially few individuals, genetic swamping and introgression from surrounding red oak (Sect. Lobatae) threaten the genetic integrity of *Q. georgiana* (R. Lance & R. Russell pers. comm., 2015). In addition, such small populations are likely to experience inbreeding; preliminary genetic data show moderate to moderately high inbreeding in some locations (S. Hoban pers. comm., 2018).

Pests and/or pathogens: Oak decline has been noted for *Q. georgiana*. This usually occurs when non-lethal stresses, such as drought and pests or pathogens, are combined to overwhelm the oaks' defenses.[11] Because *Q. georgiana* is a member of the red oak clade, it also has potential to be affected by oak wilt, Sudden oak death (SOD), and Goldspotted oak borer.[12,13,14] No serious damage has been reported to-date, though monitoring is necessary.

Low Impact Threats

Human use of landscape — tourism and/or recreation: Erosion, poor regeneration, and compacted soils resulting from foot and vehicle traffic are of concern, especially for the many occurrences within state parks and nature preserves; this is a particular threat at Stone Mountain, where plants grow alongside popular hiking trails (R. Lance pers. comm., 2017).

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:	24
Number of plants in *ex situ* collections:	208
Average number of plants per institution:	9
Percent of *ex situ* plants of wild origin:	81%
Percent of wild origin plants with known locality:	93%

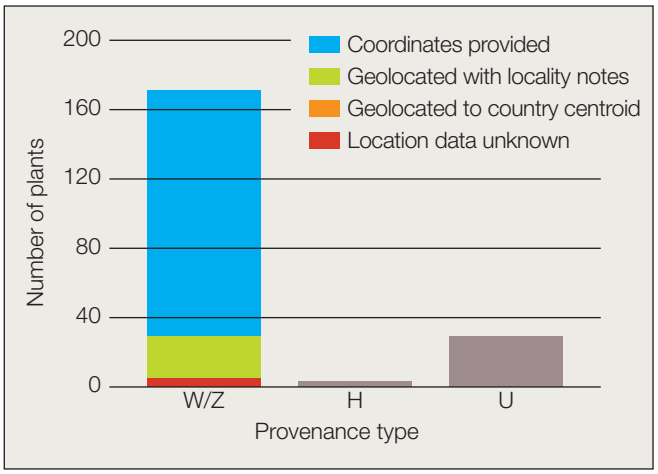

Figure 3. Number and origin of *Quercus georgiana* plants in *ex situ* collections. Provenance types: W = wild; Z = indirect wild; H = horticultural; U = unknown.

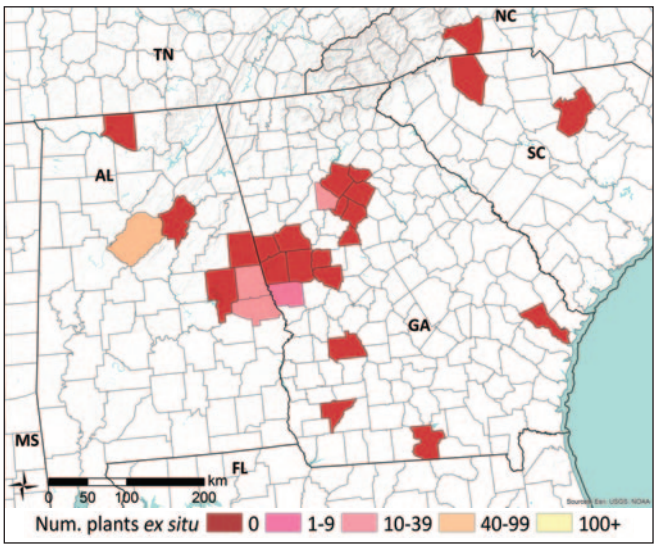

Figure 4. *Quercus georgiana* counties of *in situ* occurrence, reflecting the number of plants from each county in *ex situ* collections.

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:	29%
Ecological coverage:	41%

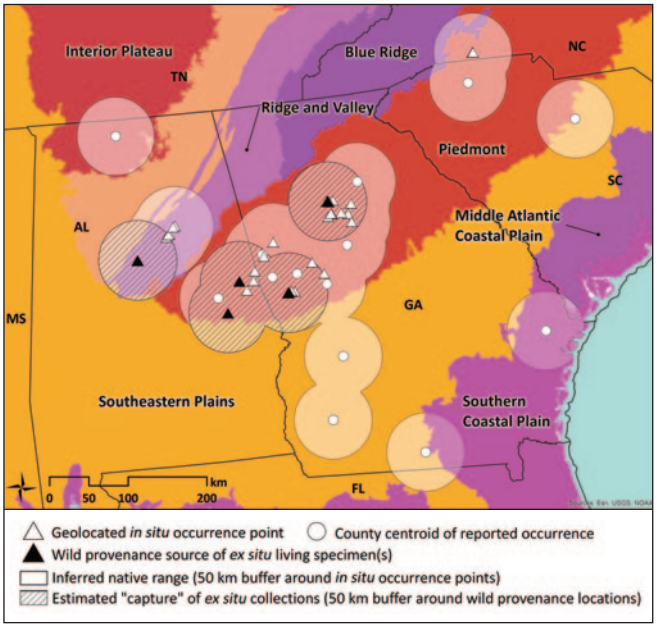

Figure 5. *Quercus georgiana in situ* occurrence points and *ex situ* collection source localities. U.S. EPA Level IV Ecoregions are colored and labelled.[15] County centroid is shown if no precise locality data exist for that county of occurrence. Email treeconservation@mortonarb.org for more information regarding specific coordinates.

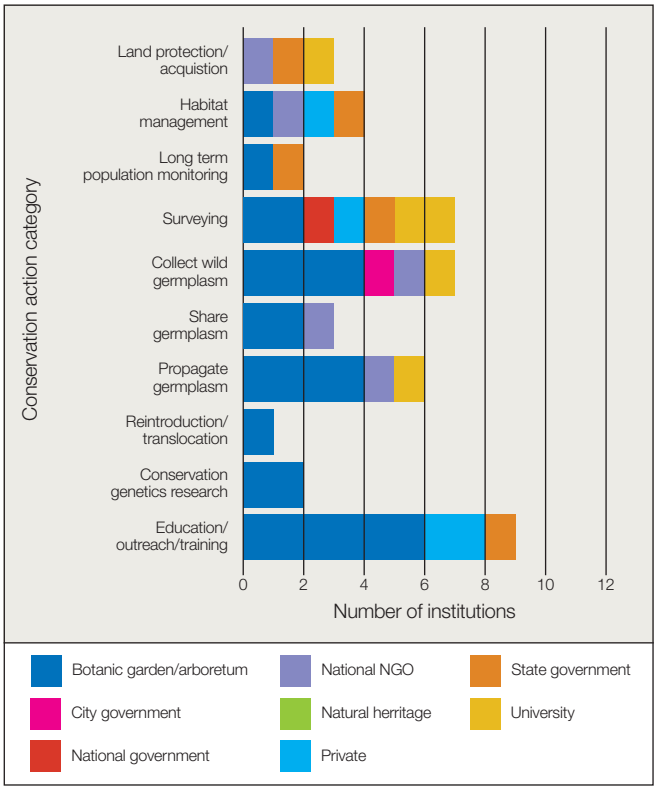

Figure 6. Number of institutions reporting conservation activities for *Quercus georgiana* grouped by organization type. Seventeen of 252 institutions reported activities focused on *Q. georgiana* (see Appendix D for a list of all responding institutions).

Land protection: Within the inferred native range of *Q. georgiana,* 7% of the land is covered by protected areas (Figure 7). Many of the well-known populations of Georgia oak are located within protected areas, however populations outside these areas are largely undocumented and likely hold a majority of the species' distribution.

The Pine Mountain Region possesses a unique diversity of Appalachian and Coastal Plain plant species, and has therefore been proposed as a vital area for conservation. A wilderness area would be the first choice, but is infeasible because the majority of land in the region is privately owned. Exceptions include FDR State Park, Sprewell Bluff State Park, and Little White House Historic Site. Conservation easements with private landowners could be the best option for protecting this unique habitat.[10]

Sustainable management of land: Volunteers at Moss Rock Preserve worked to restore the understory by removing small invasive stems and raking a quarter-acre area; they plan to continue this work in the future.[16]

Population monitoring and/or occurrence surveys: The Morton Arboretum received funding for collection of *Q. georgiana* germplasm in 2018. Through this funding the Georgia Plant Conservation Alliance (GPCA) will conduct opportunistic population surveys at their study sites throughout the state. These potential population discoveries and information about the health of existing populations will guide further collecting efforts.[17]

Wild collecting and/or *ex situ* curation: The Morton Arboretum is leading a long-term initiative to establish a coordinated national network of *ex situ* conservation groves of *Q. georgiana* and other priority threatened oak species, to act as living germplasm banks. Partner institutions from across the country will collect, distribute, and grow large, genetically diverse collections of wild origin plants from across the range of the species. Through the support of a 2018 APGA-USFS Tree Gene Conservation Partnership grant, extensive field collection of *Q. georgiana* across Georgia and Alabama was completed in 2018 though collaboration with Chicago Botanic Garden, Huntington Library and Botanical Gardens, Atlanta Botanical Garden, and Donald E. Davis Arboretum at Auburn University. Additional germplasm was distributed to five other institutions (M. Westwood pers. comm., 2018).[17]

Propagation and/or breeding programs: As part of the above mentioned *ex situ* collections network, a primary goal of the conservation groves will be to provide source material for propagation and breeding (M. Westwood pers. comm., 2018).

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

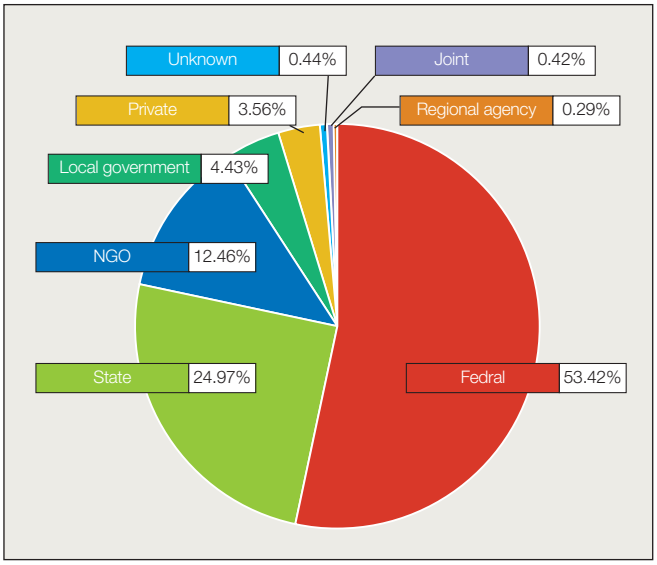

Figure 7. Management type of protected areas within the inferred native range of *Quercus georgiana*. Protected areas data from the U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).[6]

Research: A research project is currently underway by scientists at The Morton Arboretum and Chicago Botanic Garden to examine the genetic diversity of *Q. georgiana*, both in natural stands and within cultivated collections, by comparing the genetics of *Q. georgiana* to several other oak species (S. Hoban pers. comm., 2018). This study builds upon a 2012 genetic analysis that sampled approximately 25 individual trees from each of nine locations in Georgia and Alabama. Occurrences of *Q. georgiana* were noted as small and geographically isolated, though evidence of gene flow and low genetic isolation between subpopulations was detected.[18] This suggests that subpopulations are not genetically isolated enough to be considered severely fragmented, or the apparent gene flow could be a relict of past interconnectedness while negative consequences of fragmentation may still remain to be seen.[17] 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.[18]

Education, outreach, and/or training: The Georgia Forestry Commission's Sustainable Community Forestry Program has created the guidebook Recommended Community Tree Ordinance Tree Conservation Standards, which includes *Q. georgiana* as a good candidate for parking lot island trees.[19]

Species protection policies: No known initiatives at the time of publication.

PRIORITY CONSERVATION ACTIONS

Natural populations in the wild remain under threat from numerous circumstances. Preserving Georgia oak's habitat is the best way to avoid extinction. The opportunity for further land protection should be considered where possible, including arrangements such as conservation easements. Maintaining awareness of management needs within these ecosystems will also be required. Because little land within *Q. georgiana's* distribution is protected, sustainable management of land will necessitate engagement of private landowners to provide education and training.

Increased census and survey work coupled with long-term monitoring will allow quantification of the effects of climate change on this species, and will be the key to informing future conservation work. *Quercus georgiana* has recently been shown to display more varied habitat preferences than previously described. While the implications of this are unclear, it is possible that further research into the species preferences could provide new parameters, which could be applied to habitat modeling. This could reveal an increased number of occurrences for the species. These data, as well as the genetic analyses completed by The Morton Arboretum and Chicago Botanic Garden, should also inform further *ex situ* collecting initiatives.

Small and isolated populations may benefit from augmentation via outplanting of propagated material. Research into success of outplantings will be useful to establish sustainable management practices for the species. Though populations are traditionally kept separate to maintain the purity of genetic distribution across the range, another research avenue could evaluate the fecundity of wild collected seed compared to seeds generated by assisted gene flow between populations. Integrating the species into the built landscape does offer another interesting option per The Georgia Forestry Commission's Sustainable Community Forestry Program's guidebook, though rotocols for propagation must be established first. The increasing need for practitioners of conservation horticulture is evidenced by the challenge of growing species like *Q. georgiana*, which are more finicky than other oaks in the nursery trade.

Conservation recommendations for *Quercus georgiana*

Highest Priority

- Education, outreach, and/or training
- Population monitoring and/or occurrence surveys
- Research (climate change modeling; demographic studies/ecological niche modeling; land management/disturbance regime needs; pests/pathogens; restoration protocols/guidelines)
- Sustainable management of land

Recommended

- Population monitoring and/or occurrence surveys
- Land protection
- Propagation and/or breeding programs
- Reintroduction, reinforcement, and/or translocation
- Wild collecting and/or *ex situ* curation

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