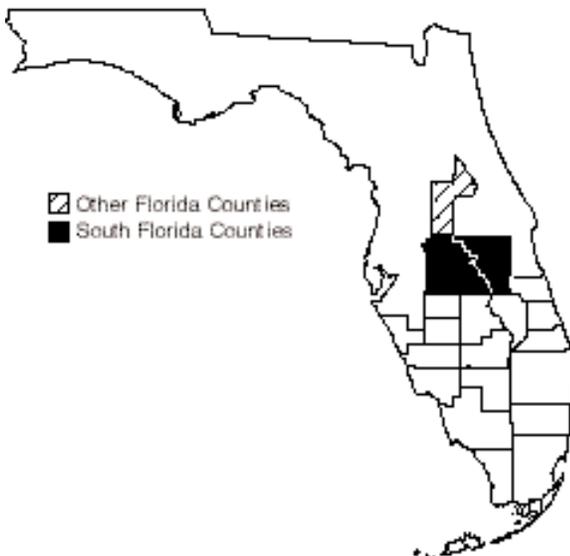

Wide-leaf Warea (or Clasping Warea)

Warea amplexifolia Nuttall

Federal Status:	Endangered (April 29, 1987)
Critical Habitat:	None Designated
Florida Status:	Endangered
Recovery Plan Status:	Contribution (May 1999)
Geographic Coverage:	South Florida

Figure 1. County distribution of wide-leaf warea.



Wide-leaf warea is an erect annual herb in the mustard family (Brassicaceae). The species has an extremely limited distribution, covering a north-south distance of about 80.5 km along the northern portion of the Lake Wales Ridge. In the South Florida Ecosystem, *Warea amplexifolia* is known to persist at only two sites in Polk County and one in Osceola County. *Warea amplexifolia* is endemic to high pine (sandhill) habitat, which has been greatly reduced by conversion of natural habitat to citrus groves, residential and commercial development, sand mining, and the lack of proper fire management in the remaining natural habitats.

This account represents South Florida's contribution to the existing recovery plan for the wide-leaf warea (FWS 1993).

Description

Warea amplexifolia is an annual herb in the mustard family (Brassicaceae). Plants may be 30 to 100 cm tall and the stalk may be unbranched or, more often, branching mid-way up the stem. Leaves are alternate, from 2 to 5 cm long, and 1 to 3 cm wide, smaller as they ascend the stalk, with a rounded apex and entire margin. On young plants, the leaves are slightly folded along the midrib, tipped upward, and the lobes at the base of leaves reach around the stem. This characteristic has led to one of the common names for the species, clasping warea. The heart-shaped clasping leaf bases and its pale green, slightly glaucous leaves readily distinguish *W. amplexifolia* from the three other species in its genus in Florida. The characteristic leaves can be used in field identification even if the plants are not flowering.

The pale lavender flowers of *W. amplexifolia* vary in individuals from almost white to almost purple. Flowers appear at the ends of the branches in spherical clusters about 5 to 6 cm across. Superficially, the flowers look like small versions of the garden cleome (*Cleome hasslerana*), a member of the family Capparaceae. The inflorescences

are dainty, and in the field the flowering plants look almost fluffy. Individual flowers are about 1.5 cm across, with four petals and six long stamens.

Warea amplexifolia is also readily identifiable in seed, even as the stalk turns brown and the leaves wither, by the clusters of narrow down-curving seed pods, from 5 to 7 cm long. The pods split longitudinally, with small black seeds on either side of the center membrane.

Polonisia tenuifolia, an annual in the family Capparaceae, which grows about as tall as *W. amplexifolia*, might be mistaken for *W. amplexifolia* when the plants are brown and dry at the end of the season. However, *Polonisia* seed pods, which are about the same size as those of *Warea*, appear singly in the leaf axils and are erect and straight (FWS 1993).

Taxonomy

Warea amplexifolia was originally described by Thomas Nuttall in 1822 from a specimen collected in central peninsular Florida by N.A. Ware. Nuttall at first placed this plant in the genus *Stanleya*, but in 1834 transferred it to the genus *Warea* and provided an amplified description that accommodated specimens from the Florida panhandle. The panhandle specimens were later recognized as a distinct species, *Warea sessilifolia*, by Nash. Shinnery (1962) proposed a new name for the peninsular species, *Warea auriculata*, but most authors consider *W. amplexifolia* the correct name (Payson 1922, Channell and James 1964, Judd 1980).

Distribution

Warea amplexifolia was collected infrequently between its initial discovery in the early 1800s and 1986, when it was listed as endangered. This is most likely due to its extremely limited range. By the time a status survey for *W. amplexifolia* was conducted (Judd 1980), much of the high pine habitat in the region had been destroyed or degraded. As a result, it is impossible to determine the species' original range.

Judd (1980) believed the former range of *W. amplexifolia* included Lake County, western Orange County, extreme northwestern Osceola County, and northern Polk County, but he wrote that the species' range had been reduced to three sites in Lake County and a single site in northern Polk County before his survey. Since then, additional sites have been discovered in Lake, Polk, and Osceola counties and several of the previously documented sites have been eliminated. The present distribution of *W. amplexifolia* includes Lake, Polk, and Osceola counties (Figure 1); the species has probably been extirpated from Orange County.

Habitat

Warea amplexifolia is endemic to the high pine (or sandhill) habitat (Myers 1990) that once covered the northern half of the Lake Wales Ridge in Lake and Polk counties. The high pine community has a relatively high diversity of herbaceous ground cover (Myers 1990), which was maintained, under natural conditions, by

Wide-leaf warea flower.

Original photograph by Steve Shirah.



patchy summer fires sparked by lightning. The FWS currently does not have a list of USDA soil series on which *W. amplexifolia* grows throughout its present range. However, comparing a map provided by Judd (1980) of a *W. amplexifolia* location in northern Polk County (Haines City site) with USDA soil maps (USDA 1990), the species was growing on Apopka fine sand. Plants at the other site in Polk County, at Bok Tower Gardens, are growing on Candler sand (T. Race, Bok Tower Gardens, personal communication 1997). Candler sand is also the dominant soil type on the higher elevations of the Lake Davenport site, Osceola County. Several of the FNAI records for this species report the species growing on Astatula Series soils (FNAI 1997).

Warea amplexifolia is limited to dry, open longleaf pine (*Pinus palustris*) woods, longleaf pine/turkey oak (*Quercus laevis*) woods, or live oak/bluejack oak (*Q. geminata*/*Q. incana*) woods that occur on well-drained, sterile, yellowish sands on the Lake Wales Ridge. *Warea amplexifolia* is limited to sunny openings in those woodlands. *Warea amplexifolia* seems unable to tolerate shading or intense competition; it may be favored by slight disturbance, but does not generally occur in weedy sites (roadsides, cleared fields, citrus groves, or pastures) (Judd 1980). Under a natural fire periodicity, *W. amplexifolia* would be expected to grow in areas having a scattered overstory of *P. palustris*. Judd (1980), however, observed that xeric oaks (*Q. laevis*, *Q. incana*, and *Q. geminata*), which under natural fire frequency are present in the understory, were forming an overstory at several of the *W. amplexifolia* sites, due to lack of fire and the cutting of longleaf pine. Under a natural fire regime, a diverse assemblage of herbaceous vegetation grows in the sunny, open areas with exposed sand. Scattered individuals of *W. amplexifolia* are generally widely spaced in these openings, with much exposed sand among patches of reindeer moss (a lichen, *Cladonia* spp.).

Reproduction

Warea amplexifolia flowers from mid-August to early October, and fruiting occurs from late September to mid-November. Senescence occurs just before the fruit matures, and the population overwinters as seeds. The showy flowers are pollinated by various Hymenoptera (bees) and Lepidoptera (butterflies). Reproduction is exclusively sexual, with seeds probably released from the pods by wind action. The small seeds generally fall near the parent plant (FWS 1986). Experimental propagation to field plots at Bok Tower Gardens suggests that the number of flowering plants is related to the amount of rainfall during the December prior to the growing season. They also found that plants grew from seeds that had been sown into the experimental plots 2 to 4 years earlier, which indicates that seed banking in the soil is important in this species (Bok Tower Gardens 1994).

Relationship to Other Species

Like many herbaceous plants that grow in open, sandy patches, *W. amplexifolia* does not tolerate shading by dense shrubs or trees. The habitat structure of the surrounding forest around the open patches is controlled under natural conditions by fire. Other methods of controlling canopy closure and potential problems with exotic grasses are discussed below under Management.

Bok Tower Gardens (1994) believes that *W. amplexifolia* and wiregrass (*Aristida beyrichiana*), the dominant native grass in the high pine community, depend on similar fire regimes, but recommends further research to determine the relationship of these species to fire intervals and burn regimes.

Bard (1996) noted that four species of ants (*Camponotus socius*, *Pogonomyrmex badius*, *Formica pallidafulva*, and *F. archboldi*) occur around *W. amplexifolia* at Lake Griffin State Recreation Area, and believed these ants help disperse *Warea* seeds. No information is currently available on the relationship of *W. amplexifolia* to wildlife species, such as the gopher tortoise (*Gopherus polyphemus*), which could be important in generating minor soil disturbance in this habitat.

Status and Trends

Warea amplexifolia was included in the list of plant species the Smithsonian Institution believed warranted listing in its January 1975 report to Congress. *Warea amplexifolia* was listed as endangered under the ESA on April 29, 1987 (52 FR 15505); the listing cited the species' limited distribution and loss of its habitat, primarily to urban expansion and conversion to citrus groves, as the primary reason for listing it endangered.

High pine was once extensive on the Lake Wales Ridge (Myers 1990). Although many people involved in conservation of natural areas associate the Lake Wales Ridge with the scrub community, the public is much less aware that the scrub was originally surrounded by a larger matrix of high pine. Although scrub has certainly been reduced to a small percentage of its historic range, high pine, which was more suitable for conversion to citrus, has been reduced to a much smaller percentage of its original range (DEP 1996).

As mentioned earlier, it is impossible to determine the original range and abundance of *W. amplexifolia*, but the high pine community in which it lives has been greatly reduced by agricultural, commercial, and residential development. Judd (1980) determined that *W. amplexifolia* had likely been extirpated from the historic Apopka, Clarcona, Ocoee, and Windemere sites in Orange County and from the Wilson Lake Road site in northwestern Osceola County. Judd located only three extant populations in Lake County and one in northern Polk County and reported that all of these were in private ownership. Judd apparently was unaware that an approximately 8 ha wooded area, surrounded by development, which he called “Leesburg Site” is a small disjunct portion of the Lake Griffin SRA.. The recovery plan (FWS 1993) stated that 10 populations had been identified in Lake and Polk counties, including a population at Bok Tower Gardens, near Lake Wales in Polk County, which had been identified by Hall (1985). Judd’s “Haines City” site, located west of U.S. Highway 27 and east of Lake St. Charles about 7 km north of Haines City, is most likely now eliminated by a residential housing development (N. Bissett, Natives Nursery, personal communication 1997).

The FNAI produced a land acquisition proposal, entitled the Warea Archipelago, for the (CARL) program, based on surveys conducted in 1991 and 1992 (R. Hilsenbeck, The Nature Conservancy, Tallahassee, personal communication 1997). Six tracts of land containing *W. amplexifolia* were identified: Sugarloaf Mountain, Ferndale Ridge, Castle Hill, Flat Lake, Schofield Sandhill, and Lake Davenport. Five of these are in Lake County and one is in Osceola County.

The FNAI conducted another survey for *W. amplexifolia* in 1994 and 1995 in Lake County on behalf of the Lake County Water Authority and the SJWMD. This survey located a total of 17 sites (G. Race, Lake County Water Authority, personal communication 1997). Unfortunately, large portions of Lake County are being cleared for the suburban expansion of the Orlando metropolitan area. Two homes are being constructed on or near the Ferndale Ridge site; although this may not preclude acquisition of the remaining properties in the Ferndale Ridge area. Increasing density of homes in the area could increase land values and make fire management of the remaining properties more difficult (G. Race, Lake County Water Authority, personal communication 1997).

Warea amplexifolia is present in a remnant high pine habitat next to a golf course in the Mountain Lake Estates housing development, near Bok Tower Gardens, Polk County (T. Race, Bok Tower Gardens, personal communication 1997). *Warea amplexifolia* has been discovered on the site of a proposed nursery along Champaign Road, between Haines City and Davenport, Polk County. The plan for the nursery on this 4 ha acre property calls for preservation of about half the site in native vegetation, which could be managed by controlled burning (N. Bissett, Natives Nursery, personal communication 1997).

Because individual plants die at the end of each growing season, and because the number of plants at a given site varies greatly from year to year (T. Race, Bok Tower Gardens, personal communication 1997), it is difficult to document trends in population numbers. The ecology of *W. amplexifolia* (a fall-blooming annual growing in a habitat which normally burns during the summer

growing season) and anecdotal evidence of plants appearing at sites where they had not been seen for several years, suggests that the species banks seeds in the soil (FWS 1993, Bok Tower Gardens 1994). This complicates the identification of population trends, requiring long-term monitoring at several sites.

Management

The CARL program includes as a high priority the Lake Wales Ridge Ecosystems Project, which in turn includes a subset of parcels commonly known as the Warea Archipelago sites, targeted at remnant high pine habitats in the northern Lake Wales Ridge. *Warea amplexifolia* occurs on all six sites proposed for acquisition. The 49 ha Flat Lake property in Lake County is now under contract for acquisition by The Nature Conservancy. The Nature Conservancy is still attempting to negotiate a sale for the Lake Davenport property in Osceola County (R. Hilsenbeck, The Nature Conservancy, Tallahassee, personal communication 1997). Purchase of all six properties should be a high priority for recovery of the species.

Bok Tower Gardens has researched methods for propagating *W. amplexifolia*. Although propagation from seed in a greenhouse resulted in a high rate of germination and early survival, all of the seedlings planted outside in native yellow sand died before flowering from the action of leaf miners, lepidopteran larvae, fungus, and unknown causes (Bok Tower Gardens 1994). Direct sowing of *W. amplexifolia* seeds in the field was more effective. In 1990, 2,000 seeds were sown, resulting in 30 percent germination and 16 flowering plants (0.8 percent). In 1991, 5,000 seeds produced 280 (5.6 percent) seedlings, and 46 (0.92 percent of total seed) flowered.

At Lake Griffin SRA, *W. amplexifolia* covered about 0.08 ha on the 8 ha parcel in May 1994. Under a FWS recovery contract, DEP started clearing oaks (except bluejack oak), and treated the cut surfaces with Garlon 3A (triclopyr) or Roundup (glyphosate). After removal of the oaks, centipede grass (*Eremochloa ophiuroides*) increased around the colony of *W. amplexifolia*. The exotic centipede grass was treated with Poast (sethoxydim). Other exotic plants that were hand pulled or treated with herbicide included rosary pea (*Abrus precatorius*), Chinese tallow (*Sapium sebiferum*), mimosa (*Albizia julibrissin*) and Sprenger's asparagus (*Asparagus sprengeri*). As of 1997, about 2 ha had been cleared. By 1996, the area covered by Warea was estimated to be about 0.2 ha. The number of individual *W. amplexifolia* plants was 57 in 1994 and 118 in 1996. Approximately 26,000 wiregrass plants have also been planted in the restored area, and within a few years, DEP anticipates that the wiregrass should be established enough to perform a controlled burn (Bard 1996; A. Bard, DEP, personal communication 1997).

Bok Tower Gardens (1994) recommends field experiments to determine the influence of wiregrass on the fire ecology of *W. amplexifolia*. Because *W. amplexifolia* also grows in association with several other protected species, research is needed on the fire ecology of each component of the community to devise a compatible management plan.

The *W. amplexifolia* population at Mountain Lake Estates is apparently not under immediate threat of development, and a conservation committee has

been formed among the residents (T. Race, Bok Tower Gardens, personal communication 1997). This may provide an opportunity to establish a cooperative agreement for management of this remnant high pine habitat on private property.

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Recovery for the Wide-leaf Warea (or Clasping Warea)

Warea amplexifolia Nuttall

Recovery Objective: PROTECT EXISTING POPULATIONS; create new populations if feasible.

South Florida Contribution: PREVENT extinction, then stabilize.

Recovery Criteria

Recovery actions for *Warea amplexifolia* in South Florida are supportive of the overall recovery goal for the species. The objective of this recovery plan should be to increase existing populations and prevent extinction. *Warea amplexifolia* 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. These sites must also be managed to maintain the high pine community to support *W. amplexifolia*.

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 *W. amplexifolia*.**
 - S1.1. **Conduct surveys of *W. amplexifolia*.**
 - S1.1.1. **Conduct surveys in Polk and Osceola counties.** New locations for this species may be found.
 - S1.1.2. **Continue surveys 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 and high pine 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 areas has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated.
- S2.1. Protect habitat** through acquisition, conservation easements, or agreements with landowners. The Warea Archipelago is a series of small properties that are being purchased through CARL that are designed to protect *W. amplexifolia* and the unique community in which it lives.
- S2.2. Protect populations on public lands.**
- S2.3. Use local or regional planning to protect habitat.** Utilize available regional and county planning processes to encourage protection of suitable habitat, both occupied unoccupied, and occupied habitat of *W. amplexifolia*.
- 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 *W. amplexifolia*.
- 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 *W. amplexifolia* as part of the National Collection.
- S2.5. Augment natural populations of *W. amplexifolia*.**
- 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 *W. amplexifolia* 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 *W. amplexifolia* 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 *W. amplexifolia*.** 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.
- S3.2. Conduct research to assess management requirements of *W. amplexifolia*.** Determine which natural populations can be stabilized or increased by habitat management. Surveys, research, and monitoring at *W. amplexifolia* 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 the existing populations of *W. amplexifolia*.**
- S4.1. Evaluate the effectiveness of the monitoring protocol used to assess population trends for *W. amplexifolia*.** As more information is gained about *W. amplexifolia*, 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 truly 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 *W. amplexifolia*.** Assess any changes in demographic characteristics of *W. amplexifolia* 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 landowners. To date a varying amount of support has been gained among the individual landowners.
- 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 *W. amplexifolia*.** 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. 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 *W. amplexifolia* and other rare species require a self-sustaining, secure, number of natural populations.

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.
- H1.1. Secure habitat through acquisition, landowner agreements, and conservation easements.** Any method of securing protected high pine habitat should be sought.
 - H1.2. Manage and enhance habitat.** Manage habitat to maintain *W. amplexifolia* 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 high pine 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 is necessary to construct a natural fire landscape. To repeat this landscape pattern, sites should be burned as a mosaic when possible to allow for variation.
 - 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 high pine as compared to other communities in South Florida.
 - H1.2.3. Control access** to areas where listed plants are growing. Collection, trampling, and off-road vehicles can severely threaten individual populations.
- 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.
 - H2.2. Enhance sites with native plant species.** Because of logging or long periods without fire, certain native plant species that were present historically may now be absent from the natural composition of the community. These species can be reintroduced if natural colonization is not possible.
- H3. Conduct habitat-level research projects.** Study the response of *W. amplexifolia* 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 *W. amplexifolia* occurs.
- H5. Provide public information about scrub and high pine and their 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 South Florida Water Management District, 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.

