



# Conservation Gap Analysis of Native U.S. Oaks

## Species profile: *Quercus ajoensis*

Emily Beckman, Beth Fallon, 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*



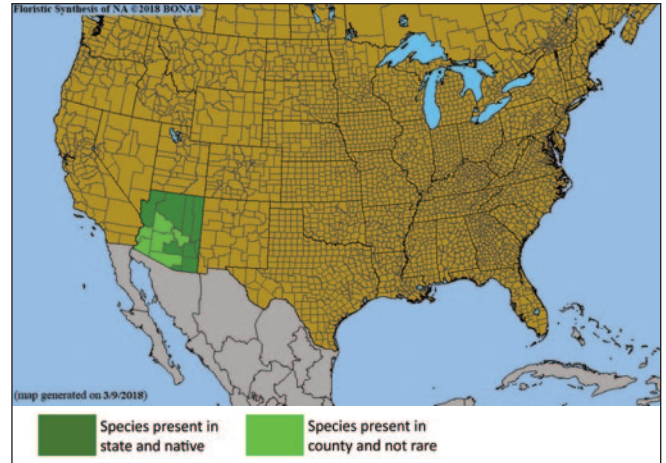
# Quercus ajoensis C.H.Müll.

**Synonyms:** *Quercus turbinella* subsp. *ajoensis* (C.H.Müller) Felger & C.H.Lowe, *Q. turbinella* var. *ajoensis* (C.H.Müller) Little

**Common Names:** Ajo mountain scrub oak

**Species profile co-author:** Beth Fallon, Department of Plant Biology, University of Minnesota Twin Cities  
**Contributors:** Tim Thibault, The Huntington; John Wiens, Arizona-Sonora Desert Museum

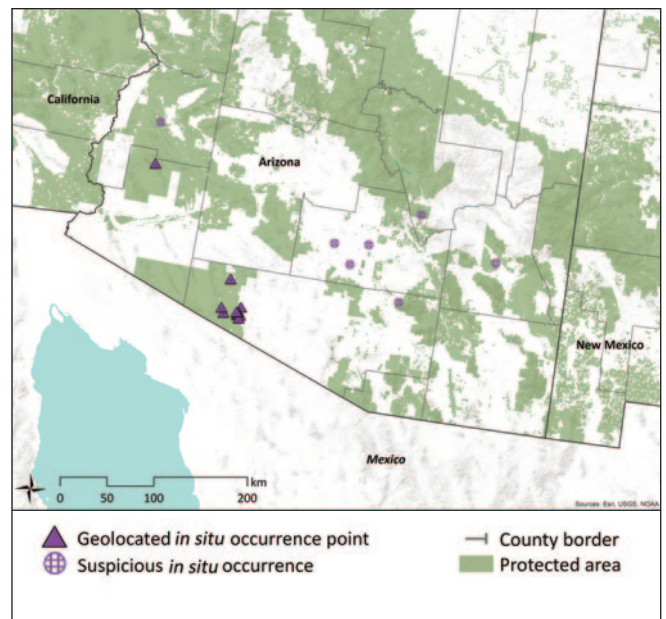
**Suggested citation:** Beckman, E., Fallon, B., Meyer, A., & Westwood, M. (2019). *Quercus ajoensis* C.H.Müll. In Beckman, E., Meyer, A., Man, G., Pivorunas, D., Denvir, A., Gill, D., Shaw, K., & Westwood, M. *Conservation Gap Analysis of Native U.S. Oaks* (pp. 56-61). Lisle, IL: The Morton Arboretum. Retrieved from <https://www.mortonarb.org/files/species-profile-quercus-ajoensis.pdf>



**Figure 1.** County-level distribution map for *Quercus ajoensis*. Source: Biota of North America Program (BONAP).<sup>4</sup>

## DISTRIBUTION AND ECOLOGY

*Quercus ajoensis*, or Ajo mountain scrub oak, is known from a few isolated populations in south-southwestern Arizona, U.S., and likely Sonora, Mexico. This species is thought to be rare and limited to the canyons of the upland Sonoran Desert Scrub near the international border. However, it has been reported to occur as far south as Baja California and Baja California Sur, Mexico. In the past, the species has also been considered a variety of *Q. turbinella*, but acceptance as a unique species has been confirmed. Introgressed individuals have been reported stretching into central Arizona and New Mexico. Some records from as far north as Colorado are likely the result of hybridization and confusion with *Q. turbinella*. Populations outside of Pima and Yuma counties in Arizona have been identified as hybrids in initial treatments and morphological studies.<sup>1,2</sup> In general, any U.S. populations outside the species' confirmed range in the Ajo and Kofa Mountains of Arizona (Pima and Yuma counties) may be viewed with suspicion until tested genetically (B. Fallon pers. Comm. 2018). A recent collecting trip only located *Q. ajoensis* in the U.S. within three canyons of the Ajo Mountains.<sup>3</sup> Collections from Mexican populations have not been made recently and need to be revisited. Volcanic canyon bottoms and north-facing slopes between 500 and 1,500 meters in the Ajo Mountains are ideal habitats for this spreading, evergreen shrub, which reaches up to three meters tall.<sup>1,2</sup>



**Figure 2.** Documented *in situ* occurrence points for *Quercus ajoensis*. Protected areas layer from U.S. Geological Survey Gap Analysis Program (GAP) 2016 Protected Areas Database of the U.S. (PAD-US).<sup>5</sup>

## VULNERABILITY OF WILD POPULATIONS

**Table 1.** Scoring matrix identifying the most severe demographic issues affecting *Quercus ajoensis*. 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 <sup>2</sup> or A00 < 10 km <sup>2</sup> or 2-4 locations	E00 < 5,000 km <sup>2</sup> or A00 < 500 km <sup>2</sup> or 5-9 locations	E00 < 20,000 km <sup>2</sup> or A00 < 2,000 km <sup>2</sup> or 10+ locations	E00 > 20,000 km <sup>2</sup> or A00 > 2,000 km <sup>2</sup>	Unknown	10
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	40
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	5
Genetic variation/integrity	Extremely low	Low	Medium	High	Very high	Unknown	10
Average vulnerability score							13.3
Rank relative to all U.S. oak species of concern (out of 19)							4

## THREATS TO WILD POPULATIONS

### High Impact Threats

**Climate change — habitat shifting, drought, temperature extremes, and/or flooding:** *Quercus ajoensis* is likely a drought tolerant species because of its distribution in the Sonoran Desert. However, it is limited to canyons, where it would usually experience seasonal flooding. Arizona is currently in its 21st year of a long-term drought.<sup>6</sup> Shifts in the seasonality of rainfall could adversely affect this species that may rely heavily on rain during the high temperature months (B. Fallon pers. comm., 2018).

**Extremely small and/or restricted population:** Ajo mountain scrub oak is likely very rare within the landscape and genetic exchange among mountain ranges is restricted (B. Fallon pers. comm., 2018). Wildfires and other disasters also present a serious threat; one event could wipe out a large portion of the population.<sup>3</sup>

### Moderate Impact Threats

**Human use of landscape — tourism and/or recreation:** The best known, and likely largest, subpopulations of *Q. ajoensis* are located within Organ Pipe Cactus National Monument adjacent to the U.S.-Mexico border. Impact from recreation is minimal but degradation occurs due to border patrol and illegal immigration. The Department of Homeland Security is authorized to construct barriers along the border without compliance to federal, state or local environmental laws. Thousands of miles of new roads were constructed in 2010.<sup>7</sup>

Border-related and recreational hiking traffic within the canyons may not directly impact tree populations, but likely increase other threats such as the spread of invasive plants and human-induced fire.

**Human modification of natural systems — disturbance regime modification, pollution, and/or eradication:** Altered fire regimes in the region, with less frequent but more severe fires, allowed for spread of the invasive buffelgrass (*Pennisetum ciliare*). This invasion has created a downward spiral in ecosystem health in some areas of southern Arizona.<sup>8</sup> Although, invasive grasses are not a significant issue in oak habitat and direct affects to oaks have not been observed (J. Wiens pers. comm., 2018).

**Human modification of natural systems — invasive species competition:** Rapid spread of buffelgrass threatens the vitality of native plants in southern Arizona; it is facilitated by an increase in severe fires that create space for vigorous invaders.<sup>8</sup>

**Genetic material loss — inbreeding and/or introgression:** Ajo mountain scrub oak frequently hybridizes with *Q. turbinella*.<sup>1,2</sup>

### Low Impact Threats

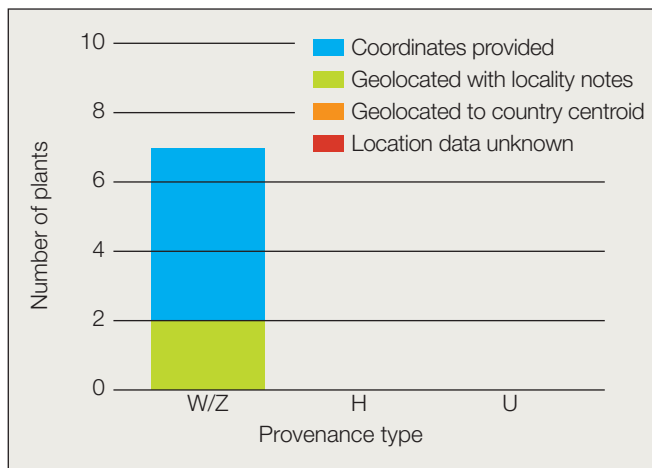
**Human use of landscape — agriculture, silviculture, ranching, and/or grazing:** The National Park Service noted “a considerable increase in the number of fence breaks associated with border activities” in 2013, which “has caused an increase in the frequency of cattle, horses, and feral burros entering [Organ Pipe Cactus National Monument], resulting in resource damage.”<sup>9</sup>

## CONSERVATION ACTIVITIES

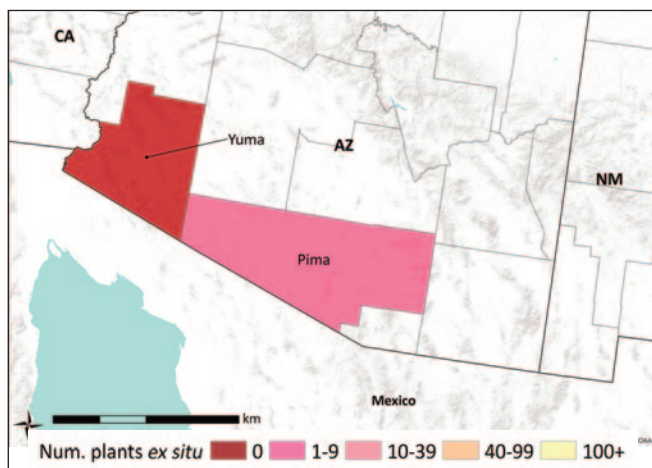
In 2017 *Quercus* accessions data were requested from *ex situ* collections. A total of 162 institutions from 26 countries submitted data for native U.S. oaks (Figures 3 and 4). Past, present, and planned conservation activities for U.S. oak species of concern were also examined through literature review, expert consultation, and conduction of a questionnaire. Questionnaire respondents totaled 328 individuals from 252 organizations, including 78 institutions reporting on species of concern. *Quercus ajoensis* was the only species of concern with no conservation activities reported in the questionnaire.

### Results of 2017 *ex situ* survey

Number of <i>ex situ</i> collections reporting this species:	3
Number of plants in <i>ex situ</i> collections:	7
Average number of plants per institution:	2
Percent of <i>ex situ</i> plants of wild origin:	100%
Percent of wild origin plants with known locality:	100%



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

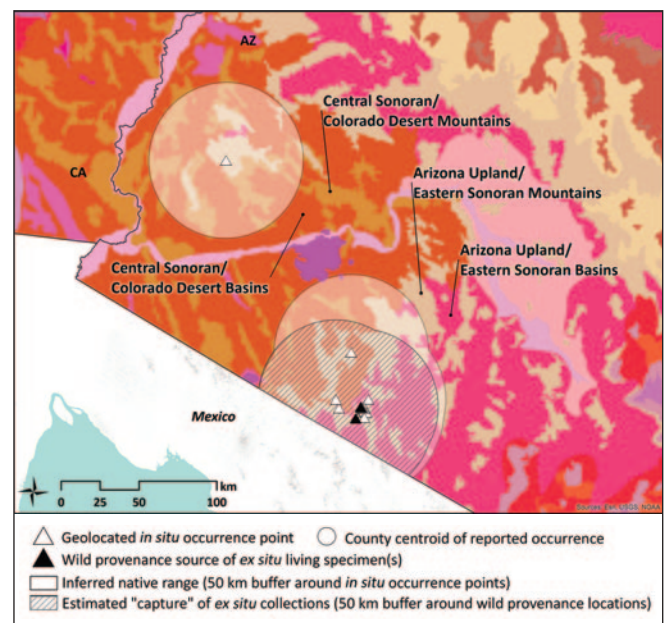


**Figure 4.** *Quercus ajoensis* counties of *in situ* occurrence, reflecting the number of plants from each county in *ex situ* collections.

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:	40%
Ecological coverage:	83%



**Figure 5.** *Quercus ajoensis* *in situ* occurrence points and *ex situ* collection source localities. U.S. EPA Level IV Ecoregions are colored and labelled.<sup>10</sup> County centroid is shown if no precise locality data exist for that county of occurrence. Email [treeconservation@mortonarb.org](mailto:treeconservation@mortonarb.org) for more information regarding specific coordinates.



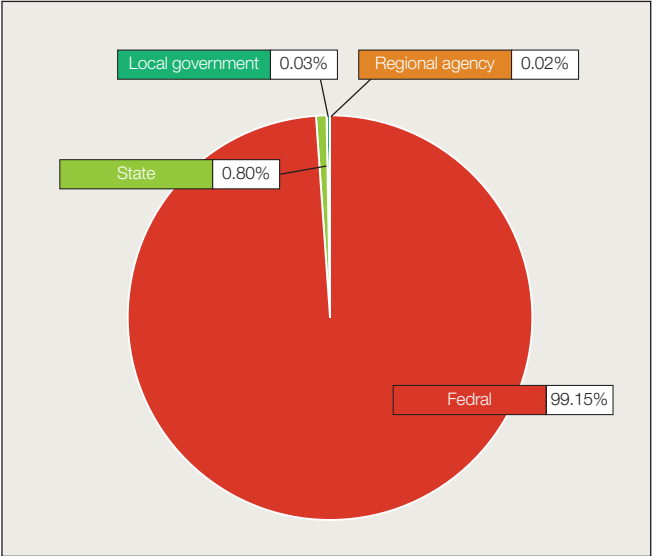


**Land protection:** Within the inferred native range of *Q. ajoensis* in the U.S., 99% of the land is covered by protected areas (Figure 7). All verified populations of Ajo mountain scrub oak are within the Organ Pipe Cactus National Monument, (managed by the U.S. National Park Service), and other locations with possible *Q. ajoensis* hybrids are located within the Kofa National Wildlife Refuge (managed by the U.S. Fish and Wildlife Service).<sup>3</sup>

Organ Pipe Cactus National Monument, including the western slopes of the Ajo Mountain range containing the primary populations of *Q. ajoensis*, is 95% designated as a wilderness area, which is the highest level of protection for federal lands. The Wilderness Act of 1964 lays down guidelines for “an area where the earth and its community of life are untrammled by man, where man himself is a visitor who does not remain...land retaining its primeval character and influence without permanent improvements or human habitation.”<sup>11</sup> However, due to national security concerns, motorized equipment and vehicles, temporary roads, and permanent structures may be constructed within the wilderness area.<sup>7</sup> Organ Pipe Cactus National Monument has also been designated a UNESCO International Biosphere Reserve.<sup>9</sup>

**Sustainable management of land:** As a designated wilderness area, land management agencies working within Organ Pipe National Monument are directed to manage areas “so as to preserve, and where possible, to restore their wilderness character.” The National Park Service describes management standards and progress within their 2013 State of the Park Report for Organ Pipe

Cactus National Monument. They note that invasive buffelgrass and fountaingrass have been declining in managed areas, but “where management is more difficult due to border related access restrictions, buffelgrass has been increasing.”<sup>9</sup>



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

**Population monitoring and/or occurrence surveys:** The Huntington lead a 2018 collecting trip for *Q. ajoensis* in collaboration with Arizona-Sonora Desert Museum, with funding from the APGA-USFS Tree Gene Conservation Partnership. The expedition visited the Ajo Mountains in Organ Pipe Cactus National Monument, including Arch, Alamo, and Estes canyons, Kofa Mountains in the Kofa National Wildlife Refuge, Pinal Mountains, White Tank Mountains, and Sand Tank Mountains and Javelina Mountains in the Sonoran Desert National Monument. *Quercus ajoensis* was only positively identified in the Ajo Mountains; likely hybrids or *Q. turbinella* individuals were found in the Kofa and Pinal mountains, while other locations did not show signs of any individuals resembling *Q. ajoensis*.<sup>3</sup>

**Wild collecting and/or *ex situ* curation:** With funding from a 2018 APGA-USFS Tree Gene Conservation Partnership grant, The Huntington lead an expedition to collect *Q. ajoensis* for *ex situ* preservation. Partner institutions in the collecting effort include Arizona-Sonora Desert Museum and Green Diamond Resource Company.<sup>3,12</sup>

**Propagation and/or breeding programs:** Germplasm gathered during the 2018 expedition is now being grown at The Huntington (in vitro buds from three individuals in Estes Canyon) and Arizona-Sonora Desert Museum (173 acorns from Alamo Canyon; T. Thibault pers. comm., 2018).

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

**Research:** No known initiatives at the time of publication.

**Education, outreach, and/or training:** No known initiatives at the time of publication.

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

## PRIORITY CONSERVATION ACTIONS

Ajo mountain scrub oak is a rare plant within the desert landscape, due to its native habitat in seasonally flooded canyons in the Sonoran Upland. Its local range is limited by canyon walls and desert expanses surrounding the small mountain ranges to which the species is endemic. The best known population of *Q. ajoensis* occurs on federally protected land within Organ Pipe Cactus National Monument, where it still produces abundant and viable acorn crops in fertile years. However the wilderness quality within the monument has been compromised due to law enforcement and border-related trade activities, which may especially impact the canyon habitat of this species. Climate change is likely the greatest long-term threat, as prolonged drought or irregularities in seasonality can reduce precipitation during the summer monsoons and winter rains that sustain the population.

Species conservation should take an approach that addresses the lack of knowledge about *Q. ajoensis*. A more thorough genetic analysis of known populations would confirm identification, especially given multiple collection vouchers from the northern edge of the species' range, which seem likely to be *Q. turbinella* x *ajoensis* hybrids or possibly misidentified *Q. turbinella*. No vouchers seem to exist from Sonora, Mexico, despite expectations that the species likely inhabits canyons there, and populations putatively identified within Baja California, Mexico should also be confirmed. A thorough investigation of these areas is needed to estimate species range size and determine its vulnerability status.

Reinforcement and/or translocation should be a consideration if populations are found to be rapidly declining, lacking recruitment, or facing severe human impact that cannot be mitigated; propagation would likely need to be carried out to support these initiatives. Further management of non-native grasses may also be required to replicate the natural disturbance regime in some areas. Given the multiple high impact threats, the species should also be conserved in more *ex situ* collections. Finally, further monitoring and research regarding climate change impacts should be carried out to determine appropriate action plans for possible reinforcement and/or translocation initiatives.

### Conservation recommendations for *Quercus ajoensis*

#### Highest Priority

- Population monitoring and/or occurrence surveys
- Wild collecting and/or *ex situ* curation
- Reintroduction, reinforcement, and/or translocation
- Research (climate change modeling; demographic studies/ecological niche modeling; population genetics; restoration protocols/guidelines; taxonomy/phylogenetics)

#### Recommended

- Sustainable management of land
- Propagation and/or breeding programs



Beth Fallon

## REFERENCES

1. Müller, C. H. (1954). A new species of *Quercus* in Arizona. *Madroño*, 12(5), 140-145. Retrieved from <https://www.jstor.org/stable/41422802>
2. Tucker, J. M., & Müller, C. H. (1956). The geographic history of *Quercus ajoensis*. *Evolution*, 10(2), 157-175. doi:10.2307/2405891
3. Wiens, J. F., & Thibault, T. (2019). Exploring for *Quercus ajoensis* and *Quercus toumeyii*. Petersburg, IL: International Oak Society.
4. 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>
5. 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/>
6. Arizona Climate Office. (2016). Arizona drought. Retrieved from <https://azclimate.asu.edu/drought/>
7. Peterson, J. (2014, September 17). After 11 years, Organ Pipe Cactus National Monument reopens. *High Country News*. Retrieved from <https://www.hcn.org/articles/after-12-years-organ-pipe-national-monument-reopens>
8. Arizona-Sonora Desert Museum. (n.d.). Current projects - research and conservation. Retrieved from [https://www.desertmuseum.org/center/current\\_projects.php](https://www.desertmuseum.org/center/current_projects.php)
9. National Park Service. (2013). *State of the park report: Organ Pipe Cactus National Monument*. Washington, D.C.: National Park Service. Retrieved from [https://www.biologicaldiversity.org/campaigns/borderlands\\_and\\_boundary\\_waters/pdfs/ORPL\\_2013\\_State\\_of\\_the\\_Park\\_report.pdf](https://www.biologicaldiversity.org/campaigns/borderlands_and_boundary_waters/pdfs/ORPL_2013_State_of_the_Park_report.pdf)
10. U.S. EPA Office of Research & Development. (2013, April). 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\\_14.zip](ftp://ftp.epa.gov/wed/ecoregions/us/us_eco_14.zip)
11. Wilderness Act of 1964. Pub. L. No. 88-577.
12. American Public Gardens Association. (n.d.). Tree Gene Conservation Partnership Showcase.

