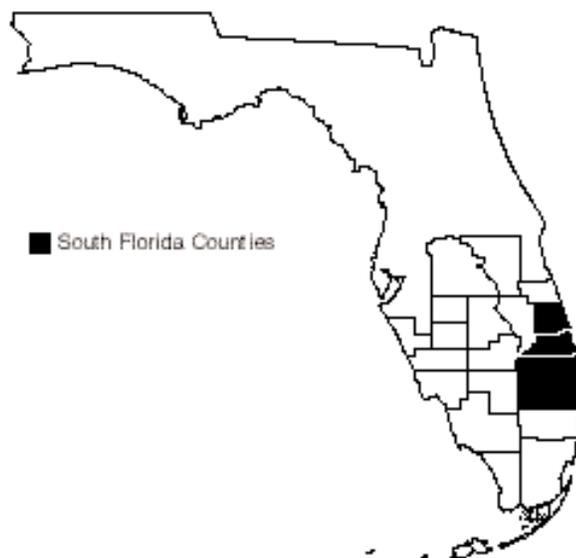

Four-petal Pawpaw

Asimina tetramera 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 four-petal pawpaw.



Asimina tetramera, the four-petal pawpaw, is an aromatic shrub belonging to the Annonaceae or custard apple family. This pawpaw is found in coastal sand pine scrub habitats in Martin and Palm Beach counties in southeast Florida. Much of the sand pine scrub habitat has been destroyed and converted for residential housing and commercial activities. This declining species continues to be threatened by further loss of habitat.

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

Description

Asimina tetramera is a 1 to 3 m tall aromatic shrub that has one to several stems arising from a deep taproot. Leaves are oblong to oblanceolate, 5 to 10 cm long, arranged alternately on the stem, and are yellow-green to deep green. The leaves are narrow at the base (A. Cox, Florida International University, personal communication 1995), have broadly acute or blunt tips, and lack stipules.

The flowers are maroon and fetid. They occur singly in the leaf axil; however, if the plant is burned or damaged, two or three flowers may develop. Perianth parts are typically in whorls of three, but may vary. The petals usually form whorls. The stamens are spirally arranged on an elevated torus or ball-shaped receptacle, surrounding one to many separate carpels. After fertilization, the receptacle expands as fruit develops.

The fruit is an aggregate of developing carpels, or monocarps, on the expanding receptacle. The monocarps are indehiscent and berry-like. An individual flower may produce from one to eight monocarps with one to nine seeds each (A. Cox, Florida International University, personal communication 1995). The fruit are oblong and greenish-yellow, emitting a banana-like aroma when ripe (A. Cox, Florida International University, personal communication 1995). The laterally flattened seeds are dark brown and shiny (Austin and Tatje 1979, Kral 1983).

Many flowers of *A. tetramera* are four-merous, with sepals, inner petals and outer petals arranged in groups of four (Kral 1960). Some flowers may have a combination of three- and four-merous parts. Four-merous flowers are more common on *A. tetramera* than on the other *Asimina*.

Taxonomy

The four-petal pawpaw was discovered at Rio, Florida, in 1924 and subsequently named *Pityothamnus tetramerus* (Small 1926, 1933). However, the new genus was rejected by other taxonomists (Kral 1960). According to Kral (1960), *Asimina tetramera* is grouped with *A. pygmaea*, *A. longifolia*, and *A. nashii*. These species have several common characteristics, including flower development on new growth, sparsely and omentulose young shoots, and glabrous petioles, peduncles and leaf surfaces.

Kral (1960) concluded *A. tetramera* more closely related to *A. pygmaea* than to the other *Asimina* species based on floral similarities. Both species have strongly recurved inner petals, are maroon, have a pungent aroma and flower between April and July. However, several differences separate these two species: the gynoecium of *A. tetramera* is larger than *A. pygmaea*, adult plants of *A. tetramera* are larger than adult plants of *A. pygmaea*, and *A. tetramera* is limited to sand pine scrub ridges in Martin and Palm Beach counties, while *A. pygmaea* occurs in mesic slash pine or long leaf pine habitats and savannas.

Distribution

Historically, *A. tetramera* occurred in sand pine scrub habitat on the coastal dune system in Martin and northern Palm Beach counties (Kral 1960). Most of the suitable habitat in the historic range of this species has been destroyed or converted. At present, the species is only found north of Palm Beach Gardens (A. Cox, Florida International University, personal communication 1996a) to the Savannas State Reserve in Martin County and in a few locations in northern St. Lucie County (Figure 1).

Habitat

Asimina tetramera is found only in sand pine scrub vegetation on old, coastal dunes (Austin and Tatje 1979). The species grows in excessively-drained, quartz sand of both the Paola and the St. Lucie soil series (Austin *et al.* 1980; A. Cox, Florida International University, personal communication 1995); however, it shows a preference for the Paola soils (Farnsworth, 1988).

Asimina tetramera is found in various seral stages of sand pine scrub, ranging from open [no canopy] to mature [closed canopy] (A. Cox, Florida International University, personal communication 1997). *A. tetramera* is adapted to infrequent, intense fires, perhaps every 20 to 80 years (FWS 1988). Abundant flowering and fruitset occur in years following fire and diminish with maturation of the community and subsequent canopy closure (A. Cox, Florida International University, personal communication 1996b).

Four-petal pawpaw.

Original drawing by Ann Murray; original flower photograph by Steve Shirah.

**Reproduction**

Reproduction in *A. tetramera* is sexual. The perfect flowers open before all the parts are fully developed, and mature from the base of the stem toward the developing tip. They are protogynous, meaning that the stigmatic surface becomes receptive before anther maturation and pollen release. The petals fall from the flowers within one day of pollen release, and carpel development and receptacle enlargement follow successful pollination and fertilization. Flowers that are not pollinated fall soon after pollen release (A. Cox, Florida International University, personal communication 1995).

Beetles are the most likely pollinators, although Dipterans (flies), Hymenopterans (wasps), and other insects have been observed visiting flowers. Gopher tortoises (*Gopherus polyphemus*), and small mammals such as the Florida mouse (*Peromyscus floridanus*) (Jones 1989) eat the fleshy fruit and may disperse seeds. Ingestion by animals is not necessary for seed germination (A. Cox, Florida International University, personal communication 1998).

Asimina tetramera seeds germinate from September to March. Old, stored, or dried seeds will not germinate (FWS 1988, A. Cox, Florida International University, personal communication 1995). Germination may take from 1 to 8 months after the seed is planted. The root system establishes several months before shoot emergence, and two to seven leaves are produced the first year (A. Cox, Florida International University, personal communication 1996b).

Asimina tetramera plants are deciduous, or partly so, with new leaves emerging in April and continuing to develop into summer. Buds are borne in the axils of the leaves as shoots develop. Flowers occur on new growth, and flower maturation proceeds from the base of the shoot toward the tip. Damaged stems sprout, producing new growth and may flower as late as September (A. Cox, Florida International University, personal communication 1995). Flowering peaks in April and May, and continues throughout the summer, with fruit ripening in 2 to 3 months (A. Cox, Florida International University, personal communication 1995).

Relationship to Other Species

The four-petal pawpaw occurs with sand pine (*Pinus clausa*) and scrub oaks (*Quercus myrtifolia*, *Q. geminata*, *Q. chapmanii*), which may shade *A. tetramera* in areas where fire has been excluded. However, *A. tetramera* is not extirpated by shading but the internodes elongate, the leaves become larger, and flowering is reduced. *Asimina tetramera* is found in association with rosemary (*Ceratiola ericoides*), saw palmetto (*Serenoa repens*), wax myrtle (*Myrica cerifera*), shiny blueberry (*Vaccinium myrsinites*), and other scrub species (Austin and Tatje 1979).

Female zebra swallowtail butterflies (*Eurytides marcellus*) lay their eggs on new growth of *Asimina* species. Developing larvae eat the leaves and flowers and may damage developing shoots (Damman 1987, 1989). The damage may encourage new growth throughout the summer and extend the breeding season of the butterflies (A. Cox, Florida International University, personal communication 1996a).

A shelf fungus (*Phylloporia frutica*) invades *A. tetramera* at sites of injury close to the ground and the fruiting bodies appear at branch junctions of the plant. Field observations indicate this does not kill the pawpaw, since new shoot growth frequently occurs below the fruiting body. However, plants with fungus may have reduced flowering and fruit set (A. Cox, Florida International University, personal communication 1995).

Status and Trends

Asimina tetramera was listed as endangered because the majority of its habitat has been lost to urban development (51 FR 34419). It now exists in fragmented populations within the historic range. Continued urban expansion is eradicating those few plants still left on unprotected private lands (FWS 1988).

Early surveys of *A. tetramera* placed the population at approximately 100 individuals (Austin and Tatje 1979). However, a 1988 Florida Natural Areas Inventory (FNAI) survey found *A. tetramera* on 16 sites in Palm Beach and Martin counties and located between 800 to 900 individual shrubs (Farnsworth 1988). The additional shrubs found in the survey do not represent a population increase, they were additional populations that were not previously located (A. Cox, Florida International University, personal communication 1996a). More recent survey efforts on two protected parcels in Palm Beach County located additional plants after prescribed fire had thinned vegetation and provided greater access to likely *A. tetramera* habitat (S. Farnsworth, Palm Beach County Department of Environmental Resource Management, personal

communication 1998) . The population is believed to be declining (FWS 1990), although this will need to be verified by additional surveys and monitoring (A. Cox, Florida International University, personal communication 1996b).

Most *A. tetramera* populations currently exist on protected sites. In Martin County these include Jonathan Dickinson SP and Savannas State Reserve. In Palm Beach County *A. tetramera* is found in Carlin Park, Juno Beach Park, a proposed (unnamed) park, Juno Hills and Jupiter Ridge natural areas, BLM's Jupiter Inlet tract, and the Florida Power and Light headquarters office grounds. Although there many of the known localities for this species are protected, the species may not be adequately preserved in the northern part of its range, as only four plants in this region lie on protected land.

Of the protected areas, Jonathan Dickinson SP is the largest site in Martin County, with 220 plants. The proposed park with 224 plants is the largest site in Palm Beach County (A. Cox, Florida International University, personal communication 1996a).

Management

Individuals of *A. tetramera* plants appear to be long-lived and are not affected by occasional freezes. Above-ground growth is lost periodically to fire, and other natural conditions; however, the plants resprout from the rootcrown just below ground (Kral 1960). In addition, the new stems produce flowers and fruits more vigorously than older stems. The optimum frequency of fire has not been determined (Austin *et al.* 1980, FWS 1988, Kral 1983).

Maintaining the coastal scrub habitats that support *A. tetramera* is essential to its survival. Research is in progress at Jonathan Dickinson SP to determine the response of *A. tetramera* to prescribed fire and alternative methods of management, such as chopping and biomass removal (A. Cox, Florida International University, personal communication 1996b). This research may yield information relating to the fire frequency, alternatives to fire, and the reproductive responses of *A. tetramera* to these management applications. Research is also in progress to determine the population trend of this species (A. Cox, Florida International University, personal communication 1996b).

At present, sites in Palm Beach and Martin counties in private ownership could be destroyed. Several sites in Martin County should be purchased, especially a large site in Jensen Beach. If these lands were acquired, *A. tetramera* populations would then be preserved in the northern, central and southern portions of the existing range.

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Recovery for the Four-petal Pawpaw

Asimina tetramera Small

Recovery Objective: RECLASSIFY to threatened.

Recovery Criteria

Asimina tetramera 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 sites within the historic range of *A. tetramera* are adequately protected from further habitat loss, degradation, and fragmentation; when these sites are managed to maintain the coastal sand pine scrub communities to support *A. tetramera*; 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 periodically 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 *A. tetramera*.** Some portions of *A. tetramera*'s range have been well surveyed yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species.
 - S1.1. Conduct surveys for additional populations of *A. tetramera*.**
 - S1.1.1. Continue surveys in Palm Beach and Martin counties.** Although the range of this species has been surveyed, sites may still be located that have *A. tetramera* populations.
 - 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 with the Florida Natural Areas Inventory to update their database.

- S2. Protect and enhance existing populations.** Much of the native xeric uplands on the Atlantic Coastal Ridge 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 privately-owned habitat through acquisition, conservation easements, or agreements with landowners.**
 - S2.2. Protect populations of *A. tetramera* 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 occupied habitat of *A. tetramera*.
 - S2.4. Continue *ex situ* conservation.** *Ex situ* collecting can preserve genetic diversity, preventing loss of the species, and determine ecological characteristics and habitat management needs. These collections will be instrumental in the recovery of *A. tetramera*. Since long-term seed storage is impossible for this species, cultivated populations are very important. *Asimina tetramera* is easily grown from seed, but cannot be grown from cuttings. Seeds should be periodically planted to maintain populations for study and to be used as seed sources for reintroduction.
 - S2.5. 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 *A. tetramera* occurs.
 - S2.5.1. Initiate section 7 consultation when applicable.** Initiate section 7 consultations when Federal activities may affect this species.
 - S2.5.2. 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.
 - S2.6. Augment natural populations of *A. tetramera*.** Augmentation of populations on protected land is appropriate because there is little prospect for protecting additional sites.
 - 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 *A. tetramera* and identify protected lands, both public and private, that will be suitable for (re)introduction.
 - S2.6.3. (Re)introduce plants to protected sites.** Plant seeds from nearby stable populations to re-establish plants in suitable habitat.

- S3. Continue research on life history characteristics of *A. tetramera*.** To effectively recover this species more specific biological information is needed.
- S3.1. Continue 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 relationship of flowering to fire, pollination, seed production, and seedling biology will help to guide reintroduction efforts.
- S3.2. Once demographic data are known, conduct a population viability and risk assessment analysis** to determine the number of plants, sites, subpopulations/populations, and spatial distribution needed to ensure persistence of the species.
- S3.3. Conduct research to assess management requirements of *A. tetramera*.** Determine which natural populations can be stabilized or increased by habitat management. Surveys, research, and monitoring will provide information contributing to a better understanding of population increases or declines for each site. Population monitoring should be in relation to various habitat management practices. Site-specific management guidelines should be provided to land managers. Close coordination among land managers is essential to develop appropriate management techniques.
- S3.4. Assess feasibility of relocating *A. tetramera*.** Removing plants threatened with destruction has only been marginally successful. Information on transplant techniques and plant survival is needed to assess whether transplanting should be pursued in the future. Seeds should be collected from reproductive plants and planted on reintroduction sites.
- S4. Monitor existing populations of *A. tetramera*.**
- S4.1. Develop monitoring protocol to assess population trends for *A. tetramera*.**
- 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 *A. tetramera*.** Assess any changes in demographic characteristics of *A. tetramera* in response to land management activities, such as prescribed fire, exotic plant control, *etc.*
- S4.2. Develop a quantitative description of the population structure of *A. tetramera*.** 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 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, 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 *A. tetramera*.** 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 *A. tetramera* and other rare species requires self-sustaining, secure, natural populations in existing native scrub habitat.

- 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. Both urbanization and fire suppression have decreased the available habitat. To date, there are two protected sites in Martin County and eight protected sites in Palm Beach 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 *A. tetramera* populations by preventing damage by off-road vehicle use, prohibiting seed collection, and providing proper management of habitat, including prescribed fire.

H1.2.1. Conduct prescribed burns. Fire is a necessary and an 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 is necessary to construct a natural fire landscape. The scrub is naturally made up of a heterogeneous matrix of suitable and unsuitable habitat. To repeat this landscape pattern, sites should be burned as a mosaic when possible. *A. tetramera* appears to benefit from burning at irregular intervals of several decades or more.

H1.2.2. Control and eliminate exotic and invasive plants and animals. Exotic plant and animal species are not major threats in sand pine scrub 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 *A. tetramera*.

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 *A. tetramera* 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 and too frequent fires may shift the species composition and alter the structure of scrub habitats. 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 seed banks may exist that could include other 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. On these sites, seed banks may exist for other rare endemic species, but if fire has been excluded for too long or applied too often, seed banks may not be present. Although *Asimina tetramera* does not have a seed bank, areas of unburned vegetation may provide refugia for *A. tetramera* seed dispersal by small animals.
- H3. Continue habitat-level research projects.** A current study at Jonathan Dickinson State Park is looking at the response of *A. tetramera* to various land management practices, such as prescribed fire regimes, mechanical chopping, and biomass removal. Researchers are hoping to provide answers to optimal disturbance interval, under conditions which mechanical alternatives will work, and the reproductive responses of *A. tetramera* to management applications.
- H4. Monitor habitat/ecological processes.** Monitor the effects of land management actions, such as prescribed fire, mechanical disturbance, *etc.*, on the habitats where *A. tetramera* occurs.
- H5. Provide public information about xeric vegetative communities and their unique biota.** Educational efforts, especially those conducted by private conservation organizations, have been successful in providing important information about xeric plant communities to the public. The State'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 others such as the Florida Park Service, the Florida Native Plant Society, and local garden clubs play crucial roles in increasing public appreciation of xeric plant communities and *A. tetramera*.

