
Four-petal Pawpaw

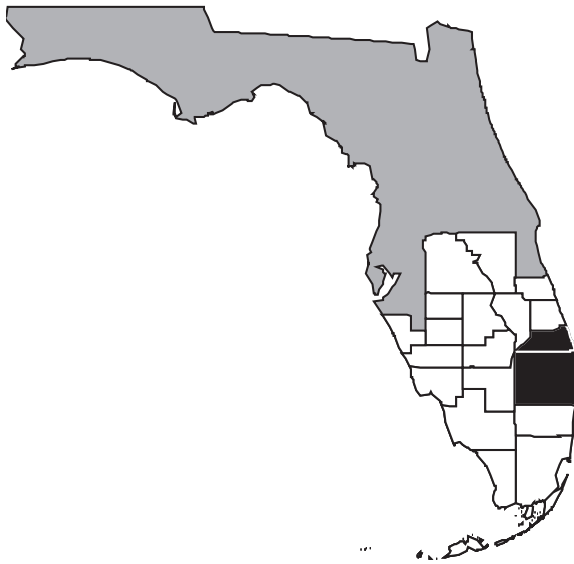
Asimina tetramera Small

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| Federal Status: | Endangered (September 1986) |
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| Critical Habitat: | None Designated |
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| Florida Status: | Endangered |
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Figure 1. Florida distribution of the four-petal pawpaw



A *simina 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 and scrub oak habitats in southeast Florida, which have been destroyed and converted for residential housing and commercial activities. This declining species continues to be threatened by further loss of its habitat.

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

Description

Asimina tetramera is a 1-3 m tall, aromatic shrub, that has one to several stems arising from a deep taproot. Its oblong or oblanceolate leaves are arranged alternately, 5-10 cm long, and are yellow green to deep green with a lighter underside. 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 or in pairs in the leaf axils and have varying numbers of perianth parts. 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

J.K. Small discovered the four-petal pawpaw at Rio, Florida, in 1924 (World Wildlife Fund 1990). He named the species *Pityothamnus tetramerus* (Small 1933); however, Small's 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 emergence of the flowers with the present season's leaves, presence of flowers on the axillary to the leaves of new growth, and the glabrous to sparsely hairy shoots, petioles, lower leaf surfaces and peduncles on new growth.

Further, Kral (1960) contends that based on floral similarity, it is possible that *A. tetramera* is more closely related to *A. pygmaea* than to the other *Asimina* species. Both species have strongly recurved inner petals, are maroon in color, 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 more 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 (World Wildlife Fund 1990) (Figure 1). 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 (FWS 1988).

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). Although not easily located, *A. tetramera* occurs in scrub oak thickets (A. Cox, Florida International University, personal communication 1996b). *A. tetramera* is

adapted to infrequent, intense fires, perhaps every 20-80 years (FWS 1988). Abundant flowering and fruitset occur in years following fire and diminish with maturation of the community (A. Cox, Florida International University, personal communication 1996b).

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*), Florida scrub jay (*Aphelocoma coerulescens coerulescens*), and small mammals such as the Florida mouse (*Podomys floridanus*) (Jones 1989) eat the fleshy fruit and may disperse seeds. It is not known whether ingestion by these, or other, species is necessary for seed germination.

Asimina tetramera seeds germinate from September to March. The endosperm of *A. tetramera* is oily and seeds must be removed from fresh fruit in order to germinate (World Wildlife Fund 1990). Old, stored, or dried out seeds will not germinate successfully (FWS 1988; A. Cox, Florida International University, personal communication 1995). Germination may take from one to eight months after the seed is planted. The root system is established 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 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 shoots may continue growth and flowering as late as September (A. Cox, Florida International University, personal communication 1995). Flowering peaks in April and May, and may continue throughout the summer, with fruit ripening in 2-3 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 oak (*Quercus spp.*), which may shade *A. tetramera* in areas where fire has been excluded (World Wildlife Fund 1990). *A. tetramera* is not, however, extirpated by the shading from these other species: when an individual tree is shaded, its internodes elongate, its leaves become larger, and flowering is reduced. *A. tetramera* is sometimes found in association with other scrub oaks (*Quercus*

myrtifolia, *Q. geminata*, *Q. chapmanii*), rosemary (*Ceratiola ericoides*), saw palmetto (*Serenoa repens*), bayberry (*Myrica cerifera*), shiny blueberry (*Vaccinium myrsinites*), and other scrub species (Austin and Tatje 1979; A. Cox, Florida International University, personal communication 1995).

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

The shelf fungus (*Phylloporia frutica*) invades *A. tetramera* at sites of injury (usually close to or below ground). The fungi's 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 expansion (51 FR 34419). It now exists in fragmented populations within its historic range. Continued urban expansion is eradicating those few plants still left on unprotected private lands (FWS 1988).

Earlier 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; this survey found 800 to 900 individual trees (Farnsworth 1988). Unfortunately, the additional trees found in the latter survey may not represent an actual population increase; it probably reflects additional populations that had not been located in the earlier survey (A. Cox, Florida International University, personal communication 1996a). 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, including Jonathan Dickinson SP, Savannas State Reserve, Carlin Park, a proposed park (yet unnamed) in Martin County, three Palm Beach County acquisition sites, BLM's Jupiter Inlet tract, and the Florida Power and Light headquarters office grounds in Palm Beach County. Although there are many protected sites, 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 Dickenson SP is the largest site in Martin County, with 140 plants. The proposed park contains 224 plants, the largest site in Palm Beach County (A. Cox, Florida International University, personal communication 1996a).

Management

Individuals of *A. tetramera* appear to be long-lived and do not seem to be affected by occasional freezes. The plant's above-ground growth is lost periodically to fire, and other natural conditions, however, the plant resprouts quickly from the rootstock (Kral 1983). In addition, the new stems produce flowers and fruits more vigorously than older stems. A substitute for fire may be artificial disturbance which removes the above-ground portion of the plants but leaves the roots unharmed. However, the optimum frequency of fire or artificial disturbance 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 Dickenson 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). Results of this research may provide answers to: the frequency at which managed disturbances should occur; how, where, and under what conditions mechanical alternatives to fire will work; and the reproductive responses of *A. tetramera* to these management applications. Research is 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 that are 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, populations would then be preserved in the northern, central and southern portions of *A. tetramera*'s existing range.

Literature Cited

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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 assure 20-90 percent probability of persistence for 100 years; when these 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 oak 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 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 *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 thoroughly surveyed., sites may still be unfound for *A. tetramera*.

S1.1.3. 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 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.** Preserving genetic diversity, preventing loss of the species, and determining ecological characteristics and habitat management needs are important information needs that can be obtained from *ex situ* collections. These collections will be instrumental in the recovery of *A. tetramera*. Since longterm seed storage seems impossible for this species, cultivated populations are very important. *A. tetramera* is easily grown from cuttings and can be kept as young plants for study and for reintroduction material.
- S2.5. Enforce available protective measures.** Use local, state and federal regulations to protect this species from over collecting and damage from off-road vehicle use. Regulations should also be used to protect xeric vegetative communities where *A. tetramera* lives.
- 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 trade 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, 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 habitat.
- S2.6.3. (Re)introduce plants to protected sites.** Use plants under cultivation 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 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 *A. tetramera*.** Determine which natural populations can be stabilized or increased by habitat management. Surveys, research, and monitoring on the information on the localities of *A. tetramera* sites, and 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 *A. tetramera*.** 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 *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 land owners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where *A. tetramera* is found.
- 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 require 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. Both urbanization and fire suppression have decreased the available habitat. To date, there are four protected and four acquisition sites for *A. tetramera* in Palm Beach and Martin counties.
- 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 habitat damage by off-road vehicle use, over collection, and provide proper management of habitat including prescribed fire.
- H1.2.1. Perform prescribed fires.** 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 to allow for variation. *A. tetramera* appears to benefit from burning at irregular intervals of a decade or more.
- 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. 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 and mulching 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 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.** 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 what conditions 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 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 play crucial roles in increasing public appreciation of xeric plant communities and *A. tetramera*.

