

Cumberland Sandwort
(*Arenaria cumberlandensis* Wofford and Kral)
(=*Minuartia cumberlandensis* (Wofford and Kral) McNeill)

5-Year Review:
Summary and Evaluation



U.S. Fish and Wildlife Service
Southeast Region
Tennessee Ecological Services Field Office
Cookeville, Tennessee

5-YEAR REVIEW
***Arenaria cumberlandensis* Wofford and Kral**
(=*Minuartia cumberlandensis* (Wofford and Kral) McNeill)

I. GENERAL INFORMATION

A. Methodology used to complete the review:

In conducting this 5-year review, we relied on the best available information pertaining to historic and current distributions, life history, potential threats, and habitat of this species. Specific sources include the final rule listing this species under the Endangered Species Act; the recovery plan; unpublished field observations by Service, U.S. Forest Service (USFS), State and other experienced biologists; unpublished survey reports; peer reviewed scientific publications, and notes and communications from other qualified biologists or experts. The lead recovery biologist for this species completed this review. We announced initiation of this review and requested information in a published *Federal Register* notice with a 60-day comment period on September 21, 2007 (72 FR 54057). We received no comments in response to this announcement. The completed draft review was sent to cooperating Service Field Offices and four peer reviewers for review. We received no responses to the requests for peer review. With this review the Service acknowledges the change in taxonomy of *Arenaria cumberlandensis* Wofford and Kral to *Minuartia cumberlandensis* (Wofford and Kral) McNeill. Official recognition of this nomenclatural change will occur when the Service publishes a technical correction to the List of Endangered and Threatened Plants (50 CFR 17.12) in the Federal Register.

B. Reviewers

Lead Region: Southeast Region, Kelly Bibb, (404) 679-7132

Lead Field Office: Tennessee Ecological Services Field Office, Geoff Call, (931) 528-6481, ext. 213

Cooperating Field Offices: Kentucky Ecological Services Field Office, Mike Floyd, (502) 695-0468, ext. 102

C. Background:

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

2. Species status: Improved - There were 27 known occurrences of *A. cumberlandensis* in Tennessee and 1 in Kentucky when the recovery plan was completed. There are now 64 extant occurrences of this species, 34 of which are considered viable as discussed below. While 3 of the viable occurrences are located on privately owned lands, the remaining 31 are located on conservation lands owned by either the State of Tennessee or the National Park Service.

3. **Recovery achieved:** 4 (4 = 75-100% species' recovery actions completed or ongoing)
4. **Listing history**
Original Listing

FR notice: 53 FR 23745
Date listed: June 23, 1988
Entity listed: species
Classification: endangered
5. **Associated rulemakings:** None.
6. **Review History:**
Recovery Plan: 1996
Recovery Data Call: 2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, and 2000

Five Year Review: November 6, 1991.
In this review (56 FR 56882), different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors as they pertained to the different species' recovery. In particular, no changes were proposed for the status of this plant in the review.
7. **Species' Recovery Priority Number at start of review (48 FR 43098):** 8
(moderate degree of threat and high recovery potential)
8. **Recovery Plan**
Name of Plan: Recovery plan for the Cumberland sandwort (*Arenaria Cumberlandensis*)
Date Issued: June 20, 1996

II. REVIEW ANALYSIS

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

The Endangered Species Act (ESA or Act) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPS 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. The recovery criteria are based on numbers of

occurrences that are protected and that remain stable or increase in numbers over time. In order to evaluate the species' status in relation to recovery criteria, Tennessee Department of Environment and Conservation (TDEC) (2011) developed specifications for delineating element occurrences of *A. cumberlandensis*. An element occurrence (EO) is a fundamental unit of information in the NatureServe Natural Heritage methodology, and is defined as "an area of land and/or water in which a species or natural community is, or was present" (NatureServe 2004).

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? 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:

Arenaria cumberlandensis (Cumberland sandwort) will be considered for reclassification from endangered to threatened status when 30 geographically distinct, self-sustaining occurrences are protected in four counties in Tennessee and Kentucky and have maintained stable or increasing numbers for 5 consecutive years. The species will be considered for delisting when 40 geographically distinct, self-sustaining occurrences are protected and have maintained statistically stable or increasing numbers for 5 consecutive years. At least 12 of these occurrences must be in counties other than Pickett County, Tennessee.

There are 64 extant EOs of *A. cumberlandensis*, 34 of which TDEC and Kentucky State Nature Preserves Commission (KYNPC) consider viable (see discussion at Section C.1.d), indicating that they likely are self-sustaining. Three of the viable EOs are located on privately owned land in Fentress County, Tennessee. The remaining 31 are located on conservation lands owned and managed by the National Park Service (NPS), Tennessee Division of Natural Areas (TDNA), Tennessee State Parks (TSP), or Tennessee Division of Forestry (TDF). The county distribution of the protected EOs is as follows: Fentress (8), McCreary (1), Pickett (21), and Scott (1). Thus, there are only 10 protected and presumably self-sustaining occurrences located outside of Pickett County.

Based on these data, the numeric criteria for reclassifying *A. cumberlandensis* to threatened status have been met. There are threats affecting some EOs on conservation lands, as discussed below in Section 2. Five Factor Analysis. However, available data indicate that these presumably viable occurrences on conservation lands are not in danger of localized extinction in the foreseeable future.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features, or demographic trends:

In 2000, TDEC initiated a monitoring program to track the status of *A. Cumberlandensis* EOs by visually estimating the size of the area occupied by plants and hand-drawing a map of each site to provide a basis for comparing the spatial distribution of plants at an EO over time (TDEC 2007). This method was favored over typical quantitative approaches for monitoring plant populations, because both *A. Cumberlandensis* and its habitat are sensitive to disturbance that would occur in the course of sampling or conducting a census. Due to the diminutive size of *A. Cumberlandensis* plants, enumeration of individual plants would require close contact and associated foot traffic would crush some plants or disturb the substrates in which plants are rooted. The number of plants present has been estimated at some sites where abundance is high and counted at others where abundance is low, but these data have not been collected regularly at all sites. Staff from TDEC collected data using these methods during the years 2000, 2006-2008, and 2011-2012. During the 2000 monitoring, TDEC emphasized estimating *A. Cumberlandensis* abundance, rather than estimating area of cover. For this reason, data collected during 2006-2008 serve as the baseline for assessing changes in the species' status. Monitoring data were collected for all but six EOs in Tennessee during this time period.

It is infeasible to annually monitor all extant EOs in Tennessee. Accordingly, TDEC has categorized *A. Cumberlandensis* EOs into three "tiers", based on degree of threat, location, and land ownership, to establish monitoring priorities and determine the frequency of data collection for each EO. In some cases where EOs consist of multiple sites, or discretely mapped patches of *A. Cumberlandensis* plants, the area occupied by *A. Cumberlandensis* at each site is estimated separately. For this reason, there are a total of 81 monitoring sites distributed among the 63 extant EOs located in Tennessee. Monitoring frequency and number of EOs and sites for each tier are as follows:

Table 1. Monitoring frequency, number of EOs, and number of monitoring sites on conservation lands and private lands for *A. Cumberlandensis* monitoring tiers.

Tier	Number of EOs	Years between visits	Sites on Conservation Lands	Sites on Private Lands
1	18	1-3	25	0
2	25	3-6	25	1
3	19	6-10	19	11

Tier 1 includes EOs that are located in rockhouses along accessible, and in some cases heavily visited, trails on public lands at Pickett State Park (PSP), Pickett State Forest (PSF), Big South Fork National Scenic River and Recreation Area (BISO), and Pogue Creek State Natural Area (PC). These EOs are assigned to Tier 1 because they are

located on conservation lands, but their close proximity to trails leaves them vulnerable to threats associated with recreation and illegal poaching of cultural artifacts (aka “relic digging”). Tier 2 sites also are primarily on conservation lands, but are not located close to trails and are under less threat than those in Tier 1. Tier 3 includes mostly remote sites on private lands and conservation lands, which face few threats from recreation or relic digging.

The monitoring approach currently used for *A. cumberlandensis* allows for evaluation of coarse changes in the estimated area currently occupied by the species at a given site, as compared to the baseline from 2006-2008. Based on available data, the area occupied by *A. cumberlandensis* remained stable or increased at 32 of the 50 (64 percent) Tier 1 and 2 sites that were monitored during 2011-2012. Declines of greater than 1 m² were documented at the remaining 18 sites (36 percent), but in some cases might not represent true declines as discussed below. Based on available data, the species’ overall status has remained stable or improved since monitoring began in 2006.

Of the 23 Tier 1 sites monitored during 2011, estimated cover had declined by more than 1 m² at six sites compared to the baseline; but, because no observable changes to site conditions had taken place, TDEC attributed this change to bias introduced by different observers having conducted the monitoring during the two time periods being compared. Either no change, increases, or decreases of less than 1 m² were seen at the other 17 Tier 1 sites monitored during 2011 (TDEC 2011a). Of the 27 Tier 2 sites monitored during 2011-2012, estimated cover had declined by more than 1 m² at nine sites compared to the baseline. Estimated cover had not changed perceptibly at eight sites and had increased by more than 1 m² at seven sites (TDEC 2012). While declines at two of these Tier 2 sites were again attributed to observer bias, declines at other sites were thought to have resulted from the following causes: shading from vegetation growing in a periodically cleared powerline right-of-way; trampling associated with adjacent trail use; drought; relic digging that had occurred since monitoring during 2007; and rockfall. Based on their remote location and low level of threat, TDEC (2012) reassigned two of the Tier 2 sites to Tier 3 for future monitoring, reducing the number of Tier 2 sites to 25 (Table 1).

These monitoring data provide a basis for assessing the persistence of EOs over time and documenting coarse changes in the area they occupy, but they do not provide insight into demographic processes such as reproductive output, germination and recruitment, and mortality rates that influence population growth rates. The only data currently available concerning seed production and germination in the species are anecdotal observations by Winder (2004), who noted that populations he sampled for an investigation of genetic diversity in *Minuartia cumberlandensis* (= *Arenaria cumberlandensis*; see section C.1.c. for a discussion of current taxonomic classification) produced copious viable seed during the years he observed them and that young seedlings were present frequently in most populations. Additional monitoring measures to understand demographic processes could become necessary at monitoring sites where declining trends become apparent from sustained decreases in estimates of area occupied by *A. cumberlandensis*. Conducting monitoring late in the growing season for *A. cumberlandensis*, rather than during the winter as it often occurs, would allow for an assessment of whether seed

production and seedling germination are occurring at monitoring sites. This would provide more useful data for determining whether EOs are self-sustaining than estimates of area occupied alone do.

b. Genetics, genetic variation, or trends in genetic variation:

Winder (2004) investigated patterns of genetic diversity in *M. cumberlandensis* and its congener *M. glabra*, which shares an island-like distributional pattern with *M. cumberlandensis* on the northern Cumberland Plateau, but is more widespread and frequent and tends to occur in larger populations. While both species contain a considerable amount of genetic diversity at the nuclear *G3pdh* locus, among population variance was found to be considerably higher in *M. cumberlandensis* (i.e.,) than in *M. glabra* (Winder 2004). Approximately 63 percent of the total variation in *M. cumberlandensis* is distributed among populations rather than contained within them, a pattern that is consistent with long-term limited gene flow among isolated populations and/or recent establishment of populations from a heterogeneous source population. This pattern suggests that *M. cumberlandensis* populations, on average, contain only a small, non-representative subset of the overall phylogenetic variation that exists in the species (Winder 2004). Interestingly, a few geographically outlying populations contain a significant amount of the species' overall variation, despite current genetic isolation from the main cluster of populations in Pickett County (Winder 2004).

Winder (2004) found reduced levels of heterozygosity in individual populations of *M. cumberlandensis*, with some containing little or no heterozygosity despite having considerable haplotype diversity, and noted that this pattern is consistent with the effects of inbreeding. Winder (2004) suggested investigation into factors that could influence breeding patterns in *A. cumberlandensis*, specifically suggesting two factors: (1) determining whether movement of pollen and seeds is highly restricted, potentially even within a single rockhouse population, and (2) conducting breeding system studies to determine whether there could be high rates of self-fertilization in populations of *M. cumberlandensis*.

c. Taxonomic classification or changes in nomenclature:

McNeill (1980) transferred *A. cumberlandensis* along with several other species of *Arenaria* to the genus *Minuartia* and retained the specific epithet. This change was based on differences in capsule dehiscence characteristics between the taxa that were reassigned to *Minuartia* versus those that McNeill (1980) retained in the genus *Arenaria*. The species is listed as *Minuartia cumberlandensis* (Wofford and Kral) McNeill in *A Fifth Checklist of Tennessee Vascular Plants* (Chester et al. 2009). The Flora of North America recognizes this taxon as *Minuartia cumberlandensis* (Wofford and Kral) McNeill (http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250060629, accessed June 17, 2013), as does the Integrated Taxonomic Information System (<http://www.itis.gov>, accessed June 17, 2013). With this review, the Service acknowledges this nomenclatural change. Official recognition of this change will occur when the Service publishes a technical correction to the List of Endangered and Threatened Plants (50 CFR 17.12) in the Federal Register.

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.):

There were 27 known EOs of *A. cumberlandensis* in Tennessee and 1 in Kentucky when the recovery plan was completed. Of the Tennessee EOs, 20 were within approximately 3 kilometers (2 miles) of each other; all the known EOs were located within 40 kilometers (25 miles) of each other in Pickett, Scott, Fentress, and Morgan counties, Tennessee, and McCreary County, Kentucky (U.S. Fish and Wildlife Service 1996). The 27 EOs were all at least partially in public ownership when the plan was written: six in PSP, six in PSF, and 15 in BISO (USFWS 1996). Bailey and Shea (2000) reported that there were 58 known EOs in 2000, all but one of which were located in Tennessee. Winder (2004) noted that all known populations occur within five contiguous counties and are contained within an area less than 45 kilometers (28 miles) diameter, and that most EOs are clustered within 10 kilometers (6 miles) in the vicinity of PSP.

A recent status survey reported that 66 naturally occurring *A. cumberlandensis* EOs – 2 in Kentucky and 64 in Tennessee – have been found across the species' range (TDEC 2011b). An additional EO was discovered in Fentress County, Tennessee, in 2012, raising the total to 67 EOs that have been found. As discussed below, 64 of these EOs are extant. In order to provide a standardized basis for assessing the species status with respect to recovery criteria based on numbers of occurrences, TDEC (2011b) developed the following criteria for delimiting EOs of *A. cumberlandensis*:

1. At a minimum, an EO is defined as a noncontiguous cluster or patch of plants that naturally occurs in suitable habitat.
2. An EO may consist of several noncontiguous patches that occur in one or more rockhouses or cliff faces which are located in a linear or vertical pattern with no barriers present. Discontinuity and barriers to dispersal have been identified based on slope aspect, stream connectivity, geologic connectivity (i.e., rockfalls), and elevation differences. These patches can be monitored separately and mapped as individual source points in order to repeat data collection.
3. The EO is assigned to a population based on the HUC-12 watershed level.

NatureServe (2010) provides guidance for determining Population/Occurrence Viability Ranks for *A. cumberlandensis* EOs, based on custom EO rank specifications written for the species by Kentucky State Nature Preserves Commission (KYNPC) in 2005. The custom ranking factors are based on quantitative and qualitative measures including habitat size and/or occupied area, with consideration for habitat quality, landscape context, and ongoing threats affecting the species or its habitat (TDEC 2011b). Custom EO rank specifications for *A. cumberlandensis* are listed below:

- **A Rank – Excellent Viability:** Population/occurrence inhabits an area of about 40 m² (430 ft²) or more, occurring as scattered dense groups of plants and these the dominant

vegetation. Few if any weedy plants present or other evidence of disturbance. Population reproductive. The rockhouse or overhang is part of a good quality mesophytic forest with trees of varying size classes and the largest over 20 in (50 cm) diameter-at-breast-height (dbh). The forested portion of the habitat is about 40 ac (16 ha) or more in size and provides buffer to the rock outcropping where the population occurs.

- **B Rank – Good Viability:** Population/occurrence inhabits an area of about 40-25 m (430-270 ft²) with scattered dense groups of plants. Population reproductive. Few of any weedy plants present or other evidence of disturbance. The rockhouse/overhang is part of a good quality mesophytic forest as defined above.
- **C Rank – Fair Viability:** Population/occurrence inhabits an area of 25-10 m² (270-110 ft²) in area, plants may be sparse and individuals scattered in this area or groups not particularly dense. Habitat may have been disturbed in the recent past and the forest structure altered.
- **D Rank – Poor Viability:** Population/occurrence of scattered individual plants or very small groups, the size of the habitat less than 10 m² (110 ft²) area.
- **X Rank:** Extirpated
- **H Rank:** Historic, not seen in 25 years
- **F Rank:** Failed to find
- **E Rank:** Extant but no data available, habitat exists at site.

NatureServe methodology recognizes two types of EO ranks – basic and range. Basic EO ranks (e.g., A, B, C, D) are assigned based on what is currently known about the factors used in defining the ranks, as described above for *A. Cumberlandensis*. Range ranks are used to indicate uncertainty about which particular basic rank a given EO should receive, and are represented by combinations of the basic ranks (e.g., AB, AC, BC, etc.) (NatureServe 2002).

Using monitoring data, TDEC and KYNPC rank *A. Cumberlandensis* EOs using the specifications listed above. Based on these data, as of October 2012 there were 64 EOs of *A. Cumberlandensis* known to be extant, 2 EOs that had not been found during recent visits, and 1 that was considered extirpated (Table 1). All but five of these EOs are located on publicly owned conservation lands. Tennessee EO numbers 2 and 19 were not found during visits in 2007 and 2008, respectively, but are not yet considered by TDEC to be extirpated. Additional survey effort is needed to determine the status of these EOs. Kentucky EO number 1 has not been seen since 1984 – despite searches during 1989, 1991, and 1994 – and is considered extirpated. Extant EOs are distributed among the following states and counties:

Table 2. Distribution by state and county of all known *A. Cumberlandensis* element occurrences (EOs)

State	County	Extant EOs	EOs either extirpated or status uncertain
Kentucky	McCreary	1	1
Tennessee	Fentress	20	--
	Morgan	--	1
	Pickett	38	1
	Scott	5	--
TOTAL		64	3

Of the 64 EOs that are known to be extant, 11 are A-ranked (A, AB, or AC), 16 are B-ranked (B or BC), 18 are C-ranked (C or CD), and 19 are D-ranked (Figures 1a, b). With the exception of those assigned a range rank of CD, EOs that fall into the basic A-, B-, and C-ranked categories are considered viable. As of October 2012, there were 34 EOs

Figure 1a: Distribution of basic and range viability ranks for *A. Cumberlandensis*

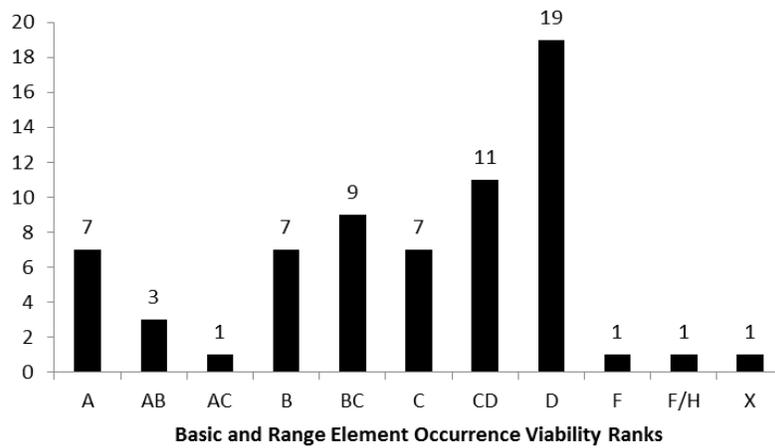


Figure 1b: Distribution of basic viability ranks for *A. cumberlandensis*

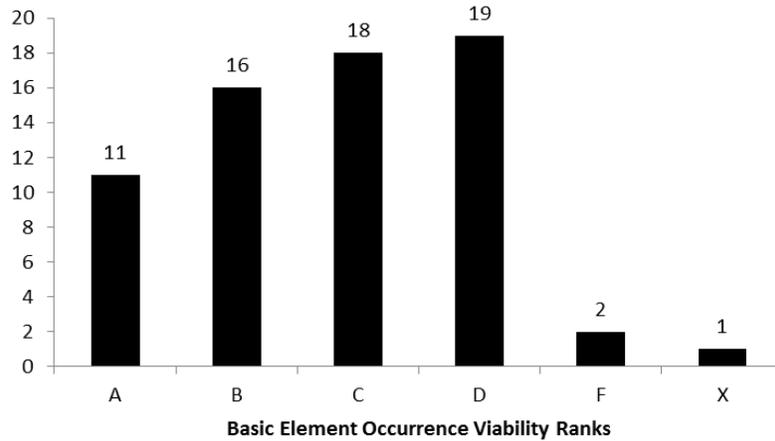
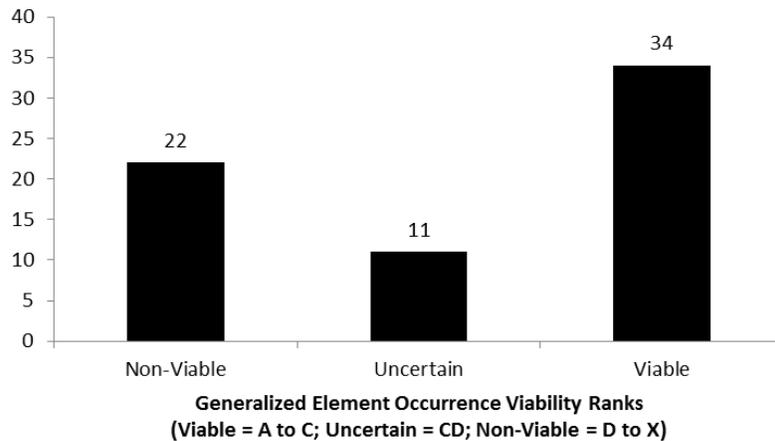


Figure 1c: Number of EOs considered viable, uncertain, or nonviable, based on EO ranks.



ranked by TDEC and KYNPC as viable (Figures 1a, c). The 11 CD-ranked EOs are considered to have uncertain viability (Figure 1c); current data are needed in order to determine whether these EOs are viable or nonviable. Nearly one-third of the EOs are ranked as nonviable (i.e., D-, F-, F/H-, or X-ranked) (Figure 1c.).

The data discussed above are the best available for determining whether a given EO is self-sustaining. The 34 EOs ranked as viable by TDEC and KYNPC likely are self-sustaining. Three of the viable EOs are located on privately owned land in Fentress County. The remaining 31 are located on conservation lands owned and managed by the NPS (15), TDNA (2), TDF (11), or TSP (3). The county distribution of the viable, protected EOs is as follows: Fentress (8), McCreary (1), Pickett (21), and Scott (1). Thus, there are only 10 protected and presumably self-sustaining EOs located outside of Pickett County.

The recovery plan mentions a historic occurrence of unknown location in the Rock Creek

drainage on Daniel Boone National Forest (DBNF) lands in McCreary County, Kentucky, which has not been relocated despite repeated attempts. In collaboration with USFS, the Center for Conservation and Research of Endangered Wildlife (CREW) at Cincinnati Zoo and Botanical Garden (CREW) has demonstrated preliminary success in establishing an introduced population of *A. cumberlandensis* at DBNF using greenhouse propagated plants (Pence et al. 2011). As part of this project, CREW developed methods for in vitro propagation of *A. cumberlandensis* from seed and for cryopreservation of shoot tips. Six genetic lines have been banked in CREW's CryoBioBank (Pence et al. 2011).

The experimental reintroduction began in 2005 with planting of 63 acclimatized plants from seven genetic lines. Plants from each of the genetic lines were combined into groups for planting into seven locations within a single rockhouse, spanning a range of soil moisture and light levels. After 6 years of monitoring, only 12 of the original 63 plants survived. However, new seedlings were observed beginning in the second summer, flowering plants and seedlings have been present in every year since 2005, and there were over 200 plants present in the locations where plants survived as of 2011 (Pence et al. 2011). Survival differed among the seven planting locations, with highest survival in locations with moderate soil moisture and light levels. No plants survived in the wettest and driest locations (Pence et al. 2011). CREW planted 14 additional plants in 2009 and 5 in 2010 into a new location in the rockhouse, and 19 plants were counted in this site in 2011 (Pence et al. 2011).

This introduced occurrence is not recognized as an EO by KYNPC. Because the long-term viability of this occurrence has not been established, we do not yet consider it to contribute to achieving the recovery criteria for *A. cumberlandensis*. However, the results of this work demonstrate that cryopreservation using shoot tips is possible, for a period of at least a decade, and that in vitro propagation and outplanting should be effective techniques for establishing new populations if this becomes a necessary strategy for recovering the species.

2. Five-Factor Analysis

a. Present or threatened destruction, modification or curtailment of its habitat or range:

The final listing rule and the recovery plan for *A. cumberlandensis* identify significant threats from human activities including hiking, camping, rappelling, and relic digging. Because *A. cumberlandensis* is restricted to sandstone rockhouses, ledges, and solution pockets on sandstone rock faces, it is vulnerable to impacts from recreational activities and relic digging that commonly occur in these habitats. The 2011 status report and monitoring reports from 2011 and 2012 confirm that these activities still pose threats to many *A. cumberlandensis* EOs (TDEC 2012, 2011a, 2011b).

Plants growing on rockhouse floors are vulnerable to trampling by hikers, campers, and picnickers on public lands where *A. cumberlandensis* occurs. Trampling by persons who

are rappelling poses a threat to plants growing on ledges or solution pockets on sandstone rock faces. Relic digging is one of the most destructive threats facing these habitats (Bailey and Shea 2000), despite the fact that the activity is illegal on public lands. In some rockhouses, fire pits are present from historic or recent recreational use. In addition to these threats resulting from recreational activities, feral hogs have caused intensive soil disturbance at a few *A. cumberlandensis* sites. The number of EOs affected by these threats, according to TDEC (2011b), is as follows:

Trampling	Recent Relic Digging	Past Relic Digging	Feral Hogs	Recent Fire Pit Use	Historic Fire Pit Use
24	9	12	3	1	5

Staff from TDEC have coordinated with NPS, TDF, and TSP, to install fencing, trail borders, and educational signs in an effort to address recreation-related impacts at eight EOs on public lands (Table 3). Recent monitoring at these EOs indicates that the protective measures typically are beneficial; but, frequent monitoring and periodic maintenance will be required for their long-term effectiveness (TDEC 2011a). The Service has provided funding to TDEC to support installation of site protection measures at additional EOs, which should be completed by 2014.

Table 3. List of *A. cumberlandensis* element occurrences where protective measures have been taken to reduce recreation-related impacts.

EO Number	Site Name	Public Land Unit	Date	Protective Measure	Comments from Monitoring Reports
4 (a & b)	Hazard Cave and West Rockhouse	PSP	1990s & 2002	fencing, boardwalk	need to block unsanctioned trail to second rockhouse
			2000	blocked unsanctioned trail	
			2003	signs	
			2008	blocked unsanctioned trail	
5	Hidden Passage Tunnel/Crystal Falls	PSP	2008	signs	hiking trail not well defined
11 (1 & 2)	Hidden Passage Rockhouses 1&2	PSF	2008	reroute and blaze trail, build bridge, trail borders	
13	Ladder Trail	PSP	2003	signs	trail borders have reduced trampling
			2008	trail borders and blazing, rock barricades	
24	Indian Rockhouse	PSF	2000	fencing	fence falling and needs repair
			2003	signs	
			2008	signs	

EO Number	Site Name	Public Land Unit	Date	Protective Measure	Comments from Monitoring Reports
26	Natural Bridge at Pickett Lake	PSP	2008	sign	
60 (2)	Hippy Cave	BISO	2004	fencing	some trampling inside fence
61 (1)	Middle Creek Loop Trail	BISO	2003	fencing, boardwalk	fencing successful

The final listing rule and recovery plan for *A. cumberlandensis* also discuss the threat that timber removal would pose if done in the vicinity of habitat containing the species, asserting that increased sunlight and subsequent alteration of the moisture conditions would likely cause its extirpation. We have no specific information concerning losses of *A. cumberlandensis* or its habitat on privately owned lands from timber removal. Tennessee Division of Forestry utilizes GIS data from TDEC, depicting the known locations of State and Federally listed species, in the course of preparing management plans for State Forest lands. Staff at PSF are aware of *A. cumberlandensis* and adjust project plans to avoid areas where the species would be affected by timber harvesting (J. Albright, Forester, TDF, pers. comm. June 24, 2013). Timber harvesting does not occur on other publicly owned lands where the species occurs. Based on these data, timber harvesting is not currently a threat to *A. cumberlandensis*.

As noted above, declines of greater than 1 m² occupied area were observed at sites where the following threats were noted: competition from vegetation growing in a periodically cleared powerline right-of-way; trampling associated with adjacent trail use; drought; relic digging that had occurred since monitoring during 2007; and rockfall. Each of these threats was implicated in the decline of individual occurrences during one monitoring visit, but none led to the extirpation of an EO. Future monitoring will provide data to determine whether *A. cumberlandensis* suffers long-term effects from these isolated incidents.

b. Overutilization for commercial, recreational, scientific, or educational purposes:

Neither the recovery plan nor the final listing rule for *A. cumberlandensis* identifies overutilization for any purpose as a threat to the species. We have no new information concerning this factor.

c. Disease or predation:

Neither the recovery plan nor the final listing rule for *A. cumberlandensis* identifies disease or predation as a threat to the species. We have no new information concerning this factor.

d. Inadequacy of existing regulatory mechanisms:

The Commonwealth of Kentucky and the State of Tennessee both list *A. cumberlandensis* (listed as *Minuartia cumberlandensis* in Tennessee) as an endangered species.

Conservation efforts are directed towards the species by KYNPC and TDEC, using funding and authorities provided under section 6 cooperative agreements with the Service for endangered species recovery.

The Kentucky Rare Plants Recognition Act, Kentucky Revised Statutes (KRS), chapter 146, section 600-619, directs the KSNPC to identify plants native to Kentucky that are in danger of extirpation within Kentucky and report every 4 years to the Governor and General Assembly on the conditions and needs of these endangered or threatened plants. This list of endangered or threatened plants in Kentucky is found in the Kentucky Administrative Regulations, title 400, chapter 3:040. The statute (KRS 146:600-619) recognizes the need to develop and maintain information regarding distribution, population, habitat needs, limiting factors, other biological data, and requirements for the survival of plants native to Kentucky. This statute does not include any regulatory prohibitions of activities or direct protections for any species included in the list. It is expressly stated in KRS 146.615 that this list of endangered or threatened plants shall not obstruct or hinder any development or use of public or private land. Furthermore, the intent of this statute is not to ameliorate the threats identified for the species, but it does provide information on the species.

The Tennessee Rare Plant Protection and Conservation Act of 1985 (T.C.A. 11-26-201) authorizes the TDEC to, among other things: conduct investigations on species of rare plants throughout the state of Tennessee; maintain a listing of species of plants determined to be endangered, threatened, or of special concern within the state; and regulate the sale or export of endangered species via a licensing system. This act forbids persons from knowingly uprooting, digging, taking, removing, damaging, destroying, possessing, or otherwise disturbing for any purpose, any endangered species from private or public lands without the written permission of the landowner, lessee, or other person entitled to possession and prescribes penalties for violations. The TDEC may use the list of threatened and special concern species when commenting on proposed public works projects in Tennessee, and the department shall encourage voluntary efforts to prevent the plants on this list from becoming endangered species. This authority shall not, however, be used to interfere with, delay, or impede any public works project.

Thus, despite the fact that *A. cumberlandensis* is listed as endangered by the Commonwealth of Kentucky and State of Tennessee, these designations confer no guarantee of protection to the species or its habitat, whether on privately owned or state-owned lands, unless such protections are voluntarily extended to the species.

e. Other natural or manmade factors affecting its continued existence:

The final listing rule for *A. cumberlandensis* identified restricted geographic range and small population size as a threat to the species, noting that in some populations the loss of even a few individuals through natural demographic fluctuations or human-induced

habitat alterations could cause their extirpation. Winder (2004) noted that, especially in the face of potential climate-induced changes in environmental parameters of *M. cumberlandensis* habitats, threats to genetic integrity, ecological flexibility, and adaptive potential of this species are of particular importance owing to its small population sizes, limited number of populations, and the geographical isolation of populations from each other. Based on his investigation of genetic variation in *M. cumberlandensis* and the fact that this species has persisted in its current location through cyclical climate changes during the Pleistocene, Winder (2004) concluded that, if protected from habitat destruction and population losses, it may be resilient to future climate change.

D. Synthesis

Wofford and Kral (1979) first described *A. cumberlandensis* in 1979, and the Service listed the species as endangered in 1988. In 1980, the taxonomic classification was revised and the name *Minuartia cumberlandensis* (Wofford and Kral) McNeill was applied to the species (McNeill 1980). This classification has been accepted by the scientific community and the Service will in the future publish a technical correction revising regulations at 50 CFR 17.12 to conform to currently accepted taxonomy. There were only five known EOs of this species when it was listed, and 27 EOs were known when the recovery plan was completed in 1996. In 2000, 58 EOs of this species were known to exist (Bailey and Shea 2000), and there are now 64 extant EOs known, all but one in Tennessee. In addition, there is an introduced occurrence located on DBNF.

The present or threatened destruction or modification of habitat remains the greatest threat to *A. cumberlandensis*, albeit a moderate one, and primarily stems from recreational uses of its habitat on public lands and relic digging for Native American artifacts. Measures to prevent or reduce threats related to recreational activities have been installed at eight EOs in rockhouses located along trails at BISO, PSF, and PSP. While these threats remain at many EOs, they do not currently place *A. cumberlandensis* at imminent risk of extinction; therefore, we consider them to continue to be moderate. The listing rule for *A. cumberlandensis* stated that most populations are potentially threatened by timber removal in or adjacent to the sites supporting the species. All but 5 of the 64 extant EOs are located on publicly owned conservation lands, where timber harvest either does not occur or is restricted in areas where *A. cumberlandensis* occurs. We have no data concerning the loss of EOs or disturbance to their habitat as a result of timber removal on privately owned lands, despite repeated monitoring visits to known sites on private lands; therefore, we do not consider timber removal to be a threat to the species at this time. The recovery potential for this species remains high; thus, the recovery priority number should remain unchanged at 8. Based on the above threat analysis, we believe *A. cumberlandensis* no longer meets the definition of an endangered species and should be reclassified as a threatened species.

III. RESULTS

- A. **Recommended Classification:** Downlist to Threatened
- B. **New Recovery Priority Number:** N/A – see Synthesis
- C. **Listing and Reclassification Priority Number:** 6 – The Service has not been petitioned to reclassify *A. cumberlandensis* to threatened status, and doing so would have little impact on management, as management efforts are needed in order to protect some sites on conservation lands regardless of reclassification and monitoring would continue until such time as the species status warrants delisting.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- A. Initiate efforts to revise regulations at 50 CFR 17.12 to reclassify this plant from endangered to threatened and to reflect current taxonomic nomenclature designating this species as *Minuartia cumberlandensis* (Wofford and Kral) McNeill.
- B. The Service should work with TDEC and land managers at BISO, PSF, and PSP, to maintain existing and install additional protective measures to reduce or eliminate threats resulting from recreational activities.
- C. Evaluate current monitoring method and distribution of monitoring plots to determine whether they will provide an effective basis for evaluating trends in *A. cumberlandensis* populations throughout the species' range. In doing so, the anticipated analyses to be performed should be identified, with consideration for analytical constraints imposed by sampling design.
- D. Regularly monitor EOs to provide data for evaluating whether populations are self-sustaining. If sustained declines are observed in sites where no apparent habitat threats are present, develop a demographic monitoring protocol to determine whether declines are affecting a particular stage class or life-history process.
- E. If sustained declines are observed at multiple sites where no habitat threats are present, initiate life history and breeding system studies to identify biological, demographic, and reproductive traits that could constrain population sizes or influence observed levels and patterns of genetic variation.

V. REFERENCES

- Bailey, C. and A. Shea. 2000. New population survey, site protection survey, and monitoring protocol for *Arenaria cumberlandensis*. Unpublished report from TDEC to USFWS, Cookeville, Tennessee. December 2000. 9 pp. plus one appendix.
- E. W. Chester, B. E. Wofford, D. Estes, and C. Bailey. 2009. A Fifth Checklist of Tennessee Vascular Plants. Botanical Research Institute of Texas Press, Fort Worth, Texas. 102 pp.
- McNeill, J. 1980. The delimitation of *Arenaria* (Caryophyllaceae) and related genera in North America, with 11 new combinations in *Minuartia*. *Rhodora* 82: 495-502.
- NatureServe. 2010. Comprehensive species report for *Minuartia cumberlandensis*; Population/Occurrence Viability, author Deborah White 2005. NatureServe Explorer: An online encyclopedia of life. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.
- NatureServe. 2004. A habitat-based strategy for delimiting plant element occurrences: guidance from the 2004 working group. Unpublished document accessed online August 13, 2008 at http://www.natureserve.org/library/delimiting_plant_eos_Oct_2004.pdf.
- NatureServe. 2002. NatureServe Element Occurrence Data Standard. Available on the internet at <http://www.natureserve.org/prodServices/eodata.jsp>. February 6, 2002. Accessed on June 11, 2013.
- Pence, V. C., B. L. Plair, S. M. Charls, J. R. Clark, and D. D. Taylor. 2011. Micropropagation, cryopreservation, and outplanting of the Cumberland sandwort *Minuartia cumberlandensis*. *Journal of the Kentucky Academy of Sciences* 72: 91-99.
- Tennessee Department of Environment and Conservation. 2012. 2011-2012 population monitoring for *Arenaria cumberlandensis* (*Minuartia cumberlandensis*), Cumberland sandwort, for the Tier 2 sites. Prepared for U.S. Fish and Wildlife Service, Cookeville, Tennessee. December 2012. 9 pp.
- Tennessee Department of Environment and Conservation. 2011a. 2011 population monitoring for *Arenaria cumberlandensis* (*Minuartia cumberlandensis*), Cumberland sandwort, for the Tier 1 sites. Prepared for U.S. Fish and Wildlife Service, Cookeville, Tennessee. August 2011. 8 pp.
- Tennessee Department of Environment and Conservation. 2011b. Status report for *Arenaria cumberlandensis* Wofford & Kral (*Minuartia cumberlandensis* (Wofford & Kral) McNeill), Cumberland sandwort. Prepared for U.S. Fish and Wildlife Service, Cookeville, Tennessee, March 2011. 51 pp.
- Tennessee Department of Environment and Conservation. 2007. Population monitoring for *Arenaria cumberlandensis*, Cumberland sandwort, on public lands in Tennessee, 2006-2007. Prepared for U.S. Fish and Wildlife Service, Cookeville, Tennessee. December 2007. 10 pp.

- U.S. Fish and Wildlife Service. 1996. Cumberland Sandwort Recovery Plan. Atlanta, Georgia. 28 pp.
- Winder, C. T. 2004. Levels and patterns of genetic diversity in the rare and endangered Cumberland stitchwort, *Minuartia cumberlandensis* (Caryophyllaceae). Unpublished M.S. thesis, University of Tennessee, Knoxville. December 2004. 73 pp.
- Wofford, B. E. and R. Kral. 1979. A new *Arenaria* (Caryophyllaceae) from the Cumberlands of Tennessee. *Brittonia* 31: 257-260.

**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Arenaria cumberlandensis***

Current Classification: Endangered

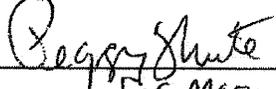
Recommendation resulting from the 5-Year Review

- Downlist to Threatened**
- Uplist to Endangered**
- Delist**
- No change is needed**

Review Conducted By Geoff Call, Tennessee Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve  Date 21 November 2013
For Mary E. Jennings

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:

Lead Regional Director, Fish and Wildlife Service

Approve  Date 12/23/13

**Appendix A. Summary of peer review for the 5-year review of (*Arenaria cumberlandensis*
=*Minuartia cumberlandensis*)**

- A. Peer Review Method:** Peer review was requested from four knowledgeable individuals on June 27, 2013.
- B. Peer Review Charge:** See attached guidance.
- C. Summary of Peer Review Comments/Report:** We received no comments in response to the request for peer review.
- D. Response to Peer Review:** N/A

Guidance for Peer Reviewers of Five-Year Status Reviews

U.S. Fish and Wildlife Service, Tennessee Ecological Services Field Office

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.