

Rock gnome lichen
(Gymnoderma lineare)

**5-Year Review:
Summary and Evaluation**



(U.S. Fish and Wildlife Service photo)

**U.S. Fish and Wildlife Service
Southeast Region
Asheville Ecological Services Field Office
Asheville, North Carolina**

March 2013

5-YEAR REVIEW

Rock Gnome Lichen (*Gymnoderma lineare*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: We announced initiation of this review and requested information in a published *Federal Register* notice with a 60-day comment period (72 FR 54057). Pertinent data were obtained from the recovery plan, published papers, unpublished reports, and experts on this species. Once all data were gathered for this species, the status information was compiled and the review was completed by the species' recovery lead biologist in the U.S. Fish and Wildlife Service's (USFWS) Asheville Ecological Services Field Office (ESFO) in Asheville, North Carolina. In conducting this 5-year review, we relied on the best available information pertaining to historical and current distribution, life history, habitats, and potential threats to this species. During the comment period, we did not receive any additional information about *Gymnoderma lineare* in response to the *Federal Register* notice. However, we did receive additional information about the species in response to requests for specific information that were made (by the USFWS) directly to biologists familiar with the species. A draft of the 5-year review was peer reviewed by three experts familiar with the plant (see Appendix A). No part of the review was contracted to an outside party. Comments received on this review were evaluated and incorporated as appropriate.

B. Reviewers:

Lead Region: Southeast Regional Office, Atlanta, Georgia - Kelly Bibb, 404/679-7132. Harold Mitchell (on detail to SERO)

Lead Field Office: Asheville ESFO, Asheville, North Carolina – Carolyn Wells (originating author; moved to a new office and position), Mara Alexander (new lead) 828/258-3939, Ext. 238.

Cooperating Field Offices: Tennessee ESFO, Cookeville, Tennessee – Geoff Call, 931/528-6481, Ext. 213; South Carolina ESFO, Charleston, South Carolina – Melissa Bimbi, 843/727-4707, Ext. 217; North Georgia ESFO, Athens, Georgia – Jimmy Rickard, 706/613-9493; Virginia ESFO, Gloucester, Virginia - Kim Smith, 804/693-6694, Ext. 126.

Cooperating Region: Northeast Regional Office, Hadley, Massachusetts – Mary Parkin, 617/417-3331.

C. Background:

1. Federal Register Notice citation announcing initiation of this review:
72 FR 54057; September 21, 2007

2. Species status: Increasing. There are now 85 known populations of *G. lineare*, which is an increase from the 35 known when the 1997 recovery plan (USFWS 1997) was written. Individual populations have not been monitored closely enough to know if they are increasing, decreasing, or are stable over time.

3. Recovery achieved: 1 (1 to 25 percent of species' recovery objectives achieved).

4. Listing history:

Original Listing:

FR notice: 60 FR 3557

Date listed: January 18, 1995

Entity listed: species

Classification: endangered

5. Associated rulemakings: Determination that critical habitat is not prudent for the species: 66 FR 51445

6. Review History:

Final recovery plan: 1997

Recovery Data Call: 1998-2011

7. Species' Recovery Priority Number at start of review (48 FR 43098): 5. This means a species with a high degree of threats and a low recovery potential.

8. Recovery plan:

Name of plan: Recovery Plan for the Rock Gnome Lichen (*Gymnoderma lineare*) (Evans)

Date issued: September 30, 1997

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy: The Endangered Species Act (Act) defines species as including any subspecies of fish or wildlife or plants and any DPS of any species of vertebrate wildlife. This definition limits listing DPSs to only vertebrate species of fish and wildlife. Because the species under review is a plant, the DPS policy is not applicable.

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 five listing factors that are relevant to the species addressed in the recovery criteria? Yes.**
- 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:** The 1997 recovery plan states the following:

*Rock gnome lichen (*Gymnoderma lineare*) will be considered for downlisting when at least 30 populations are stable over 5 years (not more than a 10-percent cumulative decline in coverage at each stable population and no extirpation of other populations over the 5-year monitoring period) and these 30 populations are in protective ownership (either on public land, such as parks and forests, where the managing agency is providing continuous monitoring and protection for the species, or on private land, where a long-term protection/management agreement with the owner is in place).*

The species will be considered for delisting when at least 40 populations are stable for a minimum of 10 years (not more than a 10-percent cumulative decline in coverage at any one of the stabilized populations and no extirpation of other populations over the 10-year monitoring period), and all of these populations are in protective ownership as defined in the downlisting criteria.

The 1995 listing rule (60 FR 3557) and the 1997 recovery plan (USFWS 1997) described the distribution of *G. lineare* in terms of “populations.” The criteria used to aggregate sites into populations are not readily

apparent from a review of our species files, which contain a list of sites known at the time the listing rule and recovery plan were prepared. In this review, references to the number of populations known at the time of listing and as of the publication of the recovery plan, are consistent with the counts provided in these documents. However, in this review, the USFWS will define “populations” consistent with the application of NatureServe element occurrence (EO) mapping standards for plants, available at:

<http://www.natureserve.org/prodServices/heritagemethodology.jsp>

In effect, this means that sites mapped together under a principal (parent) EO will be treated as members of a single “population”; and stand-alone EO records that are not linked with other locations (via a principal EO) will each be treated as a discrete population. Sites not yet mapped by a state Natural Heritage Program (NHP) will be aggregated into populations by applying the mapping standards devised by NatureServe. With respect to *G. lineare*, application of these standards will usually result in sites occurring within the same watershed or not otherwise separated by significant areas of unsuitable habitat being treated as members of the same population.

As of the 1997 recovery plan (USFWS 1997), 35 populations were known to exist; these populations occurred in North Carolina (25), Tennessee (7), Georgia (1), South Carolina (1), and 1 straddled the state line between North Carolina and Tennessee. Five populations were thought to have been extirpated.

In 2012, the species’ total range remains essentially the same, with the notable exception of a small population in Grayson County, Virginia (occupying an area of 6 square inches). Within the last 15 years, numerous populations have been discovered. The total number of known populations has increased from 35 to 85. These 85 are distributed across North Carolina (75), Tennessee (7), Georgia (1), South Carolina (1), and Virginia (1). Two of the five populations considered as extirpated in the recovery plan have been rediscovered. Of the remaining three, one was last observed in 1972 and has not been searched for since; another was last observed (despite surveys) in 1990, immediately prior to road construction that affected its habitat; and a third may be an erroneous report. This last population is reported from within the Great Smoky Mountain National Park (GSMNP), but the GSMNP botanist is not aware of the species’ having occurred at this location (Janet Rock, GSMNP, personal communication, 2008). Three additional North Carolina populations counted in the listing rule (60 FR 3557) and recovery plan are not mapped in the North Carolina Natural Heritage Program database, and supporting information for these reports (other than a brief mention of the locality) is

lacking. For purposes of this review, these three populations are regarded as potentially erroneous and have not been included in the tally of 85 known populations.

Despite the increase in the number of known populations, the recovery criteria specifying 30 protected, stable populations for downlisting and 40 protected, stable populations for delisting remain appropriate targets for recovery.

With respect to land ownership and protection, 75 populations occur on land with some potential to afford protection to this species and its habitat (e.g., owned and managed by federal, state, or city government or by private conservation organizations or otherwise subject to a conservation easement held by a conservation organization). Specifically, 56 populations occur entirely on land managed by the federal government, including the National Park Service (NPS) and the U.S. Forest Service (USFS); 9 occur on land managed by a state natural resource agency; 1 spans properties owned by the USFS and North Carolina State Parks; 9 are privately owned but subject to conservation agreements; and 11 occur on privately owned land not subject to any form of resource protection. However, continuous monitoring and protection (as specified in the recovery criteria) are not occurring at any population, nor are any populations in conserved private ownership subject to a long-term protection/management agreement with the owner (also specified in the recovery criteria).

Regarding the recovery criterion of population stability over a 5-year (for downlisting) or a 10-year (for delisting) time frame, no population has yet been demonstrated to be stable over a 5-year time frame. The level of survey effort that has taken place at most sites is not adequate to detect a 10-percent change in the species' coverage (a threshold established in the recovery criteria). According to state NHP data, the date of last observation for 19 of the 35 (54 percent) populations referenced in the recovery plan (USFWS 1997) remains the same as it was when it was written, meaning either that the species has not been found at these locations despite surveys or that there has been no subsequent recorded effort to locate the species at these sites.

Few data exist to adequately assess the status and population trend information for *G. lineare*. Discussions with those familiar with the species reveal a range of opinions with respect to the species' status, trends, and relative abundance as well as its degree of imperilment and susceptibility to threats. While some regard the species as more abundant and populations larger than originally thought (Chris Ulrey, NPS, personal communication, 2008), others have expressed concern about desiccation and dieback at existing sites (Dave Danley, USFS, personal

communication, 2008; Gary Kauffman, USFS, personal communication, 2008; Jesse Pope, Grandfather Mountain Stewardship Foundation, personal communication, 2008). In the absence of structured monitoring data, these assessments remain difficult to objectively assess.

C. Updated Information and Current Status

1. Biology and habitat

- a. **Abundance, population trends (e.g., increasing, decreasing, stable), demographic features, or demographic trends:**
Discussed in section B.3, above.
- b. **Genetics, genetic variation, or trends in genetic variation:** We are not aware of any evaluations of genetics (including genetic variation within or among populations) conducted on *G. lineare*. However, the small size exhibited by most populations may imply that genetic variability within populations is reduced.
- c. **Taxonomic classification or changes in nomenclature:** This species was federally listed under the name *Gymnoderma lineare* (Evans) Yoshimura and Sharp. Yoshimura and Sharp (1968) reclassified Evans' (1947) *Cladonia linearis* on the basis of its short and solid podetia (stem-like structures supporting the spores produced by a lichen thallus). *Gymnoderma lineare* is the only member of this genus occurring in North America; the other two species occur in the mountains of Japan and Eastern Asia, including the Himalayas (Yoshimura and Sharp 1968). There is a publication which reclassifies the genus *Gymnoderma* Nyl. sensu Yoshimura and Sharp (Cladoniaceae) (Wei and Ahti 2002). This paper recognizes a new monotypic genus (*Cetradonia* Wei and Ahti) in a new family (Cetradoniaceae Wei and Ahti), based upon *Cladonia linearis* Evans. Under the classification proposed by Wei and Ahti (2002), *Gymnoderma lineare* is reclassified to *Cetradonia linearis*. Although this new binomial has not yet been recognized in the Integrated Taxonomic Information System, if it does become recognized as valid, the USFWS will submit a technical (taxonomic) change to the federal list changing the scientific name from *Gymnoderma lineare* to *Cetradonia linearis*. A name change to a monotypic genus would change the recovery priority number of the taxon from 5 to 4.
- d. **Spatial distribution, trends in spatial distribution, or historic range (e.g., corrections to the historical range, change in distribution of the species within its historic range, etc.):**
Discussed in section B.3, above.

- e. **Habitat or ecosystem conditions:** *Gymnoderma lineare* is endemic to the Southern Appalachian Mountains of North Carolina, Tennessee, Virginia, South Carolina, and Georgia, where it occurs on high-elevation cliffs (frequently bathed in fog) or in deep river gorges at lower elevations (where the humidity is high). *Gymnoderma lineare* occurs in dense colonies of narrow strips (squamules). The rocks on which this lichen grows are of several types, including igneous, metamorphic, and metasedimentary rocks, such as quartz diorite, garnet-rich biotite, muscovite and quartz schist, quartz phyllite, metagraywacke, metaconglomerate, and metarkoses containing feldspar and chlorite, amphibole, hornblende, and feldspar gneiss (Massey et al. 1980).

The climate of occupied sites is boreal microthermal, cooler and wetter than local and sectional climates (Morgan 1980). It does well on moist, generally open sites with northern exposures, but needs at least partial canopy coverage where the slope aspect is southern or western.

2. **Five-Factor analysis**

- a. **Present or threatened destruction, modification or curtailment of its habitat or range:** Destruction and adverse modification of habitat pose a major threat to the remaining populations of this species. Some of the historically known populations have been completely extirpated, and many others have been severely reduced in size. Eighty-five populations remain, most covering an area less than 1 square meter (1.2 square yards) in size. Although the majority of the populations are on publicly owned land, many of these are subject to heavy recreational use such as rock climbing. Rock climbers can inadvertently slough the lichen off the rock face while on their ascent or descent.
- b. **Overutilization for commercial, recreational, scientific, or educational purposes:** *Gymnoderma lineare* is not currently a significant component of the commercial trade. Hale (1979) stated, “[t]his is one of the most unusual endemic lichens in North America and should not be collected by individuals.” Nevertheless, many populations have been decimated by scientific collectors. Given the very small size of most colonies and the slow growth rate of this species, extirpation by collecting is a distinct possibility (Weakley 1988).
- c. **Disease or predation:** This taxon is not known to be threatened by disease or predation.

- d. **Inadequacy of existing regulatory mechanisms:** *Gymnoderma lineare* is state-listed as endangered in North Carolina, Tennessee, and Georgia. The North Carolina Plant Conservation and Protection Act (North Carolina Code Article 19B, § 106-202.12) provides limited protection from unauthorized collection and trade of plants listed under that statute. However, the statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities. Plant species are afforded even less protection in South Carolina, where they are protected only from disturbance where they occur on those properties owned by the state and specifically managed as South Carolina Heritage Preserves (South Carolina Code of Regulations, Part 123 § 200-204). *G. lineare* is protected under the Tennessee Rare Plant Protection Act of 1985 (T.C.A. 51-901), which forbids persons from knowingly uprooting, digging, taking, removing, damaging, destroying, possessing, or otherwise disturbing for any purpose, any endangered species from private or public land without the written permission of the landowner. The Virginia Endangered Plant and Insect Species Act (Chapter 10 § 3.2-1000 through 1011 of the Code of Virginia, as amended) primarily regulates collection and trade in listed species and does not prohibit landowners from neglecting or otherwise impacting such species on their own property or in conjunction with otherwise legal activities. Georgia has laws protecting rare plants (Georgia Code Ann., Secs. 27-3-130 et seq.) and animals (Secs. 12-6-171 et seq.) Listing under both acts is limited to scientific and commercial criteria. Habitat acquisition is authorized but not required. The acts do not require recovery plans or agency consultation. Violations constitute a misdemeanor. In addition, the Georgia Environmental Policy Act requires the assessment of major proposed agency impacts on biological resources (Georgia Code Ann. Sec. 12-16-1 et seq.) (Center for Wildlife Law, at <http://wildlifelaw.unm.edu/statbio/georgia.html>).
- e. **Other natural or manmade factors affecting its continued existence:** *Gymnoderma lineare* is rare and imperiled due to its specialized habitat requirements for bare rock faces with a precise amount of moisture and light. Most of the populations are small in numbers of individuals and in terms of area covered by the lichen, making it likely that there is little genetic variability in this species. The spruce-fir forests adjacent to the high-elevation cliffs and rock outcrops occupied by this rare lichen have suffered dramatic declines due in part to airborne pollution and the impacts of an exotic insect, the balsam wooly adelgid. The impacts of this forest decline are not currently understood. Even though *G. lineare* often

grows in exposed places, the drastic decline of adjacent high-elevation forests may result in excessive desiccation of the moist sites required by the species. With the species' slow growth rate and small population sizes, even relatively small declines could pose a significant threat to the long-term survival and recovery of the species.

In addition to the indirect effects of air pollution on this species' habitat, lichens are known to effectively accumulate a wide variety of pollutants from precipitation (St. Clair 1987). Photosynthetic rates, respiration rates, and the membrane integrity of lichens have all been found to be very sensitive to a wide range of common air pollutants, including sulfur dioxide. St. Clair (1987) states: "lichen physiological processes appear to provide an indication of pollution damage long before any visible thallus necrosis or changes in community structure can be detected." A field study conducted by Pearson and Rodgers (1982) showed that membrane integrity in lichens is severely impacted following exposure to sulfur dioxide. Lawrey (1987) found that increasing levels of sulfur dioxide pollution had resulted in the elimination of some species of lichens in the central Appalachian Mountains. Heavy metals and ozone also have been found to negatively affect lichens' potassium efflux, chlorophyll content, and photosynthetic rates (Puckett 1976, Nash and Sigal 1979, Sigal and Taylor 1979). Several observers have already noted declines in populations of *G. lineare* that cannot be directly attributed to physical disturbance of the habitat (Alan Weakley, University of North Carolina at Chapel Hill, personal communication, 1992; Shawn Oakley, The Nature Conservancy, North Carolina Field Office, personal communication, 1992).

Although the listing rule (60 FR 3557) and recovery plan (USFWS 1997) did not specifically identify climate change as a threat to the species, it may significantly affect the high-elevation habitats in which this species is found. The site-specific effects of climate change are difficult to predict with any real certainty; however, increases in average temperature or decreases in precipitation could render these sites unsuitable for the species. Several botanists and others familiar with the species and its habitat have expressed concerns about periodic desiccation and/or apparent dieback of the lichen thallus (Dave Danley, USFS, personal communication, 2008; Gary Kauffman, USFS, personal communication, 2008; Jesse Pope, Grandfather Mountain Stewardship Foundation, personal communication, 2008). Although certainly too preliminary to attribute to climate change, these observations provide reason for concern and highlight the

need for long-term monitoring data capable of revealing population changes.

- D. Synthesis.** When the 1997 recovery plan (USFWS 1997) was written, a total of 35 *G. lineare* populations were known to exist. Five populations were thought to have been extirpated. As of 2012, the total number of known populations has increased from 35 to 85, primarily as a result of the discovery of 50 populations over a 15-year period in western North Carolina, tripling the number of populations known from that state to 75. The species' range since the recovery plan was written (western North Carolina, eastern Tennessee, northeast Georgia, and northwest South Carolina) remains essentially the same, with one notable exception. A very small population was discovered in Grayson County, Virginia (the first known occurrence from that state). Two of the five populations considered extirpated in the recovery plan have been rediscovered in the past 15 years.

As of 2012, 75 populations occur on public or conserved land with some potential to afford protection to this species and its habitat. However, continuous monitoring and protection (as specified in the recovery criteria) are not occurring at any population, nor are any populations in private ownership subject to a long-term protection/management agreement with the owner as specified in the recovery criteria.

The known threats to the species described in the 1995 listing rule (60 FR 3557) remain unchanged, and an additional possible threat (climate change) has been identified. Although the number of known *G. lineare* populations has increased from 35 to 85, no population has yet been demonstrated to be stable over a 5-year time frame. According to NHP data, the date of last observation for 19 of the 35 (54 percent) populations referenced in the recovery plan (USFWS 1997) remains the same as it was when the recovery plan was written in 1997, meaning either that the species has not been found at these locations despite surveys or that there has been no subsequent recorded effort to relocate the species at these sites. The level of survey effort that has taken place at most sites is not adequate to detect a 10-percent change in the species' coverage (a threshold established in the recovery criteria).

Although the majority of *G. lineare* populations occur on public land that has some potential to afford protection for the species, all populations remain threatened by recreation, which has resulted in declines to the species. The threat of desiccation and air pollution, combined with the species' slow growth rate and small population sizes, may negatively impact the species' continued existence. All these threats may be intensified with expected future changes in the Southern Appalachian climate.

Based on the information included in this review, *G. lineare* should remain classified as an endangered species. However, additional population and

monitoring data, coupled with an increased understanding of the habitat requirements of the species, is necessary for a more accurate assessment of its conservation status.

III. RESULTS

A. Recommended Classification:

X No change is needed.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- A. Work with all partners to conduct *G. lineare* surveys and obtain updated observation data at all known sites, beginning with those locations with the longest time period since last observed. Incorporate survey results in the appropriate state NHP databases. Encourage partners to use a standardized protocol for quantitative but rapid assessment of cover so that estimates of cover can be reasonably compared across sites and over time (*Recovery Tasks 1.2, 2.1, 2.3, 6*).

We worked with the USFS and NPS (Blue Ridge Parkway) to devise a method of rapid assessment of occupied area (cover), in which the percent cover of *G. lineare* is estimated in a set of temporary plots and then used to extrapolate the total occupied area (expressed in m² or cm²) at a given site. This assessment protocol was developed in response to the difficulty in reliably estimating the spatial extent of the species over large areas and the concern that estimates taken by different observers were likely to be widely variable (responsible party: the USFWS, in conjunction with various landowners/land managers or other partners).

- B. Search for additional occurrences of the species in sections of riparian corridors separating known occurrences and in the headwaters of streams located immediately below occupied high-elevation cliff habitat (*Recovery Task 1.2*).
- C. Research the species' habitat requirements to better understand periodic dieback of the lichen (*Recovery Tasks 2.2, 2.4, 5.2*).
- D. Quantitatively assess the impacts of recreational use and other threats to the species and its habitat (*Recovery Task 2.4*).

V. REFERENCES

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of Rock Gnome Lichen (*Gymnoderma lineare*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

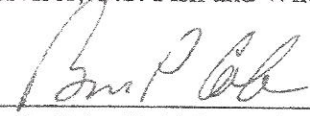
- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed.

Review Conducted By: Carolyn Wells (originally) and Mara Alexander (completed final document), Asheville Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approved


Brian P. Cole, Field Supervisor

Date:

10/18/12


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.

 Lead Regional Director, U.S. Fish and Wildlife Service

Approved



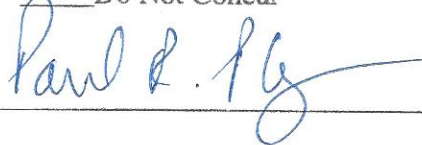
Date:

2/3/13

Cooperating Regional Director, U.S. Fish and Wildlife Service

Concur Do Not Concur

Signature



Date:

3/28/13

APPENDIX A

Summary of Peer Review for the 5-Year Review of the Rock Gnome Lichen (*Gymnoderma lineare*)

- A. Peer Review Method:** A draft 5-year review was sent to each of the following biologists, as an attachment to an email, requesting their review and any other changes or additions that should be included in the document. All reviewers have extensive knowledge of this and similar species.
1. David Danley, Botanist for the Pisgah National Forest, U.S. Forest Service, Asheville, North Carolina.
 2. Gary Kauffman, North Carolina State Botanist, U.S. Forest Service, Asheville, North Carolina.
 3. Chris Ulrey, Plant Ecologist for the Blue Ridge Parkway, National Park Service, Asheville, North Carolina.
- B. Peer Review Charge:** Reviewers were charged with providing a review of the document, including any other appropriate comments and/or additions. Reviewers were not asked to comment on the legal status of the species.
- C. Summary of Peer Review Comments/Report:** Reviewers responded by email. All reviewers thought the information in the document provided to them was accurate.
- D. Response to Peer Review:** Recommendations from the reviewers were incorporated into the document as appropriate. These consisted primarily of additional information concerning the status of certain populations, threats to the species, and recommendations for future actions.