Florida perforate cladonia
(Cladonia perforata)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Southeast Region
South Florida Ecological Services Office
Vero Beach, Florida

5-YEAR REVIEW
Florida perforate cladonia / *Cladonia perforata*

I. GENERAL INFORMATION

A. Methodology used to complete the review: This review is based on monitoring reports, surveys, and other scientific and management information, augmented by conversations and comments from biologists familiar with the species. The review was conducted by the lead recovery biologist for Florida perforate cladonia with the South Florida Ecological Services Office. Literature and documents on file at the South Florida Ecological Services Office, the Panama City Ecological Services Field Office, and the Jacksonville Ecological Services Office were used for this review. All recommendations resulting from this review are a result of thoroughly assessing all available information on Florida perforate cladonia. No part of the review was contracted to an outside party. The draft of this review document was distributed for peer review (see Appendix A), and comments received were addressed. The public notice of this review was published on September 27, 2006, with a 60 day public comment period.

B. Reviewers
Lead Region: Southeast Region, Kelly Bibb, (404) 679-7132
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C. Background

1. FR Notice citation announcing initiation of this review: September 27, 2006. 71 FR 56545.

2. Species status: Declining, 2006 Recovery Data Call. Approximately 40% of the population in Okaloosa County was lost due to Hurricane Ivan in 2004 (Eglin Air Force Base [Eglin] 2006), and the full effects of the hurricane are not known. The species is slow growing, and we do not have information suggesting that populations impacted by the hurricane have improved or recovered. Other threats (e.g., habitat loss, fire, inappropriate fire management, trampling) are continuing, and the extent of a new threat (i.e., susceptibility to mold and pathogens after hurricanes) is unknown.

3. Recovery achieved: 1 (0-25% recovery objectives achieved), 2006 Recovery Data Call.

4. Listing history
Original Listing
FR notice: 58 FR 25746
Date listed: April 27, 1993
Entity listed: Species

Classification: Endangered

5. Associated rulemakings: Not applicable

6. Review History:
Recovery Plan for Nineteen Florida Scrub and High Pineland Plant Species (June 20, 1996)
South Florida Multi-Species Recovery Plan (MSRP) (May 18, 1999)
Recovery Data Call 2001, 2002, 2003, 2004, 2005, 2006

7. Species' Recovery Priority Number at start of review (48 FR 43098): 2. A recovery priority number of "2" means high degree of threat and high recovery potential.

8. Recovery Plan or Outline
Name of plan: MSRP
Date issued: May 18, 1999
Dates of previous plans: June 20, 1996

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

1. Is the species under review listed as a DPS? No.
The Endangered Species Act (Act) defines species to include any distinct population segment of any species of vertebrate wildlife. This definition limits listings as distinct population segments (DPS) only to vertebrate species of fish and wildlife. Because the DPS policy is not applicable to this lichen species, it is not addressed further in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes.

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? No.

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-

related recovery criteria, please note which of the 5 listing factors* are addressed by that criterion. If any of the 5 listing factors are not relevant to this species, please note that here.

Criteria for reclassification of Florida perforate cladonia from endangered to threatened:

1. Enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90% probability of persistence for 100 years.

Although some information has been obtained for a few sites, demographic data for this species are largely lacking. This criterion addresses factor E.

2. These sites, within the historic range of *C. perforata*, are adequately protected from further habitat loss, degradation, and fragmentation.

There appears to be 16 known sites (populations) that support Florida perforate cladonia (Florida Division of Forestry [DOF] 2006, Florida Natural Areas Inventory [FNAI] 2006, Turner et al. 2006). The majority of sites (14) are partially protected; of these sites, 11 occur on public lands and 3 occur on private lands (DOF 2006, FNAI 2006, Turner et al. 2006). Most sites are managed to some extent; however management is by several different entities with various goals, objectives, and available resources. Four sites are not managed. The level of protection among sites varies. Sites on public lands (11) are owned by: U.S. Department of Defense (2), U.S. Bureau of Land Management (BLM) (1), DOF (1), Florida Fish and Wildlife Conservation Commission (FWC) (1), Florida Department of Environmental Protection (DEP) (3), Southwest Florida Water Management District (SWFWMD) (1), Martin County (1), and Palm Beach County (1). Sites on private conservation lands include: Archbold Biological Station (Archbold) (2) and that of an individual landowner who registered his property with The Nature Conservancy (TNC) (1). Unprotected sites (2) on private land include: Cavender Corporation (1) and multiple lot owners within Avon Park Lakes (1). Although most sites are somewhat protected, off-road vehicles (ORVs), pedestrian access, trash dumping, and management constraints and issues are threats at many sites (Yahr 2003, FNAI 2006, NatureServe 2006). We have not assessed the adequacy of protection from habitat loss or degradation at the protected sites currently or over the long-term. An assessment of protection adequacy at managed sites is needed to address this criterion. This criterion addresses factors A, D, and E.

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* A) Present or threatened destruction, modification or curtailment of its habitat or range;
B) Overutilization for commercial, recreational, scientific, or educational purposes;
C) Disease or predation;
D) Inadequacy of existing regulatory mechanisms;
E) Other natural or manmade factors affecting its continued existence.

3. These sites are managed to maintain the rosemary phase of xeric oak scrub communities to support *C. perforata*.

Sites are owned and managed by various entities with different goals, objectives, and available resources. At some sites, management practices have generally favored maintenance of the rosemary phase of xeric oak scrub communities inhabited by Florida perforate cladonia. Other sites may be impacted by fire suppression, inappropriate fire regime, lack of other disturbances, ORVs, or other human activities (Yahr 2003, FNAI 2006, NatureServe 2006). In some cases, management for other scrub endemics may conflict with management for the lichen. For example, lichens and some rare forbs prefer open sandy areas between shrubs, but as lichen cover becomes more complete, open sandy habitat needed by rare forbs may decrease (A. Johnson, FNAI, pers. comm. 2007). Populations of rare forbs may be maximized by more frequent burning, but this may pose a conflict in managing for lichens (A. Johnson, pers. comm. 2007). We have not assessed to what extent managing entities will be able to maintain native vegetation or habitat conditions over the long-term. An assessment of management practices at managed sites is needed to address this criterion. This criterion addresses factors A, D, and E.

4. 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.

A monitoring program is in place for Florida perforate cladonia at Eglin Air Force Base (Eglin 2005a, 2006) in the Florida panhandle. In the past, Archbold has conducted some monitoring work at its sites (Yahr 2000a), but no active monitoring is in place at this time (E. Menges, Archbold, pers. comm. 2007). Elsewhere on the Lake Wales Ridge, DOF has conducted monitoring within the Arbuckle Tract of the Lake Wales Ridge State Forest in 2001-2004 (Cox 2003; DOF 2003, 2004). More recently, DOF has conducted surveys following a prescribed fire in 2005 that nearly extirpated a large subpopulation (K. Clanton, DOF, pers. comm. 2007). FNAI also conducts periodic inventories (FNAI 2006) at sites, but information is limited. Detailed monitoring information from most populations, however, is largely absent. No monitoring is conducted at other sites. Without rigorous or regular monitoring, it will be difficult to address this criterion. At this time, we cannot determine if populations are self-sustaining or stable throughout the species' historic range. This criterion addresses factors A, D, and E.

Factor C was not relevant at the time of listing, but appears to be a factor now.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth

rate, age at mortality, mortality rate), or demographic trends: Limited detailed information is available on abundance and trends. Florida perforate cladonia does not have an established monitoring program at most sites. Using data from FNAI (2006) and DOF (2006), there appear to be 29 element occurrences, which have been grouped into 16 populations (DOF 2006, FNAI 2006, Turner et al. 2006) based upon the assumption that populations are greater than 3,280 feet (1,000 meters [m]) apart (A. Jenkins, FNAI, pers. comm. 2007; L. Patrick, Service, pers. comm. 2007). This population approach of merging element occurrences within 3,280 feet (1,000 m) buffers probably represents the biological structure of diversity of this lichen in terms of dispersal and connectedness at this time (R. Yahr, Royal Botanic Garden Edinburgh, pers. comm. 2007).

The 16 populations occur in 4 separate geographic areas. Central Florida's Lake Wales Ridge (Highlands and Polk County) supports seven sites (FNAI 2006, DOF 2006). Six sites occur on the Atlantic Coast Ridge, including 4 in Martin County and 2 in Palm Beach County (FNAI 2006). One site occurs on the west coast in Manatee County (FNAI 2006). Two sites occur on the North Gulf Coast at Eglin in Okaloosa County (FNAI 2006); these sites are the most disjunct from the others and the only ones not in peninsular Florida.

Abundance information for most populations is generally lacking or outdated. In a comprehensive study, Hilsenbeck and Muller (1991) conducted field surveys of 12 known occurrences in Highlands and Okaloosa Counties. At that time, results suggested that there were, at a minimum, over 26,000 individuals (thalli) within 11 extant populations (Hilsenbeck and Muller 1991). Hilsenbeck and Muller (1991) indicated that their estimates were rough due to the difficulty in physically counting such a small and relatively inconspicuous organism. They believed that they had grossly underestimated the true number of individuals because they accounted for only larger and more readily apparent individuals within a given site rather than small lichen fragments.

Limited current abundance data are difficult to compare to previous estimates. FNAI (2006) provides estimated population sizes and viabilities (e.g., excellent, good, fair, poor) for some occurrences; however, some data are outdated. On the Lake Wales Ridge, Archbold is not actively monitoring Florida perforate cladonia (E. Menges, pers. comm. 2007); however Rebecca Yahr had studied the ecology and post-fire recovery of this species at three rosemary balds at Archbold, monitoring abundance of all lichen species yearly during the winters of 1997-1999 (Yahr 2000a). Results are difficult to compare with other studies because data are largely given in aerial coverage and biomass. The viability at 2 sites at Archbold was estimated as excellent in 1989 (FNAI 2006). The DOF conducted some monitoring (i.e., abundances of individuals determined) from 2001-2002 (DOF 2003). Florida perforate cladonia has been found within the Arbuckle tract, but not in the Walk-in-

Water or Boy Scout tracts (DOF 2003). The lichen has only been found in 5 locations in 2 burn units within the Arbuckle tract of Lake Wales Ridge State Forest in Polk County (Cox 2003). Keith Clanton (pers. comm. 2007) indicates that in approximately 9.3 acres (3.8 hectares [ha]) this lichen occurred densely in four distinct subpopulations prior to a prescribed fire in 2005. However, the largest area (4.4 acres [1.8 ha]) was nearly extirpated, despite precautions, due to a fire that was hotter than expected, similar to other post-2004 hurricane burns (K. Clanton, pers. comm. 2007). Abundance of 3 other populations on private lands within Highlands County is not known; viability estimates for these sites are unavailable or outdated (e.g., 1991) (FNAI 2006, A. Johnson, pers. comm. 2007).

Data for the populations in Martin (4) and Palm Beach Counties (2) are mixed in terms of abundance and also somewhat outdated. In Martin County, this species was considered abundant throughout a 30-acre (12.1-ha) area within Jonathan Dickinson State Park in 1993 and, at that time, was considered to have excellent or good viability (FNAI 2006). This population is now thought to have fair to good viability (R. Rossmanith, DEP, pers. comm. 2007). Two populations within the Atlantic Ridge Preserve State Park had several to many individuals scattered within a scrub area in 1994, but no estimations of viability were made (FNAI 2006). One of these sites is now managed by the South Florida Water Management District (R. Rossmanith, pers. comm. 2007). Another population at Leopold Scrub, previously part of the Atlantic Ridge Preserve State Park but now owned by Martin County, was considered to be abundant with variable estimated viability (i.e., excellent, good, or fair) in 1998 (FNAI 2006). Martin County has not conducted a systematic assessment of the population occurring within this 1-acre (0.4-ha) property (now known as Scrub Oak); an adjoining piece of private property also supports the lichen, but also occurs on a <1-acre (0.4-ha) parcel (Mike Yustin, Martin County, pers. comm. 2007). One population in Palm Beach County within the Jupiter Ridge Natural Area was estimated to have more than 5,000 individuals on approximately 5 acres (2 ha) in 2003 and good estimated viability in 2004 (FNAI 2006). Another population was observed in 1995 at the Jupiter Lighthouse Scrub site, owned by the BLM, but abundance and viability were not estimated (FNAI 2006).

A population of Florida perforate cladonia was found on the west coast of Florida in Manatee County in 2006 by Anne Cox (A. Johnson, pers. comm. 2006; A. Jenkins, pers. comm. 2007). This site is located on the Little Manatee River site, owned by the SWFWMD, and the population was characterized as moderate in size with good estimated viability in 2006 (FNAI 2006). Although this appeared to be a range expansion, this species had been known to exist in Manatee County previously based upon field work by Kris DeLaney (Service 1996, 1999). Anne Cox (ecolo~G, Inc., pers. comm. 2007) believes that it is likely that there are more sites supporting the species in proximity to the SWFWMD property or elsewhere in Manatee County.

More recent data are available for populations at Eglin in Okaloosa County, and a monitoring plan is in place (Eglin 2005a, 2006). Prior to 1995, three populations existed at Eglin - 1 large population (Santa Rosa Island [east]), and 2 smaller populations on restricted portions (Santa Rosa Island [west]) (Eglin 2005a, 2006). The Santa Rosa Island (east) population was considered large (223-2,100 thalli) with excellent estimated viability in 2005 (FNAI 2006). The other populations, Santa Rosa Island (west), had been considered extirpated in 1999 following Hurricane Opal in 1995 (FNAI 2006). Storm surge from Hurricane Opal caused the westernmost populations to be lost and impacted approximately half of the population and habitat on the east (Eglin 2005a, 2006). In June 2000, Rebecca Yahr led a project to reintroduce 2 populations, each with 14 subpopulations, into the previously occupied portion of Santa Rosa Island (Eglin 2004a, 2005a, 2006). Santa Rosa Island was also impacted by Hurricane Ivan in 2004 (Eglin 2004b, Eglin 2006). After reintroduction efforts, a small amount of lichen persisted at this site in 2005 (A. Jenkins, pers. comm. 2007).

Little is known about the life history and ecology of Florida perforate cladonia, and demographic features and trends remain poorly understood. This species' growth rate and seasonality are unknown (Yahr 1997), but it appears to grow slowly and branches once a year (Yahr 2003, Yahr and DePriest 2005). Hammer (2000) described the ontogeny (development) of this species and a summary of relatively recent studies in Cladoniaceae morphogenesis. The main form of reproduction is presumably through vegetative reproduction (fragmentation), which can happen via trampling or natural breakage after decades of growth *in situ* (Yahr 2003). No primary thallus (body), apothecia (reproductive structure), and spermagonia (cavity or receptacle in which spermatia are produced) of this species are known (Evans 1952, Moore 1968, Hammer 2000, Yahr 2000a, Cox 2003). Yahr (2003) indicated that this lichen consists of strictly asexual, branching structures, which reproduce via vegetative fragmentation and that genetic studies have so far supported an asexual life history. However, in 2006, specimens collected from the Manatee County site by Anne Cox and Ann Johnson may have been the first documented presence of reproductive bodies recorded for this species (A. Cox, pers. comm. 2007). Dana Griffin at the University of Florida Herbarium stated that "The specimen has brown, immature apothecia which are previously unrecorded for this species" (University of Florida Herbarium Collections Catalog 2006). However, Richard Harris, a bryologist at New York Botanical Garden, who conducted the initial identification, did not note presence of apothecia (A. Johnson, pers. comm. 2007).

Basic status surveys and demography of lichens is challenging due to lack of determinate life stages and slow observable responses to environmental changes (Yahr and DePriest 2005). Counts of individual fragments are generally not feasible and probably not informative, since individuals cannot

be readily defined (Service 1999). In addition, the vagrant habit of Florida perforate cladonia is such that fragments are unattached to any substrate and are free to drift; fragments can be carried by wind, water, or animals (Yahr and DePriest 2005). Yahr (2003) suggested that density and area occupied are probably better measures of abundance for this species than count data. According to Yahr (2003), most subpopulations likely contain less than 24.7 acres (10 ha) coverage of lichen, and some contain only a few square meters. Yahr (2003) indicated that the extent of fragmentation of subpopulations is naturally high, since open Florida scrub is naturally patchy and disjunct.

Yahr and DePriest (2005) state that an important part of lichen demography is estimating dispersal of various propagules including spores, vegetative fragments, or specialized structures (e.g., soredia). Although some lichens can colonize disjunct habitat patches via spores or specialized long-distance dispersal units, Florida perforate cladonia has only large, bulky, vegetative fragments, which are poor dispersers (Yahr and DePriest 2005). Limited dispersal may be the most important demographic feature of this species (Yahr 2000a, Yahr and DePriest 2005). Unoccupied but otherwise suitable sites can support lichen; survival of transplants into recently burned or unoccupied suitable sites is nearly 100% (Yahr 2000a, Yahr and DePriest 2005).

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding): In a pilot study of 5 populations of this species, Yahr (2000b) found no evidence of gene flow, long-distance dispersal, or sexual reproduction. She completed a preliminary genetic survey in 1999-2000, sampling ten individuals from each of 5 populations using nuclear ribosomal intergenic spacer (ITS) regions 1 and 2 (Yahr 2000b). Preliminary results suggested that discrete populations of both symbiotic partners are apparently monomorphic (having one or the same genotype, form, or structure) for ITS in all but one case (Yahr 2000b).

Based on DNA fingerprinting studies by Yahr, 2 of the populations at Archbold are identical to one another and completely invariable (R. Yahr, pers. comm. 2000). Yahr (pers. comm. 2000) noted that this is astounding since the DNA extracts used included both fungal and algal partners. According to Yahr (pers. comm. 2000), this is evidence of strict clonality on a geographic scale of roughly 2,625 feet (800 m) and a good indication that this method will work to describe population variability. Although other populations on the Lake Wales Ridge had not yet been compared, there is concern about the apparent low genetic diversity.

In contrast, the most isolated north Florida population has a unique fungal and algal genotype (Yahr 2000b). The Eglin population seems to contain some variability, which is surprising since the expectation was that each population would basically be doing or would have done the same things through time in

terms of population dynamics (R. Yahr, pers. comm. 2000). Yahr (pers. comm. 2000) suggests that the implications of these findings for management are not yet clear, but that the Eglin population is unique and may be an important source for genetic variation in the species.

Based on an analysis of 16 populations across three regions, Yahr (pers. comm. 2007) has found strong evidence for fungal clonality within sites (consistent with the results presented in Yahr and DePriest 2005) and evidence for differences among regions (Lake Wales Ridge, North Gulf Coast, Atlantic Coast Ridge). Yahr (pers. comm. 2007) indicates that genetic diversity seems to mirror, in general, spatial structuring of populations. Additional effort is needed to understand the population dynamics among populations (R. Yahr, pers. comm. 2000). Based upon preliminary work, it appears that the relationships between genotypes suggest isolated and severely bottlenecked relictual populations (Yahr 2000b). Yahr and DePriest (2005) indicate that historical population bottlenecks and resulting low genetic diversity are a concern in efforts to conserve populations. They suggest that since each population of this species is predominantly clonal, variability can only be protected by protecting multiple, genetically different, populations (Yahr and DePriest 2005).

c. Taxonomic classification or changes in nomenclature: None. The Integrated Taxonomic Information System (2007) indicates that the current standing of the taxonomic status is accepted.

d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range): Endemic to Florida, Florida perforate cladonia is found in sandy soil and white sand scrubs (Evans 1952, Moore 1968) and is highly specific in habitat requirements (Buckley and Hendrickson 1988). In addition, this species' mode of reproduction is likely an important limitation in its distribution (Yahr 1997, Yahr 2000a). Although some lichens can colonize disjunct habitat patches via spores or specialized long-distance dispersal units, Florida perforate cladonia has only large, bulky, vegetative fragments, which are poor dispersers (Yahr and DePriest 2005). Population recovery via dispersal may be slow and decrease with distance from source due to relatively large and heavy vegetative fragments (Yahr 1997). Yahr (2000a) suggested that dispersal of this species beyond occupied rosemary scrub patches may be physically impeded by dense accumulations of leaf litter or plant stems in adjacent habitat types. In a pilot study of five populations of this species, Yahr (2000b) found no evidence of long-distance dispersal. Trends in spatial distribution or historic range are difficult to determine. In 1988, the species appeared to be confined to eight land sections in southern Highlands County (Buckley and Hendrickson 1988). Hilsenbeck and Muller (1991) conducted a comprehensive field survey of all previously known sites

and 111 potential sites in Florida and another 15 potential sites in Georgia. They found Florida perforate cladonia only at 10 sites in Highlands County and 2 sites in Okaloosa County, but none in any of the other 16 counties in Florida or 8 counties in Georgia (Hilsenbeck and Muller 1991). At the time of listing in 1993, this species occurred in Highlands, Okaloosa, and Martin Counties (58 FR 25746). The final rule indicated that this species already suffered serious loss of habitat due to agriculture (citrus groves and pastures) and residential development and that it was threatened by future development (58 FR 25746). At the time of listing, only 27,500 acres (11,129 ha) of the original 250,000 acres (101,172 ha) within the Lake Wales Ridge remained (58 FR 25746).

As of 1996, the Florida perforate cladonia was distributed in Highlands, Okaloosa, Martin, Palm Beach, Polk, and Manatee Counties (Service 1996). Based upon information from Rebecca Yahr and Kris DeLaney in 1995, the lichen had been found in Polk County (i.e., at the Trout Lake North site and other sites) (Service 1996). The Palm Beach County site was confirmed by Richard Roberts and collaborators in 1995 (Service 1996). The Manatee County occurrences were based upon information provided by Kris DeLaney in 1996 (Service 1996). The county distribution remained the same in 1999 (Service 1999).

The current geographic distribution appears to be roughly the same as that identified in the recovery plans (DOF 2006, FNAI 2006, Turner et al. 2006). Occurrences in Polk County (beyond the Lake Wales Ridge State Forest) and Manatee County (beyond the SWFWMD property) may be somewhat tenuous. For example, this species was previously found at the Trout Lake site in Polk County, but was not recently found to occur there (Turner et al. 2006). However, despite some data gaps, we believe additional occurrences and patches of suitable habitat are still in existence in Manatee and Polk Counties.

Each region where Florida perforate cladonia occurs consists of several to many severely fragmented occupied habitat patches (subpopulations) (Yahr 2003). Geographic isolation of distinct regions appears to be further enhanced by smaller-scale patchiness (Yahr 1997). On a local scale, Florida perforate cladonia only occurs in a subset of available sites within open-structured rosemary scrub communities, which are naturally patchy and disjunct (Yahr 1997). Most sites are separated by many kilometers of intervening unsuitable habitats; sites that support several subpopulations within close proximity may still have very effective barriers to dispersal among them (Yahr 2003).

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem): Florida perforate cladonia occurs over a total extent of roughly 840,155 acres (340,000 ha); however, each of

the four regions consist of several or many severely fragmented occupied habitat patches, which are roughly 247 acres (100 ha) or less (Yahr 2003).

In a 517,190-acre area (209,300 ha) of the Lake Wales Ridge, the lichen is estimated to occupy less than 1,236 acres (500 ha) in disjunct patches (Yahr 2003, Weekley et al. in press). This area supports the bulk of the subpopulations (Yahr 2003). Archbold, Lake Wales Ridge State Forest (DOF), and Lake Apthorpe (FWC) are important in terms of amount of protected habitat, active fire management programs, and presence of several large occupied and unoccupied patches of habitat (Yahr 2003). Additional high habitat quality habitat remains on private land (Yahr 2003, FNAI 2006).

The Atlantic Coast Ridge has an overall low extent of occurrence of the species (approximately 177,915 acres [72,000 ha]) and area of occupancy, but still supports important locations (e.g., Jonathan Dickinson State [DEP], Jupiter Lighthouse [BLM]) (Yahr 2003). Several other scattered populations in public ownership are small; those in private ownership are not likely to persist under dense tree canopies and are at risk of extirpation from coastal development (Yahr 2003).

In Manatee County, the known occupied site (Little Manatee River) is owned by the SWFWMD (FNAI 2006). The population appears to occur over a small area (i.e., one area approximately 0.025-0.25 acre (100-1,000 m^2) supports >100 clumps; two areas approximately 1.2-2.5 acres (0.5-1.0 ha) support >100 clumps) (FNAI 2006). It is not known to what extent this area is managed.

In the North Gulf Coast, Eglin supports the largest known population (Yahr 2003). The east population occupies in an area approximately 124-247 acres (50-100 ha) (Yahr 2003). The west populations were destroyed by Hurricane Opal, but are the focus of reintroduction efforts (Yahr 2003; Eglin 2004a, 2005a, 2006). Although populations at Eglin have benefited from protection and management, habitat is still vulnerable to threats associated with hurricanes, public use (e.g., pedestrian traffic, ORVs), and management activities (e.g., dune restoration, exotic control) (Eglin 2006, FNAI 2006).

Florida perforate cladonia is patchily distributed in open gaps in rosemary scrub within a fire-prone landscape, co-occurring with other fire-adapted species (Yahr 2000a). Fires in peninsular Florida and hurricanes along the Gulf Coast are natural periodic disturbances that may be important in maintaining adequate habitat structure for Florida perforate cladonia (Menges and Kohfeldt 1995, Hawkes and Menges 1996, Yahr 2000a). Such periodic natural disturbances influence both long-term habitat maintenance for this species, and short-term subpopulation persistence (Yahr 2003). Natural fire return intervals in rosemary scrub have been estimated at 15-40 years (Menges and Kohfeldt 1995). However, as natural areas have become

fragmented, natural fire has been replaced by either fire suppression or prescribed fire (Yahr 2000a).

Fire suppression causes the loss of open space and presumably the loss of Florida perforate cladonia (Yahr 2000a). However, lichens are destroyed by fire, and recovery is a slow process (Yahr 1997, Yahr 2000a). Hawkes and Menges (1996) found *Cladonia* species increased slowly with time since fire, not comprising more than 10% cover until more than 20 years post-fire. In general, *Cladonia* species increased in cover and density with time since fire, but decreased in cover with open space (Hawkes and Menges 1996). Menges and Kohfeldt (1995) found Florida perforate cladonia increased between 4 and 20 years post-fire, but not thereafter. Florida perforate cladonia can only recolonize sites slowly, from a very local source (e.g., unburned patch within a site) (Yahr 1997). However, the costs of fire-caused mortality in the short term are far outweighed by availability of habitat in a fire-maintained landscape over the long term (Yahr 2000a). Yahr (2000a) recommended that management plans balance the times since fire to maintain favorable habitats for species with varying microhabitat site tolerances, life histories, and colonization abilities. Ann Johnson (pers. comm. 2007) believes that there is not much direct evidence that this species is being shaded out or otherwise harmed by lack of burning. Johnson (pers. comm. 2007) suggests that the challenge for managers may be how to maintain a reasonable interval for prescribed burns in the surrounding oak scrub while not burning the embedded rosemary scrubs too often or too completely (e.g., burns set on the ground can be better controlled and preferable to burns set by helicopter). Archbold has recently implemented a fire return interval for rosemary scrub of 20-30 years (H. Swain, Archbold, pers. comm. 2007), which may benefit the cladonia.

Florida perforate cladonia may be dependent on a limited spatial distribution of suitable habitat, determined in part by availability of a suitable temporal element or seral stage (Yahr 1997). Overgrown scrub with dense overstory and thick litter layers eventually excludes species dependent upon canopy openings; periodic disturbances, although initially destructive, can temporarily create gaps (Yahr 1997). Yahr (2000a) stated that unburned refugia are crucial for the survival of this species, and precautions should be taken to ensure that areas of unburned occupied habitat persist through prescribed fires. In some cases, it may be necessary to artificially maintain gaps that are unlikely to carry fire (Yahr 2000a). In coastal scrubs, patches of stable vegetation that are resistant to wind and water erosion from hurricane overwash may serve as refugia (Yahr 1997).

The best approach to fire management for Florida perforate cladonia may be to avoid overly regular fire regimes, fire suppression, or burning too frequently and to encourage a mosaic of times since fire for each habitat type (Menges and Kohfeldt 1995, Yahr 2000a). Conducting patchy burns will also

achieve these objectives; it is helpful to have a specific goal for burn prescriptions that avoids intensive head fires, or particularly hot fires, going through rosemary balds, and lighting patterns to facilitate patchy burns (H. Swain, pers. comm. 2007). Yahr (2000a) suggests that in cases where it is necessary to burn a specific site critical for this species' persistence, it may be possible to salvage lichens pre-burn in difficult-to-manage sites (where complete burns are possible) and reinstall the fragments post-fire.

f. Other: In experimental transplant treatments, growth of Florida perforate cladonia was found to be highest in bare sand sites in comparison with litter or other lichen species-covered sites (Yahr 1997). Transplant experiments suggest that open sites without shade are best for maximizing growth (Yahr 2000a). Yahr (2000a) found that transplants into unoccupied sites grew just as well as those in occupied sites and suggested that this lichen may be limited by dispersal rather than intolerance to some aspects of unoccupied sites. The maximum distance of spread over a two-year period was approximately 66 feet (20 m), and this may have been higher than expected since all sites were moderately impacted by human trampling (Yahr 2000a). Yahr (2000a) indicated that dispersal of this species beyond occupied rosemary patches may be physically impeded by dense accumulations of leaf litter or by plant stems in intervening cover types. Although lichens are killed by fire and recolonize solely via dispersal from unburned sources, Florida perforate cladonia may be somewhat protected from fire when it occurs in bare-sand gaps and between shrubs, which are considered low- or no-fuel sites (Yahr 2000a). However, Yahr (2000a) also found this species scattered in litter under trees or shrubs where dead leaves and litter can easily carry fire. In high intensity fires sometimes found in rosemary scrub, Florida perforate cladonia is extremely susceptible to destruction by fire, even in gaps with relatively low fuels (Yahr 2000a).

Eglin is the only protected occupied site with a plan that includes management objectives and monitoring and management protocols specifically for Florida perforate cladonia (Eglin 2005b, 2006). Following Hurricane Opal in 1995, Eglin supported work to reintroduce two populations of lichens into a previously populated area on the restricted portion of Santa Rosa Island (Eglin 2004a, 2006). After Hurricane Ivan in 2004, 4 of 28 plots were either completely destroyed or only a few individuals remained; survival at the public beach was approximately 56% (Eglin 2004b, 2005b). Eglin and Historic Bok Sanctuary (HBS) have entered into a conservation agreement to provide a safe haven for Florida perforate cladonia at HBS, located in Lake Wales Ridge (Eglin 2005b). In November 2003, 200 thalli were transported from Eglin to HBS (Eglin 2004a, 2006). This was intended as a source for reintroduction for Eglin in the event of extirpation due to catastrophic hurricane or other major disturbance (Eglin 2005b). However, lichens originally transported to HBS did not survive the 2004 hurricane season; Eglin

and HBS are working towards reestablishing the population at HBS (D. Teague, Eglin, pers. comm. 2007).

Preliminary results from a study to examine the effects of mechanical treatments and fire on Florida scrub vegetation suggests that lichens are killed by fire but not by mowing (Rickey et al. 2006). Preliminary findings indicate that lichen cover decreased in the burn-only and mow and burn treatments one year post-treatment; however, lichen cover did not decrease in the control or mow-only treatments (Rickey et al. 2006).

Analyses by Turner et al. (2006) show the relative importance of the Lake Wales Ridge to Florida perforate cladonia compared to the rest of its range. Turner et al. (2006) indicated that 7 of 14 locations occur on the Lake Wales Ridge. Prior to 1988 on Lake Wales Ridge, the species only occurred on two managed lands (Archbold and Lake Wales Ridge State Forest). The species now occurs at Archbold, Lake Wales Ridge State Forest (Arbuckle Tract), and the Lake Wales Ridge and Environmental Area (Royce-Clements-Apthorpe), owned by FWC (Turner et al. 2006). Only one unprotected site on Lake Wales Ridge, Avon Park Lakes, remains as an acquisition target (Turner et al. 2006). Overall, Turner et al. (2006) found that virtually all of the species investigated will depend upon some form of active management for their long-term persistence, and most would require more intensive monitoring and research and coordinated planning for conservation on public and private lands.

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms) –

a. Present or threatened destruction, modification or curtailment of its habitat or range: Florida perforate cladonia continues to be threatened by habitat loss, modification, and fragmentation. Sources of habitat impacts have been characterized as follows: agriculture (i.e., crops, agroindustry farming, large-scale agriculture, non-timber plantations); land management of non-agricultural areas (i.e., abandonment and change of management regime); infrastructure development (i.e., human settlement, fires) (Yahr 2003). Although many sites are protected, habitat loss along the Lake Wales Ridge and Atlantic Coast Ridge remains a significant threat (Yahr 2003). In these areas, private lands that support unprotected subpopulations or habitat are at risk of development due to high real estate values, and long-term persistence of these occurrences are unlikely without protection (Yahr 2003). Similarly, occupied and suitable habitat in Manatee County that is on private, unprotected land is at risk of habitat loss and degradation due to development and agriculture. Scrub habitats are becoming increasingly fragmented and isolated by urban and agricultural development; recovery of small, isolated populations following a natural disturbance may be more unlikely since larger breaks in suitable habitat exist, making recolonization through natural

dispersal more difficult or impossible (Yahr 1997).

Along the Lake Wales Ridge, which supports the bulk of the subpopulations, the loss of habitat has also resulted in a concomitant reduction in the frequency and extent of wildfires (Yahr 2003, Turner et al. 2006). While public and private entities have protected 21,498 acres (8,700 ha) of scrub and sandhill habitat over the past two decades, protected fragments are surrounded by residential neighborhoods, citrus groves, and other anthropogenic habitats, and are managed by a variety of entities (Turner et al. 2006); management in general is confounded by habitat fragmentation and land ownership. As natural areas have become fragmented, natural fire has been replaced by either fire suppression or prescribed fire (Yahr 2000a). Fire suppression causes the loss of open space and presumably the loss of Florida perforate cladonia (Yahr 2000a). However, wildfires and prescribed fires (e.g., at Archbold and Arbuckle) have reduced populations of Florida perforate cladonia more than fire suppression (A. Johnson, pers. comm. 2007).

Fire is a critical component in the conservation of this species, and improper fire management is considered a threat throughout its range (Yahr 2003). Although some sites have active fire management programs (e.g., Archbold, Lake Wales Ridge State Forest), use of fire at other protected sites is less certain; lack of fire at unprotected sites is also a concern. Yahr (pers. comm. 2007) suggests the loss of even a small percentage of subpopulations could be a problem for this species, since it has few refuges from development, climate change, and habitat loss from management decisions (i.e., too frequent or too infrequent fire return intervals).

The availability of suitable habitat and the ability to adequately manage it is expected to decrease in the future. Analyses by Zwick and Carr (2006) indicate that the central Florida region is expected to experience "explosive" growth, with continuous urban development from Ocala to Sebring; virtually all of the natural systems and wildlife corridors in this region will be fragmented, if not replaced, by urban development. Highlands County, with a population of 93,625 in 2005, is projected to increase to 170,038 by 2060 (Zwick and Carr 2006). Polk County, with a population of 538,220 in 2005, is projected to increase to 1,029,606 by 2060 (Zwick and Carr 2006). Along the Atlantic coast, Martin County, with a population of 140,292, is projected to increase to 277,297 by 2060 (Zwick and Carr 2006). Manatee County, with a population of 302,002 in 2005, is projected to more than double to 643,808 by 2060 (Zwick and Carr 2006). As a result of this development, the chances of finding additional suitable habitat in Manatee County or elsewhere will diminish through time.

Although the majority of known sites are partially protected (FNAI 2006), threats associated with habitat loss, degradation, and fragmentation are still occurring. Threats to suitable habitat (occupied and unoccupied) are expected

to increase with increases in population and human use and are considered imminent and of high magnitude.

b. Overutilization for commercial, recreational, scientific, or educational purposes: Overutilization of this species does not appear to be a current threat. The final listing rule stated that there was little commercial trade of this species (58 FR 25746). However, this species is not considered to be commercially exploited (Coile and Garland 2003), and the Association of Florida Native Nurseries (2007) does not list any wholesale sources of Florida perforate cladonia, suggesting that there is little or no commercial trade.

We do not have evidence of overutilization for scientific or educational purposes. However, over-collection is considered a threat by NatureServe (2006). In a letter of support written after the proposed listing rule (57 FR 45620) in 1992, Roger Rosentreter of Boise State University (in litt.) recommended the restriction of scientific collection of Florida perforate cladonia due to the worldwide interest in the genus and the demand for comparison material of this taxon by ecologists and taxonomists. In another letter of support, William Louis Culberson of Duke University (in litt.) indicated that Florida perforate cladonia was one of few lichens that produce para-depside squamatic acid; while no medicinal or other useful properties had been identified for this natural product because it had not been studied, other lichen products have been found to have medicinal applications. At this time, however, we do not have evidence of collection and do not consider overutilization to be a threat.

c. Disease or predation: The final listing rule did not identify disease or predation as threats (58 FR 25746). However, in 2004, Florida perforate cladonia being housed at HBS appears to have been impacted by a pathogen or mold (Eglin 2004b). Three of four hurricanes that made landfall in 2004 impacted HBS, and prior to each storm HBS personnel collected thalli from the garden bed, placed them in a bucket with native sand, and brought these indoors for protection (Eglin 2004b). After each storm passed, thalli were returned to the garden bed (Eglin 2004b). Although lichen appeared unaffected following the first hurricane, overall health appeared to decline after the last two storms (Eglin 2004b). Yahr suggested that this could be due to loss of native sand during the storm event and / or the result of not fully drying out while indoors, causing them to be affected by some pathogen or mold (Eglin 2004b). The original thalli relocated to HBS have died with one cause being pathogen or mold (D. Teague, pers. comm. 2007). Eglin is awaiting a new permit to take additional lichen to HBS with precautions in place for future relocations (D. Teague, pers. comm. 2007). Precautions are now in place should the lichen need to be moved indoors in the future (Eglin 2004b). In addition, precautions to prevent growth of mold have been incorporated into Eglin's reintroduction protocol (Eglin 2005b).

At this time, it is difficult to assess the overall magnitude and immediacy of this threat. It appears that precautions are in place to reduce this threat in controlled environments. The extent to which pathogens or mold occurs on Florida perforate cladonia in its natural habitat is not known.

d. Inadequacy of existing regulatory mechanisms: At the time of Federal listing, Florida perforate cladonia became a State endangered species.

The Preservation of Native Flora of Florida law, Rule Chapter 5B-40 of the Florida Administrative Code under authority from the Florida Statutes Chapter 581.185, 581.186 and 581.187 (fines defined in 581.141) provides protective measures to the Regulated Plant Index of endangered, threatened, and commercially exploited taxa. Permitting is administered by the Division of Plant Industry of the Florida Department of Agriculture and Consumer Services. It is unlawful for any person to willfully destroy or harvest Florida perforate cladonia growing on the private land of another or on any public land without first obtaining the written permission of the landowner or legal representative of the landowner and a permit from the Division of Plant Industry.

With additional State protection, regulatory mechanisms for this species have, in general, improved since its federal listing in 1993. However, despite this added protection, losses of the species and its habitat on public and private land continue to occur. While the taking, transport, and sale of this species is regulated under State law, neither State nor Federal law provides adequate habitat protection because both laws only protect against possession of the plant and not its habitat. Therefore, existing regulatory mechanisms do not appear to be adequate.

e. Other natural or manmade factors affecting its continued existence: Florida perforate cladonia continues to be threatened by numerous natural and anthropogenic factors, including: accidental mortality, human disturbance, natural disasters, pollution, and intrinsic factors (Yahr 2003). Habitat loss and alteration from invasive exotic plants and the treatment of exotics may also be threats.

Human activities, including ORV use, trash dumping, and inadvertent trampling during outdoor recreation activities, as identified at the time of listing (58 FR 25746), continue to threaten this species. Physical destruction of the lichen itself and destabilization of its habitat is a concern at some sites. Crushing or trampling by vehicles, animals, and humans may break up thalli into small fragments that are easily carried away by the wind into unsuitable habitats (swales, areas of heavy leaf litter, or other vegetation), easily covered by wind-swept sand, or too small to recolonize suitable habitats. Based upon data from FNAI (2006), it appears that at least 6 occurrences may be impacted by human activities and / or ORV use at three locations (Eglin, Avon Park

Lakes, and Jupiter Ridge Natural Area). However, unrestricted human activities have the potential to impact the species or its habitat at any occupied site (public or private). In the North Gulf Coast, recreational use continues to increase on the eastern section of Santa Rosa Island; however, Eglin is taking steps to minimize impacts to Florida perforate cladonia (e.g., exclusion areas, beach access points, designated foot trails, fencing) on the public use portion of the island (Eglin 2005b). Eglin is also taking precautions to protect the lichen (fencing, flagging, monitoring) during mission activities and in restricted areas (Eglin 2005b). However, vehicle damage at the east population has occurred over the years (R. Yahr, pers. comm. 2007). In 2003, damage occurred to lichen within three reintroduced subpopulations when contractors working on fence installation drove ATVs through the area (Stevens 2003). Other documented unauthorized recreation in the restricted area includes: beach driving, sand dune sledding/boarding, night camping, campfires, climbing on and traversing the dunes where not protected. Such activities can result in the physical destruction of the lichen and destabilization of the sand dunes. Management of Florida perforate cladonia should include protection of all sites from vehicle or heavy foot traffic (Service 1999).

Natural events such as storms and wildfires are a threat to Florida perforate cladonia and its habitat. However, such natural periodic disturbances may be important in maintaining adequate habitat structure (Menges and Kohfeldt 1995, Hawkes and Menges 1996, Yahr 2000a). Florida perforate cladonia has no apparent recovery mechanism (e.g., stored seed, spore bank, persistence of underground penetrating structures) for tolerating disturbances and can survive only in relatively undisturbed areas (Yahr 2000c). With high intensity fires typical of rosemary scrub habitats, this species is extremely susceptible to destruction by fire even in gaps with relatively low fuels (Yahr 2000a). During a prescribed fire at Lake Wales Ridge State Forest in 2005, one large area of lichen (4.4 acres [1.8 ha]) was nearly extirpated because the fire burned hotter than expected despite efforts to ensure survival of the subpopulation (K. Clanton, pers. comm. 2007). Low-fuel patches that do not carry fire are critical refugia for this species and must be maintained for subpopulations to persist (Yahr 2000a, 2003).

Similarly, hurricanes are a major threat, causing overwash and windthrow into unsuitable habitat (Yahr 2003). Unattached to its substrate, Florida perforate cladonia is susceptible to high winds, which may result in fragments being carried out of suitable habitat and reduce the species' ability to maintain itself (Yahr 2000c, NatureServe 2006). In 1995, Hurricane Opal had winds in excess of 100 miles-per-hour and caused storm surge over 20 feet (6 m) in the vicinity of populations on Santa Rosa Island; two of the three subpopulations were extirpated and a third subpopulation was reduced by more than 70% (Yahr 1997, 2000c, 2003). Several additional hurricanes and tropical storms have affected Santa Rosa Island since Opal, the most notable being Hurricane

Ivan (category 3) in 2004 (Eglin 2004b, 2006). A significant amount of sand had shifted within the dunes supporting the lichen and the area had been inundated by water and contained a considerable amount of debris, prompting rescue efforts to unbury as much lichen as possible within a two day span (Eglin 2004b). Overall an estimated 40% of the population was lost due to the storm surge and coverage by sand and debris (Eglin 2006). Future hurricanes in Florida along the North Gulf Coast and Atlantic Coast continue to place populations at risk.

Intrinsic factors including limited dispersal, slow growth rates, population fluctuations, and restricted range are also threats to this species (Yahr 2003). Yahr (1997) suggested that local patches or isolated mats that are destroyed by locally severe disturbances can be recolonized and recover only from a relatively local source if intervening barriers to dispersal do not exist (e.g., litter impedes or prevents movement of fragments, surface or standing water kills fragments). Increasingly fragmented and isolated scrub habitats coupled with periodic natural disturbances can be catastrophic (Yahr 1997). For example, the extirpation of a small isolated population may not be recoverable because of larger breaks in suitable habitat and limited dispersal (Yahr 1997). Populations exposed to repeated catastrophic losses (e.g., hurricanes in coastal areas, fires in inland areas) may no longer have a local source from which to disperse and thus, be at a higher risk of extinction (Yahr 1997). The species' poor dispersal and patchy distribution make it inherently vulnerable to extinction from large-scale disturbances (Yahr 1997).

Historical population bottlenecks and resulting low genetic diversity are a concern (Yahr and DePriest 2005). Since each population is predominantly clonal, variability can only be protected by protecting multiple, genetically different, populations (Yahr and DePriest 2005). However, despite the low number of genotypes and strong spatial structure, Yahr and DePriest (2005) suggest that populations are likely to be stable under natural disturbance regimes. Yahr and DePriest (2005) believe that the overall risks from demographic factors appear low compared to those associated with habitat loss and improper management.

In addition, many lichens are sensitive to air pollution, and the IUCN redlist lists atmospheric pollution as a major threat to the species and / or its habitat (Yahr 2003). In general, lichens are sensitive to gaseous pollutants, especially sulfur dioxide, nitrogen oxides, ozone, and fluorine (Blett et al. 2003). Lichens are also sensitive to depositional compounds, particularly sulfuric and nitric acids, sulfites and bisulfites, and other fertilizing, acidifying, or alkalinizing pollutants (Blett et al. 2003). Yahr and DePriest (2005) acknowledge that lichen sensitivity to air pollution presents a difficult management issue since air- and wind-borne pollutants cross management and jurisdictional boundaries. The extent to which Florida perforate cladonia and its habitat may be affected by air pollution is not known at this time.

The IUCN redlist for this species lists global warming / oceanic warming as a major threat to the species and / or its habitat (present, future) (Yahr 2003). Since roughly half of the known populations occur in coastal scrub (FNAI 2006), sea level rise may impact the species and its habitat in the future (e.g., inundation, overwash from storms). The extent to which Florida perforate cladonia and its habitat may be impacted by increased sea level or climate change is not known.

At this time, invasive exotic plants do not appear to be a significant threat to Florida perforate cladonia (Service 1999). However, in isolated areas, exotic species are becoming established. Without control, exotic/invasive plants may become a threat to the species or its habitat. Eglin (2006) has incorporated a management objective into its management plan to survey for invasive non-native plant species on at least a five-year cycle and to treat documented species on an annual basis. However, treatment of exotics through management actions (e.g., herbicides) may inadvertently present additional threats. For example, herbicide treatment activities may result in trampling by application crews (D. Teague, pers. comm. 2007). Eglin (2006) has incorporated precautions into its management plan to decrease the likelihood of impacts to the lichen during exotics control (e.g., treatment crews trained in identification to avoid walking on lichen, hand removal of exotics to reduce herbicide use).

Numerous natural and anthropogenic factors threaten Florida perforate cladonia and its habitat at this time; we expect most of these threats to increase through time. Overall, the magnitude of threats from natural and human-caused factors is considered high and immediacy, imminent.

D. Synthesis - The species' recovery plan contains objective, measurable criteria for reclassification. Based upon inventories, there appears to be 16 sites or populations in four geographic regions in Florida (DOF 2006, FNAI 2006, Turner et al. 2006). Little current abundance data are available. Life history, ecology, and demographic features and trends of this species remain poorly understood. This species grows slowly and its large, bulky, vegetative fragments are poor dispersers; limited dispersal may be the most important demographic feature (Yahr 2000a, 2003; Yahr and DePriest 2005). Relationships between genotypes suggest isolated and severely bottlenecked relictual populations (Yahr 2000b). Since each population is predominantly clonal, variability can only be maintained by protecting multiple, genetically different, populations (Yahr and DePriest 2005).

Florida perforate cladonia is a narrow endemic, distributed in widely disjunct regions and restricted to isolated patches of suitable habitat (Yahr 2000b). Each region consists of several or many severely fragmented occupied habitat patches; most subpopulations likely contain less than 24.7 acres (10 ha) coverage of lichen, and some contain only a few square meters (Yahr 2003). This species has benefited from

conservation efforts. Land acquisition efforts along the Lake Wales Ridge and elsewhere have resulted in the majority of known sites being partially protected on public and private lands.

Threats from habitat loss, degradation, and fragmentation are currently occurring at protected and unprotected sites. Fire is a critical component in the conservation of this species, and improper fire management is considered a threat throughout its range (Yahr 2003). The availability of suitable habitat (occupied and unoccupied) and the ability to manage it is expected to decrease in the future with projected population growth and increases in human use (Zwick and Carr 2006). Natural events such as fires and hurricanes are major threats and likely to occur (Yahr 2003). Recreation activities (e.g., ORV use, walking on dunes) can destroy lichen and disturb habitat. Intrinsic factors including limited dispersal, slow growth rates, population fluctuations, and restricted range are also threats (Yahr 2003). Historical population bottlenecks and resulting low genetic diversity are a concern (Yahr and DePriest 2005). In addition, atmospheric pollution and climate change may be major threats to the species and / or its habitat (Yahr 2003); potential and long-term impacts are not known and may be difficult to address. The extent to which pathogens or mold affects Florida perforate cladonia in its natural habitat is not known, but protocols are in place to reduce this threat in controlled environments. Exotic species and treatment of exotics is considered a potential threat. For these reasons, Florida perforate cladonia continues to meet the definition of endangered under the Act.

III. RESULTS

A. Recommended Classification:

_X__ **No change is needed**

B. New Recovery Priority Number 5c

We are recommending a change in priority number to 5c, high degree of threat with low recovery potential and conflict (48 FR 43098, 48 FR 51985). Recovery potential is severely limited by several factors: (1) slow growth and population expansion (Yahr 2000a, 2000d); (2) limited unoccupied habitat for new colonization (R. Yahr, pers. comm. 2007); (3) limited dispersal capabilities (Yahr 1997, 2000a, 2003; Yahr and DePriest 2005); and, (4) lack of ability to propagate/encourage growth (e.g., unsuccessful attempts at HBS to grow *ex situ*, despite best efforts) (R. Yahr, pers. comm. 2007).

IV. RECOMMENDATIONS FOR FUTURE ACTIONS -

- Secure land that supports this species where possible (Service 1999, Yahr and DePriest 2005, Turner et al. 2006). Protect populations on private land through acquisition, conservation easements, or agreements with landowners (Service 1999).
- Protect populations on public lands. Include specific management goals and objectives for Florida perforate cladonia in management plans for State and Federal lands and other protected areas (H. Swain, pers. comm. 2007). Develop management guidelines that allow for a fire regime that includes a mosaic of successional stages including fire frequency,

lighting practices, fire intensity, and avoidance (Service 1999; Yahr 2000a; A. Cox, pers. comm. 2007; H. Swain, pers. comm. 2007). Public lands with potential for wildfire incidents should have preexisting plans in place to support decision making the day of the event.

- Protect multiple, genetically different, populations (Yahr and DePriest 2005).
- Prevent loss, modification, and degradation of existing habitat.
- Avoid overly regular fire regimes, fire suppression, or burning too frequently and encourage a mosaic of times since fire for each habitat type (Menges and Kohfeldt 1995, Yahr 2000a). Encourage patchy burns in rosemary scrub (H. Swain, pers. comm. 2007).
- Maintain unburned refugia during prescribed fire and low-fuel patches that do not carry fire; these are critical refugia for this species and must be maintained for subpopulations to persist (Yahr 2000a, 2003). If effective means of protecting refugia are developed, coordinate with conservation and land management entities to ensure further protection of refugia (K. Clanton, pers. comm. 2007).
- Quantify (using GIS analysis) the degree to which current fire practices are providing a mosaic of unburned and burned patches, based on available fire intensity maps and burn histories; adjust fire regime and prescribed fire guidelines based on these results (H. Swain, pers. comm. 2007).
- Protect all sites from vehicle or heavy foot traffic (Service 1999). Limit access and prevent ORV traffic in public areas where this species occurs (FNAI 2006). Monitor and evaluate the impact of vehicle or heavy foot traffic (H. Swain, pers. comm. 2007).
- Maintain coastal scrub habitat; patches of stable vegetation that are resistant to wind and water erosion from hurricane overwash may serve as refugia (Yahr 1997).
- Monitor existing populations. Detailed monitoring information from most populations is largely absent. Monitor to detect changes in population status and to assess the effects of land management actions on this species (Service 1999). Monitoring burned sites that formerly supported the species would be particularly useful to understand how well and how quickly the species recovers after fire so the risks of burning areas where it occurs can be assessed accurately (A. Johnson, pers. comm. 2007).
- Establish and implement a feasible and statistically-reliable monitoring protocol (R. Yahr, pers. comm. 2007).
- Convene an expert group to develop standardized monitoring practices, facilitate summary information, and compare long-term trends across sites in relation to fire management and other management practices (H. Swain, pers. comm. 2007).
- Share monitoring protocols with administrators and other appropriate personnel within each cooperating entity to ensure wider appreciation and application of these protocols. Such staff should include all those active in land management decisions and those responsible for the application of land management (K. Clanton, pers. comm. 2007).
- Convene an expert group to determine the key components of population biology and demographic processes that can, and should, be measured (H. Swain, pers. comm. 2007). Continue research to determine demographic information (Service 1999; K. Clanton, pers. comm. 2007). Determine what demographic data are needed to conduct population viability and risk assessment analyses, then collect data and conduct analyses (H. Swain, pers. comm. 2007). Rigorous sampling methods need to be developed and consistently applied (R. Yahr, pers. comm. 2007).
- Expand work to better understand genetics, genetic variation, and trends in genetic variation. Based on an analysis of 16 populations across three regions of Florida, Yahr (pers. comm.

2007) has found strong evidence for fungal clonality within sites and evidence for differences among geographic regions. These data are not yet published, but should be available soon (R. Yahr, pers. comm. 2007).

- Conduct surveys for additional populations. It appears that there are data gaps in Manatee and Polk Counties. There may be additional populations that have not been located, especially in central Florida and on the east coast (A. Cox, pers. comm. 2007). In addition, scrub and high pine habitat in Osceola, Hardee, and Hendry Counties should be surveyed for possible occurrences and potential habitat (Service 1999). Since this species has never been reported from these counties, it might be more productive to make sure that biologists and land managers are informed of what this species looks like so that they can report any new occurrences (A. Johnson, pers. comm. 2007).
- Restore areas to suitable habitat and restore natural fire regimes. Explore restoration techniques to assess effective practices for Florida perforate cladonia (H. Swain, pers. comm. 2007). Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves; depending on fire management needs (Service 1999).
- Determine if pathogens or mold are threats to Florida perforate cladonia in its natural environment, following hurricanes, tropical storms, or other flooding events.
- Continue safe haven population efforts at HBS with collections from other sites or across the range of the species; this project should be carefully monitored in light of its poor survival rate (R. Yahr, pers. comm. 2007). If more lichen will be transported for *ex-situ* conservation, individuals must be grown on extremely well-drained white sand collected from a native source (R. Yahr, pers. comm. 2007).
- Continue to provide the public with educational information about scrub and its unique biota (Service 1999). This is especially important at Eglin, where the largest population is quite susceptible to trampling and damage from vehicular access (R. Yahr, pers. comm. 2007). Yahr (pers. comm. 2007) states that two parts of this education process must be considered, authorities and the public. Yahr (pers. comm. 2007) states that is imperative that local authorities and contractors are made aware of the delicate nature of lichen habitats. Boardwalks and informational panels describing the delicate dune habitats should be provided, and access limited as much as possible by encouraging the use of well-maintained trails, boardwalks and beach facilities (R. Yahr, pers. comm. 2007).
- Consider translocating "individuals" (e.g., whole individuals, fragments) from each of the four geographical areas to other regions to increase genetic diversity within each region, using great caution so as to not inadvertently transfer noxious biological agents such as molds or pathogens (K. Clanton, pers. comm. 2007). Consult with experts on Florida perforate cladonia (i.e., Yahr and DePriest) prior to planning and implementing (K. Clanton, pers. comm. 2007).

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of
Florida perforate cladonia (*Cladonia perforata*)

Current Classification ___Endangered_____
Recommendation resulting from the 5-Year Review

_X__ **No change is needed**

Appropriate Listing/Reclassification Priority Number, if applicable _____

Review Conducted By __Paula J. Halupa_____

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 9-5-07

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

for **Lead Regional Director, Fish and Wildlife Service**

Approve _____ Date 9/17/07

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. If a change in classification is recommended, written concurrence from other regions is required.

APPENDIX A: Summary of peer review for the 5-year review of Florida perforate cladonia (*Cladonia perforata*)

A. Peer Review Method: The Service conducted an influential level of peer review. Recommendations for peer reviewers were solicited from the Florida Department of Agriculture and Consumer Services, Florida Division of Forestry and Florida Division of Forestry, Plant Conservation Program; Highlands County Department of Planning; and Florida Department of Environmental Protection. Additionally, one peer reviewer was selected by the Service. Individual responses were requested from seven peer reviewers and one additional technical reviewer. Responses were received from seven reviewers.

B. Peer Review Charge: See attached guidance.

C. Summary of Peer Review Comments/Report: Peer review comments provided insights that were beneficial in conducting this review. Although there were a variety of substantive comments, they predominantly addressed degrees of emphasis as opposed to points of contention or entirely new subject matter. Comments and concerns covered a variety of topics and included the following general needs: establish a feasible and statistically-reliable monitoring protocol and apply monitoring methods consistently; obtain demographic data and conduct rigorous studies to determine population viability; develop management guidelines, especially relating to fire management; include specific goals and objectives for Florida perforate cladonia in management plans for State, Federal, and other protected lands; conduct additional surveys to locate additional populations that may exist; make biologists and land managers aware of the species' possible presence so that potential new findings can be reported; and provide the public with educational information about scrub and its unique biota in a positive way to minimize damage to vulnerable populations in recreation areas.

More specific needs relating to fire management were also identified, including the need to: maintain unburned refugia during prescribed fires; use patchy burns that require prescriptions that set this as an explicit goal; use lighting patterns to facilitate patchy burns; avoid intensive head fires, or particularly hot fires, going through rosemary balds; monitor burned sites that formerly supported the species to understand how well and how fast the species recovers after fire so impacts can be assessed accurately; and design prescribed burns to meet the needs of multiple listed species dependent on rosemary scrub. It was suggested that the degree to which current fire practices are currently providing a mosaic of unburned and burned patches be quantified, using GIS analyses and based on available fire intensity maps and burn histories; these results could be used to adjust fire regime and prescribed fire guidelines. In general, the challenge of implementing a fire return interval that maintains rare rosemary scrub specialists and also allows for persistence of Florida perforate cladonia was acknowledged by several reviewers.

Concerns were expressed over the lack of genetic variability among populations and the possible need to establish a more complete *ex situ* tissue bank or translocate individuals from each of the four major geographically areas to other regions to increase genetic diversity within each region. However, concerns were also expressed over the lack of success in establishing a safe haven population since lichens originally collected did not survive. It was recommended that the

project by Eglin and HBS be reconsidered. Concerns were also expressed over: the use of mechanical treatments in land management and the potential impacts to this species; habitat loss and modification from exotic species and impacts from treatment of exotic species (herbicide, trampling); and damage from pedestrians and vehicles. It was suggested that the impacts of vehicle or heavy foot traffic be monitored.

One reviewer suggested that an expert group be convened to develop standardized monitoring practices, facilitate summary information, and compare long-term trends across sites in relation to fire management and other management practices. This reviewer also suggested that an expert group be convened to determine what key components of population biology and demographic processes can, and should, be measured. We agree that it would be beneficial to have standardized monitoring protocols applied consistently across the range of the species over the long-term to better understand the species' current status and future trends.

Finally, it was suggested that experiments with restoration techniques be conducted to assess effective practices for this species. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves, depending on fire management needs.

D. Response to Peer Review: The Service was in agreement with essentially all of the comments and concerns received from peer reviewers. Comments were largely incorporated.

Guidance for Peer Reviewers of Five-Year Status Reviews

U.S. Fish and Wildlife Service, South Florida Ecological Services Office

February 20, 2007

As a peer reviewer, you are asked to adhere to the following guidance to ensure your review complies with U.S. Fish and Wildlife Service (Service) policy.

Peer reviewers should:

1. Review all materials provided by the Service.

2. Identify, review, and provide other relevant data apparently not used by the Service.

3. Not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.

4. Provide written comments on:
   - Validity of any models, data, or analyses used or relied on in the review.
   - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
   - Oversights, omissions, and inconsistencies.
   - Reasonableness of judgments made from the scientific evidence.
   - Scientific uncertainties by ensuring that they are clearly identified and characterized, and that potential implications of uncertainties for the technical conclusions drawn are clear.
   - Strengths and limitation of the overall product.

5. Keep in mind the requirement that the Service must use the best available scientific data in determining the species' status. This does not mean the Service must have statistically significant data on population trends or data from all known populations.

All peer reviews and comments will be public documents and portions may be incorporated verbatim into the Service's final decision document with appropriate credit given to the author of the review.

Questions regarding this guidance, the peer review process, or other aspects of the Service's recovery planning process should be referred to Cindy Schulz, Endangered Species Supervisor, South Florida Ecological Services Office, at 772-562-3909, extension 305, email: Cindy_Schulz@fws.gov.