Doug


# THE HARVARD UNIVERSITY HERBARIA

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Bryan Arroyo
Assistant Director, Endangered Species Program
United States Fish and Wildlife Service
4401 North Fairfax Drive, 4th floor
Arlington,VA 22203

22 May 2008

Dear Dr. Arroyo,

I submitting a petition for the potential listing of a plant species, *Calopogon oklahomensis* D.H. Goldman (family Orchidaceae), as Endangered or Threatened. I described this species in 1995 while I was a graduate student at the University of Texas, doing my Ph.D. research on this genus. In this petition I am submitting five paper reprints or photocopies, all addressing (and supporting) the distinctiveness of this species; four are papers I've published and the fifth is by Trapnell et al. I am also submitting four maps showing its historical distribution (one of these highlighting counties containing collections from the last 30 years and another from the last 15 years), my personal collection data for this species, and two versions of a list of all of the preserved specimens I've seen of this species in my survey of herbaria (botanical museums) around the world, sorted by date or by locality. I've surveyed 150 herbaria to date for *Calopogon* and 76 herbaria contained specimens of this species. Lastly, to support my credentials as a formally trained botanist, I am submitting a current CV.

I hope that the contents of this petition are adequate to begin the review process for this species. If you have any questions please do not hesitate to contact me.

Sincerely,

Douglas Goldman
Herbarium Associate

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2008 MAY 28 A 11:57
DIVISION OF ENDANGERED
ST. LOUIS-USFWS

*Calopogon oklahomensis* is distinguished from the other four species of *Calopogon* by petal shape, fragrance, leaf length relative to inflorescence length, corm shape, flowering time and habitat preferences. It is also genetically distinct from the other species, having numerous unique genetic features, including three times the chromosome number of the other species. The species may be of ancient hybrid origin, although that is unclear. If it is of hybrid origin it is derived from a hybridization event dating back many thousands to millions of years, more than enough time for a stable species to develop, which could explain how it has unique features that the other species do not have. Please see the enclosed reprints and photocopies of my papers for further details.

*Calopogon oklahomensis* is endemic to the United States, and was historically native to 17 states, from Minnesota and Indiana south to Texas and Louisiana, thence eastward through Mississippi, Alabama, Tennessee, Georgia, Florida and South Carolina (U.S. Fish and Wildlife Service regions 2, 3, 4, 6). Throughout its range it prefers moist to seasonally dry-mesic prairies, prairie-haymeadows, savannas and open woodlands, avoiding the wetter habitats preferred by most of the other species in the genus. I have observed that it thrives under a frequent burning regime or haymeadow management, with the latter where most or all of the above-ground vegetation is effectively removed once every 1-2 years, this species flowering within a year after the last burn or hay-mowing. Presently, the species can be found only in Arkansas, Illinois, Louisiana, Mississippi, Missouri, Oklahoma, Texas, and Wisconsin. Most collections are relatively old (please note that in the enclosed herbarium specimens lists, collections with no date are likely over 100 years old), and cited herbarium acronyms follow Index Herbariorum: **http://sciweb.nybg.org/science2/IndexHerbariorum.asp**

The decline of this species has been severe since its first date-recorded collection in 1835. Throughout its range it has suffered habitat loss from expanding agricultural and forestry land use, fire suppression, and urbanization. Table 1 below gives a summary of the occurrences of this species from each of the 17 states where it was historically known. It has disappeared from at least nine of those states. Of the total 233 records that give localities, perhaps only 25-35 populations still remain. The states that still contain this species but have suffered the greatest loss of populations are Illinois (only one population remains out of an original 42 records) and Texas (1-3 populations of an original 27 records). The state with the least relative amount of population loss is Mississippi, with 2-3 closely-spaced populations of an original four populations. Within the four USFWS regions in which it occurs (Table 2), this species has entirely disappeared from Region 6 (Kansas) and has otherwise declined most severely within Region 3.

There are a total of only 237 known records of this species that are documented by herbarium collections. 158 of these records are from prior to 1958 (prior to 50 years ago), or 66.7% of the total. 183 of these records are from prior to 1978 (prior to 30 years ago), or 77.2% of total. 55 of the records are from 1978 to present, the last 30 years (23.2% of total), and 21 records are from 1993 to present, the last 15 years, (8.9% of total). Although this gives only a rough estimate of the decline of this species, active interest in orchid species conservation in the last few decades would have resulted in far more recent records if this species was still common. Another way to view these herbarium data are the number of counties originally containing this species versus those

still having it relatively recently. Please see the enclosed maps highlighting current distribution as of the previous 15 years and 30 years.

For the states that have tried to assess this species, most of them mention the global rarity of this species as "G4?", suggesting that it is possibly fairly common. However, these states have not accumulated the herbarium information for this species nearly to the degree that I have. If this species was still common throughout its restricted range it justifiably could be considered a G4 species. However, with the massive and continuing reduction in the range of this species in the last century or more, including several losses in the last 30 years, it is now found in relatively few sites. Therefore I would say it may be a G3-species but my suspicion is it is now more likely a G2.

Table 1. *Calopogon oklahomensis* history by state, based upon herbarium specimen records.

| STATE | LAST OBSERVED | RECORDS | ESTIMATED EXTANT POPULATIONS | COMMENTS |
|---|---|---|---|---|
| AL | 1887 | 5 | 0 | |
| AR | 1995 | 22 | 3—5 | |
| FL | 1882 | 1 | 0 | Locality unknown |
| GA | 1943 | 1 | 0 | Site destroyed |
| IA | 1941 | 8 | 0 | |
| IL | 2006? | 42 | 1 | State-managed site with one small population; *not* documented with a herbarium specimen. |
| IN | 1933 | 15 | 0 | |
| KS | 1980 | 1 | 0 | Site destroyed |
| LA | 1996 | 22 | 3—6 | |
| MN | 1884 | 5 | 0 | |
| MO | 1994 | 16 | 4—6 | Probably more secure in MO than any other state. |
| MS | 2006 | 4 | 2—3 | All extant populations occur within Camp Shelby, within close-proximity to each other, so they might be considered one scattered population. |
| OK | 2004 | 53 | 10? | |
| SC | ? | 1 | 0 | Collection probably predates 1800. |
| TN | 1939 | 2 | 0 | |
| TX | 2004 | 27 | 1—3 | Most recent observation is my revisiting the Brazos Co. site in 2004, which I originally documented with a herbarium collection in 1994. |
| WI | 1987 | 8 | 1 | A few plants in a reconstructed prairie at the University of Wisconsin. |
| **TOTAL** | | **233** | **25—35** | **10.7%—15% of original.** |

Table 2. *Calopogon oklahomensis* history by USFWS region, based upon herbarium specimen records.

| USFWS REGION | LAST OBSERVED | RECORDS | ESTIMATED EXTANT POPULATIONS | COMMENTS |
|---|---|---|---|---|
| 2 | 2004 | 80 | 11—13? | Greatest population loss is in Texas, but more common (yet disappearing) in Oklahoma. |
| 3 | 2006 | 94 | 6—8? | Region with the loss of the largest number of populations. Once widespread, now mostly restricted to several populations in southwestern MO, & one population each in northeastern IL & southern WI. |
| 4 | 2006 | 58 | 8—14 | Most population loss is from states east of the Mississippi River. Now found only in relatively few populations each in AR, LA & MS. |
| 6 | 1980 | 1 | 0 | Kansas only, now extirpated. |

**_Calopogon_ stem morphology and survivability:**

All species of *Calopogon* have corms 1-2 inches below the soil surface (one corm per plant), which can easily be affected by drought or various animals. The above-ground parts of the plant, the leaves and inflorescence, last only 4-6 months but the corm underground lasts a year. A corm coming out of dormancy will give rise to a leaf and possibly an inflorescence, with a new corm forming at the base of these structures by late spring or early summer and the old corm withering away.

A *Calopogon* corm contains two growing points, which basically means two chances for success in a given year. If both of these points are damaged or destroyed, the corm will not form new corms to perpetuate the plant through the next winter; in other words, the plant dies. If only one growing point is functional then the plant stands a much better chance at surviving to the next year. Optimally both growing points should survive, although *Calopogon* don't always initiate both of these, so a plant frequently gives rise to one corm instead of two. I have observed that if both growing points initiate, they do so at different times, one earlier in the season and one slightly later. *Calopogon* corms, when dormant, can survive some drying, but if drought or other disturbance strikes while they are forming new leaves or flowering, they can be severely damaged or killed. However, the second growing point, by initiating up to a few months later when conditions hopefully will have improved, seems to be an adaptation to survive springtime droughts or other disturbance such as fires or grazing. Still, two chances is not a lot of chances. Most other vascular plants can survive such disturbance by

resprouting from multiple tiny, dormant buds, or forming new buds. *Calopogon* can not do this, so therefore they are unavoidably vulnerable to local extirpation because of this limitation. *Calopogon oklahomensis* lives in perhaps the most drought-prone habitat of all the species in the genus (the habitat of *C. multiflorus* is also relatively dry), but they do succumb to drought, even as dormant corms (I've observed this over many years, through my cultivation of this species for research and conservation).

This suggests that *Calopogon oklahomensis* probably also historically relied on a widespread mosaic of large populations and abundant seed reproduction, with some habitat variation in these population mosaics. In a drought affected a region, the few plants in the slightly wetter areas would survive and be the ones to regenerate the species locally via seed reproduction, whereas widespread damage in wet years would be overcome by plants living in slightly drier sites. Small or widely-scattered populations are dangerously more vulnerable to extirpation; this seems to be the situation that now has developed with *Calopogon oklahomensis* throughout its range.

**Anecdotal observations:**

In the absence of any formal ecological studies of this species, I can present only my field observations and other knowledge of the species. Through graduate school until the last couple of years, I have made an intense effort to find this species in the field. My personal collection data, included with this package, indicates where I've collected it since 1994. However, of these 11 sites represented by my data, two of those from Oklahoma are gone and one from Louisiana may be as well. Furthermore, in my visits to some historically-known sites for this species I was never able to find it. My comments for each state are as follows:

Alabama: *Calopogon oklahomensis* was collected in Alabama a handful of times in the late 1800s, near the town of Mount Vernon, in what was reported to be relatively dry sites in open pine woods. Potential habitat still exists for this species to the west of Mt. Vernon, although it is severely fire-suppressed. The best opportunity for finding it in these areas is in frequently-mowed power line or gas line right-of-ways through these forests. However, over a few visits to this area in the last ten years I have not found this species, even if the site had been burned, so this species truly may be lost from Alabama. This species has no State listing in Alabama.

Arkansas: Historically this species was relatively common in Arkansas. However, due to the loss of upland prairie in northern and western Arkansas, and the severe reduction in mesic prairie in eastern Arkansas, this species is now known from only a handful of sites in this state. The upland prairies it prefers often contain "mima mounds" or "pimple mounds", which are naturally-occurring, usually less than one meter tall. These prairies have been lost to plowing, over-grazing, lowering of the water table, fire-suppression and construction. The mesic prairies of eastern Arkansas, also known as the "Grand Prairie", have mostly been destroyed by the conversion of prairie haymeadows to rice-agriculture in the last 30 years. A number of the very few sites that remain for this species in Arkansas are on state-owned or managed land, and are burned every several years. I was not able to find this species in those state-owned/managed sites that I explored in eastern Arkansas (I did not look for it in northern or western Arkansas). The site I found it on

was private land, with one half of the prairie remnant managed by the state as a conservation easement and the other half still used as a haymeadow by the landowners. It was the landowner-managed half that had where I found this species, and in some abundance (this is my collection #553). This species has no State listing in Arkansas.

Florida: The one collection of this species from Florida is from 1882, and the label says only "Florida" for the locality. My guess is that it was collected in the western Florida Panhandle. Nonetheless, considering the abundance of botanical documentation in Florida since 1882, because this species has not been collected again there I assume it is extirpated. I found this 1882 specimen after I prepared the Flora of North America treatment for this genus (see enclosed photocopy), so it is not mentioned in that treatment. This species has no State listing in Florida.

Georgia: This was collected only once, in 1947 by Robert Thorne, for his Ph.D. work on the flora of southwestern Georgia, at a site six miles east of Arlington. Several years ago I explored this area and found that it was mostly converted to pine plantation or was otherwise logged and very disturbed. I did not find this species and there didn't seem to be much remaining habitat in that area that could support it. This species has no State listing in Georgia.

Iowa: This species was apparently never common in Iowa and was last seen in 1945. Habitat loss has been severe throughout the state via conversion to agriculture, or fire suppression resulting in prairies becoming forests. I visited the Muscatine Co. site in 1995, which is now Wildcat Den State Park, and the areas where it may have occurred are now shady forests. This species has no State listing in Iowa.

Illinois: Once relatively common in Illinois, at least in the northern part, this species is very close to disappearing from this state. The last remaining population is in Will Co., in a site containing sandy prairie and savanna, which is owned and managed by the state. I have not seen this population and it is not documented by a herbarium specimens, but apparently it consists of 30 or fewer plants. The next most recent collection from Illinois, from 1980, is also from a similar habitat in Will Co. I have visited this site (also state-owned) and never was able to find the species and apparently nobody else has been able to find it either.

Illinois has experienced some significant droughts in recent years. I am unsure if the Will Co. population survived the severe drought in 2005. Nonetheless, the presence of merely one small population in this state means that it is easy for this species to become extirpated in Illinois due to natural climate fluctuations, insect attacks, rodent damage or other natural occurrences. This species is listed as endangered in Illinois.

Indiana: This species was historically known from three counties in northwestern Indiana but it has not been seen there since 1933. Although there is some potentially optimal habitat remaining in noethwestern Indiana, the fact that it has not been documented in 75 years suggests that it may be extirpated there. This species has no State listing in Indiana.

Kansas: This species was collected only once in Kansas, in 1980, from a prairie-haymeadow in Cherokee Co., in the extreme southeastern corner of the state. I visited this site in 1995 or 1996 and it was converted from prairie to active cultivation, having been plowed and sown with what appeared to be winter wheat or cultivated grass for hay. Therefore this species probably is extirpated from Kansas. This species has no State listing in Kansas.

Louisiana: This species was once relatively common in western Louisiana, found in the coastal prairie region and in pine savannas further north. However, fire-suppression and lumbering have reduced habitat for this species in pine savannas, and the coastal prairie region has almost entirely been converted of agriculture, particularly rice farming in the past several decades. In 1995 I was taken to a large population in Fort Polk (Vernon Parish), which happens to be in a tank training range (my collection #552). The plants were responding favorably to the frequent fires caused by exploding ammunition. I was told that there were a few other sites with small populations, scattered in Kisatchie National Forest, although I never found the species in those. In 1996 I visited a several-mile-long prairie remnant running parallel to a railroad in Jefferson Davis Parish, where *Calopogon oklahomensis* had been reported (erroneously as *C. barbatus*). I found this species in a few spots in this railroad prairie. This prairie was owned by the railroad company but the State of Louisiana had a conservation agreement with them to manage it delicately because it contained so much rare prairie vegetation. However, when I visited the site again in 1997 or 1998, I arrived while the railroad company was bulldozing several miles of the prairie to control woody vegetation, despite the conservation agreement. I found the last remaining *Calopogon oklahomensis* plants before they were destroyed, dug them up and gave them to Prof. Malcom Vidrine at Louisiana State University, Eunice, who was involved with prairie restoration and creating a prairie preserve in Eunice. These plants may still be alive in the Eunice prairie, but I am doubtful this species remains at the railroad site anymore after the severe disturbance in the late 1990s.

In the mid to late 1990s I visited some other known sites for this species in Louisiana, the Beauregard Parish site collected by J.K. Williams in 1996, the Sabine Parish site and the Winn Parish site (see the enclosed herbarium records for details), and I was never able to find the species at any of them. This species has no State listing in Louisiana.

Minnesota: It has been about 124 years since this species was last seen in Minnesota. Little is known about its preferred habitat there, although it probably preferred prairies and savannas. Nonetheless, it is likely extirpated in Minnesota and this species has no State listing there.

Missouri: Historically this species was relatively widespread in southern Missouri, although now it is restricted almost entirely to the southwestern part of the state. It probably occupied prairie or savanna habitats in the Ozarks, and in southeastern Missouri it is known from upland pimple-mound prairies, like those mentioned for Arkansas above. It is known from several prairie preserves owned and managed by the State of Missouri, such as the prairie in Barton Co. where I collected this species in 1994 (my

collection #525). This Barton Co. prairie had a moderate-sized population of the species (perhaps 100-200 plants) and had been burned within the previous year, if I recall correctly. However, another state-owned prairie I visited that was reported to have this species (it may have been in Pettis Co.) had been mowed at some point in the previous two years and the thatch left on the ground; I could not find *Calopogon oklahomensis* there, even sterile plants. Nonetheless, because this species is reported from a number of prairie preserves in southwestern Missouri, the species is probably more secure in this state than any other state. This species has no State listing in Missouri.

Mississippi: The first record of this species in Mississippi is relatively recent, from 1965 in the highway cloverleaf-intersection of U.S. routes 11 and 49 in Hattiesburg. Despite the extensive urban development in this area, including an old shopping mall next to this intersection, the cloverleaf contains a remnant *Pinus palustris* (longleaf pine) savanna with a moderate native herbaceous diversity, although it is mowed several times per year. However, since the mid 1990s I have visited this site a few times and have never found any evidence of any species of *Calopogon* persisting there, probably because of the frequent mowing interval. More recently, however, this species was found in Camp Shelby, in pine savannas (much of it intentionally cleared of trees) that are used as firing ranges for small arms to tanks. As in Fort Polk, LA, the frequent fires caused by exploding ammunition seem to favor this species. When I visited this site in 2006 (my collection #3745), this plant was locally common in a few spots relatively near one another, forming a number of sub-populations. However, a botanist doing plant surveys at the time at Camp Shelby, Steve Leonard, told me that there was possibly going to be much more intensive training usage of this area, which may have affected these populations in the last two years. This species has no State listing in Mississippi.

Oklahoma: Oklahoma has the greatest number of records of this species made from the last 30 years, primarily thanks to careful and thorough field collecting efforts of Prof. Lawrence Magrath at the University of Sciences and Arts of Oklahoma in the late 1970s and early 1980s (Larry passed away in early 2007). However, there are only five records of this species in Oklahoma after 1990. This species occupies moist to seasonally dry-mesic pimple-mound prairies, just as it does in Arkansas and Missouri. However, little of such habitat is protected in Oklahoma. The four prairies where I've seen this species in Oklahoma are privately-owned prairie-haymeadows. The prairies where I made my collections from Leflore and Bryan counties on 9 May 1994 (my collection numbers 513 and 515, respectively) are now gone or severely degraded. The Leflore Co. site appeared quite degraded when I last looked at it in 2004 (it was overgrazed even in 1994), and the Bryan Co. site was destroyed for the construction of a dumpster factory in 1995. My collection from Bryan Co. in 2004 (my collection #2820), was on land that was going to be partially developed for a church. My suspicion is that many of the other historical sites for this species (up through the early 1980s) are also degraded or destroyed now. For example, Dr. Magrath told me that the prairie where he collected this species two miles west of Leach, Delaware Co., on 5/25/1980 (his collection #10532), originally containing an enormous population of this species, now contains none because the landowners put in several ditches, greatly lowering the water table, thereby destroying the habitat. Sites that still contain this species do so because of landowners' particular

haymeadow management style, and even mild changes in management could eliminate these species from these sites altogether. In addition, recent severe droughts in Oklahoma may have had a detrimental impact on this species there. This species has no State listing in Oklahoma.

South Carolina: The record of this species is obscure. It is a single, very old specimen at the Royal Botanic Gardens, Kew, and the label says only "S.C." My guess is that this specimen is from before 1800 and comes from within less than 50 miles of Charleston. Because this species has not otherwise been found in South Carolina, it is unlikely it still persists there. This species has no State listing in South Carolina.

Tennessee: Collected in Tennessee only twice, most recently in 1939, this species probably no longer exists in this state. I have explored some of the barrens near Tullahoma, one site where this species was found, and was never able to find it, and otherwise I was never able to find it or much appropriate habitat for it in Van Buren Co. The state of Tennessee lists this species as Endangered and possibly extirpated.

Texas: This species was once common in Texas but is now rather rare, collected only twice in the last 30 years. In 1994 I documented it in a city-owned park near College Station, Brazos Co. (my collection #516), where I saw it again in 2004. It is also known from the Turkey Creek Savanna Unit of the Big Thicket National Preserve in Tyler Co. and I was told that in the late 1990s it was still occasionally seen there. In both spots it is not common, and likes damp sandy loam, influenced by a small amount of seepage, although the sites are not wet (boggy areas may occur nearby, however). The Turkey Creek site is burned on occasion, but the Brazos Co. site is not and is experiencing tree and shrub encroachment. This species has no State listing in Texas.

Wisconsin: This species was always rare in Wisconsin, the most recent record from Greene Prairie, a reconstructed prairie owned and managed by the University of Wisconsin (Madison) Arboretum. Many decades ago this prairie was constructed primarily from wild-collected and purchased plants from elsewhere. The record of *Calopogon oklahomensis* from this site is a photograph taken in 1987, assumed to be *C. tuberosus*. In the construction of this prairie, *Calopogon* was obtained from a nursery in the northeastern U.S., and from wild-collected plants from a prairie nearby in Wisconsin. Obviously the plants of *C. oklahomensis* here can be attributed to the Wisconsin source. Professor Ted Cochrane, at the University of Wisconsin, tells me that this species is still present in Green Prairie, although perhaps only four plants still remain, some at risk from tree encroachment. Minimal forms of other disruption (such as animal damage or recent droughts) will easily eliminate this species from Wisconsin altogether. I have read that the Greene Prairie also now suffers from water runoff problems from development on adjacent land. Obviously, this species is dangerously close to disappearing from Wisconsin. This species has no State listing in Wisconsin.

**Preferred ecology, threats to existence, and methods of conservation:**

This species seems to prefer relatively frequent but mild disturbance: relatively frequent fires (every 1-3 years), late-season haymeadow mowing (= where the thatch is removed, not left behind), and perhaps light grazing. However, this species is elusive and erratic in its occurrence, and it is not present in all potentially optimal sites that contain the habitat it prefers. Considering its preference for mesic conditions, loamy soil, sun to shade, and prairies to moderately open woodlands, one would think the species would be very common. The reality is it is quite hard to find, being anything but common. The summarized threats to this species are:

—Fire suppression, or infrequent burning.

—Severe drainage, rendering mesic sites too dry to support the species.

—Mowing without thatch removal.

—Excessively frequent mowing or premature mowing, such as any time within the growing season before the fruit ripen on this species (usually about 6-8 weeks after flowering).

—Over-grazing.

—Natural biological perturbations, such as insects, rodents, deer, or other herbivores.

—Natural local or regional climate perturbation, such as drought.

—Intensive trampling, deep local soil disturbance, or damage due to vehicular traffic (this is the primary risk in military bases).

—Soil disturbance and shading due to conversion to forestry plantations.

—Urbanization or other development.

All of these threats have resulted in the populations of this species becoming smaller and more widely scattered, particularly in the past century. As this pattern of population reduction and disconnection continues, it renders this species highly vulnerable to local, regional & widespread extirpation in the next decade or two. Thereafter extinction is not far off.

Conservation solutions would be:

—Purchasing appropriate habitat containing this species.

—Arranging conservation agreements with landowners, especially those with haymeadows, encouraging them to maintain their mowing habits permanently.

—Manage sites with this species using late-season mowing and thatch removal, or fires every 1-2 years.

—Reintroducing this species into areas of appropriate existing habitat, preferably from sources nearby (which favors local adaptations to climate and soil).

—Reintroducing this species into areas of reconstructed habitat, also preferably from local sources.

—Ex-situ conservation, propagating this species from seed and cultivating them in capable botanical gardens and/or reintroducing the seedlings to the wild.

This species should be relatively easy to protect, considering that it can tolerate late-season haymeadow mowing annually. this suggests that fire is not required for its survival, rather that fire is just one means to reduce competition. Such a management style would benefit a number of annual and herbaceous perennial prairie species, although it wouldn't benefit all prairie plants, such as those with woody or other perennial above-ground parts or plants requiring fire for the resulting nutrient input. Still, in areas where fire-management of natural areas is problematic, either because it is too expensive or otherwise not agreeable with local communities (such as in urbanized areas), mowing and thatch removal would be relatively easy, require less training and preparation, be more amenable to the use of conservation volunteers, and give ample opportunity to work with the decreasing number of local landowners who, for generations, have successfully managed prairies as haymeadows (thereby validating their good efforts).

**Current propagation efforts:**

I have several plants in cultivation from my collections from Mississippi (my collection #3745), Bryan Co., OK (#2820), and Brazos Co., TX (#516) From these cultivated plants I have obtained seed, which were sent away for micropropagation at a special orchid germination facility in Ohio. Seedlings derived from my Bryan Co., OK, plants are now in cultivation here at Harvard (tended by myself), and seedlings from my Mississippi and Texas plants were germinated only recently and are still in sterile culture in the lab in Ohio. My plan is to repatriate these seedlings into appropriately protected areas in the regions from which their parents came. Germination and propagation of this species is easy and relatively inexpensive (the efforts for these three populations cost only a few hundred dollars). This indicates that ex-situ conservation is an effective method for this species, and can be used by state agencies, conservation organizations and botanical gardens if this species continues its steep decline.

**Contacts:**

State heritage programs or Nature Conservancy offices can be easily found with a web search. Botanists with such organizations can provide information in this species in a given state. However, below I provide contact information for some particulalry knowledgeable individuals who can comment on this species within their state or geographic region:

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