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# Florida Ziziphus

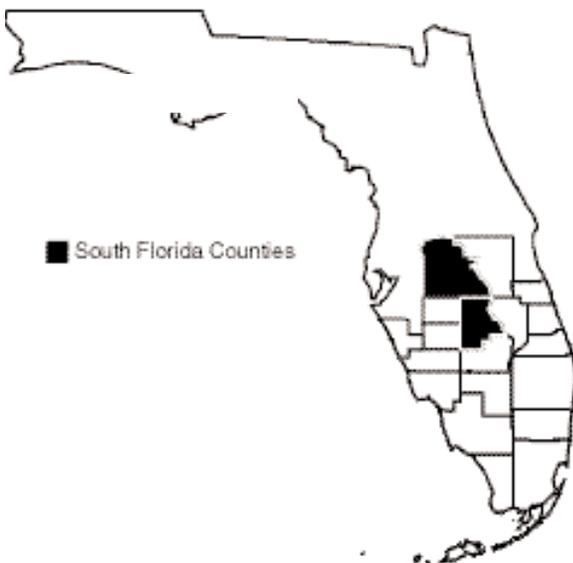
*Ziziphus celata* Judd and D. Hall

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<b>Federal Status:</b>	Endangered (July 27, 1989)
<b>Critical Habitat:</b>	None Designated
<b>Florida Status:</b>	Endangered
<b>Recovery Plan Status:</b>	Revision (May 18, 1999)
<b>Geographic Coverage:</b>	Rangewide

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Figure 1. County distribution of Florida ziziphus.



Florida ziziphus is a shrub that is endemic to the Lake Wales Ridge in central Florida. Florida ziziphus, which was believed extinct until 1987, occurs on the periphery of turkey oak sandhills or yellow sand oak-hickory scrub communities. The ziziphus is known to exist in only five remnant populations that are found in Polk and Highlands counties, but none of the plants on these sites appear to reproduce. These sites are threatened by continued land conversion for residential housing, agriculture, and road construction. Three of the five sites are pasture. Recovery efforts for the Florida ziziphus will include habitat protection, controlled propagation, reintroduction of this plant into unoccupied, suitable habitats, and land management of the scrubby flatwoods and high pine communities.

This account represents a revision of the existing recovery plan for the Florida ziziphus (FWS 1996).

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## Description

*Ziziphus celata* is a spiny shrub that averages between 0.5 to 1.5 m in height, but can grow to over 2 m. Plants occur in groups of stems, arising from what are assumed to be connected root systems. The primary branches are jointed and bent, and give rise to short, straight, spiny, branchlets. The oblong-elliptic to obovate leaves are alternate and deciduous. The leaves are characterized by rounded tips, cuneate bases, and entire margins. The upper leaf surface is dark glossy green, while the underside is a dull light green. Leaves vary from 4.5 to 21 mm in length, and from 3 to 13 mm in width. Fragrant *Z. celata* flowers are small, axillary, and solitary, but are tightly bundled on short shoots. Flowers are perfect, with five greenish-yellow sepals, and five white petals clasping five stamens; however, three- and four-merous flowers have been observed (Race and Weekley 1996). The bright yellow drupes range from 10 mm to 20 mm long, and 3 mm to 10 mm wide (Judd and Hall 1984, DeLaney *et al.* 1989, Race and Weekley 1996).

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## Taxonomy

*Ziziphus celata* was originally collected near Sebring in 1948. A second specimen was collected in 1954, perhaps from the same site as the original specimen, but the location of the latter collection is unknown. The plant remained unidentified and unnamed until 1984, when Judd and Hall (1984) named the original herbarium specimen *Ziziphus celata*. When it was named, the Florida ziziphus was thought to be extinct. However, it was rediscovered in 1987 at a site in Polk County (DeLaney *et al.* 1989).

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## Distribution

The original *Z. celata* herbarium specimen was collected from a scrub site near Sebring, Highlands County, Florida. Despite extensive searches, no specimens have been located in this area since 1955. *Z. celata* occurs at five known sites; four sites in Polk County and one in Highlands County, all on the Lake Wales Ridge of central Florida (Figure 1). Based on historic and existing locations, the north to south range of this species was approximately 56 km, and included much of the Lake Wales Ridge, from Highlands County north to at least central Polk County, and possibly further north (Burkhart *et al.* 1997).

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## Habitat

*Ziziphus celata* appears to prefer high pine habitat or the transition zone between scrubby flatwoods and high pine. K. DeLaney (Environmental Research Consultants, personal communication 1995) described the healthiest plants as growing on the lower slopes of turkey oak knolls with sparse cover. Based on Soil Conservation Service mapping, all of the sites where *Z. celata* occurs are characterized by excessively drained, nutrient poor soil types, including Tavares Fine Sand, Astatula, and Candler Sand (DeLaney *et al.* 1989, Soil Conservation Service 1990, Burkhart *et al.* 1997).

Three of the five sites where *Z. celata* occurs are improved pasture. The Lake Wales Ridge SF site is a degraded narrow ecotone between a high pine ridge and scrubby flatwoods. Other species in this ecotone include *Quercus* sp., *Bumelia tenax*, *Sabal etonia*, *Erigeron tomentosum*, *E. longifolium* var. *gnaphalifolium*, and *Serenoa repens* (DeLaney *et al.* 1989). The fifth site, referred to as the sandhill site, lies along the sloping edge of former sandhill. The site is surrounded by cherry laurel (*Prunus caroliniana*), oaks (*Quercus virginiana*, *Q. incana*, and *Q. laevis*), and invading blackberry (*Rubus cuneifolius*). Within the site, *Z. celata* is associated with long leaf pine (*Pinus palustris*), wire grass (*Aristida beyrichiana*), scrub buck wheat (*Eriogonum longifolium* var. *gnaphalifolium*), and *Serenoa repens* (Burkhart *et al.* 1997).

Habitat characterization for this species is difficult since many of the known sites are in pasture, with one site identified as a remnant sandhill and another an open oak-hickory, yellow sand scrub. This species does seem to prefer unshaded and uncrowded microsites within these communities (C. Weekley, Lake Wales Ridge SF, personal communication 1998).

**Florida ziziphus.**

Original drawing by Jean C. Putnam Hancock; original flower photograph by Steve Shirah.

**Reproduction**

*Ziziphus celata* is deciduous, losing its leaves in late fall. It begins blooming in late December or early January and blooming continues through late February (varying by site and year), while the branches are still bare (Burkhart *et al.* 1997). Fruits begin to develop in March, with new leaves forming at the same time or soon after. The fruits ripen in May or early June. No seedlings have been found in the wild, so it is not known whether the seeds germinate in the summer or later in the year. Common pollinators (bees and flies) have been observed visiting the flowers, although it is not known if these are pollinators of *Ziziphus*. No viable seeds have been observed in the wild. Natural fruit set has been observed twice in the wild, but few fruit were produced, and of those all aborted before maturity (K. DeLaney, Environmental Research Consultants, personal communication 1994; Burkhart *et al.* 1997). Lack of sexual reproduction may be due to the absence of compatible genotypes at a given site and/or the age of the above ground stems (Burkhart *et al.* 1997).

*Ziziphus celata* spreads asexually by sending shoots up from its roots. These additional stems give *Z. celata* a clump-like appearance, where individual plants in the clump are not distinguishable. Like other members of its genus, *Z. celata* is capable of parthenocarpic production of fruit, but it differs from others in its genus by not being dichogamous, having pistils and stamens that mature at different times to prevent self-fertilization (Burkhart *et al.* 1997).

Based on allozyme analysis, using five loci, it was found that the five remnant sites of *Z. celata* are composed of 11 distinct genotypes (Godt *et al.* 1996). Four of the sites consist of only one genotype. At least seven genotypes occur at the Highlands County site. More genotypes may exist since only a

subsample of the population was analyzed. The genetic analyses are supported by observations in the field that plants at some sites seem to be reproductively incompatible and only reproduce vegetatively. However, plants in cultivation at Bok Tower Gardens from two different sites (eight genotypes) did produce fruits and viable seed in spring of 1994 and 1995. It is likely that the plants' proximity to one another in the Gardens allowed them to cross-pollinate between genotypes. In 1996 and 1997, only plants from the Highlands County site (seven genotypes) produced fruit, suggesting that plants at this site in the wild are capable of sexual reproduction. However, access to this site is restricted and these plants have not been included in annual population surveys. Based on a recent reproductive study (Burkhart *et al.* 1997), *Z. celata* plants are self-incompatible, and are not compatible within genotypes. The only successful pollinations occurred between different genotypes.

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### Relationship to Other Species

At the Lake Wales Ridge SF ecotone site, *Z. celata* occurs with a mixture of scrub and sandhill species such as *Quercus chapmanii*, *Q. geminata*, *Q. incana*, *Q. laevis*, *Q. myrtifolia*, *Bumelia tenax*, *Sabal etonia*, *Erigonum tomentosum*, *E. longifolium*, *Aristida* sp., and *Serenoa repens*. At the sandhill site in Polk County, it occurs with *Q. laevis*, *Q. virginiana*, and *Q. incana*, *Pinus palustris*, *Serenoa repens*, and *Aristida beyrichiana*. Also, blackberry bushes (*Rubus* spp.) are encroaching from the edges of the site.

Because of its rarity, little is known about animal interactions with *Z. celata*. Fruits of southwestern *Ziziphus* species are eaten by birds (MacMahon 1985). Herbivory on stems and leaves has been observed in the wild (K. DeLaney, Environmental Research Consultants, personal communication 1995). Rabbits have been observed eating the pulp from fruits which had fallen to the ground (T. Race, Bok Tower Gardens, personal communication 1995), and other animals such as rodents and gopher tortoises may also find the fruits palatable. The dense thorny branches provide protection for small animals; rabbits, lizards, and nesting mockingbirds have been observed using these plants as cover at Bok Tower Gardens.

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### Status and Trends

After almost 40 years of being presumed extinct, *Z. celata* was rediscovered in 1987. It was listed as an endangered species in July 1989 (54 FR 31190). The reasons for listing *Z. celata* are habitat loss, potential reproductive and genetic limitations, exotic species invasion, and the potential for overcollection and vandalism (54 FR 31190). Most *Z. celata* habitat was converted to pasture and citrus production before the species was rediscovered in 1987. Currently, *Z. celata* occurs at five locations; allozyme analysis indicates 11 different genotypes. Only the Lake Wales Ridge SF population occurs on protected public land. The remaining populations are on private property. Lack of protection and reproductive failures in the wild make this species more vulnerable to extinction.

Land conversion for agriculture and residential housing on the Lake Wales Ridge has greatly reduced the amount of *Z. celata* habitat and has caused much of the remaining habitat to become even more isolated. If cross-pollination is necessary between sites, increased isolation will decrease the chance of successful seed production. The further loss of any genetic material will weaken the possibilities of recovery for this species.

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## Management

*Ziziphus celata* plants at Lake Wales Ridge SF were heavily shaded, covered in lichens, and appeared stressed (Delaney et al. 1989, Wallace 1990), yet regenerated quickly after prescribed fire (Weekley 1996). Plants at the more open high pine site and open pasture sites appear to grow vigorously in full sun or light canopy. This combination of a need for open canopy and quick regeneration suggests that this species is adapted to the frequent fire regime which historically maintained the high pine ecosystem.

The Lake Wales Ridge SF is the only site on public lands where *Z. celata* occurs. Current management activities at this site include semi-annual monitoring and prescribed burning. An augmentation project is proposed for this site.

The Highlands County population occurs in improved pasture on private property. Access to this site has been restricted and these plants have not been included in the regular monitoring program. This population was sampled in 1989 and propagated for the National Rare and Endangered Plant Collection at Bok Tower Gardens. Management needs for this population include: developing contact with the landowners, including this group in the regular monitoring program, and propagating additional samples to ensure that a backup of all genetic variability is preserved.

The two populations of *Z. celata* that occur in improved pasture on private lands in Polk County have similar management needs. Both sites are open and the plants are fairly vigorous, flowering annually. However, plants at one site are impacted by livestock and many of the older stems are senescing due to old age and trampling. The landowner has fenced this site for protection. Plants at both sites are included in the regular monitoring program. Since the site has been fenced, prescribed burns are planned, which encourage new growth.

The population on the remnant sandhill site on private property in Polk County is currently protected. The owners have posted the property as a nature preserve. However, the main threat to this population is the invasion of exotics. Bok Tower Gardens and DACS' Division of Forestry have implemented some control of these species, but this control will need to be continued. Prescribed fire is recommended for portions of the site in order to limit the spread of exotics, encourage the growth of natural ground cover, and stimulate vigorous new growth of *Z. celata*. In addition, this population should be sampled and propagated for inclusion in the Bok Tower Gardens collection of endangered plants.

Management for *Z. celata* on private land depends on competing land uses and on the landowners' willingness to embrace land management techniques

that will benefit this species. On the three pasture sites *Z. celata* has been exposed to mowing. Though currently not a problem, *Z. celata* only produces flowers on woody vegetation, so if mowing is done more frequently than every 2 to 3 years, the plant may be unable to reproduce (C. Weekley, Florida Department of Forestry, personal communication 1997). Other threats such as trampling and competition with invasive and exotic vegetation can only be eliminated if the private landowners support management recommendations.

To offset possible losses from private lands, plants have been propagated from three different sites (nine genotypes) and are maintained in the Center for Plant Conservation National Collection at Bok Tower Gardens. Plants representing two sites (eight genotypes) produced seed in 1994; plants from one site (seven genotypes) produced seed in 1995. Because the species is easily propagated, it appears feasible to establish new populations at the Lake Wales Ridge SF and other suitable sites.

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# Recovery for the Florida Ziziphus

*Ziziphus celata* Judd and D. Hall

**Recovery Objective:** PREVENT EXTINCTION, then stabilize.

## Recovery Criteria

*Ziziphus celata* may never reach a level at which reclassification could be possible. The objective of this recovery plan should be to increase existing populations and prevent extinction. Extinction is likely for this species due to low numbers of individuals and no known reproduction in the wild. *Ziziphus celata* may be considered stabilized when: existing populations, within the historic range, are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression and when this plant is successfully reproducing in the wild. These sites must also be managed to maintain the seral stage of high pine to support *Z. celata*.

This recovery objective is an interim goal because of the limited data on the biology, ecology, and management needs of this species. The recovery objective will be reassessed annually based on new research, management, and monitoring information. Reclassification criteria may be refined if new information identifies ways of re-establishing populations of this species to expand its current distribution within its historic range.

## Species-level Recovery Actions

- S1. Determine current distribution of *Z. celata*.** It is possible that populations of this species have yet to be discovered. Currently, three of the sites for *Z. celata* are in pastures and the other two are in restricted remnant areas. A complete survey has not been made of the Lake Wales Ridge for this species, making defining a distribution difficult.
- S1.1. Conduct surveys for additional populations of *Z. celata*.**
- S1.1.1. Conduct surveys in Polk and Highlands counties.** The southern portion of this species' range has been well surveyed; the northern section needs further attention.
- S1.1.2. Continue surveys for *Z. celata* on protected lands.** New sites for listed species are still being found on protected lands. This survey work should be continued to catalog all existing protected sites and new sites as they are purchased.
- S1.2. Maintain distribution of known populations and suitable habitat in GIS database.** Use GIS to map existing populations and to assess the species' status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review, in land acquisition activities, and to coordinate updates with the FNAI.

database. Currently, the Lake Wales Ridge Ecosystem Working Group and Archbold Biological Station are proposing to map the entire central ridge. This information would show potential habitat for scrub endemics based on their habitat needs.

- S2. Protect and enhance existing populations.** Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. Within the islands of xeric habitat, this species is found in only two remnant natural sites and three pastures sites, indicating how little habitat is left for *Z. celata*. For this reason, existing populations are in need of protection.
- S2.1. Protect privately owned habitat through acquisition, conservation easements, or agreements with landowners.**
- S2.2. Protect populations of *Z. celata* on public lands.** The only publicly-owned site for *Z. celata* is on the Lake Wales Ridge SF, where managers are developing a strategy for the benefit of *Z. celata*. Guidelines allow for a mosaic of successful habitat stages.
- S2.3. Use local or regional planning to protect habitat.** Utilize available regional and county planning processes to encourage protection of suitable unoccupied and occupied habitat of *Z. celata*.
- S2.4. Continue *ex situ* conservation.** *Ex situ* collections are important for preserving genetic diversity, preventing extirpation, and determining ecological characteristics and habitat management needs of species. These collections will be instrumental in the recovery of *Z. celata*.
- S2.4.1. Conserve germ plasm.** The seed for this species is not presently in long-term storage.
- S2.4.2. Maintain *ex situ* collection.** Currently, the Center for Plant Conservation coordinates conservation activities and maintains a database for the National Collection. Bok Tower Gardens, as a participating institution, maintains and propagates *Z. celata* as part of the National Collection.
- S2.5. Augment natural populations of *Z. celata*.** Augmentation of known populations may be necessary to induce reproduction.
- S2.5.1. Establish a protocol for reintroduction.** Records for source plants, techniques for establishing new populations, and protocols for monitoring are needed.
- S2.5.2. Locate potential (re)introduction sites.** Survey habitat within the historic range of *Z. celata* and identify protected lands, both public and private, that would be suitable habitat.
- S2.5.3. (Re)introduce plants to protected sites.** Use plants under cultivation to (re)establish plants in suitable habitat.
- S2.6. Enforce available protective measures.** Use local, State and Federal regulations to protect this species from overcollecting and damage from off-road vehicle use. Regulations should also be used to protect xeric vegetative communities where *Z. celata* lives.
- S2.6.1. Initiate section 7 consultation when applicable.** Initiate section 7 consultations when Federal activities may affect this species.

- S2.6.2. Enforce take and trade prohibitions.** This species is protected by take provisions of the ESA (including its prohibition against removing and reducing to possession any endangered plant from areas under federal jurisdiction; maliciously damaging or destroying any such species on any such area; or removing, cutting, or digging up any such species), by the Preservation of Native Flora of Florida Act, and by the Florida rules regarding removal of plants from state lands.
- S3. Continue research on life history characteristics of *Z. celata*.** Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed.
- S3.1. Continue research to determine biology and demographic information, such as numbers of sites and populations, numbers of individuals in a population, morphology, reproduction, recruitment, dispersal, growth, survival, and mortality.** Since this plant is not reproducing in the wild, the questions surrounding this issue are crucial to the recovery of *Z. celata*.
- S3.2. Continue research to assess the reproductive potential of *Z. celata* in the wild.** No mature fruit has been observed in the wild for this species. All recent growth in *Z. celata* has been vegetative. A pollination study is currently being conducted to ascertain the factors preventing natural reproduction.
- S3.3. Continue research to assess management requirements of *Z. celata*.** Determine which natural populations can be increased by habitat management. Surveys, research, and monitoring information will provide factors contributing to any declines at each site. Monitoring of populations should be in reference to various habitat management practices. Site-specific management guidelines should be provided to land managers. Close coordination among land managers is essential to develop adaptive management techniques.
- S4. Continue monitoring existing populations of *Z. celata*.**
- S4.1. Evaluate the effectiveness of the monitoring protocol used to assess population trends for *Z. celata*.** As more information is gained about *Z. celata*, monitoring protocols may need to be altered to make use of new information.
- S4.2. Monitor and detect changes in demographic characteristics, such as growth, survival, and mortality.** Herbivory, pollinators, disease, and injury should also be monitored. Characteristics such as reproduction, recruitment, and dispersal cannot be monitored in the wild at this time, but should be included as introductions make reproduction possible.
- S4.3. Monitor the effects of various land management actions on *Z. celata*.** Assess any changes in demographic characteristics of *Z. celata* in response to land management activities, such as prescribed fire, exotic plant control, etc.
- S4.4. Continue to work with private landowners.** The successful recovery of this species will be influenced by the participation of private land owners. To date a varying amount of support has been gained among the individual land owners.
- S4.5. Monitor introduced plants.** Monitoring of reintroduced plants will be essential for assessing the status of new plants and their contribution to the population as a whole.

Compare adult survival, seedling production, germination rates, seed survival, seedling survival, and growth rates between transplanted and natural plants. Where monitoring indicates that introduction has been unsuccessful, reevaluate protocol and methodology developed.

- S5. Provide public information about *Z. celata*.** It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about *Z. celata*.

Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *Z. celata* and other rare species requires a self-sustaining, secure, number of natural populations.

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### Habitat-level Recovery Actions

- H1. Prevent degradation of existing habitat.** Extensive habitat loss has already occurred throughout the range of this species. Both development and fire suppression have decreased the available habitat. There is one protected site for *Z. celata* in Polk County and none in Highlands County.

**H1.1. Secure habitat through acquisition, landowner agreements, and conservation easements.** With so little xeric scrub habitat left, any method of securing protected populations should be sought.

**H1.2. Manage and enhance habitat.** Manage habitat to maintain *Z. celata* populations by preventing damage from off-road vehicle use and collection, and by providing proper management of habitat including prescribed fire.

**H1.2.1. Conduct prescribed burns.** Fire is a necessary and integral characteristic of the scrub community. A variable interval in fire return and in season is important to mimic the natural fire regime. In addition, spatial variation in fire intensity and unburned patches are necessary to construct a natural fire landscape. The scrub is naturally made up of islands of suitable and unsuitable habitat. To repeat this landscape pattern, sites should be burned as a mosaic when possible.

**H1.2.2. Control and eliminate exotic and invasive plants and animals.** Exotic plant and animal species are not yet a major threat in Florida scrub as compared to other communities in South Florida. However, in isolated areas, exotic species are becoming established, for example, camphor, wild cherry trees, and blackberry bushes have threatened one *Z. celata* site, but they have been removed and are no longer a threat. Without control, exotic/invasive plants may become a threat to the survival and recovery of *Z. celata*.

**H1.2.3. Control access to areas where listed plants are growing.** Collection, trampling, and off-road vehicles can severely threaten individual populations. *Ziziphus celata* is currently threatened at one site by cattle trampling and by the expansion of a county waste facility on another site.

Fencing is being installed at the first site, but the potential new facility may need future attention if an entire *Z. celata* site is not to be destroyed.

- H2. Restore areas to suitable habitat.** Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves.
- H2.1. Restore natural fire regime.** Long periods without fire can change the species composition and the ability of the site to carry fire. Rehabilitation of a site may be a lengthy process, but with fewer and fewer sites remaining, these sites may become more valuable for future recovery. On these sites a seed bank may exist that could include rare endemic species.
- H3. Conduct habitat-level research projects.** Study the response of *Z. celata* to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation.
- H4. Monitor habitat/ecological processes.** Monitor the effects of land management actions, such as prescribed fire, exotic plant control, *etc.*, on the habitats where *Z. celata* occurs.
- H5. Provide public information about scrub and its unique biota.** Educational efforts, especially those conducted by Archbold Biological Station, have been successful. Without these successful efforts, the Lake Wales Ridge NWR would not have been created. Florida's system of biological preserves depends on a broad base of public understanding and support for its funding and future success. In addition to past and ongoing educational efforts by The Nature Conservancy, Bok Tower Gardens, and Archbold Biological Station, future efforts by these organizations, and the Florida Park Service, the Florida Division of Forestry, the SFWMD, the Florida Native Plant Society, and local garden clubs are crucial in increasing public appreciation of scrub and high pine communities and their associated plant species. The Arbuckle Appreciation Day sponsored by the Florida Division of Forestry has been especially successful in disseminating knowledge about these unique communities.

