

Cumberland Sandwort *(Arenaria cumberlandensis)* **Recovery Plan**



U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

RECOVERY PLAN

for

Cumberland Sandwort (*Arenaria cumberlandensis*)

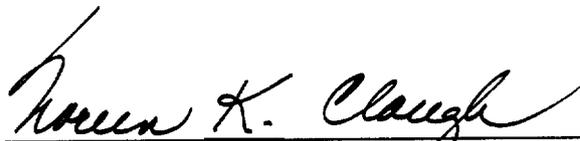
Prepared by

Alexa McKerrow
Tennessee Department of Environment and Conservation
Nashville, Tennessee

for

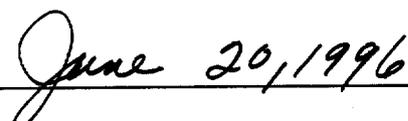
U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

Approved:



Noreen K. Clough, Regional Director, Southeast Region
U.S. Fish and Wildlife Service

Date:



Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modifications as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1996. Cumberland Sandwort Recovery Plan.
Atlanta, GA. 28 pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
Phone: 301/492-6403 or
1-800/582-3421

The fees for recovery plans vary, depending upon the number of pages.

ACKNOWLEDGMENTS

Thanks to Andrea Shea and Milo Pyne of the Tennessee Heritage Program; Dr. Robert Kral, Vanderbilt University; Dr. Eugene Wofford, University of Tennessee - Knoxville; Robert Emmott, Big South Fork National River and Recreation Area; Margaret Shea, Kentucky State Nature Preserves Commission; Virginia Small and Billy Glen Smith, Pickett State Park; Billy Swafford, Pickett State Forest; and Chris Dietrich and David Knechtle, Missouri Botanical Garden, for the information they provided.

EXECUTIVE SUMMARY

Current Status: *Arenaria cumberlandensis* (Cumberland sandwort) is listed as endangered. There are 28 extant occurrences of the species, 27 in Tennessee and one in Kentucky. One additional Kentucky occurrence is presumed extirpated (Libby 1994). At the time the species was added to the Federal list, there were about 12 known occurrences that were grouped into five populations (one in Kentucky and 11 in Tennessee). Threats to Cumberland sandwort include trampling by recreational users and habitat alteration caused by timber harvesting on adjacent land.

Habitat Requirements and Limiting Factors: Cumberland sandwort is restricted to sandstone ledges and rock houses in the Cumberland Plateau Province of south-central Kentucky and north-central Tennessee. Specialized habitat requirements, in combination with habitat alteration, appear to be the primary limiting factors for the species.

Recovery Objective: Delisting

Recovery Criteria: Cumberland sandwort will be considered for reclassification from endangered to threatened status when 30 geographically distinct, self-sustaining occurrences are protected and managed for the species' benefit 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 stable or increasing numbers for 5 consecutive years. In order to maintain a balanced geographic distribution for the species, at least 12 of these occurrences must be in counties other than Pickett County, Tennessee.

Actions Needed:

1. Protect existing occurrences and essential habitat and search for additional populations.
2. Determine and implement the management necessary for long-term reproduction, establishment, maintenance, and vigor.
3. Maintain a cultivated source of plants and provide for long-term seed storage.
4. Enforce laws protecting the species and/or its habitat.
5. Develop materials to inform the public about the status of the species and the recovery plan objectives.

Costs (\$000s):

YEAR	NEED 1	NEED 2	NEED 3	NEED 4	NEED 5	TOTALS
1996	6.0	25.0	12.0	*	3.0	46.0
1997	30.0	23.0	0.5	*	0.5	54.0
1998	30.0	29.0	0.5	*	0.5	60.0
1999	10.0	13.0	0.5	*	0.5	24.0
2000	0.0	13.0	0.5	*	0.5	14.0
2001	0.0	13.0	0.5	*	0.5	14.0
2002	0.0	13.0	0.5	*	0.5	14.0
2003	0.0	13.0	0.5	*	0.5	14.0
2004	0.0	13.0	0.5	*	0.5	14.0
2005	0.0	13.0	0.5	*	0.5	14.0
TOTALS	76.0	168.0	16.5	*	7.5	268.0
*Unknown						

Date of Recovery: 2005, provided that funds are available to accomplish the required recovery tasks and that the recovery criteria are met.

TABLE OF CONTENTS

	<u>Page</u>
PART I:	
INTRODUCTION	1
Description, History, and Distribution	1
Habitat, Life History, and Threats	4
Conservation Measures and Recovery Strategy	9
 PART II:	
RECOVERY	10
A. Recovery Objectives	10
B. Narrative Outline	11
C. Literature Cited	16
 PART III:	
IMPLEMENTATION SCHEDULE	17
 PART IV:	
LIST OF RECIPIENTS	20

LIST OF FIGURES

	<u>Page</u>
1. Illustration of <i>Arenaria cumberlandensis</i>	2
2. Distribution of Cumberland Sandwort in Kentucky and Tennessee	5

LIST OF TABLES

1. Extant occurrences of <i>Arenaria cumberlandensis</i> (Cumberland sandwort) in Kentucky and Tennessee	6
--	---

PART I

INTRODUCTION

Arenaria cumberlandensis (Cumberland sandwort) was described as a new species by Wofford and Kral (1979). This perennial, herbaceous member of the Pink family (Caryophyllaceae) is 4 to 6 inches (10 to 15 centimeters) tall and has small white-petaled flowers and relatively long narrow leaves. The species is known from the Cumberland Plateau of south-central Kentucky and north-central Tennessee. It was added to the Federal list of endangered species in 1988 (U.S Fish and Wildlife Service [Service] 1988). At the time of listing, the plant was known from five sites (one in Kentucky and four in Tennessee); these sites were believed to consist of about 12 occurrences. The sandstone rock houses where Cumberland sandwort is found make the species susceptible to trampling by hikers and other recreational users of its habitat. Habitat destruction by collectors of Indian artifacts and the negative effects of the alteration of site hydrology and erosion due to timbering of surrounding forests also adversely affect or threaten the species.

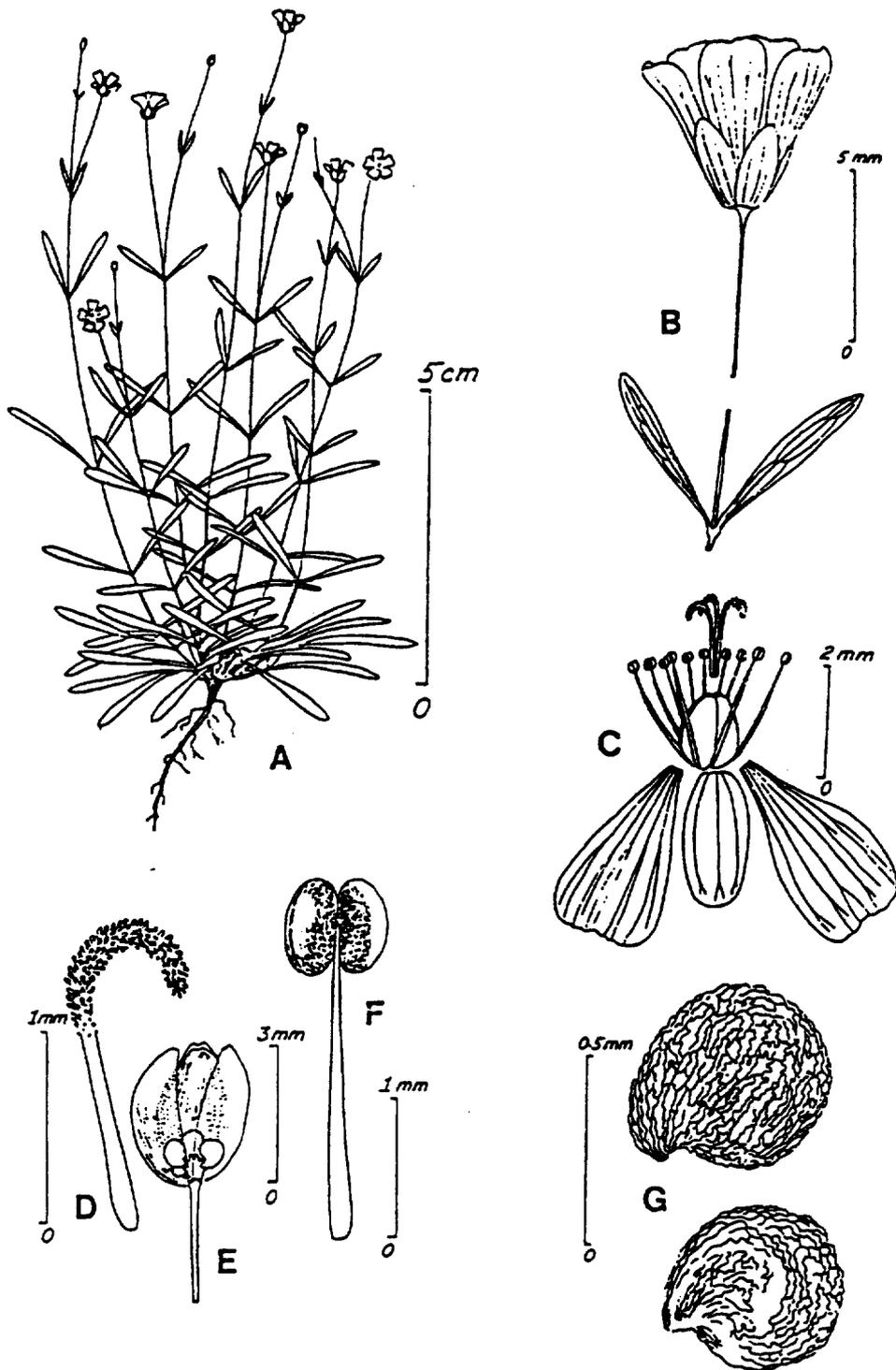
New occurrences of the species have been discovered since 1988. At this time there are 27 known occurrences in Tennessee and one in Kentucky. Of those in Tennessee, 20 are within 2 miles of each other. All of the sites occur within 25 miles of each other.

Description, History, and Distribution

The following description of Cumberland sandwort is modified from Kral (1983) and Wofford and Kral (1979). This species is a delicate perennial that occurs in tufts (Figure 1, page 2). The upright stems are 10 to 15 centimeters (cm) tall (3.9 to 6.25 inches), are slender and triangular in shape, and form small cushionlike clumps. The leaves are opposite, and the basal leaves are longer and wider than those at the top of the stems. The leaves are 2 to 3 cm long (0.8 to 1.2 inches) and 1 to 3 millimeters (mm) wide (0.04 to 0.12 inches); they are thin and are bright green in color, with glassy margins. The flowers are symmetrical, five-parted, and usually solitary at the end of the stems. The sepals are green and inconspicuously three-veined, and the white petals usually have five green veins. The fruit is a 3- to 3.5-mm-long (0.12 to 0.14 inches) ovoid capsule containing numerous reddish-brown reticulated seeds that are 0.5 to 0.7 mm long (0.02 to 0.03 inches). Flowering occurs from early July through August.

Cumberland sandwort resembles *Arenaria groenlandica* (mountain sandwort) and *Arenaria glabra* (glabrous mountain sandwort), but Kral (1983) states that it can be distinguished by "its longer, broader, thinner, veinier leaves, leafier upper stems, which produce fewer flowers as a rule, and by its distinctive seed sculpture." The

Figure 1. Illustration of Arenaria cumberlandensis.



Cumberland sandwort (Arenaria cumberlandensis), taken from the original description of Wofford & Kral (1979, Brittonia 31:258). A = whole plant; B = flower; C = dissected flower, showing two petals and a sepal; D = a stigma; E = a capsule (fruit) with seeds; F = an anther; G = seeds.

flowering period separates Cumberland sandwort temporally from *Arenaria glabra*, which flowers in early spring. In addition, *Arenaria glabra* and *Arenaria groenlandica* grow in full sun, whereas *Arenaria cumberlandensis* is found in shaded habitats.

The following summarizes the known history of the existence and distribution of Cumberland sandwort:

1941 - Shaver first collected the taxon in Pickett County, Tennessee. This and

South Fork National River and Recreation Area, personal communication, 1993; Emmott, *in litt.*, 1994).

Cumberland sandwort is currently known from four counties in Tennessee (Pickett, Scott, Fentress, and Morgan) and one county in Kentucky (McCreary) (Figure 2, page 5; Table 1, page 6). The majority of the sites are within close proximity of each other. The species occurs in sandstone rock houses, which tend to be discrete locations that are locally abundant where the geology is favorable to their formation. Although the geographic separation of the sites is not great, the exchange of genetic material is likely to be limited between individual rock houses.

Habitat, Life History, and Threats

Arenaria cumberlandensis is apparently restricted to sandstone rock houses, ledges, and solution pockets on sandstone rock faces. All known sites are within the Big South Fork watershed of the Cumberland River (Wofford and Smith 1980, Wofford and Kral 1979). The habitat requirements for the species include shade, moisture, relatively constant cool temperatures, and high humidity (Kral 1983, Wofford and Smith 1980). The rock houses in the area are formed through the differential weathering of Pennsylvanian sandstone, which results in the formation of cavelike overhangs.

Cumberland sandwort is perennial from short basal over-wintering shoots (Kral 1983). Flowering usually occurs in July and August (Wofford and Kral 1979). Fruit develops soon after flowering occurs. An investigation of the species' germination requirements has been initiated by the Center for Plant Conservation (Sud, *in litt.*, 1994).

Arenaria cumberlandensis is endangered directly and indirectly by human activities in and adjacent to its unique habitat. The species is found on the sandy floors of rock houses, in solution pockets on the face of sandstone cliffs, and on ledges beneath overhanging sandstone. Significant threats to the plants growing on the rock house floors include trampling by hikers, campers, picnickers, individuals rappelling down the sandstone cliffs, and collectors digging illegally within the rock houses for Native American artifacts. The plants growing on ledges and in solution pockets on the cliff faces are vulnerable to trampling by people rappelling down the cliffs. Many populations are potentially threatened by timber removal in or adjacent to the sites supporting the species. Increased sunlight on the plants and the subsequent alteration of the moisture conditions would probably lead to extirpation of *Arenaria cumberlandensis* from the timbered area.

Cumberland sandwort is not currently a component of the commercial trade in native plants. Its small size and restrictive habitat requirements should limit future

Figure 2. Distribution of Cumberland sandwort in Kentucky and Tennessee.

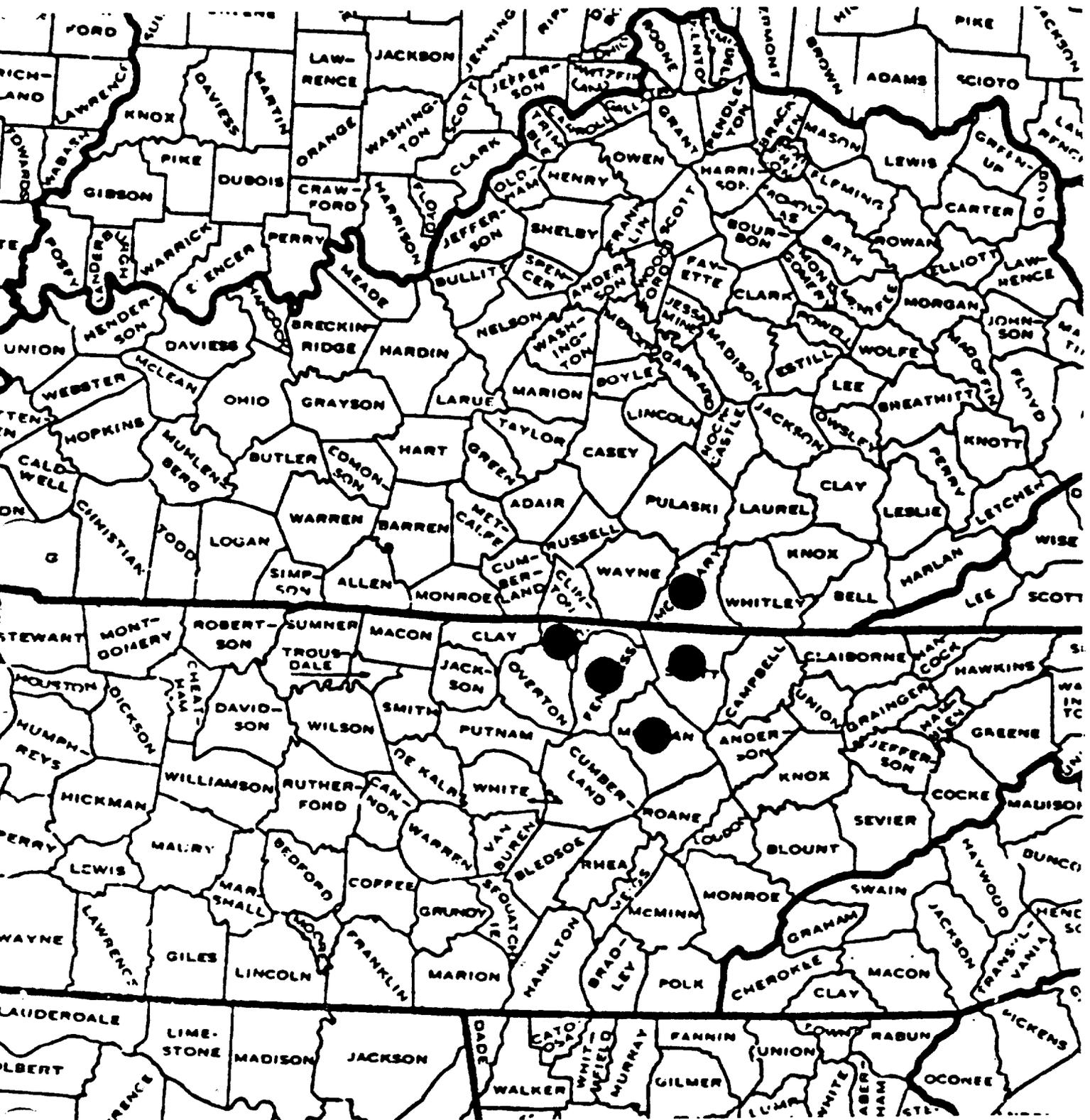


Table 1. Extant occurrences of *Arenaria cumberlandensis* (Cumberland sandwort) in Kentucky and Tennessee.

State (Site)	County	Ownership	Population Data	Last Seen	Threats to Population
KENTUCKY - Big South Fork National River and Recreation Area:					
1. Big Spring Hollow	McCreary	NPS	Hundreds of plants	1994	
TENNESSEE - Pickett State Park:					
1. Hazard Cave	Pickett	TDEC	Several hundred plants	1993	Trampling, relic hunting
2. Hidden Passage	Pickett	TDEC	Small population	1984	
3. Double Falls	Pickett	TDEC		1984	
4. Swinging Bridge	Pickett	TDEC	Several dozen plants	1993	
5. Ladder Trail	Pickett	TDEC	Thousands of plants	1993	Trampling
6. Watson Branch	Pickett	TDEC		1993	Trampling (remote location)
TENNESSEE - Pickett State Forest:					
1. Power line	Pickett	TDF		1979	Timbering
2. Rock Creek	Pickett	TDF		1979	Timbering
3. Hidden Passage 1	Pickett	TDF	Small colony	1984	Timbering
4. Hidden Passage 2	Pickett	TDF	Large colony	1984	Timbering

Table 1 (continued)

State (Site)	County	Ownership	Population Data	Last Seen	Threats to Population
5. Thompson Creek	Pickett	TDF		1980	Trampling, timbering
6. Rock Creek	Pickett	TDF		1980	Timbering
TENNESSEE - Big South Fork National River and Recreation Area:					
1. Slave Falls	Pickett	NPS	5 to 10 m ²	1992	
2. Middle Creek 1	Pickett	NPS		1992	
3. Middle Creek 2	Pickett	NPS		1992	
4. Middle Creek 3	Pickett	NPS		1992	
5. Middle Creek 4	Pickett	NPS		1992	
6. Middle Creek 5	Pickett	NPS		1992	
7. Middle Creek 6	Pickett	NPS		1992	
8. Big Island	Scott	NPS	Locally abundant	1980	Trash dumping, trampling, digging
9. Peters Bridge	Morgan	NPS/ Private	Scattered plants	1994	Timbering, unauthorized use
10. Sunbright	Morgan	NPS		1977	Trampling, timbering

Table 1 (continued)

State (Site)	County	Ownership	Population Data	Last Seen	Threats to Population
11. Middle Creek Nature Loop 1	Pickett	NPS	Several scattered groups of plants	1994	
12. Nature Loop 2	Pickett	NPS	Scattered plants covering 5 to 10 m ²	1994	
13. Nature Loop 3	Fentress	NPS	One small patch	1994	
14. Jamestown Barrens	Fentress	Private		1979	Vehicles, trampling
15. Big Branch	Scott	NPS	Two small patches	1994	

Abbreviations include: NPS - National Park Service
TDEC - Tennessee Department of Environment and Conservation
TDF - Tennessee Division of Forestry

demands (resulting from increased publicity) to a few wildflower enthusiasts who specialize in rare species. Several of the known populations are small and could be significantly damaged or extirpated by scientific collecting. *Arenaria cumberlandensis* is an extremely rare species, found only within a small portion of the Cumberland Plateau. In some populations, the loss of even a few individuals through natural fluctuations in numbers or human-induced habitat alterations could eliminate the occurrence and thereby reduce the likelihood that the species will continue to exist.

Conservation Measures and Recovery Strategy

Conservation measures currently in place include all or partial public ownership of 27 of the known occurrences of the species. Of these 27 sites, 6 occur in Pickett State Park, 6 occur in Pickett State Forest, and 15 occur in the Big South Fork National River and Recreation Area.

Searches for the species were conducted in Kentucky in 1991, 1994, and 1995; all three searches focused on McCreary County (Shea 1991; Libby 1994; Deborah White, Kentucky State Nature Preserves Commission, personal communication, 1995). A floristic inventory of Pickett State Park is currently near completion and will include additional information on the distribution of *Arenaria cumberlandensis* in the park (Virginia Small, Pickett State Park, personal communication, 1993).

Some measures to protect vulnerable sites within Pickett State Park have been taken. Primarily, a boardwalk and guard rails have been constructed at the Hazard Cave site, a popular attraction for park visitors.

Plant conservation measures have been initiated by the Center for Plant Conservation at the Missouri Botanical Garden in St. Louis, Missouri. Seeds were collected in 1991 from two sites in Pickett State Park (McCook, *in litt.*, 1992). In 1994, seeds were collected from four occurrences within the Pickett State Park and placed in long-term storage. The Missouri Botanical Garden has also initiated germination trials for the species (Sud, *in litt.*, 1994).

The primary strategy for the recovery of Cumberland sandwort includes monitoring the known occurrences and protecting them from habitat alterations; searching for new occurrences; and determining and implementing the management necessary for long-term reproduction, establishment, maintenance, and vigor. Additional actions include long-term seed storage and maintenance of living plants and studies of the species' biology, enforcement of existing laws, and a public education/information program.

PART II

RECOVERY

A. Recovery Objectives

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. The estimated date for recovery completion is 2005, provided that funds are available to accomplish the required recovery tasks and that the recovery criteria are met.

B. Narrative Outline

1. Protect existing occurrences and essential habitat. Only 28 extant occurrences of Cumberland sandwort are currently known to exist. Until more is known about the species' biology, genetic diversity, specific habitat requirements, and management needs, all existing occurrences should be protected in order to prevent extinction.
 - 1.1 Develop interim research and management plans and develop cooperative management agreements with landowners or land managers. Cumberland sandwort is typically found growing within sandstone rock houses or on ledges or within solution pockets on sandstone cliffs. Immediate emphasis will be on protection (prevention of site alterations that are known to be detrimental), in cooperation with the landowners and land managers, until appropriate management procedures have been developed through research. Demographic studies should provide important insights into the management needs of the species.
 - 1.2 Search for additional occurrences and characterize all known occurrences. Several intensive searches have been conducted for Cumberland sandwort. However, a thorough systematic effort to locate additional occurrences in Tennessee and to carefully describe the nature of the habitat occupied by the species in both States is needed. Searches should be preceded by an examination of soil and topographic maps and aerial photographs to determine potential habitat and to develop a priority list of sites to survey. The habitat requirements of the species appear to be specialized, and although it is locally abundant at some sites, it is currently known from only a small portion of one watershed. Searches for new occurrences should include areas within and adjacent to the Big South Fork watershed.
 - 1.3 Determine habitat protection priorities and develop landowner or land manager agreements. Because of the small number of existing occurrences and the pervasive threats to the habitat, it is essential to protect as many of the extant occurrences as possible. However, efforts should first be concentrated on the largest and most vigorous occurrences and sites under State or Federal management.
 - 1.4 Evaluate habitat protection alternatives. The greatest possible protection should be obtained for those existing occurrences that are considered critical to the recovery of the species. Conservation agreements or easements provide the greatest degree of protection. However, it is as yet unknown how much buffer land around each occurrence is necessary to

protect the integrity of occupied sites. Protection through memorandums of understanding may provide adequate short-term protection but should only be considered as an intermediate step in the process of ultimately providing for permanent protection. Short-term protection strategies may be necessary if private landowners are not agreeable to, or monies are not available for, the acquisition of conservation easements or fee simple title. Conservation agreements with adjacent landowners or owners of rights-of-way (power companies, highway departments, etc.) should be developed to prevent inadvertent adverse alteration of the habitat directly supporting the species or within the buffer areas needed to provide adequate protection.

1.4.1 Protect the species from recreational overuse of the habitat. Sites that occur on hiking trails within Pickett State Forest, Pickett State Park, and the Big South Fork National River and Recreation Area need to be carefully monitored. In heavily impacted areas, the installation of signs, construction of boardwalks, and diversion of trails or other appropriate techniques should be used to reduce or eliminate the adverse effects of recreational use.

1.4.2 Protect the species' habitat from adverse timber management activities. Timber management activities within Pickett State Forest should be conducted in a manner consistent with the protection needs of Cumberland sandwort. Through conservation agreements, currently occupied sites should be protected from adverse management activities. Protected areas identified within the conservation agreements should include buffer areas designed to eliminate adverse habitat modification. Timber planning should include surveys to identify currently unknown sites as well as potential sites for introduction of the species. Introduction of the species should be undertaken only if it is determined to be essential to the long-term survival of the species.

2. Determine and implement the management necessary for long-term reproduction, establishment, maintenance, and vigor. Protection of the species' habitat is the obvious first step in ensuring its long-term survival, but this alone may not be sufficient. Habitat protection and, potentially, habitat management may be necessary to allow the species to perpetuate its life cycle over the long term. However, because very little is known about this species, information about its genetic diversity, population biology, and ecology is necessary before we can determine whether active management is needed and effective management guidelines can be formulated and implemented.

- 2.1 Determine occurrence size and stage-class distribution for all occurrences. Occurrence size and stage-class distribution data are essential for determining whether populations are self-sustaining or predicting what factors may be necessary for populations to become self-sustaining (Menges 1987). Such data are needed for the existing occurrences and for any newly discovered occurrences.
- 2.2 Study abiotic and biotic features of the species' habitat. An understanding of the nature of the habitat occupied by the species is essential for the long-term survival and recovery of Cumberland sandwort. Monitoring studies should include occurrences within both altered and undisturbed habitats. Permanent plots or other appropriate monitoring methods should be selected and established to determine the relationship between abiotic factors (such as soil depth and type, soil moisture content, and light intensity) and biotic factors (such as reproduction, germination, and degree of competition and predation). This information is necessary to determine the appropriate timing and type of management necessary to ensure the continued vigor of existing occurrences and to accurately select good potential sites for introduction, if necessary.

The vectors of seed dispersal, if any, must be determined and their effectiveness under different ecological and spatial conditions assessed. Major pollinators and pollination mechanisms of this species need to be determined.

- 2.3 Conduct long-term demographic studies and determine genetic variability between occurrences. Long-term demographic studies should be conducted in permanent plots located within each study site established for habitat analysis. Plots should be visited annually, for at least 5 consecutive years. Through isozyme analysis, the degree of genetic variability between occurrences should be determined. This information will be essential to the determination of the location, distribution, and number of occurrences that need to be protected to ensure the long-term survival of the species.
- 2.4 Determine the effects of past and ongoing habitat disturbance. Establishment and long-term monitoring of permanent plots may be the most effective means of assessing the effects of disturbance. Appropriate methodology for this must be determined and included in the implementation of Tasks 2.2 and 2.3.

- 2.5 Define criteria for self-sustaining occurrences and determine the size of the area needed to protect each occurrence. There is currently insufficient data to determine what this species requires in order for populations to be self-sustaining and how large an area is needed to maintain viable populations. Research, as described under Tasks 2.2 through 2.4, should provide the information needed to protect and, if necessary, manage occupied habitat so that the continued survival of healthy occurrences is assured. This information should also be used to refine the definition of "geographically distinct, self-sustaining occurrence" used in the recovery criteria for the species.
- 2.6 Implement appropriate management techniques as they are developed from previous tasks.
- 2.7 Develop techniques and reestablish populations in suitable habitat within the species' historic range, if necessary, to recover the species. Techniques for seed collection, germination, propagation, and transplantation of this species should be developed. If determined to be necessary, reintroduction efforts should be carefully monitored and conducted in cooperation with knowledgeable personnel at private nurseries, botanical gardens, and the Center For Plant Conservation. Introduction into currently unoccupied but apparently suitable sites and reintroduction into sites from which the species has been extirpated should be undertaken only if such actions are determined to be essential to the survival of the species. Plants used to supplement existing depauperate populations, if this technique is determined to be appropriate, should be grown exclusively from plants (seeds) that originated at the supplementation site.
3. Maintain a cultivated source of plants and provide for long-term seed storage. Techniques for seed storage, germination, and, if appropriate, maintenance of cultivated specimens should be developed by private nurseries, botanical gardens, and the Center for Plant Conservation. Maintenance of seeds in storage and plants in cultivation will ensure that representative genetic material is available for research on the species and that seeds and, if necessary, plants are available for reintroduction to sites from which the species has been extirpated. All collections of material from wild populations must be conducted in a manner designed to eliminate all risks to the occurrences from which they are obtained.
4. Enforce laws protecting the species and/or its habitat. Cumberland sandwort is not currently known to be significantly threatened by commercial trade. If this becomes a threat in the future, the Endangered Species Act prohibits

taking of the species from Federal lands without a permit and regulates trade. Section 7 of the Act provides additional protection of the habitat from impacts related to federally funded or authorized projects. In addition, for listed plants, the Act prohibits (1) their malicious damage or destruction on Federal lands and (2) their removal, cutting, digging, damaging, or destroying in knowing violation of any State law or regulation, including State criminal trespass law.

5. Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of Cumberland sandwort could play an important part in encouraging conservation efforts. Information materials should not identify the plant's locations so as not to increase the threat of taking.
 - 5.1 Prepare and distribute news releases and informational brochures. News releases concerning the status and significance of the species and recovery efforts should be prepared and distributed to newspapers in the range of the species.
 - 5.2 Prepare articles for popular and scientific publications. The need to protect the species in its native habitat and cooperation among local, State, and Federal organizations and individuals should be stressed. Scientific publications should emphasize additional research that is needed and solicit research assistance from colleges and universities that have conducted studies on this or closely related species.
6. Annually assess the success of recovery efforts for the species. Review of new information, evaluation of ongoing actions, and redirection, if necessary, is essential for assuring that full recovery is achieved as quickly and efficiently as possible.

C. Literature Cited

- Kral, R. 1983. A Report on Some Rare, Threatened, or Endangered Forest-related Vascular Plants of the South. Tech. Publ. R8-TP-2. USDA-Forest Service. Vol. I, pp. 363-366.
- Libby, Gary W. 1994. Field Survey for Cumberland Sandwort (*Minuartia cumberlandensis* [Wofford and Kral] McNeill). Kentucky Endangered Plant Species Program (Project E-1-8). 20 pp.
- Menges, E. 1987. Predicting the future of rare plant populations: demographic monitoring and modeling. *Natural Areas Journal* 6(3):13-26.
- Shea, M. 1991. Field Survey for Cumberland Sandwort (*Arenaria cumberlandensis* Wofford and Kral). Kentucky Endangered Plant Species Program (Project E-1-5). 9 pp.
- U.S. Fish and Wildlife Service. 1987. Endangered and Threatened Wildlife and Plants; Proposal to Determine Endangered Status for *Arenaria cumberlandensis*. *Federal Register* 52(128):25268-25271.
- U.S. Fish and Wildlife Service. 1988. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for *Arenaria cumberlandensis*. *Federal Register* 53(121):23745-23748.
- Wofford, B. E., and R. Kral. 1979. A New *Arenaria* (Caryophyllaceae) from the Cumberlands of Tennessee. *Brittonia* 31(2). Pp. 257-260.
- Wofford, B. E., and D. K. Smith. 1980. *Arenaria cumberlandensis* Status Survey Report. Report for the U.S. Fish and Wildlife Service. 20 pp.

PART III

IMPLEMENTATION SCHEDULE

Priorities in column one of the following Implementation Schedule are assigned as follows:

1. Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
2. Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
3. Priority 3 - All other actions necessary to meet the recovery objective.

Key to Acronyms Used in This Implementation Schedule

CPC	- Center for Plant Conservation
FWS	- U.S. Fish and Wildlife Service
KSNPC	- Kentucky State Nature Preserves Commission
LE	- Law Enforcement Division, U.S. Fish and Wildlife Service
NPS	- National Park Service
R4	- Region 4 (Southeast Region), U.S. Fish and Wildlife Service
TDEC	- Tennessee Department of Environment and Conservation
TDF	- Tennessee Division of Forestry
TE	- Endangered Species Division, U.S. Fish and Wildlife Service
USDA	- U.S. Department of Agriculture

CUMBERLAND SANDWORT IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates (\$000s)			Comments
				FWS	Other	FY1	FY2	FY3	
1	1.1	Develop management plans.	Ongoing	R4/TE	NPS, TDF, TDEC	3.0	3.0	3.0	
1	1.3	Prioritize sites and develop agreements.	2 years	R4/TE	NPS, TDF, TDEC		4.0	4.0	
1	1.4	Evaluate protection alternatives.	1 year	R4/TE	NPS, TDF, TDEC				
1	1.4.1	Protect sites from overuse.	3 years	R4/TE	NPS, TDF, TDEC		10.0	10.0	
1	2.5	Refine recovery criteria.	1 year	R4/TE	NPS, TDF, TDEC, KSNPC			6.0	
1	6.0	Annually review recovery efforts and goals.	Ongoing	R4/TE	NPS, TDF, TDEC, KSNPC				
2	1.2	Search for new populations and characterize known populations.	3 years	R4/TE	NPS, TDF, TDEC, KSNPC	6.0	6.0	6.0	
2	1.4.2	Protect sites from adverse timber management.	Ongoing	R4/TE	TDF				
2	2.1	Conduct baseline inventory.	1 year	R4/TE	NPS, TDF, TDEC, KSNPC	12.0			
2	2.2	Characterize habitat.	2 years	R4/TE	NPS, TDF, TDEC, KSNPC		10.0	10.0	
2	2.3	Conduct long-term demographic studies.	Ongoing	R4/TE	NPS, TDF, TDEC, KSNPC	10.0	10.0	10.0	

CUMBERLAND SANDWORT IMPLEMENTATION SCHEDULE (continued)

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates (\$000s)			Comments
				FWS	Other	FY1	FY2	FY3	
2	2.4	Evaluate habitat alterations.	3 years	R4/TE	NPS, TDF, TDEC, KSNPC	6.0	6.0	6.0	
2	2.6	Implement needed management.	Ongoing	R4/TE	NPS, TDF		6.0	6.0	
2	3.0	Maintain plants and seeds.	Ongoing	R4/TE	CPC, USDA	12.0	0.5	0.5	
2	4.0	Enforce laws.	Ongoing	R4/TE and LE	NPS, TDF, TDEC				
3	2.7	Reestablish populations, if necessary.	3 years	R4/TE	NPS, TDF, TDEC, KSNPC				Costs unknown; tasks may not be necessary.
3	5.1	Prepare news releases and brochures.	Ongoing	R4/TE	NPS, TDF, TDEC, KSNPC	3.0	0.5	0.5	
3	5.2	Prepare articles for journals and magazines.	Ongoing	R4/TE	NPS, TDF, TDEC, KSNPC				

PART IV

LIST OF RECIPIENTS

The following agencies, organizations, and individuals were mailed copies of this recovery plan. This does not imply that they provided comments or endorsed the contents of this plan.

Mr. Reginald Reeves, Director
Endangered Species Division
Tennessee Department of Environment
and Conservation
401 Church Street
Eighth Floor, L&C Tower
Nashville, Tennessee 37243-0447

Mr. Roy Jensen
Division of Parks and Recreation
Tennessee Department of Environment
and Conservation
401 Church Street
Eighth Floor, L&C Tower
Nashville, Tennessee 37243-0447

Mr. Bob Rochelle
Division of Forestry
Tennessee Department of Environment
and Conservation
401 Church Street
Eighth Floor, L&C Tower
Nashville, Tennessee 37243-0447

Mr. Bob Leonard, Manager
Kentucky State Clearinghouse
Department of Local Government
Second Floor, Capital Tower
Frankfort, Kentucky 40601

Superintendent
Big South Fork National River and
Recreation Area
Route 3, Box 401
Oneida, Tennessee 37841-9544

Mr. Bob Emmott
Big South Fork National River and
Recreation Area
Route 3, Box 401
Oneida, Tennessee 37841-9544

Forest Supervisor
Daniel Boone National Forest
1700 Bypass Road
Winchester, Kentucky 40391

Mr. David Taylor
Daniel Boone National Forest
1700 Bypass Road
Winchester, Kentucky 40391

Dr. William H. Redmond
Regional Natural Heritage Project
Tennessee Valley Authority
Norris, Tennessee 37828

Mr. David Yancy
Kentucky Department of Fish and
Wildlife Resources
Number 1 Game Farm Road
Frankfort, Kentucky 40601

Mr. Robert McCance, Jr., Director
Kentucky State Nature Preserves Commission
801 Schenkel Lane
Frankfort, Kentucky 40601-1403

Commissioner of Parks
Kentucky Department of Parks
Tenth Floor, Capital Plaza Building
Frankfort, Kentucky 40601

Mr. James E. Daniel, II, President
Kentucky Audubon Council
P.O. Box 137
Frankfort, Kentucky 40602

Drs. Jerry and Carol Baskin
School of Biological Sciences
University of Kentucky
Lexington, Kentucky 40506

Mr. Max E. Medley
Biology Department
University of Louisville
Louisville, Kentucky 40292

New England Wildflower Society, Inc.
Garden in the Woods
Hemenway Road
Framington, Massachusetts 01701

Dr. Janice Coffey Swab
Conservation Committee
American Society of Plant Taxonomists
Meredith College
Hunter Hall
3800 Hillsborough Street
Raleigh, North Carolina 27607-5298

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560

Traffic U.S.A.
World Wildlife Fund
1250 Twenty-fourth Street, NW., Suite 500
Washington, DC 20037

Dr. Susan H. Lathrop, Executive Director
American Association of Botanical
Gardens and Arboreta, Inc.
786 Church Road
Wayne, Pennsylvania 19087

Natural Resources Defense Council, Inc.
40 West 20th Street
New York, New York 10011

The Garden Club of America
598 Madison Avenue
New York, New York 10022

Kentucky Resources Council, Inc.
P.O. Box 1070
Frankfort, Kentucky 40602

Dr. Leo Collins
Forestry, Fisheries, and Wildlife Division
Tennessee Valley Authority
Norris, Tennessee 37828

The Nature Conservancy
2002 Richard Jones Road, Suite 304-C
Nashville, Tennessee 37215

The Nature Conservancy
1815 N. Lynn Street
Arlington, Virginia 22209

Mr. Joe Jacob
The Nature Conservancy
P.O. Box 2267
Chapel Hill, North Carolina 27514

Mr. Bob McCartney
Woodlanders
1128 Colleton Avenue
Aiken, South Carolina 29801

Mr. John Sherman
Tennessee Environmental Council
1700 Hayes Street, Suite 101
Nashville, Tennessee 37203

Mr. Ken Warren, Secretary
Harvey Broome Group
Sierra Club
105 Evans Lane
Oak Ridge, Tennessee 37830

Mr. Arthur Smith
Sierra Club - Tennessee Chapter
100 Otari Drive
Kingsport, Tennessee 37664

Dr. Murray A. Evans
c/o Botany Department
University of Tennessee
Knoxville, Tennessee 37916

Dr. Bob Kral
Biology Department
Vanderbilt University
Box 1705, Station B
Nashville, Tennessee 37235

Mr. Edward Schell
416 Lambeth Drive
Johnson City, Tennessee 37601-1042

Dr. Eugene Wofford
Curator of Herbarium
Department of Botany
University of Tennessee
Knoxville, Tennessee 37916

Ms. Liane B. Russell
130 Tabor Road
Oak Ridge, Tennessee 37830

Director
Tennessee Wildlife Resources Agency
Ellington Agricultural Center
P.O. Box 40747
Nashville, Tennessee 37204

Dr. Bob Cook
Arnold Arboretum
125 Arborway
Jamaica Plain, Massachusetts 02130

Center for Plant Conservation
Missouri Botanical Garden
P.O. Box 299
St. Louis, Missouri 63166

Mr. Rich Owings
North Carolina Arboretum
P.O. Box 6617
Asheville, North Carolina 28816

Mr. Mike Turner (PD-R)
U.S. Army Corps of Engineers
Louisville District
P.O. Box 59
Louisville, Kentucky 40201

Lt. Col. John Whisler
Nashville District Engineer
U.S. Army Corps of Engineers
P.O. Box 1070
Nashville, Tennessee 37202-1070

U.S. Forest Service
Wildlife, Fisheries, and Range
1720 Peachtree Road, NW.
Atlanta, Georgia 30367

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814

Project Manager (7507C)
Environmental Protection Agency
Endangered Species Protection Program
Environmental Fate and Effects Division
Office of Pesticide Programs
401 M Street, SW.
Washington, DC 20460

The Nature Conservancy
Eastern Regional Office
201 Devonshire Street, 5th Floor
Boston, Massachusetts 02110

Mr. Rob Gardner
Curator of Rare Plants
North Carolina Botanical Garden
University of North Carolina - Chapel Hill
CB Number 3375, Totten Center
Chapel Hill, North Carolina 27599-3375

Dr. Peter White, Director
North Carolina Botanical Garden
University of North Carolina - Chapel Hill
CB Number 3375, Totten Center
Chapel Hill, North Carolina 27599-3375

Dr. Gary B. Blank
North Carolina State University
Box 8002
Raleigh, North Carolina 27695-8002

Mr. Alan Smith
P.O. Box 887
Mars Hill, North Carolina 28754

Mr. Julius T. Johnson
Director of Public Affairs
Tennessee Farm Bureau Federation
P.O. Box 313
Columbia, Tennessee 38401

Ms. Laura Knoth
Director of Environmental Affairs
Kentucky Farm Bureau Federation
P.O. Box 20700
Louisville, Kentucky 40250-0700

Ms. Margaret Shea
The Nature Conservancy
642 West Main Street
Lexington, Kentucky 40508

Mr. Billy Glen Smith
Superintendent
Pickett State Park
Rock Creek Route, Box 174
Jamestown, Tennessee 38556

Mr. Jim Matthews
Pickett State Forest
Rock Creek Route, Box 112
Jamestown, Tennessee 38556

Ms. Alexa McKerrow
Tennessee Department of Environment
and Conservation
401 Church Street
Eighth Floor, L&C Tower
Nashville, Tennessee 37243-0447

Environmental Protection Agency
Hazard Evaluation Division - EEB (TS769C)
401 M Street, SW.
Washington, DC 20460

Ms. Alice L. Gustin
Publisher/Editor
Land Use Chronicle
P.O. Box 468
Riverton, Wyoming 82501

Mrs. Ruby Pharr
111 York Street
Morganton, North Carolina 28655

Mr. Steven Gisler
Oregon State University
Department of Botany
Cordley Hall
Corvallis, Oregon 97331

Mr. Charles P. Nicholson
Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, Tennessee 37902-1499

Dr. Harriet Gillett
World Conservation Monitoring Centre
219 Huntingdon Road
Cambridge CB3 0DL
United Kingdom