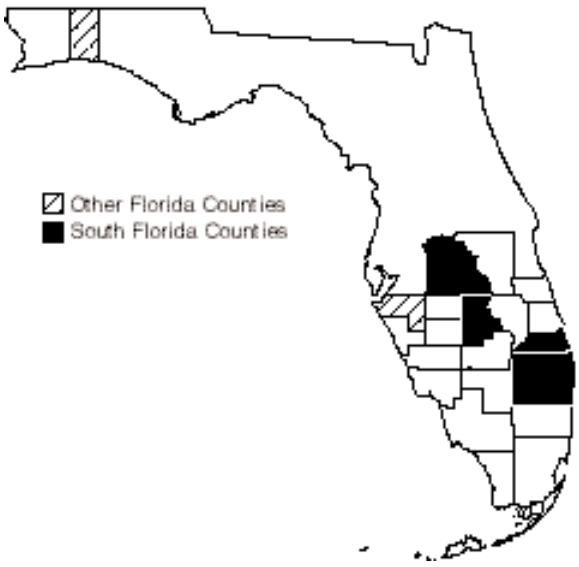
Florida Perforate Cladonia

Cladonia perforata Evans

Federal Status:	**Endangered (April 27, 1993)**
Critical Habitat:	**None Designated**
Florida Status:	**Threatened**
Recovery Plan Status:	**Revision (May 18, 1999)**
Geographic Coverage:	**Rangewide**

Figure 1. County distribution of Florida perforate cladonia.



Cladonia perforata is a member of the family Cladoniaceae, commonly called the reindeer lichens. Unlike the more common and widely distributed species of the Cladoniaceae with which it occurs, *C. perforata* is restricted to the high, well-drained sands of rosemary scrub in Florida. *Cladonia perforata* was listed as endangered because of the significant loss of scrub habitat in Florida. This species is known to occur on approximately 27 sites in Florida; all but two sites are in the South Florida Ecosystem. Sixteen of the sites are protected, and others are proposed for acquisition in the future.

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

Description

Cladonia perforata is easily recognized in the field by the conspicuous holes or perforations below each dichotomous branch point and its wide, smooth, yellowish gray-green branches.

Unlike other fruticose lichens whose branches develop from the primary or vegetative body, the branches of members of *Cladonia* and *Cladina* are developmentally derived from spore-producing structures called apothecia, present as colored, expanded tips of fertile branches. These specialized, hollow branches are called podetia and are structurally characteristic of this group. *Cladonia perforata* differs from other fruticose terrestrial Cladoniaceae in several podetial characters, including color, shape and texture, in addition to having specific habitat requirements. *Cladonia perforata* has rather wide (up to 6 mm), pale yellowish gray-green podetia, punctuated in the axils by 1 to 1.5 mm perforations. The branching pattern is complex and consists of roughly subequal dichotomies near the tips and, more commonly, sympodia (unequal branchings with the smaller branch deflected to one side) below (Evans 1952), resulting in a more-or-less compressed tuft. Its outer surface is mostly uniformly smooth. Individual podetia are

typically 4 to 6 cm long (Evans 1952), although specimens of up to 8 cm across and several cm high have been observed (R. Yahr, Archbold Biological Station, personal communication 1995). No primary thallus is known. The oldest parts of the podetia degenerate, leaving no means of determining ages. No studies of growth rates in *C. perforata* have been completed. In boreal areas, growth studies of *Cladonia* species suggest that one branching occurs each year (Thomson 1967); however, in more tropical areas, more than one branching per year may be possible. *Cladonia perforata* is suspected to reproduce only by vegetative fragmentation; no spore-producing organs (apothecia) have been described (Thomson 1967).

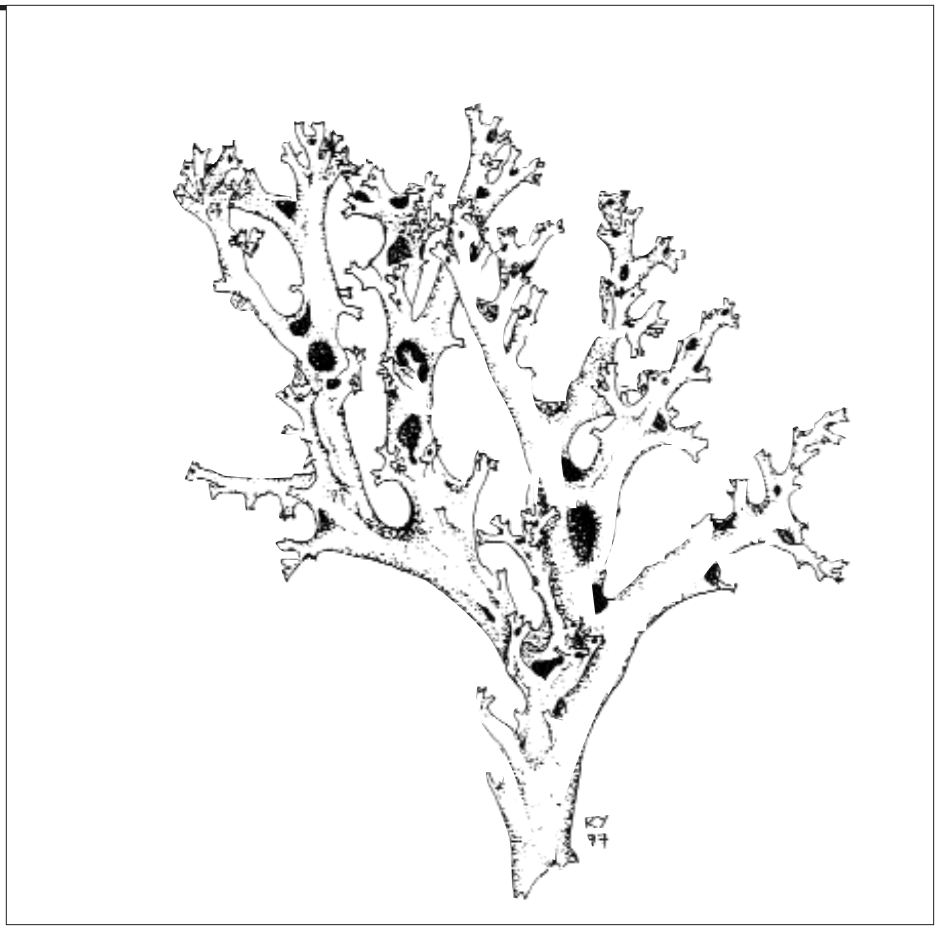
Cladonia uncialis is a closely related and similar-looking species, although its occurrence in Florida is disputed by Moore (1968). Its podetia are wide and perforate, though not at every dichotomy, and are glossy with greenish areolae (Evans 1952). The other fruticose, terrestrial species of *Cladonia* and *Cladina* which commonly co-occur with *C. perforata* can easily be distinguished from it. Although *Cladonia leporina* may sometimes have small perforations in the podetia and is occasionally confused with *C. perforata*, *C. leporina* is a darker yellow-green color, has narrower podetia with rough surfaces and can often be found with conspicuous red apothecia. *Cladonia pachycladodes* is similar in color to *C. perforata* but is more of a light bluish-grey color and has finer branches, drooping at the tips. *Cladonia subsetacea, Cladina evansii*, and *Cladina subtenuis* all have much narrower, filiform podetia, usually less than 1mm wide.

Taxonomy

The Cladoniaceae is represented in Florida by the two large, widespread, and closely related genera *Cladonia* and *Cladina*. Moore (1968) considers this conspicuous and diverse group to be one of the most important in the Florida lichen flora, represented by a total of 33 species, three of which are endemic to the state. George Llano first collected *C. perforata* Evans in 1945 from Santa Rosa Island, Florida, and in 1952, Alexander Evans described the species from this type (Buckley and Hendrickson 1988). Both Llano's and Evans' collections of *C. perforata* were purportedly from Escambia County, but Wilhelm and Burkhalter (1990) determined the actual locality to be in Okaloosa County. No other names have been applied to the species.

Distribution

In northern biomes such as boreal forests and the tundra, members of *Cladonia* and *Cladina* form continuous mats which cover the ground and provide important forage for caribou and reindeer. In temperate and subtropical regions, open rock outcrops or patches of bare ground or sand provide habitat for reindeer lichens (Thomson, 1967). Florida scrub, which is characterized in part by persistent, open patches of sand, supports a relatively rich assemblage of these terrestrial lichens. Up to eight species of reindeer lichens commonly occur in Florida scrub. *C. perforata* is the most unique member of the scrub-lichen community, by virtue of its restricted and unusual disjunct distribution and overall global rarity.



Florida perforate cladonia. *Original drawing by Rebecca Yahr.*

In 1991, the Florida Natural Areas Inventory surveyed 111 sites throughout central and coastal Florida to determine the status of *C. perforata*. A total of only 12 sites were located, six of which were at Archbold Biological Station (FWS 1993). Two additional sites were later located at Archbold Biological Station (R. Yahr, Archbold Biological Station, personal communication 1995). With one Eglin Air Force Base site in Okaloosa County, and several other more recently discovered south-central and coastal Florida locations, approximately 27 sites for *C. perforata* are currently known from four disjunct geographic regions; the counties within these regions are shown in Figure 1. The farthest and most disjunct region, supporting the only remaining North Florida site, is defined by Santa Rosa Island in Okaloosa County. This region is about 644 km northwest of the next closest region. Central Florida's Lake Wales Ridge supports the bulk of the known sites for *C. perforata*. South-coastal Martin and Palm Beach counties support three sites, and southwest Florida's Manatee County has one disjunct site for this lichen (K. DeLaney, Environmental Research Consultants, Inc., personal communication 1995).

The type locality, which was reported from Escambia County on the west side of Santa Rosa Island, was likely reported in error according to Wilhelm and Burkhalter (1990), who rediscovered *C. perforata* on the eastern end of

the island. The western part of the island has scrub that should be surveyed. The current patchy distribution of *C. perforata*, represented by the fragmented scrubs on high white-sand ridges of central Florida may reflect all or only part of its historic range.

Habitat

Several of the fruticose, terrestrial *Cladonia* and *Cladina* species form a conspicuous and characteristic part of Florida's white sand scrub communities (Moore 1968). Typical habitat for *C. perforata* is found on the high sand dune ridges of Florida's peninsula, including the Atlantic Coastal and the Lake Wales Ridges. In these areas *C. perforata* is restricted to the highest, xeric white sands in sand pine scrub, typically in the rosemary phase (Abrahamson *et al*. 1984). Such rosemary scrubs, frequently referred to as "rosemary balds," are particularly well-drained and structurally open. Specific aspects of *C. perforata* microhabitat require further investigation and, presently, can only be roughly generalized with the following associated plant species: scrub oaks (*Quercus inopina, Q. geminata, Q. myrtifolia*), which are clumped and scattered throughout, sand pine (*Pinus clausa*), which dominates the tree-layer (although the canopy may be sparse or absent), and Florida rosemary (*Ceratiola ericoides*), which dominates the shrub layer. *Cladonia perforata* typically occurs in open patches of sand between shrubs in areas with sparse or no herbaceous cover.

In Highlands and Polk counties on the Lake Wales Ridge, *C. perforata* occurs at relatively higher elevations than surrounding areas, on excessively well-drained, nutrient-poor, white sands of the St. Lucie series, with pH ranging from 5.0 to 6.0 (Buckley and Hendrickson 1988, R. Yahr, personal communication 1995). At Archbold Biological Station, *C. perforata* occurs in the most xeric microsites even within rosemary scrub (E. Menges, Archbold Biological Station, personal communication 1995). A small site in xeric scrubby flatwoods on Lake Wales Ridge SF (formerly Lake Arbuckle SF) was recently discovered (R. Yahr, Archbold Biological Station, personal communication 1998). Other Lake Wales Ridge SF sites are on open rosemary scrubs or under dense sand pine in rosemary scrub. In the coastal scrubs of Jonathan Dickinson State Park in Martin County, *C. perforata* is reported from open areas in oak-dominated sand pine scrub and scrubby flatwoods. The Okaloosa County sites are on undifferentiated coastal beach sands in white-sand scrub; *C. perforata* was collected from an Okaloosa County site dominated by rosemary and "downslope into margins of gallberry swales" *(Johnson and Blythe 1986; collection deposited at Archbold Biological Station*).

Reproduction

Reproduction in the Cladoniaceae is typically by means of sexually produced spores or dispersal of vegetative fragments, either via soredia (microscopic clumps of algal cells surrounded by fungal threads which emerge from the lichen surface as a powder) or simple fragmentation (Thomson 1967). However, neither spore-producing structures nor soredia are known from *Cladonia perforata* (Thomson 1967). Presumably, the main form of reproduction is via vegetative fragmentation.

Relationship to Other Species

Cladonia perforata is a habitat-specialist, usually restricted to openings in very xeric sites. It can occur in monospecific mats or in mixed-species mats with *Cladonia leporina, Cladonia prostrata, Cladonia pachycladodes, Cladina evansii, Cladonia subsetacea*, and/or *Cladina subtenuis*. However, these other co-occurring *Cladonia* and *Cladina* species appear to be less restricted to rosemary scrub and can also be found in lower, less well-drained communities like scrubby flatwoods and flatwoods, in addition to other xeric upland habitats such as sandhills, from which *C. perforata* is notably lacking.

In addition to the more common reindeer lichen species that co-occur with *C. perforata*, associated vascular plant species may include *Serenoa repens, Sabal etonia, Lyonia ferruginea, L. fruticosa, Bumelia tenax, Asimina obovata, Persea humilis, Licania michauxii*, *Hypericum cumulicola, Polygonella basiramia, Opuntia humifusa, Lechea cernua,* and *Selaginella arenicola* (Buckley and Hendrickson 1988). *Cladonia perforata* occurs most commonly with Florida rosemary and sand pine, typically in patches of bare sand with other *Cladonia* and *Cladina* species, sometimes forming mixed-species tangled clumps. It can, however, occasionally occur in dense, long-unburned sand pine scrub on a mat of pine needles, as observed at the southernmost portion of Archbold Biological Station, on an adjacent privately owned parcel, and under dense sand pines on the Lake Wales Ridge SF (R. Yahr, Archbold Biological Station, personal communication 1995). However, Menges and Kohfeldt (1995) found that *C. perforata* decreases in dominance in sites that have gone unburned for more than 20 years. This decrease in dominance on unburned sites may be a result of a combination of factors that influence microhabitat, such as decreased insulation or increased litter accumulation.

Status and Trends

The loss of scrub habitat is the primary reason *C. perforata* is listed as endangered (58 FR 25754). Less than 15 percent of the historic distribution of scrub habitat persisted as of 1992 (FWS 1992), and land conversion to citrus and residential development continues to diminish scrub habitat almost daily. As with all species restricted to the developable upland landscape, including species of the scrubs of the Lake Wales Ridge, nearby parallel central ridges, and the Atlantic Coastal Ridge, habitat loss is the most critical concern.

In addition to habitat loss, *C. perforata* is also threatened by trampling, off-road vehicles, hurricane washover, and improper land management (Buckley and Hendrickson 1986, R. Yahr, Archbold Biological Station, personal communication 1995). Sixteen of the 27 known sites for *C. perforata* occur on dedicated conservation lands and are protected. In Highlands County eight sites are protected on Archbold Biological Station and one site is protected at the Lake Apthorpe Preserve (managed cooperatively by The Nature Conservancy and GFC). In Polk County, two sites on the Lake Wales Ridge SF were discovered by R. Yahr in 1996 (C. Weekley, DACS, personal communication 1998). In Martin County, one site occurs at Jonathan Dickinson

SP. There are three protected sites in Palm Beach County: two at the Jupiter Inlet tract, owned and managed by the BLM, and one recently discovered site on the Jupiter Ridge Natural Area (Steve Farnsworth, Palm Beach County DERM, personal communication 1998). A 1997 survey revealed approximately 5,000 lichen fragments on this site. The Okaloosa County site, on Eglin Air Force Base, occurs on a beach with restricted vehicular access, but completely open to foot traffic. In addition to the already-protected sites for *C. perforata,* the Trout Lake site in Polk County is proposed for inclusion in the State's Preservation 2000 program. Other potential sites for protection include several privately held properties in Highlands County.

A low proportion of all known sites support large areas of *C. perforata*. At only two of the Archbold Biological Station sites is this lichen very abundant, making up the dominant ground cover in most of the site with densely crowded and overlapping thalli. Abundant stands are also reported from the site at Jonathan Dickinson SP and from the east end of Santa Rosa Island.

Despite the conservation status of these sites, populations of this lichen may be extremely limited in areal extent and, therefore, subject to significant losses from local events. For example, two former Okaloosa County sites supported only small fragments of *C. perforata* prior to Hurricane Opal, which severely impacted Santa Rosa Island in October 1995. One estimate suggested that more than half of the potential habitat of *C. perforata* on the east end of the island was negatively affected by the storm, with large areas swept clean of all ground lichens or inundated with salt water (R. Yahr, Archbold Biological Station, personal communication 1995). At Archbold Biological Station, *C. perforata* occurs on eight of more than 100 discrete, available habitat patches (rosemary balds). Five of these eight sites were partially burned in a prescribed fire in 1993, but in each, the lichen persisted in unburned patches, although almost certainly in lower numbers.

Throughout its distribution, *C. perforata* is considered as rare. It has a limited areal extent and its management is further complicated by its limited reproduction and dispersal capability.

Management

Florida scrub has historically experienced variable fire frequencies and patchy high-intensity fires (Myers 1990). Scrub plant communities are therefore fire-adapted, and recover relatively quickly (Abrahamson 1984). In sand pine and rosemary scrub, however, recovery of dominant species is slower than in oak-dominated scrubs (Johnson *et al*. 1986) and open spaces between shrubs persist longer. In fire-maintained systems, low-fuel, bare sand patches may serve as refugia from fire for *C. perforata* and other lichen species which cannot survive fire. These refugia provide a local source for recolonization and population recovery.

While patch-level dynamics on a long time-scale, including local extirpation and recolonization events, are probably important in the persistence of *C. perforata* in the fire-maintained landscape, improper management may threaten the species at the site level. Due to *C. perforata*'s presumed slow growth and observed slow recolonization (Menges and Kohfeldt 1995), land managers should

avoid complete burns in large areas supporting *C. perforata*. Such fires likely reduce the possibility of recolonization from unburned patches within sites or from nearby sites. Additionally, complete lack of fire is also detrimental to the species. Fire suppression creates closed canopies and causes microsite characteristics to change, possibly encouraging complete burns when a fire does occur.

Management recommendations for *C. perforata* should provide for fire-return intervals long enough to restore vigorous lichen growth and to allow regeneration of mature shrub layers, since reburning rosemary scrub too frequently can deplete its soil seed banks (Johnson 1982, Gibson and Menges 1994). Archbold Biological Station's Fire Management Plan recommends a 20 to 60 year fire interval for rosemary scrub, which is designed to allow recovery of shrub canopy while maintaining the endemic-rich open sand patches (Hawkes and Menges 1996). These factors must also be balanced with caution regarding the build-up of litter and other ground fuels over very long intervals which may contribute to homogeneous burns. Perhaps more frequent burns in adjacent habitats may serve to occasionally burn small areas of rosemary and reduce fuels enough to prevent large, complete fires. Spatially patchy fires leave unburned areas within a burned matrix from which species of *Cladonia* may recolonize, and without which, *C. perforata* may be threatened with local extinctions.

Cladonia perforata population dynamics have, to date, only been inferred from observations of occupied sites. Menges and Kohfeldt (1995) found that *C. perforata* and four other terrestrial Cladoniaceae species respond to burning by slow recolonization (within four years) and, later, by steady increases in dominance up to 20 years post fire. However, in contrast to the more common *Cladonia* and *Cladina* species which continue to increase in dominance post fire for at least 60 years, Menges and Kohfeldt (1995) found that *C. perforata* increases in dominance only until an intermediate post fire time of about 20 years, and then decreases in dominance again. Until population trends are studied, it is probably important to provide a mosaic of times-since-fire in the landscape and to encourage patchy burns if fuels have become continuous due to long-unburned conditions. Because *C. perforata*, like other lichens, cannot survive fire and likely can recolonize sites slowly and from local sources, such as unburned patches within sites, it is important to avoid complete burns in sites which support this species. Although *C. perforata* is characteristically found in open sand gaps between shrubs, it can, apparently, persist in long-unburned sites (probably for more than 50 years) under a dense sand pine canopy (R. Yahr, Archbold Biological Station, personal communication 1995). Conducting a mosaic of burns over long time frames would, therefore, be an appropriate management goal for this species.

In some cases, however, prescribed fire may be infeasible due to the proximity of residential development or due to high fuel buildup which could lead to local extirpations. In these instances, it is possible that *C. perforata* would respond well to mechanical clearings adjacent to occupied patches. Evidence of this is noted by the recolonization of some areas disturbed by off-road vehicles with a dense cover of *C. perforata* (R. Yahr, Archbold Biological Station, personal communication 1995). Research on the effects of various

management regimes on *C. perforata* based on such observations may be useful in the recovery of the species.

Recent patchy burns in rosemary scrub at Archbold Biological Station and the Lake Apthorpe Preserve may be successful in promoting the persistence of this species, creating or re-opening new bare sand patches adjacent to occupied, unburned areas. A monitoring project in several sites was instituted in the winter of 1996-97 by Archbold Biological Station to investigate the rate and mode of post-fire recolonization in the peninsular region of *C. perforata*'s range; compare natural recolonization of *C. perforata* with establishment via transplantations into unoccupied suitable habitat and with previously occupied, hand-cleared sites; and to test hypotheses regarding dispersal limitations for *C. perforata*'s persistence and growth in several transplant sites.

Management of *C. perforata* should include protection of all sites from vehicle or heavy foot traffic and promoting fire management planning at sites where fire is an important part of that site's ecology. Because each site has a unique set of circumstances, appropriate management plans should be tailored to accommodate these. Unpredictable events, like hurricanes and wildfires, are best mediated by having a large number of protected sites, which provide local sources for natural recolonization and population recovery. It may be possible to reintroduce *C. perforata* into severely damaged sites, if impacts have been so severe that the nearby natural population has not been able to recolonize the site.

Little is known about the life history and ecology of *C. perforata*. This causes concern regarding its recolonization potential, since relatively large, heavy fragments may not disperse far or fast. Additionally, indeterminate branching structures which vegetatively fragment lead to problems in estimating demographic trends. Counts of individual fragments are infeasible and probably not informative, since individuals cannot be defined. Some estimate of areal coverage may be the best way to describe the population size and spread.

A review of current ecological and management research on the genus may yield valuable suggestions for applied management of *C. perforata*. Studies of boreal forest terrestrial *Cladonia* species biology and ecology, for example, may offer useful information for management of Florida's terrestrial lichen communities.

Literature Cited

Abrahamson, W.G. 1984. Post-fire recovery of Florida Lake Wales Ridge vegetation. American Journal of Botany 71:9-12.

Abrahamson, W.G., A.F. Johnson, J.N. Layne, and P.A. Peroni. 1984. Vegetation of the Archbold Biological Station, Florida: An example of the southern Lake Wales Ridge. Florida Scientist 47(4): 209-250.

Buckley, A., and T.O. Hendrickson. 1986. An update of the macrolichens of Archbold Biological Station with mphasis on the tatus of *Cladonia perforata* Evans. Unpublished Archbold Biological Station records.

Buckley, A., and T.O. Hendrickson. 1988. The distribution of *Cladonia perforata* Evans on the southern Lake Wales Ridge in Highlands County, Florida. The Bryologist 91(4):354-356.

DeLaney, K. 1995 FWS Multi-Species Recovery Team meeting. December 6-8, 1995.

Evans, A. W. 1952. The Cladoniae of Florida. Transactions of the Connecticut Academy of Arts and Sciences 38:249-336.

Farnsworth, S. 1998. Comments on techical/agency draft multi-species recovery plan for South Florida. March 19, 1998.

Gibson, D.J., and E.S. Menges. 1994. Population structure and spatial pattern in the dioecious shrub *Ceratiola ericoides.* Journal of Vegetation Science 5:337-346.

Hawkes, C. V., and E.S. Menges. 1996. The relationship between open space and fire for species in a xeric Florida shrubland. Bulletin Torrey Botany Club 123(2): 81-92.

Johnson, A.F., 1982. Some demographic characteristics of the Florida rosemary *Ceratiola ericoides* Michx. American Midland Naturalist 108: 170-174.

Johnson, A.F., W.G. Abrahamson, and K.D. McCrea. 1986. Comparison of biomass recovery after fire of a seeder (*Ceratiola ericoides*) and a sprouter (*Quercus inopina*) species from south-central Florida. American Midland Natururalist 116:423-428

Menges, E. 1995. FWS Multi-Species Recovery Team meeting. December 6-8, 1995.

Menges, E.S., and Kohfeldt, N. 1995. Life history strategies of Florida scrub plants in relation to fire. Bulletin Torrey Botany Club 122:282-297.

Moore, B.J. 1968. The macrolichen flora of Florida. The Bryologist 71(3):161-266.

Myers, R.L. 1990. Scrub and high pine. Pages 150-193 *in* R.L. Myers and J.J. Ewel, eds. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida.

Thomson, J.W. 1967. The Lichen Genus *Cladonia* in North America. University of Toronto Press.

U.S. Fish and Wildlife Service [FWS]. 1992. draft land protection Plan for the proposed establishment of the Lake Wales Ridge National Wildlife Refuge.

U.S. Fish and Wildlife Service [FWS]. 1996. Recovery plan for nineteen central Florida scrub and high pineland plants (revised). U.S. Fish and Wildlife Service; Atlanta, Georgia.

Weekley, C. 1998. Comments on technical/agency draft multi-species recovery plan for South Florida January 28, 1998.

Wilhelm, G.S. and J.R. Burkhalter. 1990. *Cladonia perforata,* the northwest Florida population. The Bryologist 93:66-68.

Yahr, R. 1995. FWS Multi-Species Recovery Team Meeting. December 6-8, 1995.

Yahr, R. 1998. Comments on technical draft multi-species recovery Plan for South Florida February 5, 1998,

Recovery for the Florida Perforate Cladonia

Cladonia perforata Evans

Recovery Objective: **RECLASSIFY** to threatened.

Recovery Criteria

Cladonia perforata 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 to 90 percent probability of persistence for 100 years; when these sites, within the historic range of *C. perforata*, are adequately protected from further habitat loss, degradation, and fragmentation; when these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support *C. perforata*; 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 new ways of re-establishing populations of this species to expand its distribution within its historic range.

Species-level Recovery Actions

S1. Determine current distribution of *C. perforata.* This species' known distribution is scattered from the panhandle area of Florida south to Martin and Palm Beach counties in South Florida with large areas having no individuals. A thorough survey is needed to determine the distribution for this species.

S1.1. Conduct surveys for additional populations of *C. perforata* in South Florida.

S1.1.1. Survey scrub and high pine habitat for *C. perforata* in Osceola, Hardee, and Hendry counties. Adequate survey work has not been performed off the Lake Wales Ridge. Sites on private property cannot be protected without survey knowledge.

S1.1.2. Continue surveys in Polk and Highlands counties. The Lake Wales Ridge has been well surveyed, though new sites are still being found. This species by nature is hard to identify and dispersed sparsely. Survey work should continue for this species.

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.

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 areas and cover, and status. This information should also be used for project review and in land acquisition activities.

S2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have 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. Protect populations on private land 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. Prepare post-hurricane restoration plans for the southeast Florida counties.

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 *C. perforata* lives.

S2.4.1. Initiate section 7 consultations when Federal activities may affect this species. In particular, it will be important to consult with the Florida DOT and the Federal Highway Administration to protect occupied habitat of *C. perforata* from further fragmentation and the secondary effects of road construction.

S2.4.2. 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.

S2.5. Initiate *ex situ* conservation of *C. perforata*. *Ex situ* collections can preserve genetic diversity, prevent loss of the species, and determine ecological characteristics and habitat management needs. These collections may be instrumental in the recovery of *C. perforata*, although lichens are known to be quite difficult to culture. The efforts of organizations like the Center for Plant Conservation of the Missouri Botanical Gardens, which collect, store, and maintain the germ plasm of rare species should continue to be supported. Emphasis should be placed on culturing techniques rather than trying to maintain living symbioses.

S3. Conduct research on life history characteristics of *C. perforata*. 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 demographic information, such as numbers of sites and populations, numbers of individuals in a population, recruitment, dispersal, growth, survival, and mortality.

S3.2. Continue research to better understand the mechanisms of establishment of C. perforata, the effects of translocations of fragments, and the effects of fire on survival.

S3.3. Once demographic data are known, conduct population viability and risk assessment analysis to determine the spatial distribution needed to ensure persistence of the species.

S3.4. Conduct research to assess management requirements of *C. perforata*. Determine which natural populations can be stabilized or increased by habitat management. Surveys, research, and monitoring will provide information on the localities of *C. perforata* sites, and on the factors contributing to any declines at each site. Site-specific management guidelines should be provided to land managers.

S4. Monitor existing populations of *C. perforata*.

S4.1. Monitor to detect changes in demographic characteristics, such as reproduction, recruitment, growth, dispersal, survival, and mortality. Also monitor for herbivory, disease and injury.

S4.2. Monitor the effects of various land management actions on *C. perforata*. Assess any changes in demographic characteristics of *C. perforata* in response to land management activities, such as prescribed fire, exotic plant control, *etc*.

S4.3. Develop a quantitative description of the population structure of *C. perforata*. 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 (or fragment's) microsite (vegetation cover, litter depth, substrate, and closest neighbors) should also be included.

S5. Provide public information about *C. perforata*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where *C. perforata* 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 *C. perforata* 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. Both urbanization and fire suppression have decreased the available habitat. To date, there are 15 protected sites for *C. perforata* in South Florida.

H1.1. Secure habitat through acquisition, landowner agreements, and conservation easements. Little xeric scrub habitat is remaining for this species; any method of securing *in situ* protected populations should be sought.

H1.2. **Manage and enhance habitat.** Manage habitat to maintain *C. perforata* 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 scrub community. A variable interval in fire return and in season is important to mimic the natural fire regime. The scrub landscape is naturally made up of islands of suitable and unsuitable habitat. To repeat this landscape pattern, sites should be burned as a mosaic when possible.

H1.2.2. **Control and eliminate exotic and invasive plants and animals.** Exotic plant and animal species are not yet a major threat in this species habitat 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 *C. perforata*.

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.

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 *C. perforata* to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. Although recently studied, questions still exist on management reactions.

H4. **Monitor habitat/ecological processes.** Monitor the effects of land management actions, such as prescribed fire, exotic plant control, *etc*., on the habitats where *C. perforata* occurs.

H5. **Provide public information about scrub and its unique biota**. Educational efforts, especially those conducted by Archbold Biological Station, have been successful. Without these successful efforts, the Lake Wales Ridge NWR would not have been created. 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 scrub, high pineland vegetation, and their plant species.