

2018 Quercus georgiana collecting report
APGA/USFS Tree Gene Conservation Partnership

Project Overview

Quercus georgiana, or Georgia Oak, is an Endangered tree native to the Piedmont Plateau of the southeastern US. It is restricted to small occurrences on isolated granite outcrops and is suffering from a variety of threats including soil compaction, climate change, drought, and genetic introgression with other oak species. Some populations are already extirpated or below viable population size.

The Morton Arboretum is undertaking an ambitious, long term initiative to establish on-site conservation groves (~50-200 trees) of priority threatened oak species to act as living germplasm banks for this group of exceptional species. The on-site groves will form part of a network of nationally coordinated ex situ collections to ensure that no native US oak species goes extinct. Following the completion of three extensive research projects, *The Red List of US Oaks*, a Conservation Gap Analysis of US Oaks, and a population genetics survey of *Quercus georgiana*, the Arboretum can now systematically prioritize and target threatened species and populations for these conservation groves, based on the needs and threats facing the species, and the ability for those species to survive in our zone 5 climate. *Quercus georgiana* is one of five priority oak species for these conservation groves. An important aspect of these groves is that the germplasm is “backed up” in other collections across the country, as an insurance policy against pests/pathogens, natural disasters, and the unknown impacts of climate change. Partner institutions from across the country are invested in supporting rare oak conservation and are committed to growing their own high quality conservation collections. Together, we will ensure that *Q. georgiana* is protected in genetically diverse and representative living collections, both “near situ” (e.g. Atlanta Botanical Garden) and ex situ.

Objectives:

- Collect and distribute large, genetically diverse collections of wild origin acorns from across the range of the species, prioritizing those populations that are un- or under-represented in ex situ collections currently.
- Document occurrences of *Q. georgiana* in locations that are poorly known or unsurveyed.
- Identify any threats or reasons for concern affecting the surveyed populations.

***Quercus georgiana* Habit and Ecology**

Quercus georgiana is a small, often multi-stemmed tree, typically growing eight to 15 metres tall. This species is restricted to intermittent granite outcrops and shallow soils overlying granite in the Piedmont Plateau. These discontinuous pockets of soil, sometimes referred to as "soil islands," have been reported to have a soil depth of only 50-100 cm at Arabia Mountain. Georgia Oak is associated with the oak-pine forests of dry slopes of the southeastern US. Its acorns provide an important food source for numerous bird and mammal species, while Luna Moth and Red-spotted Purple larvae feed on its leaves (Wenzel & Kenny, 2015).

Populations

Quercus georgiana is documented from 14 counties in Georgia, reported from seven counties in Alabama and historically from South Carolina and North Carolina (Fig. 1). The type locality of this species, located at Stone Mountain, DeKalb County, Georgia, is the best-documented and probably the largest occurrence. Another well-documented occurrence, located on Pine Mountain, Harris Co., Georgia, was observed to be relatively large and healthy in the late 1980s (R. Lance and M. Westwood pers. comm. 2015). Houle and Delwaide (1991) observed that *Q. georgiana* was often the second most frequent and abundant woody species on soil islands on Arabia Mountain, DeKalb Co., Georgia, in addition to noting a high proportion of juvenile trees (seedlings and saplings), suggesting successful reproduction was occurring at that time (Wenzel & Kenny, 2015).

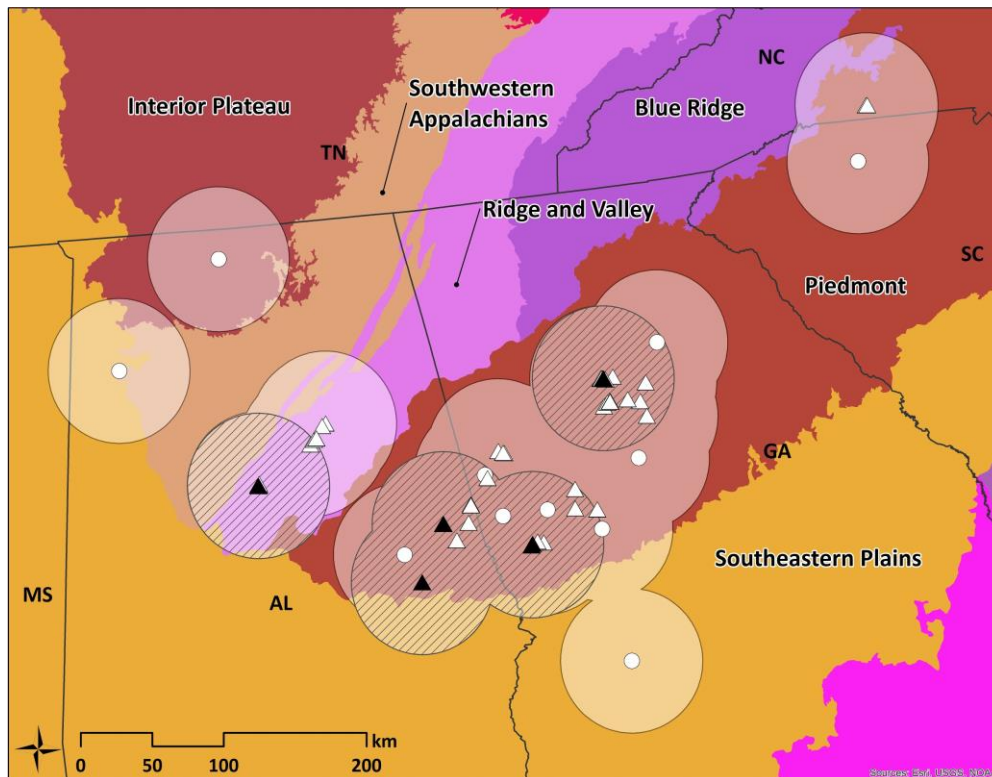


Figure 1: Distribution of *Q. georgiana* populations based on occurrence records from biodiversity and herbarium databases. Pentagons represent geo-located occurrences, while circles represent county centroids (used when no other location information about the wild population was available). Black pentagons represent the source locality of an accession in an ex situ collection, according to an ex situ survey conducted in 2017 (Beckman et al., 2019). Red pentagons are populations that are confirmed or likely extirpated. Concentric rings around circles and pentagons mark a 50km² buffer zone representing the potential range of the species. Figure adapted from Beckman et al., 2019, with permission. Collecting strategy will prioritize white pentagons, then black pentagons, then white circles.

Occurrences in South Carolina are believed to be extirpated, and the single known occurrence in North Carolina, first documented in 2011, is reported to contain too few individuals to be considered viable (i.e., fewer than ten). Additionally, the North Carolina stand shows a high level of putative hybridization, likely due to introgression by other, more common red oak species in the vicinity. Therefore, for the purposes of maintaining the true genetic identity of the species, this subpopulation should be considered eradicated (R. Lance and P. Manos pers. comm. 2015).

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 (Toppila 2012). The report did note, though, that 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 (Wenzel & Kenny, 2015).

Status of *Q. georgiana* ex situ collections

Beckman et al. (2019) completed a global ex situ survey for US native oak species in 2017. At that time, *Q. georgiana* was represented by just 26 accessions (133 plants) in 14 collections in North America. Of these accessions, only 10 were of documented wild origin, and 70% were represented by fewer than four individual trees. Furthermore, the plants in ex situ collections were not representative of the full range of the species. Rather, five counties were heavily represented in collections, while populations from many other counties are completely unrepresented in living collections (Fig. 1).

Threats

Recent and ongoing declines in occurrences, habitat quality, and number of individuals, along with its highly restricted area of occupancy, result in *Q. georgiana* recently being assessed as Endangered on the IUCN Red List of Threatened Species. Threats to Georgia Oak include erosion, poor regeneration and compacted soils resulting from foot and vehicle traffic on granite outcrops. Impacts of tourism and recreation are of concern, given that many occurrences lie within state parks and nature preserves, particularly at Stone Mountain where plants grow alongside popular hiking trails.

For occurrences with especially small numbers of individuals, genetic swamping and introgression from surrounding Red Oak species threaten the genetic identity of *Quercus georgiana* (R. Russell pers. comm. 2015, R. Lance and M. Westwood pers. comm. 2015).

Climate change may prove a serious threat to this species as well, given that *Q. georgiana* is confined to intermittent "soil islands" on granite outcrops, which have little or no connectivity to allow migration. Additionally, *Q. georgiana* 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 (Pacifi et al. 2015).

Drought also poses a considerable threat to Georgia Oak, given its restriction to very thin soils (50-100 cm in depth at some sites) on granite flat-rocks which provide little or no access to groundwater. Severe drought has been reported as an inciting factor in the phenomenon of oak decline, occurring when typically non-lethal stresses, such as drought, defoliating pests or fungal pathogens, are combined under certain conditions and effectively overwhelm oaks' defences, resulting in potentially widespread mortality (Bendixsen et al. 2015, Thomas et al. 2002). Additionally, many climate models project that climate change will contribute to dramatic increases in drought conditions in much of the United States, including the Southeast (Aiguo 2011). Recent severe drought events are already taking place, such as the drought

that reached its peak in 2012, during which the entire extent of occupancy was considered to be affected, with much of this area experiencing Extreme or Exceptional drought intensity in late summer 2012 (Svoboda and the National Drought Mitigation Center 2012).

Results of our 2018 Collecting Efforts



Georgia populations:

See the attached report

Alabama populations:

See the attached report

Herbarium records on SEINet: <http://swbiodiversity.org/seinet/collections/list.php>

Before this collecting project, *Q. georgiana* was represented in 14 collections in North America. Now it is present in 20 collections, a 43% increase. In 2017, ex situ collections of *Q. georgiana* consisted of 10 accessions of documented wild origin, 70% of which were of fewer than four individual trees. That number has now doubled to 20 wild origin accessions. The 10 new accessions collected for this project are from many populations that were previously unrepresented in ex situ collections (Fig. 2). In total, nearly 600 acorns were collected and distributed to 10 institutions across the U.S.

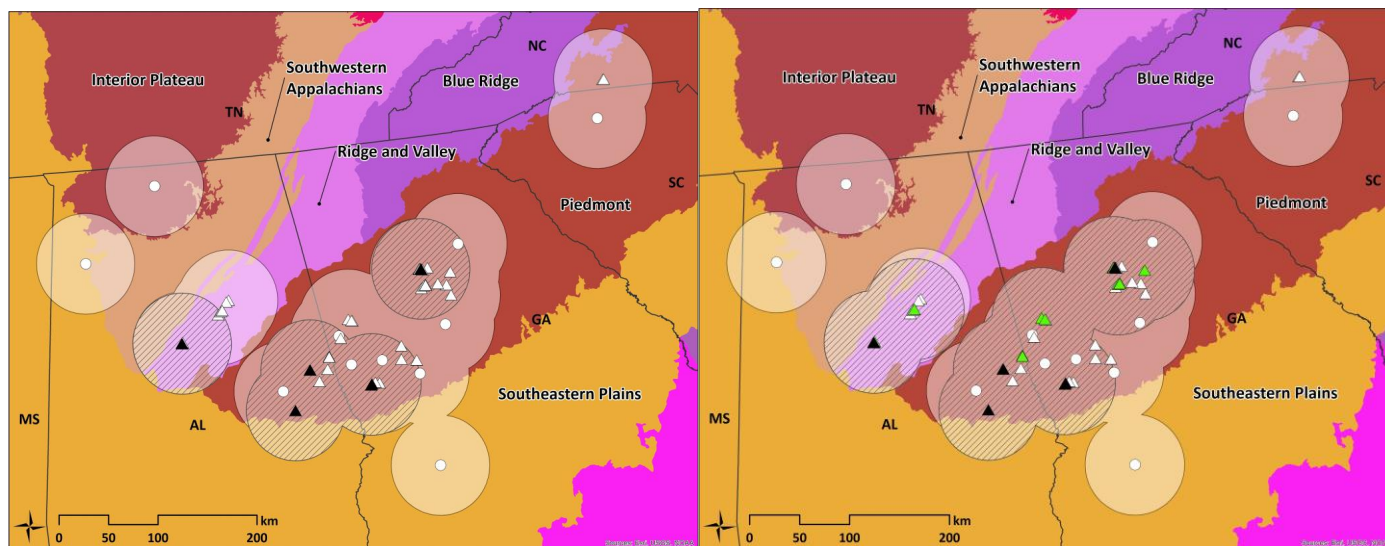


Figure 2: Origin of *Q. georgiana* ex situ collections before (left) and after (right) this project. Triangles represent geolocated occurrences, while circles represent county centroids (used when no other location information about the wild population from that county was available). Black triangles represent the source locality of an accession in an ex situ collection prior to our 2018 collecting efforts. Green triangles (right) represent newly added ex situ collections from this project. Concentric rings around circles and triangles mark a 50km² buffer zone representing the potential range of the species. Figure adapted from Beckman et al., 2019, with permission. Our 2018 collecting strategy prioritized white triangles from GA and AL in the map on the left.

Acorns distributed to:

	GA collections	AL collections
The Morton Arboretum* (Lisle, IL)	36	62
Chicago Botanic Garden* (Glencoe, IL)		62
Huntington Library and Gardens ⁺ (Los Angeles, CA)		~200
Atlanta Botanical Garden ⁺ (Atlanta, GA)	14	62
Davis Arboretum at Auburn University* (Auburn, AL)		25
Tulsa Botanic Garden ⁺ (Tulsa, OK)		62
Bartlett Tree Research Laboratories & Arboretum* (Charlotte, NC)		25
Missouri Botanical Garden** (St. Louis, MO)		25
Mt. Auburn Cemetery ⁺ (Cambridge, MA)		25
Scott Arboretum** (Swarthmore, PA)		25

Total acorns collected: 50 from GA ~550 from AL

*Indicates a nationally accredited PCN Quercus Multisite Collection

+ Indicates a garden that did not have *Q. georgiana* in its collection before this project

Vouchers and future collecting efforts:

Voucher specimens from the AL collections were deposited at HNT, AUA, MOR and a subset were sent to USNA. Because of the poor acorn crop from the GA populations, additional acorn collections will be made in 2019 and voucher specimens will be provided to USNA from that expedition.

Important observations from Patrick Thompson in AL:

A previously unexplored 145 acre parcel that we were permitted to access for acorn collection on *Q. georgiana* was found to contain the largest population encountered during our efforts to visit every reported population in the state. In addition to hundreds of *Q. georgiana* we also discovered a previously unreported population of *Q. boyntonii* at the site. It is the fact that populations occur on private lands that mean there still exist large amounts of unbotanized potential habitat for all southern species. Education, outreach, and training are the tools we use to increase the number of informed individuals owning and observing these properties. In one county, we observed that the only recorded site for *Q. georgiana* seemed to have been extirpated or suffered from such severe hybrid introgression from *Q. nigra* that it could not be reported as extant. Just weeks later several individuals were located on another outcrop at the other end of the county. There is certainly more documentation of *Quercus* to be done in Alabama. I would add field work as an effective and needed activity. *Oglethorpensis* has only been known in the state for 20 years, and what may be the only extant population wasn't discovered until 2013. The size of that population remains unknown. Though *Q. arkansana* populations tend to be small and scattered, it would not be surprising to discover that the largest population in the state is hiding on a multi thousand acre hunting club that hasn't been seen by the right botanist. I expect the same is true of *Q. similis* which is cryptic and not on the radar of most of the state's field biologists. If there was funding available for surveys, it could result in a more diverse group of opportunities for protection and land acquisition.

Expenses

Huntington BG (Alabama scouting collections): \$1,115.80 (7/18/18)

Huntington BG (Alabama collecting): \$567.81 (1/17/19)

Davis Arboretum (Patrick's hours 40 x \$26.25): \$1,050 (2/1/19)

Atlanta BG (Georgia scouting and collecting, shipping): \$3,300

Total cash expenses paid by The Morton Arboretum: \$6,033.61

Total grant originally requested from APGA: \$5,597

Total cost-sharing by all partners: \$15,327.59

Project Participants

1. Murphy Westwood, Director of Global Tree Conservation, The Morton Arboretum
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Murphy Westwood runs the Global Tree Conservation Program at The Morton Arboretum. She holds a Ph.D. in Plant Developmental Genetics from Cambridge University (UK), an M.S. in Taxonomy and Biodiversity from Imperial College London (UK), and a B.S. in Environmental Policy and Behavior from the University of Michigan. She has 10 years of experience in plant research and conservation in universities and botanical gardens in the US and Europe. She has conducted fieldwork in Central America and South Africa. She led the Red List of US Oaks project and the Conservation Gap Analysis for US Oaks. She is the Chair of the Plant Conservation Professional Section for APGA, the Conservation Officer for The Morton Arboretum for the Center for Plant Conservation, and a member of the IUCN Global Tree Specialist Group.

Murphy coordinated and organized the project, documented the collections and distribution of germplasm, and reported on grant progress.

2. Matt Lobdell, Curator and Head of Collections, The Morton Arboretum

Matt Lobdell has served as Curator of The Morton Arboretum since 2014. He holds a M.S. in Plant and Soil Science from the University of Delaware, and has previously been employed in a variety of horticultural and curatorial capacities by the Arnold Arboretum, Polly Hill Arboretum, Moore Farms Botanical Garden, and University of Delaware Botanical Gardens. He has participated in seed collecting expeditions to the Pacific Northwest US, the Republic of Georgia, and has led three collecting trips in the southeastern United States, including projects targeting *Quercus oglethorpensis* (2015) and *Magnolia fraseri* var. *pyramidata* (2016) with the goal of supporting ex-situ conservation activities through the APGA/USFS Tree Gene Conservation Partnership.

Matt helped develop the fieldwork strategy, guided collecting and propagation protocols, and received and propagated germplasm for The Morton Arboretum.

3. Patrick Thompson, Arboretum Specialist, Davis Arboretum of Auburn University

Patrick Thompson graduated with a bachelor degree from Auburn University (AU) Department Horticulture in the curriculum of Nursery and Greenhouse Science in 2003. He has been employed by AU Department of Biological Sciences' Davis Arboretum (AUDA) since the year 2000. Patrick has curated the Arboretum's *Quercus* collection since 2008, developing it into a viable member of the Association of the Public Gardens of America's Plant Collection Network (PCN). Patrick has been a climbing arborist since 2010. His certification is maintained through the International Society of Arboriculture. Patrick is the Coordinator of Alabama Plant Conservation Alliance, which he helped establish in 2009. Current efforts include the application of the AUDA's *Rhododendron* collection to the PCN. Patrick is the President of the Alabamense Chapter of the Azalea Society of America, and a graduate student in AU's Department of Horticulture researching vegetative propagation of deciduous azaleas. He has participated in numerous botanical forays across the Southeastern US with strong focus within the state of Alabama. These include projects targeting *Quercus oglethorpensis*

(2015), *Magnolia fraseri* var. *pyramidata* (2016), and *Quercus arkansana* (2017), with the goal of supporting ex-situ conservation activities through the APGA/USFS Tree Gene Conservation Partnership.

Patrick coordinated the Alabama scouting and collecting trips, and propagated and distributed germplasm for Davis Arboretum.

4. Tim Thibault, Curator of Woody Collections, The Huntington Library and Gardens

Tim Thibault is a Summa cum Laude graduate of Washington State University with a degree in ornamental horticulture. He has over two decades of curatorial experience with seven public gardens, but has spent the past decade at The Huntington. Tim has extensive field collecting experience in the Southeast, as well as in Asia and the Americas. He has chaired the plant collections professional sections for American Public Gardens Association (APGA), as well as serving as the first chair if the council of sections. Tim has spoken on collections management topics at APGA conferences and symposia.

Tim assisted in scouting and collecting efforts in Alabama and received and propagated germplasm for Huntington Garden.

5. Phil Douglas, Curator of Woody Plants, Chicago Botanic Garden

Phillip Douglas is a Northern Kentucky native who currently serves as the Curator of Woody Plants at the Chicago Botanic Garden. A veteran of the United States Marine Corps, he received a Bachelors of Science in Horticulture from the University of Cincinnati. Beginning his career at the Boone County Arboretum, Phil spent several years working as a horticulturist for the historic landscape at Spring Grove Cemetery and Arboretum in Cincinnati, Ohio. As the Director of Horticulture for Gainesway Farm, Phil managed 1600 acres of planted and natural areas bisected by the Elkhorn Creek. In April of 2017, Phil accepted the position of Curator of Woody Plants for the Chicago Botanic Garden. In December of 2017, Phil will complete his Masters of Public Administration from Eastern Kentucky University.

Phil assisted in collecting efforts in Alabama and received and propagated germplasm for Chicago Botanic Garden.

6. Emily Coffey, Vice President of Conservation & Research, Atlanta Botanical Garden

Dr. Emily E. D. Coffey is VP for Science and Conservation at the Atlanta Botanical Garden. Coffey joined the Garden in 2017 to lead the Conservation and Research Department where she leads and collaborates with a team of conservation scientist and horticulturists to expand the conservation activities across the Southeastern US. She received a B.S. in Biology from University of Missouri – St. Louis, a M.S. in Biodiversity, Conservation, and Management from University of Oxford – UK, and Ph.D. in long-term ecology and conservation biology from the University of Oxford –UK. As a post-doc she conducted research in the long-term ecology lab at The Biodiversity Institute – Oxford, UK. For more than two decades the ABG has collaborated within diverse partnerships to conserve rare species from private and publicly owned land throughout the southeastern U.S. Signature programs include restoration of pitcher plant bogs with The Nature Conservancy (TNC), US Fish and Wildlife Service, GA Department of Natural Resources (DNR), and Florida Park Service; as well as native orchid restoration with the Florida Park Service, Florida Fish and Wildlife Commission. With support from

the Georgia Plant Conservation Alliance volunteers (Botanical Guardians), Atlanta BG will be coordinating the Georgia collections.

Emily recruited and coordinated volunteers and ABG staff to collect priority populations of trees in Georgia. ABG propagated, distributed, and is growing *Q. georgiana* germplasm.