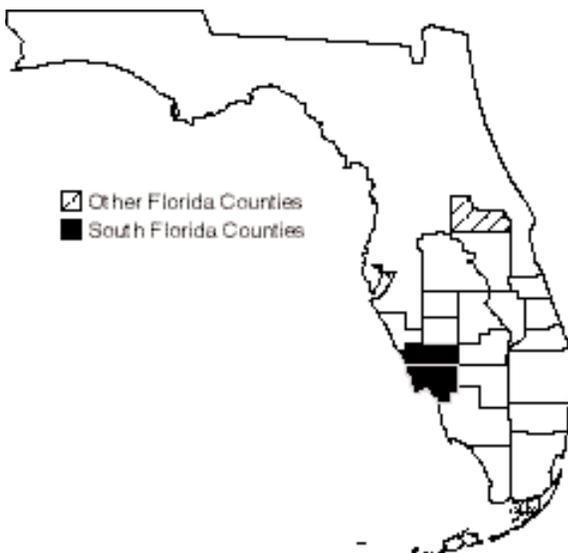

Beautiful Pawpaw

Deeringothamnus pulchellus Small

Federal Status:	Endangered (Sept. 26, 1986)
Critical Habitat:	None Designated
Florida Status:	Endangered
Recovery Plan Status:	Revision: May 18, 1999
Geographic Coverage:	Rangewide

Figure 1. County distribution of the beautiful pawpaw.



The beautiful pawpaw (*Deeringothamnus pulchellus*) is a low shrub of the Annonaceae family that occurs in two disjunct locations in central and southwest Florida. It is found in xeric, mesic, and hydric pine flatwoods in western Charlotte and Lee counties and eastern Orange County. The beautiful pawpaw is threatened with extinction because of habitat loss due to agricultural, residential, and commercial conversion of land. The exclusion of fire is also responsible for habitat degradation throughout much of the species' range. Habitat conservation and management are conservation measures that will ensure survival of this species.

This account represents a revision of the existing recovery plan for the beautiful pawpaw (FWS 1988).

Description

The beautiful pawpaw is a low-growing, diminutive shrub rarely exceeding 0.5 m in height. In mowed areas the plant grows more prostrate with decumbent woody stems, whereas in fire-maintained habitat it grows more erect with arching stems. In both growth forms, the stems may be annual or perennial. The stems arise from a stout taproot that averages 32.5 cm long and is about 2.5 cm wide at its widest point (Passarella and Associates, Inc. 1996). The leaves are alternate, leathery, deciduous, and 4.0-7.0 cm long with slightly revolute (curving under) margins. The leaf shape is oblong to oblong-ovate or spatulate, with a rounded or notched end. The base of the leaf is rounded or tapering to a 2.0-4.0 mm long petiole. Young leaves have sparse, short, red hairs on both sides. Maturing leaves become dark green to glossy green above and paler green below.

The flowers of *D. pulchellus* occur singly in leaf axils and have between six and 10 creamy-white petals that are about 2.0-3.0 cm long. The fruits are fleshy, smooth and yellow-green when ripe and are 4.0-7.0 cm long. The seeds are dark brown and from 1.0-1.5 cm long.

Taxonomy

The beautiful pawpaw was described and named by Small (1926) as *Deeringothamnus pulchellus*. Zimmermann (1944) later renamed the plant *Asimina pulchella*, but this name was not accepted by the botanical community. Rehder and Dayton (1944) combined *Deeringothamnus* and *Asimina* and then correctly named the beautiful pawpaw *Asimina pulchella*. Subsequently, Walker (1971) indicated that pollen of *D. pulchellus* and *D. rugelii* were distinct and warranted generic status. *Deeringothamnus* is currently considered a distinct genus.

Distribution

Deeringothamnus pulchellus occurs in the vicinity of Charlotte Harbor and the Caloosahatchee River from Punta Gorda to Fort Myers in southwestern Florida (Wunderlin and Richardson 1981). It is also found in eastern Orange County, in the suburbs of Orlando (Hilsenbeck 1992). Overall, 11 sites are known from Lee County, seven from Charlotte County, and three from Orange County (Beever 1990, E. Norman, Stetson University, personal communication 1998) (Figure 1).

In Lee County, the pawpaw exists on Pine Island, where it occurs in pristine and modified flatwoods, on road edges, and on mowed lots. In Charlotte County it is found in an area broadly known as the Charlotte Harbor flatwoods and includes sites along State Road 765 and the GFC's Cecil M. Webb Wildlife Management Area.

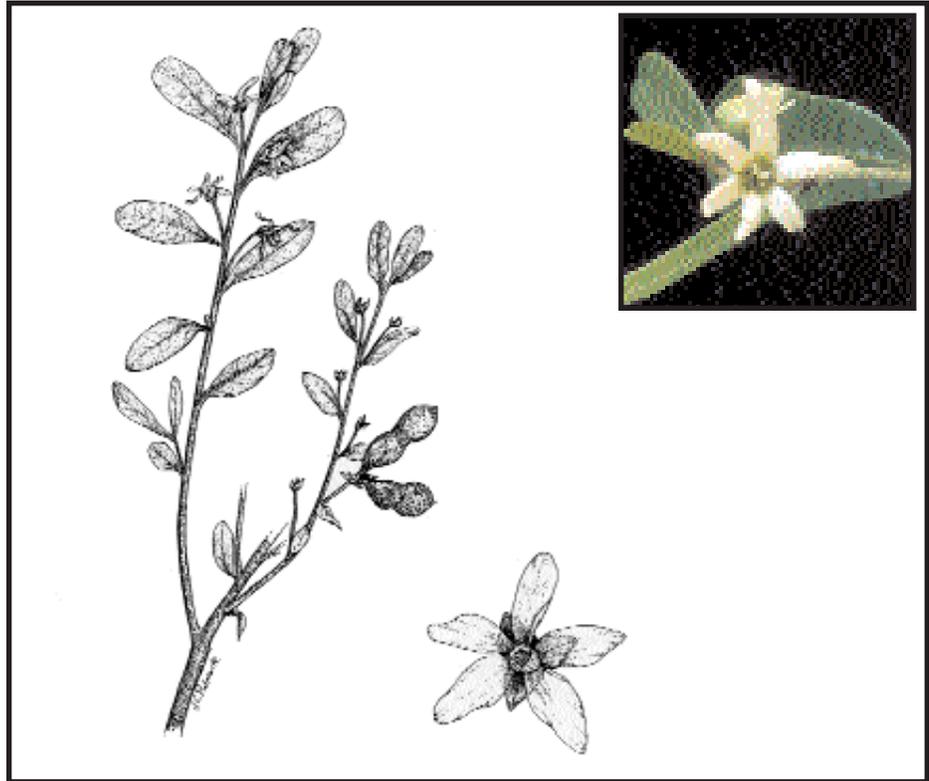
Recently, 200 individual pawpaws were relocated from private land on Pine Island where habitat destruction was anticipated due to conversion for agricultural purposes. The plants were relocated to suitable, but unoccupied habitat in Lee County's St. James River Preserve on Pine Island and the Charlotte Harbor Environmental Center (CHEC) in Charlotte County (Passarella 1996). If these relocations prove successful, neither site will result in an extension of the historical range of the species; however, the CHEC location will represent a new site within the species' range.

Habitat

The beautiful pawpaw is native to longleaf pine (*Pinus palustris*) and slash pine (*P. elliotii*) flatwoods consisting of *Aristida* spp. low shrubs including evergreen blueberries (*Vaccinium myrsinites*), saw palmetto (*Serenoa repens*), wax myrtle (*Myrica cerifera*), flag pawpaw (*Asimina reticulata*) and dwarf oak (*Quercus minima*), *Lyonia fruticosa*, and *Befaria racemosa*. Soils in these habitats are poorly drained, although slight elevations provide better drainage than surrounding soils that are wetter. The pine flatwoods are adapted to frequent ground fires that seldom kill or harm mature pine trees, but are usually hot enough to thin or clear understory vegetation. *Deeringothamnus pulchellus* depends on such fires to limit competition with larger grasses and shrubs. It takes advantage of fire-created openings by flowering and setting fruit the first growing season after a fire.

Beautiful pawpaw.

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

**Reproduction**

The reproductive biology of *D. pulchellus* is not thoroughly understood but the plant is thought to reproduce entirely by seed. D. Martin (FWS, personal communication 1996) indicated that available information suggests this species has poor fertilization, seed-setting, and germination rates. However, because *D. pulchellus* is probably long-lived, it does not need to be reproductively successful each year.

On Pine Island, plants begin flowering by mid-March and are at the peak of flowering the last week of April. On the mainland, flowering dates are probably one to two weeks later. The pollinators of this species have not been identified. Fruit is likely produced and dispersed during the summer. Gopher tortoises (*Gopherus polyphemus*) may be an important seed disperser. Although not investigated in detail, ingestion of the seeds by gopher tortoises or other herbivores may be important for seed germination. However, seeds have been germinated without this type of treatment (E. Norman, Stetson University, personal communication 1998).

Relationship to Other Species

The pollination vector for this species is not known. However, if a single species pollinator system is present, it could be extremely important to the continued survival of this species, particularly since encroaching agricultural

and urban land uses often rely on broad-spectrum insecticides to control nuisance pests. Adverse effects from chemical drift or long-term persistence could reduce or eliminate pollinators.

Seeds of this species are probably dispersed with the assistance of animal vectors since *D. pulchellus* is low growing and there are no seed structures that would aid aerial dispersal. Herbivores, though not common in the pine flatwoods, are probably responsible for seed dispersal. Whitetail deer (*Odocoileus virginianus*) likely eat *D. pulchellus*, but whitetail tend to browse more than they graze, suggesting that a low-growing plant such as the beautiful pawpaw may not be utilized extensively. The eastern cottontail rabbit (*Sylvilagus floridanus*) and gopher tortoise probably consume pawpaw opportunistically since forbs and small shrubs are seasonally important components of the diet of these two species. It is not known whether *D. pulchellus* depends on any of these herbivores, or others, for dispersal and germination.

Status and Trends

Beever (1992) estimated that about 9,550 individuals may have been present in southwestern Florida in the early 1990s. This estimate probably represents only a small portion of the historic numbers. *Deeringoyhamnus pulchellus* numbers and distribution have undoubtedly decreased since agricultural and residential projects have degraded or destroyed pawpaw habitat in southwestern and central Florida. On the mainland of Charlotte County, extensive land clearing associated with land speculation and development of Cape Coral probably resulted in substantial losses of habitat and individual plants. Currently, pawpaws along State Road 765 in Charlotte County are particularly susceptible to residential development. On Pine Island, increasing threats from land clearing for horticulture, tropical fruit production, grazing, and residential housing have destroyed habitat and individual plants. Residential housing demands and associated infrastructure also threaten plants in eastern Orange County.

The suppression of fire has also resulted in the degradation of habitat throughout the beautiful pawpaw's range. As mentioned above, this species does not persist where it must compete for light with tall grasses and larger shrubs. Because fires are typically excluded from urban and agricultural settings, much of the remaining habitat for *D. pulchellus* is overgrown.

A small number of plants persist in areas where continued human alterations have created and maintained a suitable environment. On Pine Island and the mainland of Charlotte County, mowing of undeveloped agricultural, residential, and commercial property, and maintenance of road right-of-ways effectively limit competition with other vegetation. Unfortunately, protection of plants in these areas is tenuous and depends entirely on the location and rate of habitat alteration associated with agricultural and residential uses of the landscape.

Very few *D. pulchellus* are protected on public lands. To date, only five sites for pawpaw occur on public lands. Two of these sites, St. James Creek Preserve and CHEC, were recipient sites of pawpaw relocations in 1996. The State's (CARL) program currently protects one *D. pulchellus* site, and two other sites are on the Cecil M. Webb WMA. Some pawpaw may exist on county road right-of-ways but these have not been inventoried. One site on private land is protected

because of its use as a pawpaw mitigation area. Existing and proposed land management techniques on these public and private lands will probably be sufficient to ensure localized persistence of the species. Additional monitoring is needed to verify the species' status on public lands. The vast majority of plants and habitat occur on private lands and are under increasing threat from agricultural and urban land conversion.

Management

The survival and recovery of *D. pulchellus* requires that additional habitat be protected and properly managed. Habitat acquisition may include fee title purchase, establishment of conservation easements, transfer of development rights, *etc.* Land management techniques include burning, mowing, and possibly selective grazing.

Control of competing vegetation is essential to the survival of *D. pulchellus*. Periodic fire or mowing can reduce competition and allow beautiful pawpaw to persist indefinitely. Low-intensity fires at one-to three-year intervals, or mowing at similar intervals have been used with success on several public lands. Prescribed fire is used on Lee County's St. James Creek Preserve on Pine Island and at the CHEC in Charlotte County. Pawpaw also persists on Cecil M. Webb WMA where periodic winter burns in combination with grazing are used to manage wildlife habitat. At the Greater Pine Island Water Association's pawpaw preserve, periodic mowing has replaced burning as the preferred management technique. Preliminary surveys of the site after mowing indicate that pawpaws persist on the preserve. However, concerns exist that mowing may not sufficiently recycle nutrients and could result in long-term adverse affects. Monitoring of burned and mowed sites is needed to assess which technique is most beneficial to pawpaw reproduction and survival.

Under the CARL program about 1,440 ha of pine flatwoods have been acquired under the Charlotte Harbor Flatwoods project (DEP 1995). At least one *D. pulchellus* site is known from these CARL lands (J. Beever, GFC, personal communication 1996). Additional sites are known to exist on about 6,040 ha that are still being considered for acquisition, protection, and management under the CARL program. Areas outside South Florida, in Orange County, should also be assessed for possible acquisition.

If managed properly, all existing public land and lands proposed for public acquisition that contained *D. pulchellus* would probably be sufficient to ensure the persistence of the species. However, management for this species may conflict with other public land uses. For example, *D. pulchellus* occurs on the GFC's Cecil M. Webb WMA under a frequent, low-intensity, winter fire prescription (Martin 1984). Recent changes from a winter to growing-season burning regime have been proposed, but such changes could result in damage to the above-ground vegetation during the flowering period (Beever 1990). Seed destruction over a number of consecutive years could adversely affect recruitment of sufficient seed stock to ensure survival of pawpaws in this area. The use of fire on other public lands that contain *D. pulchellus* appears to be compatible with the needs of this species. However, long-term monitoring of individual pawpaws must be initiated to ensure that existing and proposed land management actions benefit this endangered species.

Though the species may persist for some time on small tracts of publicly held land, many of the remaining individual pawpaws exist on private lands, and as a result are susceptible to habitat degradation and loss associated with land alterations or mismanagement. Protection of additional habitat through fee title acquisition, conservation easements, transfer of development rights, or other mechanisms that ensure perpetual protection are needed to ensure persistence of the species in the wild.

In addition to protection afforded through acquisition of habitat, Lee County protects the pawpaw through a listed species ordinance which requires that adverse effects to state and federally listed species be mitigated (Municipal Code Corporation 1994, Lee County 1996). Currently, one preserve site has been established for mitigation purposes. Unfortunately, the protective ordinances are not applicable to agricultural lands or lands being rezoned for agricultural purposes. Since most of the current threats to *D. pulchellus* in Lee County are from agricultural activities, the conservation of pawpaws cannot be achieved by county ordinances.

In Charlotte County, the Southwest Florida Regional Planning Council and Florida Department of Community Affairs provided on-site preserves for the beautiful pawpaw on a Development of Regional Impact (DRI) for a large subdivision. Unfortunately, *D. pulchellus* occurring in areas where smaller-scale projects and single family homes are constructed have not been protected by the DRI process. In addition, Charlotte County has no ordinances to protect federally or state listed plants at the county level (D. Beter, Charlotte County Division of Community Development, personal communication 1996).

Most known *D. pulchellus* do not occur on protected public lands and are afforded only limited protection by local conservation measures. These measures are insufficient to protect *D. pulchellus* on private land. Additional protection is needed and will most likely have to be accomplished by local municipalities or county governments.

In the absence of sufficient local, state, or federal regulatory protection, we consider the relocation of *D. pulchellus* to be a potentially valuable management tool. To date three pawpaw relocations have been undertaken. None of these efforts have been monitored long enough to determine the success rate of transplanting this species. Initial inspections, up to two years post-transplant, indicate good vegetative regrowth and flowering (K. Passarella, Passarella and Associates, Inc. personal communication 1996, G. Wass de Czege, Southern Biomes, personal communication 1996) and a 40 to 60 percent survival rate (FWS, unpublished data). Transplantation of *D. rugelii* in Volusia County has been successful; however, comparison of mortality, flowering, and seed production may not be possible since these data are not readily available for pawpaw in undisturbed sites. If monitoring indicates that plant relocation is biologically viable, we believe this technique could be used where destruction of plants and permanent alteration of habitat is inevitable. Even if relocation success is not high, this technique may still be preferred to the destruction of plants and habitat. Relocation of pawpaw may be limited by the relatively high cost associated with contracting consultants experienced in relocating this species.

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Recovery for the Beautiful Pawpaw

Deeringothamnus pulchellus Small

Recovery Objective: RECLASSIFY to threatened, then delist.

Recovery Criteria

Deeringothamnus pulchellus may be reclassified from endangered to threatened when: enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years; when these sites, within the historic range of *D. pulchellus*, are adequately protected from further habitat loss, degradation, and fragmentation; when these sites are managed to maintain pine flatwoods to support *D. pulchellus*; and when monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species.

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 *D. pulchellus*.

S1.1. Conduct surveys for *D. pulchellus*.

S1.1.1. Continue surveys in Lee and Charlotte counties. Though the range of this species has been thoroughly surveyed, current survey work is needed. An accurate survey of all suitable habitat would maximize the possibilities for protection, by enabling agency personnel to work with individual land-owners as projects are proposed.

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 Florida Natural Areas Inventory database.

- S2. Protect and enhance existing populations.** Much of the native pine flatwood community in Florida has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats.
- S2.1. Acquire or otherwise protect habitat through acquisition, conservation easements, or agreements with landowners.**
- S2.2. Protect populations on public lands.** Develop management guidelines that allow for a fire regime that includes a mosaic of successional 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 habitat occupied habitat of *D. pulchellus*. Protecting this species on private property in Lee County is possible due to county ordinances that require conservation of listed plants.
- S2.4. 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 *D. pulchellus* lives.
- S2.4.1. Initiate section 7 consultation when applicable.** Initiate section 7 consultations when Federal activities may affect this species.
- S2.4.2. Enforce take and trade prohibitions.** This species is protected by take provisions of the Endangered Species Act (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.
- S2.5. Develop an *ex situ* collection.** *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 *D. pulchellus*. Since longterm seed storage seems impossible for this species, cultivated populations are very important. Although *D. pulchellus* is not easily grown from cuttings, young plants should be kept for study and reintroduction material.
- S2.6. Augment natural populations of *D. pulchellus*.**
- S2.6.1. Establish a protocol for reintroduction.** Records for source plants, techniques for establishing new populations, and protocols for monitoring are needed.
- S2.6.2. Locate potential (re)introduction sites.** Survey habitat within the historic range of *D. pulchellus* and identify protected lands, both public and private, that will be suitable habitat.
- S2.6.3. (Re)introduce plants to protected sites.** Use plants under cultivation to (re)establish plants in suitable habitat.
- S3. Conduct research on life history characteristics of *D. pulchellus*.** To effectively recover this species more specific biological information is needed.

- S3.1. Conduct research to determine demographic information, such as numbers of sites and populations, numbers of individuals in a population, recruitment, dispersal, growth, survival, and mortality.** Observations of the relation of flowering to fire, pollination, seed production, and seedling biology will help to guide reintroduction efforts.
- S3.2. Once demographic data are known, conduct population viability and risk assessment analysis to determine the numbers of plants, sites, subpopulations/populations, and spatial distribution needed to ensure persistence of the species.**
- S3.3. Conduct research to assess management requirements of *D. pulchellus*.** Determine which natural populations can be stabilized or 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 and close coordination among land managers is essential to develop adaptive management techniques.
- S3.4. Assess feasibility of relocating *D. pulchellus*.** Removing plants threatened with destruction may be the only conservation strategy available in some situations. Information on transplant techniques and plant survival are needed to assess whether transplanting should be pursued.
- S4. Monitor existing populations of *D. pulchellus*.**
- S4.1. Develop monitoring protocol to assess population trends for *D. pulchellus*.**
- S4.1.1. Monitor to detect changes in demographic characteristics, such as reproduction, recruitment, growth, dispersal, survival, and mortality.** Also monitor for pollinators, herbivory, disease, and injury.
- S4.1.2. Monitor the effects of various land management actions on *D. pulchellus*.** Assess any changes in demographic characteristics of *D. pulchellus* in response to land management activities, such as prescribed fire, exotic plant control.-.
- S4.2. Develop a quantitative description of the population structure of *D. pulchellus*.** This description will provide a baseline for monitoring population dynamics in response to natural environmental changes and management treatments. Data recorded should include morphology, survivorship, mortality, and reproduction for individual plants. Data about each plant's microsite (vegetation cover, litter depth, substrate, and closest neighbors) may prove helpful in future management.
- S4.3 Monitor reintroduced 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, seed production, germination rates, seed survival, seedling survival, and growth rates between transplanted plants and natural plants. Where monitoring indicates that the introduction has been unsuccessful, reevaluate protocol and methodology.
- S5. Provide public information about *D. pulchellus*.** 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 *D. pulchellus* and other rare species requires a self-sustaining, secure, number of natural populations.

- S6. Establish delisting criteria.** Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria.

Habitat-level Recovery Actions

- H1. Prevent degradation of existing habitat.** Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Urbanization, fire suppression, and agricultural land uses have decreased the available habitat.
- H1.1. Secure habitat through acquisition, landowner agreements, and conservation easements.** With so little undisturbed pine flatwoods habitat left, any method of securing protected populations should be sought.
- H1.2. Manage and enhance habitat.** Manage habitat to maintain *D. pulchellus* populations by preventing damage from off-road vehicle use and overcollection, 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 pine flatwood 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. Pine flatwoods are naturally made up of islands of suitable and unsuitable habitat. To repeat this landscape pattern, sites should be burned as a mosaic when possible to allow for variation. *D. pulchellus* appears to benefit from burning at the short intervals of a natural pine flatwood community.
- 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. However, in isolated areas, exotic species are becoming established. Without control, exotic/invasive plants may become a threat to the survival and recovery of *D. pulchellus*.
- H1.2.3. Control access** to areas where listed plants are growing. Trampling and off-road vehicles can severely threaten individual populations. Fencing may be needed for some sites, and clearing around individual *D. pulchellus* plants has been suggested.
- 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. Continue habitat-level research projects.** Study the response of *D. pulchellus* 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, mechanical disturbance, *etc.*, on the habitats where *D. pulchellus* occurs.
- H5. Provide public information about pine flatwood vegetative communities and their unique biota.** Educational efforts, especially those conducted by private conservation organizations, have been successful in providing important information about pine flatwood plant communities to the public. The State's system of biological preserves depends for its funding and future success on a broad base of public understanding and support. In addition to past and ongoing educational efforts by The Nature Conservancy, Bok Tower Gardens, and Archbold Biological Station, future efforts by these organizations, the Florida Park Service, the Florida Native Plant Society and local garden clubs will play crucial roles in increasing public appreciation of pine flatwood plant communities and *D. pulchellus*.

