Recovery Plan
For
Cumberland rosemary
(Conradina verticillata)

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

RECOVERY PLAN

for

Cumberland Rosemary (*Conradina verticillata*)

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Date: July 12, 1996

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Literature citations should read as follows:

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ACKNOWLEDGMENTS

The authors wish to express their thanks to Robert Emmott, Big South Fork National River and Recreation Area; Melissa Gay, Student Assistant, and Milo Pyne, State Botanist, Tennessee Department of Environment and Conservation, Natural Heritage Division; and Tom Bloom and Deborah White, Kentucky State Nature Preserves Commission, for their contributions to this recovery plan.

EXECUTIVE SUMMARY

Current Status: There are currently three populations (91 extant colonies) of *Conradina verticillata* (Cumberland rosemary) in two States, with 79 colonies in Tennessee and 12 in Kentucky. At the time of listing (1991) there were three populations and 44 known colonies of the species. *Conradina verticillata* was listed as threatened by the U.S. Fish and Wildlife Service because of the small size of most populations in its limited geographic distribution and the significance of the threats to the species.

Habitat Requirements and Limiting Factors: *Conradina verticillata* occurs on sandy or gravelly stream banks, sandbars, and gravel/boulder bars associated with floodplains or islands. Periodic flooding is important to maintain openness and enhance sand deposition. Shading due to woody plant encroachment results in reduced growth and reproduction of the species.

Recovery Objective: Delisting.

Recovery Criteria: Cumberland rosemary will be considered for delisting when there are five protected and managed colonies with 50 genetically distinct individuals per colony in each of the five main rivers (Big South Fork, Emory, Clear Fork, Caney, and Obed) where it occurs (25 colonies total). Introduced colonies will not be considered successfully established until after a 5-year period.

Actions Needed:

1. Protect existing colonies and habitat.
2. Develop management plans.
3. Study the biology of the species.
4. Conduct genetic studies; maintain seeds in storage and plants in cultivation.
5. Search for new populations.

Costs ($000s):

YEAR	NEED 1	NEED 2	NEED 3	NEED 4	NEED 5	TOTALS
1996			65.0	35.0	25.0	**125.0**
1997	15.0		20.0	20.0	25.0	**80.0**
1998		20.0	20.0	10.0		**50.0**
1999			10.0			**10.0**
2000			10.0			**10.0**
2001			10.0			**10.0**
2002			10.0			**10.0**
2003			10.0			**10.0**
2004			10.0			**10.0**
2005			10.0			**10.0**
TOTALS	**15.0**	**20.0**	**175.0**	**65.0**	**50.0**	**325.0**

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

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PART I

INTRODUCTION

Cumberland rosemary (*Conradina verticillata* Jennison), a shrub in the mint family (Lamiaceae), is endemic to the Cumberland Plateau of north-central Tennessee and adjacent southeastern Kentucky. In 1991 the U.S. Fish and Wildlife Service (Service) listed the species as threatened due to the small number of populations and the known threats to the species' survival (Service 1991). *Conradina verticillata* is listed as endangered by the State of Tennessee (Tennessee Department of Environment and Conservation 1995) and by the State of Kentucky (Kentucky State Nature Preserves Commission 1994).

Description and Taxonomic Status

Conradina is a genus of six allopatric species confined to the Southeastern United States (Shinners 1962, Gray 1965, Kral and McCartney 1991). *Conradina verticillata*, as discussed above, occurs on the Cumberland Plateau of Tennessee and Kentucky. *Conradina canescens* occupies coastal dunes and longleaf pineland in southeastern Mississippi, south Alabama, and the Florida panhandle. *Conradina glabra* grows in pineland and other upland habitats east of Florida's Apalachicola River. *Conradina brevifolia* and *C. grandiflora* occur in sand scrub areas in eastern and central Florida, and *C. etonia* is restricted to a limited area in northeastern Florida. Three species--*C. etonia, C. glabra*, and *C. brevifolia*--are listed as federally endangered; *C. verticillata* is federally listed as threatened; and *C. grandiflora* does not have a Federal status but is considered rare (Service 1994).

Gray (1965) considered *Conradina verticillata* to be an old species represented by relict occurrences in a few stream-bank habitats of the Cumberland Plateau. It is disjunct from the other species of *Conradina* and has reduced seed germination and a reduced ability to reproduce and disperse sexually. The following history of the taxon is adopted from Patrick and Wofford (1981) (see Table 1).

1884 - *Conradina verticillata* was first collected by Albert Ruth along Clear Fork River near the town of Rugby, Tennessee. Early collections were regarded as a disjunct population of *Conradina canescens* (Torr. & Gray) Gray, a Coastal Plain species.

1931 - Holotype and other specimens collected by Jennison and Sharp along Clear Fork near the town of Rugby. Holotype deposited in the University of Tennessee Herbarium.

1933 - Species described as *Conradina verticillata* by H. M. Jennison.

Table 1. History of the discovery of Cumberland rosemary, Conradina verticillata (from Patrick and Wofford 1981).

DRAINAGE	MAJOR STREAM	YEAR OF DISCOVERY	COLLECTORS/ OBSERVERS
Cumberland River	Clear Fork	1894	Ruth, Percival
	White Oak Creek	1930	Cain
	Big South Fork, KY	1935	Braun
	Big South Fork, TN	1947	Clebsch, Shanks, Sharp
	Caney Fork	1961	Channell
	New River	1975	Leonard
Tennessee River	Clear Creek	1965	Sharp, Taylor
	Daddys Creek	1969	Clebsch, Bowers, Evans
	Obed River	1979	Schmalzer
	Emory River	1979	Schmalzer

1933 - Species described as *Conradina montana* by J. K. Small in Manual of the Southeastern Flora. Name published 7 months later than *C. verticillata* Jennison and later reduced to synonymy.

1934 - Holotype destroyed in a fire at the University of Tennessee Herbarium.

1965 - Isotype material at the Gray Herbarium designated as the Lectotype by T. C. Gray

1981 - Status report for *Conradina verticillata* Jennison completed by T. Patrick and B. E. Wofford.

1991 - Cumberland rosemary is listed as a threatened species by the Service (*Federal Register* 56(230):60937-60941).

Cumberland rosemary, an evergreen perennial shrub in the mint family, is most noted for its aromatic leaves, which smell like the culinary herb rosemary, and for its abundant pink to purple flowers, which make it attractive to horticulturists (see Figure 1). A full technical description can be found in Gray (1965), but a few characteristics from Kral

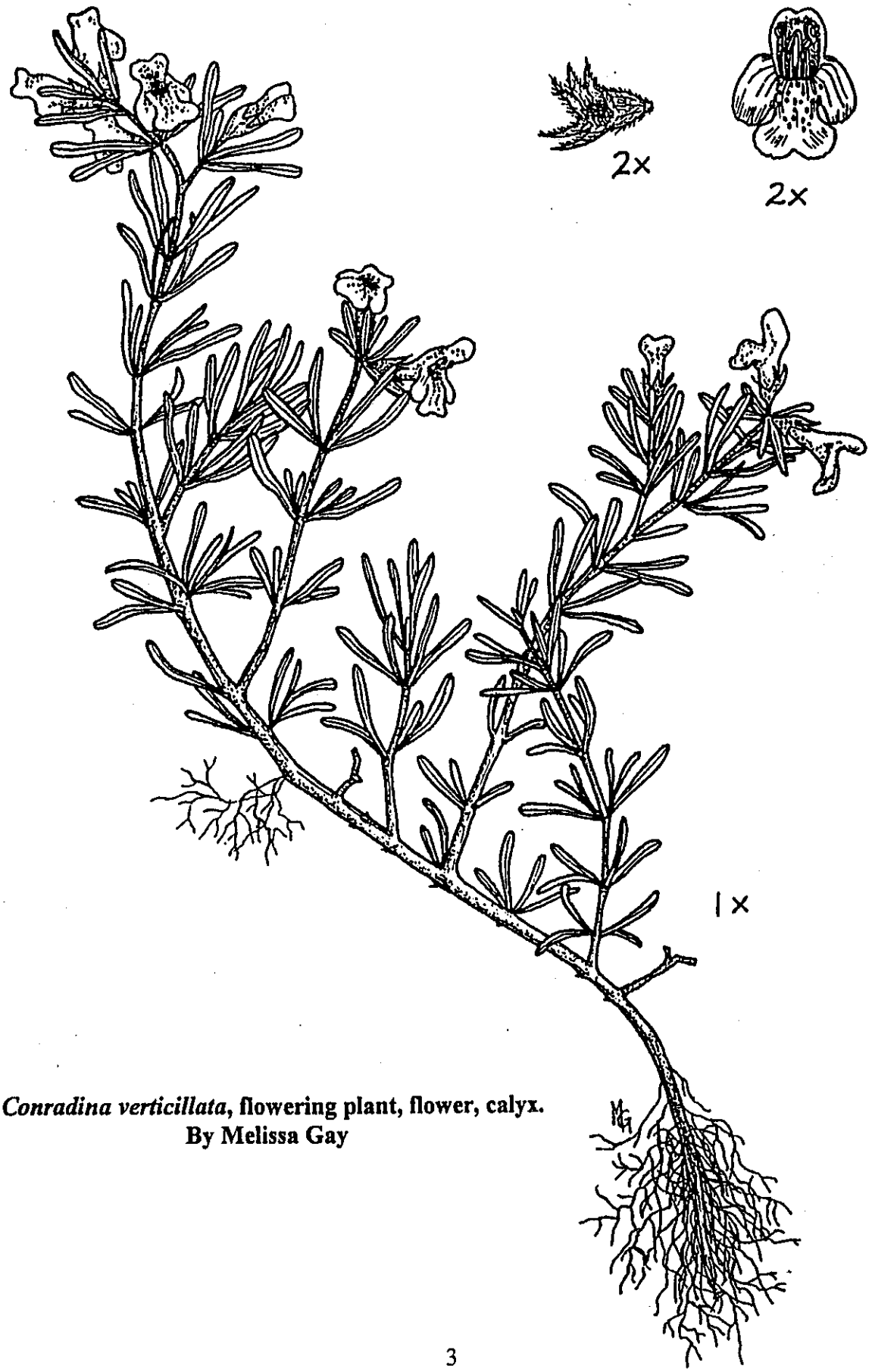

Figure 1. ***Conradina verticillata*****, flowering plant, flower, calyx.**
By Melissa Gay

(1983), Patrick and Wofford (1981), and Roulston (1994) are presented and will aid in field identification.

Inflorescence: Flowers on short-stalked, linear-bracted, axillary cymes from most or all upper nodes; the cyme stalks hispidulous; the bracts covered with long-spreading gland-tipped hairs.

Flowers: They are 1 to 2 centimeters (cm) long; lavender, purple, or rarely white, usually with dark spots leading down the throat; two-lipped, the upper lip with two lobes, the lower with three; floral tube strongly bent, giving the flower an s-shape in profile; borne in small clusters in the axils of the present year's leaves from early May until early June.

Calyx: Bilabiate, five-toothed, persistent, 7 to 9 millimeters (mm) long, glandular-pubescent and/or sparsely puberulent to appressed pubescent.

Stems: Four-sided; woody but lax, often decumbent; seldom growing more than 1 foot tall before falling over, rooting at the nodes, and putting up more stems.

Leaves: Entire, needlelike, opposite with additional pairs clustered in the axils appearing whorled, somewhat fleshy, with strongly revolute margins, 1 to 3 cm long, resin dotted, aromatic.

Seeds: Up to four per calyx, dry, dark brown, spherical, 1 mm in diameter; loose in calyx but usually not falling out before calyx falls off plant.

No other plants are likely to be mistaken for it when it is in flower. Without flowers, however, it resembles *Aster linariifolius, Hypericum densiflorum,* and *Pycnanthemum tenuiflorum,* which also have needlelike leaves and grow in the same habitat but do not have the distinctive rosemary aroma. The closest relatives of Cumberland rosemary, the other species of the genus *Conradina,* occur on the Gulf Coast of Alabama, Mississippi, and Florida and the Atlantic Coast of Florida, far from the range of *Conradina verticillata.* It is distinguished from its congeners by its decumbent habit, longer leaves, and long glandular-hairy calyx tubes.

Distribution

Cumberland rosemary is known from five counties in north-central Tennessee and one county in southeastern Kentucky (Figure 2). At present, 91 occurrences (colonies) are thought to be extant. (Occurrences believed to be extant are those that have been observed in the recent past.) These are along nine major streams of the Cumberland Plateau--Big South Fork River, New River, Clear Fork River, White Oak Creek, Caney Fork River, Obed River, Daddys Creek, Clear Creek, and Emory River (Tennessee Department of Environment and Conservation 1995, Kentucky State Nature Preserves

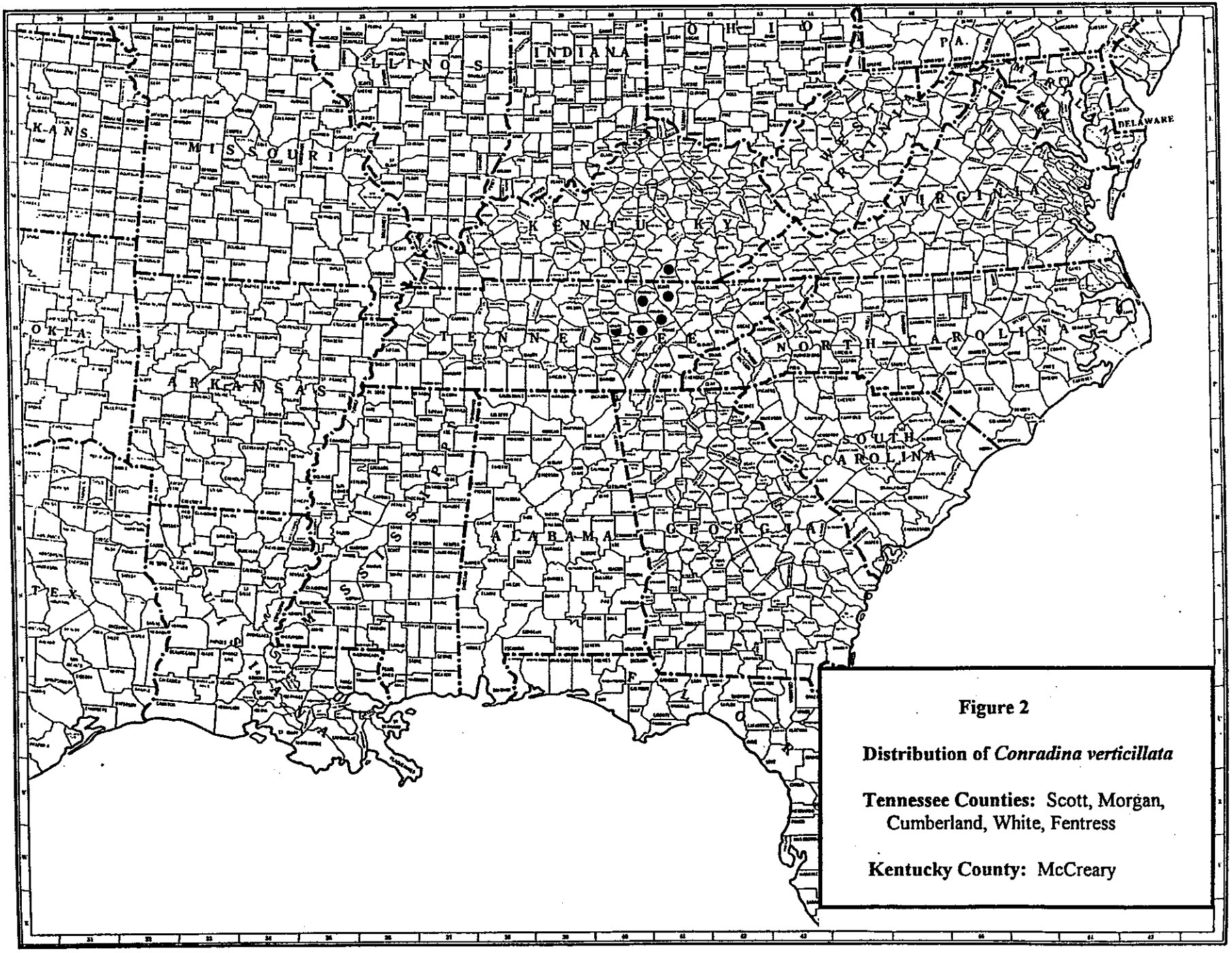

Figure 2

Distribution of *Conradina verticillata*

Tennessee Counties: Scott, Morgan, Cumberland, White, Fentress

Kentucky County: McCreary

Commission 1994). There are three distinct populations. Within these populations genetic exchange is believed to occur on a frequent basis, while it is less frequent between the populations. These populations are located along the following rivers: (1) the Big South Fork River and its tributaries in Morgan, Scott, and Fentress Counties; (2) the Obed River in Morgan and Cumberland Counties; and, (3) the Caney Fork River in Cumberland and White Counties. The locations in Kentucky are considered part of the Big South Fork River population of Tennessee (Figure 3).

Although it is widespread along several of these streams, it is often disjunct and seldom abundant, often with only a single plant (see Appendix). There are fewer than ten locations that are known to have more than 100 clumps (see Life History section for explanation of clumps) and probably fewer than 4,000 total clumps from all known locations (Table 2). Population data for each extant occurrence is presented by stream or river in the Appendix.

One occurrence is assumed extirpated. Lucy Braun collected *Conradina verticillata* from a site 50 miles downstream of the type locality in McCreary County, Kentucky, within the area now inundated by Lake Cumberland, which was formed by the Wolf Creek Dam (Patrick and Wofford 1981). The current status of the type locality is not known. In 1979 and 1992, attempts were made to relocate Cumberland rosemary along the north bank of the Clear Fork in Fentress County, Tennessee. High water levels were detrimental to both search efforts (field search by Roulston in 1993, Patrick and Wofford 1981).

Habitat

Cumberland rosemary grows in full to moderate sunlight in the floodplain of major streams flowing over sandstone bedrock. The substrate varies from expanses of deep, pure sand to densely rocky areas that are always well drained and devoid of organic matter. Plants occur on boulder bars, bouldery gravel bars, sandy gravel bars, terraces of sand on gradually sloped riverbanks and islands, and sandy pockets between boulders. Seasonal flooding occurs along these major Cumberland Plateau rivers and streams. Essential habitat requirements for Cumberland rosemary include periodic flooding to maintain openness, topographic features to enhance sand deposition, and periods of inundation of at least 2 weeks to induce rooting at the lower nodes of the stems (Service 1984).

The primary importance of the periodic flooding is probably the elimination or reduction of trees and shrubs that would out-compete Cumberland rosemary for light. Although it will tolerate moderate amounts of shade, the species will produce fewer flowers and appear less vigorous. Other possible benefits of flooding include the induction of roots at the nodes by inundation or sand deposition, thereby increasing the clump size; the

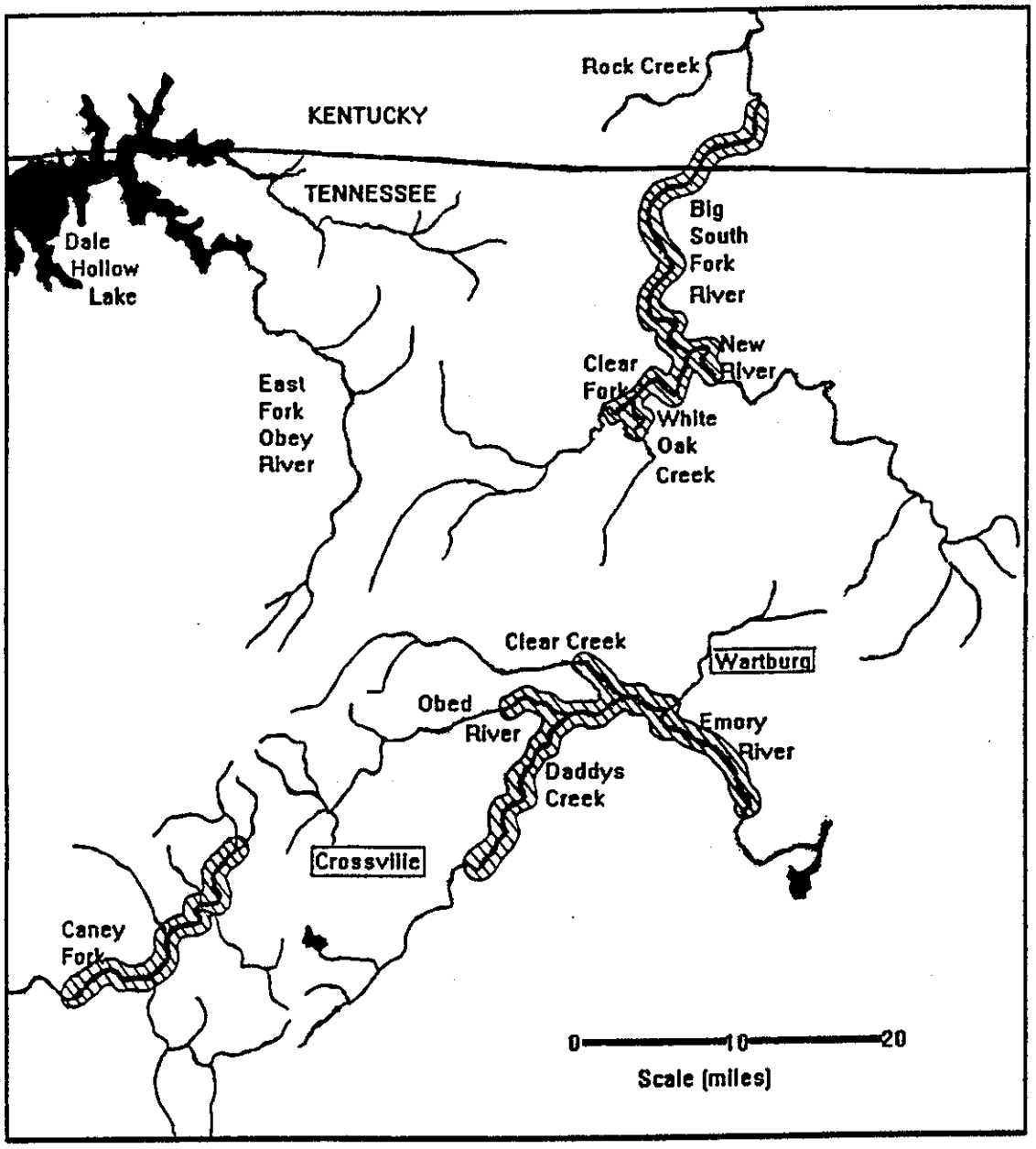

Figure 3. POPULATION RANGE OF CUMBERLAND ROSEMARY

Table 2. Estimates of abundance of *Conradina verticillata* from known occurrences based on qualitative and quantitative collection information. Actual population data are listed in the Appendix.

STREAM/RIVER	NUMBER OF LOCATIONS	TOTAL NUMBER OF CLUMPS	NUMBER OF LOCATIONS WITH >100 CLUMPS
Clear Fork	15	100-250	0
Big South Fork	25	1,000-1,500	2
New River	2	No data	
White Oak Creek	2	2	0
Daddys Creek	8	100-250	0
Obed River	12	250-500	2
Emory	4	50-100	0
Clear Creek	10	250-500	1
Caney Fork	13	250-500	0
TOTAL	**91**	**2,000-3,600**	**5**

downstream dispersal of seeds; and the transport and deposition of viable plant fragments downstream.

The duration, severity, and frequency of flooding varies greatly from year to year within, as well as between, populations. Available data show that some populations may be flooded three to seven times a year for up to 3 days at a time. Floods are most common during the winter (Pennington 1992).

Although Cumberland rosemary tolerates extended periods of submersion and thrives in full sunlight, it seldom, if ever, grows directly beside the normal (nonflooded) riverbed, probably because of the soil saturation associated with the higher water table at these locations. Such habitat constraints greatly limit the distribution of the species within a river system. The banks of Cumberland Plateau rivers are very steep in some areas and forested to the edge, leaving no marginal area of well-drained soil. With few exceptions, the only place where Cumberland rosemary is found in any abundance (more than 50 clumps) is on wide gravel/boulder bars of river bends or low-lying islands. These frequently occur where major tributaries enter the main channel, depositing sediment and

widening the floodplain. These areas tend to be dominated by grasses such as big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and Indian grass (*Sorgastrum nutans*); shrubs such as laurel, rhododendron, and farkleberry; and occasional flood-twisted yellow pines, eastern red cedar, and sycamore.

Several taxa listed as State or federally endangered or threatened occur frequently in these habitats--*Calamovilfa arcuata, Helenium brevifloium, Sporobolus junceus, Marshallia grandiflora, Spiraea virginiana, Leucothoe racemosa, Polygonella americana*, and *Fothergilla major.*

The most efficient way to find locations for Cumberland rosemary is to travel by boat and look on sandy stream banks and gravel/boulder bars during the month of May for the most prominent co-flowering species--phlox (*Phlox glaberrima*), wild indigo (*Baptisia tinctoria*), and *Tephrosia virginiana.*

The habitat consists of many native perennial shrubs and herbaceous species that are frequently found in association along the flood-prone, broad sections of Cumberland Plateau rivers. Some species include *Aster linariifolius, Aster patens, Coreopsis pubescens, Hypericum densiflorum, H. denticulatum* var. *recognitum, Ipomea pandurata, Liatris microcephala, Lysimachia lanceolata, Pycnanthemum tenuifolium, Rudbeckia laciniata, Silphium trifoliatum, Schrankia microphylla, Thalictrum revolutum, Trautvetteria carolinensis,* and *Veronicastrum virginicum* (Patrick and Wofford 1981).

Life History (adapted from Roulston 1994)

Conradina verticillata is a highly clonal species. Its branches spread across the ground, root at the nodes, and are partially covered by sand and rocks each time the river floods; this makes connected branches appear as separate plants. For this reason the term "plant" is highly subjective when applied to this species. In rocky habitats the term "clump" adequately describes an assemblage of aerial branches that are most likely connected below the ground, but in sandy areas the branches may spread out over many feet. It then becomes impossible to separate them into distinct genetic entities by observation alone. In order to determine individual plants as genetic units, it would be necessary to apply a molecular analysis technique, such as starch gel electrophoresis, which has been successfully applied to many clonal species.

Cumberland rosemary produces abundant flowers in May and early June. Flowers are functionally male when they first open, producing pollen from several hours or up to a day before the female parts are receptive. They produce small quantities of nectar that attracts many different insects, including butterflies and hover flies, but are pollinated mainly by bees, particularly bumblebees and honeybees. The flowers fall off within 2 days of being pollinated but last up to a week if unpollinated.

Insect visits are necessary for seed production, and many seeds are produced each year, maturing about the middle of June. Less than 10 percent of the seeds, however, are fully developed and fertile. One way of distinguishing fully developed seeds from poorly developed ones is to place them in water; the well-developed ones are much more likely to sink.

The only known factors that promote seed germination are surface sterilization of the seed coat with bleach and hydrogen peroxide, soaking in water for 24 hours, and daily exposure to room light or sunlight. There are apparently no dormancy mechanisms in the species. Germination takes about 2 weeks. This can be reduced to 2 to 3 days through scarification. Seeds will germinate on damp filter paper or sand and survive for many months on sand only.

The low percentage of seeds that germinate seems to be related to poor development. The factors causing poor development of Cumberland rosemary seeds are largely unknown, but one important factor may be self-pollination. In this species, self-pollination appears to be less likely than outcrossing to produce fully developed seeds. Because the species is highly clonal and the pollinators tend to visit adjacent flowers, any given flower is most likely to receive pollen from a flower of the same genetic individual. Another factor causing poor seed development is fungal attack. Fungi were observed to be quite prominent on many Cumberland rosemary seeds while still in the calyx. Studies have shown that fungi quickly destroy seeds that have not been surface sterilized.

Cumberland rosemary seedlings are rare in the wild; only one investigator has reported seeing one. This is probably due in great part to poor production of fully developed seeds, but summer drought and winter floods may also play a prominent role. The species maintains itself almost entirely by clonal spread and stem longevity. Dispersal seems to be mainly through fragmentation during winter storms.

Reasons for Listing

A number of factors threaten the continued survival of *Conradina verticillata*, including biological factors, human disturbances, competition with other species, and natural habitat disturbances. The small size and number of extant populations are two of the most important reasons for its designation as a threatened species. Three short stretches of stream account for about 80 percent of all known plants of this species and should be considered the most important areas for its conservation: (1) Big South Fork River - Bandy Creek (Leatherwood Ford) to the Kentucky border, (2) Obed River - final 9 miles to its confluence with the Emory River, and (3) Clear Creek - site at Lilly Bridge.

By far the greatest threat to Cumberland rosemary is inundation by reservoirs constructed for recreational water supply or hydroelectric purposes. The northernmost population

was extirpated by the building of Wolf Creek Dam on the Big South Fork River, and it is possible that the construction of other dams in the region has caused the extirpation of undiscovered populations. Most of the known locations for the species were discovered after 1960, after many dams in the region were built. A dam is located downstream of every river where Cumberland rosemary occurs. Dam building can harm the plant directly by permanently inundating it or indirectly by altering the flood regime. There is the potential for dam building upstream from all of the colonies. Presently, there are proposals to build dams on the upper part of Clear Creek and the Clear Fork River. No environmental assessments of these proposals have been completed, and it remains to be determined what effect the dams would have on water quality and flooding regime downstream.

Cumberland rosemary does not compete well and depends on yearly flooding to eliminate or reduce the growth of overstory shrubs and trees. In shady conditions it produces very few flowers and growth is inhibited, which diminishes reproduction.

The species is known in the horticultural trade and could suffer due to removal for personal or commercial use. However, there is no evidence of unauthorized take from wild populations. Because it is extremely easy to propagate vegetatively, there is little incentive for commercial growers to remove it from the wild.

A very critical threat is the destruction of habitat by recreational activities such as camping, hiking, horseback riding, off-road-vehicle traffic, and white-water boating. The Obed River, a National Wild and Scenic River (ONWSR), and the Big South Fork National River and Recreation Area (BSFNRRA) are managed by the National Park Service. Nearly one million people visit these areas every year, and some sites experience heavy use. One of the places that harbors a large colony--Big Island, in the BSFNRRA--receives heavy recreational use because of the series of hiking and equestrian trails that cross the island. The large colony at the Lilly Bridge site in the ONWSR also receives a great deal of vehicular and camping activity. Damage to *Conradina* was observed by Roulston (1994) during his visits to this site. Generally, the smaller colonies of Cumberland rosemary are located on remote sections of rivers and are visited primarily by fishermen and white-water boaters who tend to unknowingly stay out of the plant's habitat (observation by Roulston [1994]). Problems are more likely to arise where motorized off-road vehicles can access the river near its banks during periods of low water. The Big Island colony and the Caney Fork colonies are continually affected by vehicular activities.

Coal mining and oil and gas exploration are threats that could result in the deterioration of water quality (Kral 1983, Service 1984). Coal is actively being mined in the New River drainage. Abandoned strip mines and underground coal mines exist along the Caney Fork, Big South Fork, Emory, and Obed Rivers. During a visit to the Bandy Creek site in 1993, a spring flood had deposited a layer of coal fragments up to 15 cm

deep on the gravel bar. Subsequently, the next flooding episode washed away the coal. It is not known what effects extremely acidic water conditions have on Cumberland rosemary. Generally, extremely acidic waters kill all wildlife and vegetation.

Conservation Measures

All 13 sites on the Caney Fork River and two sites on Daddys Creek are located on privately owned land. A total of 76 sites are located on National Park Service land. These 76 colonies receive some protection under Section 7 of the Endangered Species Act of 1973, as amended (Act). Section 7 requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any is designated. Section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a species or to destroy or adversely modify its critical habitat. The Act is referenced in the BSFNRRA Master Plan, Design Memorandum, Volume 1, Chapter 2 - 2.03.02., U.S. Army Corps of Engineers. The Master Plan states that when particular recreational activities are found to be detrimental to the continued existence or successful reproduction of an endangered or threatened species, appropriate measures should be implemented to eliminate the disturbance, Chapter 9 - 9.02.48.

A draft Roads and Trails Management Plan has been prepared for the BSFNRRA and has received coordination comments. The plan includes improvements to existing trails and the development of new trails for hiking, mountain biking, horseback riding, all-terrain-vehicle activity, and camping. There is no special section on endangered species; however, general statements addressing the protection of endangered species are included. The protection of threatened and endangered species will be considered prior to the development of any new trails. Areas with known threatened or endangered species will be avoided; if this is not possible, each site will be evaluated. Areas with existing trails that are traversing endangered species populations will be monitored to determine impacts (Jeanne Richardson, National Park Service, personal communication, 1995).

Conradina verticillata is listed as endangered by the Tennessee Department of Environment and Conservation. The Rare Plant Protection Act of 1986 regulates the sale and take of plants that are endangered, but it does not provide for the protection of their habitats. Kentucky provides no legal protection for the species.

Conradina verticillata plants are being grown *ex situ* at the North Carolina Arboretum (NCA) in Asheville, North Carolina, a participating institute of the Center for Plant Conservation. Nineteen plants from six colonies were transferred to NCA from the Arnold Arboretum in 1993. In the summer of 1995, only seven plants existed in the collection at NCA from two colonies (two populations)--Big Island and Daddys Creek. Additional vegetative material from other colonies will be collected in the fall of 1995

(Ron Lance, NCA, personal communication, 1995). In this, as well in other cultivation efforts designed to protect the genetic diversity of the species, it is essential to maintain stocks from separate localities in genetic isolation. Numerous plant nurseries located in the following States propagate Cumberland rosemary: Tennessee, Georgia, Louisiana, North Carolina, South Carolina, Mississippi, and Maryland. Plants from these sources could be used to establish new populations.

Searches for new populations of *Conradina verticillata* were conducted in Kentucky primarily during May and June of 1994 (White 1994). The survey was designed to investigate other river systems in Kentucky and other sections of the Big South Fork River. After a thorough search, no new populations were discovered in apparently suitable habitat.

Genetic studies for the genus *Conradina*, using DNA as well as electrophoresis, are currently being conducted at the University of Georgia, Athens. The results of this analysis will be important for the management of Cumberland rosemary, identifying genetically distinct populations (or colonies) for protection.

Strategy for Recovery

Management plans should be developed for legally protected populations. Two of the three populations are located on land owned and managed by the National Park Service, and the largest colonies of these populations should be protected from major recreation-related activities. Efforts to protect the privately owned colonies should be initiated. This may be difficult, given the location of plants along the banks and gravel bars of the waterways. Some of the gravel bars may actually extend into the water. The closest landowners to the sites should be contacted and informed of the presence of the species and the threats to its survival. One type of protection is the registry of land in the Natural Areas Program (administered by the Tennessee Department of Environment and Conservation, Natural Heritage Division). A registry is not legally binding but usually involves a cooperative management agreement.

Surveys for new populations in Tennessee should be conducted in other river systems on the Cumberland Plateau. Many of the known locations have not been visited since 1979 and should be monitored at regular intervals. Both inventory and monitoring will be challenging, given the remote habitat Cumberland rosemary occupies.

Because seed production is known to be low for *Conradina verticillata*, seed dispersal and germination requirements need to be studied in depth. Genetic studies are extremely important for determining the extent of individual populations and identifying the populations that should be protected and managed.

PART II

RECOVERY

A. Recovery Objectives and Criteria

Cumberland rosemary will be considered for delisting when there are 25 protected and managed colonies with 50 genetically distinct individuals per colony on the five major rivers (five colonies on each river) where it occurs. These criteria will provide protection for all three populations. The estimated date of recovery completion is 2005. The requirements for delisting are preliminary and may be revised as recovery tasks are implemented and additional information about the species is obtained.

B. Narrative Outline

1. Protect existing populations and habitat. Only three populations with 91 colonies are known to exist, with the majority in north-central Tennessee and a few in adjacent Kentucky. The largest colonies in each population need immediate protection. A total of 76 colonies are located on land managed by the National Park Service, and 15 sites are located on privately owned land. Only five colonies are known to have more than 100 clumps of plants. Protection of five colonies in each of the five major rivers (see Figure 3) in which Cumberland rosemary occurs is considered to be essential to the recovery of the species and to prevent its irreversible decline.

   1.1 Determine protection priorities. Because the majority of the colonies are located on land managed by the National Park Service, it may be possible to protect a large percentage of the sites from recreational or commercial activities that jeopardize the plants. Each individual site will need to be evaluated and the threats to it will need to be determined. All-terrain-vehicle activity is one of the major threats to the larger colonies that occur on gravel bars and islands. All of the heavy use areas in the BSFNRRA and the ONWSR that contain colonies of Cumberland rosemary should be a high priority for protection measures. Privately owned sites along the Caney Fork River should be prioritized for protection based on the immediacy of threats and our ability to develop cooperative agreements with the landowners. Acquisition of some of these privately owned sites should be undertaken if it is determined to be essential to the recovery of the species. Colonies in all three populations need to be protected in order to maintain the genetic diversity of the species. The identification of protection priorities is the first step in providing the protection that is essential to the recovery of the species and to prevent its irreversible decline.

   1.2 Develop management plans. The next step in providing essential protection and preventing an irreversible decline is the development of site-specific management plans. Management plans should be developed by the BSFNRRA and the ONWSR to protect colonies of Cumberland rosemary, as well as other State- and federally listed plant species that occur in the same habitat. Due to increased visitation and the development of additional recreational trails, trampling or other forms of habitat degradation may pose threats to the species. Protection measures, such as the redesigning and rerouting of trails, may be necessary. Management plans should be written for privately owned land once they are under some form of protection or cooperative management agreement.

1.3 Obtain baseline population data. All known colonies need to be visited in order to obtain initial information on the number of individuals occupying each site. Only a few sites have been visited since 1979 and population data were merely estimated (i.e., scattered clumps, many clumps). Individual plants can have many stems, and the rootstock is usually buried beneath the sand or gravel. The term "clump" is used to describe the assemblage of aerial branches that spread over a few square feet. Because the species is clonal, determining the number of individuals will be a difficult but important task.

1.4 Monitor colonies that have been determined to be essential for the survival of the species. Important colonies in all populations should be monitored to check for vigor and habitat degradation due to natural events or human activities. Natural movement of the sand and gravel bars due to flooding regimes could affect the growth of *Conradina*, although this has not been studied. Monitoring will determine if changes in abiotic features have any effect on the plants. Monitoring should include, among other things, seedling establishment success.

1.5 Contact private landowners. All private landowners should be contacted and informed of the significance of the species and the potential threats to its continued existence. Potential threats to Cumberland rosemary on private land are commercial and residential development and habitat degradation due to recreational activities. Because the sites are so remote and are probably not visited regularly by landowners, riverbank protection could be a problem. If the landowners are receptive to the conservation of the species, protection through short-term leases or management agreements can be negotiated. Other types of protection include conservation easements, registry as a natural area (as previously mentioned), and acquisition.

2. Search for new populations within the known range and in other watersheds. The search for new populations is necessary within both the known range and other watersheds. This information will be useful in making management decisions and for determining the genetic variability of the species. The most intensive searches for Cumberland rosemary in Tennessee were conducted in 1979 and 1980 (Patrick and Wofford 1981, Patrick 1979, Schmalzer and DeSelm 1982). These searches were restricted to the five major rivers within the known range of the species. Only a few new colonies have been found since 1980 (see Appendix). Suitable habitat north of and between the known Kentucky population has been thoroughly searched; no new colonies were located (White 1994). Searches should be conducted in other watersheds in Tennessee's northern Cumberland Plateau. Because of the restricted riparian habitat, access by canoe is the most efficient method of surveying for new colonies. Searches in the BSFNRRA and the

ONWSR should continue in order to ensure that all federally owned colonies are adequately managed and protected.

3. Conduct studies of the species' biology. Additional information on the biology of *C. verticillata* is important and necessary for developing and implementing management guidelines.

   3.1 Study seed biology and germination. An intensive seed germination experiment needs to be conducted to determine the cause of low seed germination and limited production of viable seeds.

   3.2 Conduct further genetic research. A genetic analysis for the *Conradina* genus is currently being conducted at the University of Georgia. This research will provide preliminary information for *C. verticillata*. A molecular analysis technique should be applied to several of the larger Cumberland rosemary colonies in order to determine the extent of clonal spread within these locations and to test the hypothesis that extensive vegetative reproduction, which increases a flower's likelihood of being self-pollinated, is decreasing the reproduction by seeds. If so, populations could be artificially augmented through field interplantings of different genetic individuals in order to increase reproduction by seeds. A genetic comparison of individuals within a river system may provide data to confirm or refute the proposition that dispersal of this species is primarily through fragmentation. Further genetic analysis will determine if the recovery goal of 50 genetically distinct individuals at 25 colonies can be met.

4. Maintain and expand cultivated sources for the species. Vegetative material should be preserved for the purpose of establishing new populations if natural populations were to be eliminated.

   4.1 Maintain seeds. Viable seeds should be placed in long-term storage at the U.S. Department of Agriculture Research Service National Seed Storage Laboratory in Fort Collins, Colorado. Viability of seeds in storage should be periodically checked in order to ensure that viable seeds will, in fact, be available if they are needed.

   4.2 Maintain plants ex situ. Cumberland rosemary plants should continue to be maintained by the Center for Plant Conservation station at the NCA in Asheville, North Carolina, in order to ensure survival of the species. Currently, only two populations are represented in the collection. In order to preserve a broad range of genetic variability, additional collections should be made from several additional occurrences and from all populations. These occurrences should be maintained in a manner designed to prevent

cross-breeding between stock from genetically different occurrences. Given the immediate threats to the species posed by intensive recreational use, it is important that these artificial populations be maintained.

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 rosemary could play an important part in encouraging conservation efforts. In order to ensure that the taking threat is not increased, information materials should not identify specific plant locations.

   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 the 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. The review of new information, evaluation of ongoing actions, and redirection of recovery efforts, if necessary, are essential for assuring that full recovery is achieved as quickly and efficiently as possible.

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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
NPS - National Park Service
R4 - Region 4 (Southeast Region), U.S. Fish and Wildlife Service
TDEC - Tennessee Department of Environment and Conservation
TE - Endangered Species Division, U.S. Fish and Wildlife Service
USDA - U.S. Department of Agriculture

CUMBERLAND ROSEMARY IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates ($000s)			Comments
				FWS	Other	FY1	FY2	FY3	
1	1.1	Determine protection priorities.	1 year	R4/TE	NPS, TDEC, KSNPC		15.0		
1	1.2	Develop management plans.	1 year	R4/TE	NPS, TDEC, KSNPC			20.0	
2	3.1	Study seed biology and germination.	3 years	R4/TE	NPS, TDEC, KSNPC	25.0	10.0	10.0	
2	3.2	Conduct genetic research.	3 years	R4/TE	NPS, TDEC, KSNPC	20.0	20.0	10.0	
2	1.3	Obtain baseline population data.	1 year	R4/TE	NPS, TDEC, KSNPC	30.0			
2	1.4	Monitor major colonies.	Ongoing	R4/TE	NPS, TDEC, KSNPC	10.0	10.0	10.0	
2	1.5	Protect privately owned colonies.	1 year	R4/TE	TDEC, KSNPC	Unknown			
2	2.0	Search for new populations.	2 years	R4/TE	NPS, TDEC, KSNPC	25.0			
2	4.1	Maintain seeds in long-term storage.	Ongoing	R4/TE	USDA, NPS, TDEC, KSNPC				
2	4.2	Maintain plants in cultivation.	Ongoing	R4/TE	CPC, NPS, TDEC, KSNPC	15.0			
3	5.1	Prepare news releases.	Ongoing	R4/TE	NPS, TDEC, KSNPC				
3	5.2	Prepare magazine articles.	Ongoing	R4/TE	NPS, TDEC, KSNPC				
3	6.0	Annually review recovery progress.	Ongoing	R4/TE	NPS, TDEC, KSNPC				

PART IV

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APPENDIX

Extant Occurrences of *Conradina verticillata*. Ownership codes are as follows: BSFNRRA = Big South Fork National River and Recreation Area; ONWSR = Obed National Wild and Scenic River.

Stream/River (Site Name)	County	Quad	Ownership	Population Data	Year of Data and Reporter
Clear Fork					
Rugby	Morgan	Rugby	Private		1934: Jennison and Sharp
Rugby (type)	Fentress	Rugby	BSFNRRA	Type locality	1931: Jennison and Sharp
CF2	Scott	Honey Creek	BSFNRRA	A few scattered individuals	1992: Roulston, McConkey and Sloan
CF3	Scott	Honey Creek	BSFNRRA	A few scattered individuals	1992: Roulston, McConkey and Sloan
John Muir	Scott	Honey Creek	BSFNRRA	Several dense clumps	1987: Somers and Gunn
Skull Creek	Scott	Honey Creek	BSFNRRA	1 x 2 patch	1987: Somers and Lyon
	Scott	Honey Creek	BSFNRRA	A few scattered individuals	1992: Roulston
Burnt Mill Bridge	Scott	Honey Creek	BSFNRRA	12 plants	1995: Kral and Rust
CF5	Scott	Oneida South	BSFNRRA	A few scattered individuals	1975: Leonard
CF6	Scott	Oneida South	BSFNRRA		1975: Leonard
CF7	Scott	Oneida South	BSFNRRA		1975: Leonard
CF8	Scott	Oneida South	BSFNRRA		1975: Leonard
CF9	Scott	Oneida South	BSFNRRA		1975: Leonard
	Scott	Honey Creek	BSFNRRA	Numerous clumps	1975: Leonard
	Scott	Honey Creek	BSFNRRA	Numerous clumps	1975: Leonard
Big South Fork					
Pine Creek	Scott	Honey Creek	BSFNRRA	3-4 plants	1993: Campbell and Emmott

Stream/River (Site Name)	County	Quad	Ownership	Population Data	Year of Data and Reporter
BSF2	Scott	Honey Creek	BSFNRRA	A few plants	1993: Campbell and Emmott
Jakes Hole	Scott	Honey Creek	BSFNRRA	At least 10 plants	1993: Campbell and Emmott
Downstream Jake's Hole	Scott	Honey Creek	BSFNRRA	Shrub to 3 dm high.	1981: Patrick and Wofford
RR Bridge	Scott	Honey Creek	BSFNRRA	At least 20 plants	1993: Campbell and Emmott
Panther Creek	Scott	Honey Creek	BSFNRRA	1 healthy clump	1979: Patrick
N. White Oak Creek	Scott	Honey Creek	BSFNRRA	A few scattered plants	1979: Whitten
Bandy Creek	Scott	Honey Creek	BSFNRRA	100 clumps	1993: Roulston
Leatherwood Ford	Scott	Honey Creek	BSFNRRA		1979: Patrick
Rough Shoals Br.	Scott	Barthell SW	BSFNRRA	23 clumps	1993: Roulston and Allawos
Station Camp	Scott	Barthell SW	BSFNRRA	A few well-established clumps	1980: Patrick and Wofford
				None found	1993: Roulston and Allawos
Parch Corn Creek	Scott	Barthell SW	BSFNRRA		1975: Leonard
Big Island	Scott	Barthell SW	BSFNRRA	Extensive population	1980: Patrick and Wofford
				Several hundred clumps	1993: Roulston
Difficulty Creek	McCreary Co., KY	Oneida North	BSFNRRA	Large, extensive population	1980: Patrick and Wofford
				At least 20 scattered clumps	1989: Campbell
				75 clumps	1993; Roulston and Allawos

Stream/River (Site Name)	County	Quad	Ownership	Population Data	Year of Data and Reporter
BSF12	McCreary Co., KY	Oneida North	BSFNRRA	A few scattered plants	1980: Patrick and Wofford
				Ca. 10 small patches	1989: Campbell
Troublesome Creek	McCreary Co., KY	Oneida North	BSFNRRA	Numerous vigorous plants	1980: Patrick and Wofford
				10 small patches	1989: Campbell
				2 patches, ca. 5x5 ft and 5x10 ft	1989: Risk
				4 plants found	1993: Roulston and Allawos
BSF14	McCreary Co., KY	Oneida North	BSFNRRA	A few clumps	1979: Medley, Somers and Wofford
Gaging Station	McCreary Co., KY	Barthell	BSFNRRA	A few small scattered plants	1979: Medley, Somers and Wofford
Salt Branch	McCreary Co., KY	Barthell	BSFNRRA	A few small plants, widely scattered	1979: Medley, Somers and Wofford
				Ca. 10 clumps up to 1 sq yd. scattered in 40x5 ft area	1989: Campbell
Big Shoals	McCreary Co., KY	Barthell	BSFNRRA	A few scattered plants	1979: Medley, Somers and Wofford
				One clump ca. 1 ft across	1989: Campbell
Downstream Big Shoals	McCreary Co., KY	Barthell	BSFNRRA	A few widely scattered plants	1980: Patrick and Wofford
				Few small clumps in ca. 1 sq yd area	1989: Campbell and Risk
8	McCreary Co., KY	Barthell	BSFNRRA	A few scattered clumps of 1-3 sq. ft	1989: Campbell
9	McCreary Co., KY	Barthell	BSFNRRA	Ca. 4 scattered clumps of 1-10 sq. ft	1989: Campbell and Risk

Stream/River (Site Name)	County	Quad	Ownership	Population Data	Year of Data and Reporter
Big Spring Hollow - Upstream	McCreary Co., KY	Barthell	BSFNRRA	One patch of ca 1 sq. ft.	1989: Risk
Big Spring Hollow - Downstream	McCreary Co., KY	Barthell	BSFNRRA	One patch of 5-10 sq. ft.	1989: Campbell and Risk
New River					
Reed Bottom	Scott	Oneida South	BSFNRRA		1975: Leonard
New2	Scott	Oneida South	BSFNRRA		1975: Leonard
White Oak Creek					
Clear Fork Jct.	Scott	Rugby	BSFNRRA	2 small clumps	1975: Farmer et al.
White Oak	Scott	Rugby	BSFNRRA	Vegetative relic colonies	1930: Cain (annotated by Gray, 1965)
Daddys Creek					
Peavine Road Bridge	Cumberland	Ozone	Private		1976: Kral
Cove Branch	Cumberland	Hebbertsburg	Private		1981: Horn
Devil's Hanging Table	Cumberland	Hebbertsburg	ONWSR	A few scattered plants	1980 Schmalzer
DAD3	Morgan	Hebbertsburg	ONWSR	1 small plant	1980 Schmalzer
DAD4	Morgan	Hebbertsburg	ONWSR	Several widely scattered plants	1980: Patrick, Perkins and Schmalzer
DAD5	Morgan	Hebbertsburg	ONWSR	Several widely scattered plants	1980: Patrick, Perkins and Schmalzer
DAD6	Morgan	Hebbertsburg	ONWSR	A few scattered clumps	1980: Schmalzer
Daddy's Island	Morgan	Hebbertsburg	ONWSR	Scattered clumps	1980: Schmalzer
				Ca. 50 clumps	1993: Roulston

Stream/River (Site Name)	County	Quad	Ownership	Population Data	Year of Data and Reporter
Obed					
Potter Ford	Morgan	Hebbertsburg	ONWSR	8-10 small clumps	1980: Schmalzer
Obed Junction	Morgan	Hebbertsburg	ONWSR	Many clumps 50-100 clumps	1980: Schmalzer 1993: Roulston
Turkey Creek	Morgan	Lancing	ONWSR	1 small clump	1980: Patrick and Schmalzer
Obed 4	Morgan	Lancing	ONWSR	Many large clumps	1980: Patrick and Schmalzer
Obed 5	Morgan	Lancing	ONWSR		1980: Patrick and Schmalzer
Obed 6	Morgan	Lancing	ONWSR	Compact population	1980: Patrick and Schmalzer
Clear Creek Jct. (bank)	Morgan	Lancing	ONWSR	Ca. 15 large clumps, spreading vegetatively	1980: Schmalzer
Clear Creek Jct. (island)	Morgan	Lancing	ONWSR	Scattered plants	1980: Patrick and Schmalzer
Obed8	Morgan	Lancing	ONWSR	A few plants	1980: Patrick and Schmalzer
Obed9	Morgan	Lancing	ONWSR	A few scattered plants	1980: Patrick and Schmalzer
Milligan Branch	Morgan	Lancing	ONWSR	1 plant	1980: Patrick and Schmalzer
Emory Jct.	Morgan	Lancing	ONWSR	A few scattered plant	1980: Patrick and Schmalzer
Emory					
Obed-Emory Jct.	Morgan	Lancing	ONWSR	A few scattered plants	1980: Schmalzer
Emory2	Morgan	Lancing	ONWSR	A few scattered plants	1980: Schmalzer
Nemo Bridge	Morgan	Lancing	Private	Hundreds of plants	1994: Kral, Rust, Medlin
Emory3	Morgan	Harriman	ONWSR	3 clumps	1984: Patrick, Wofford, and McFarland

Stream/River (Site Name)	County	Quad	Ownership	Population Data	Year of Data and Reporter
Clear Creek					
Clear1	Morgan	Twin Bridges	ONWSR	Several scattered plants	1980: Schmalzer
Clear2	Morgan	Pilot Mountain	ONWSR	2 small clumps	1980: Schmalzer
Clear3	Morgan	Lancing	ONWSR	12-15 clumps	1980: Schmalzer
Jett Bridge	Morgan	Lancing	ONWSR	12-15 clumps	1980: Schmalzer
Clear5	Morgan	Lancing	ONWSR	A few widely scattered individuals	1980: Schmalzer
Clear6	Morgan	Lancing	ONWSR	4 small clumps	1980: Schmalzer
Clear7	Morgan	Lancing	ONWSR	A few scattered plants	1980: Schmalzer
Fred Taylor's Place	Morgan	Lancing	ONWSR		1966: Sharp
W. Lilly Bridge	Morgan	Lancing	ONWSR	4 small clumps	1980: Schmalzer
Lilly Bridge	Morgan	Lancing	ONWSR	At least 20 clumps	1980: Schmalzer
				Ca. 150 clumps	1993: Roulston
Caney Fork					
Caney1	Cumberland	Pleasant Hill	Private	Ca. 20 small clumps	1980: Patrick, Whitten and Perkins
Caney2	Cumberland	Pleasant Hill	Private	Several large clumps	1980: Patrick, Whitten and Perkins
Caney3	Cumberland	Pleasant Hill	Private	One dense patch	1980: Patrick, Whitten and Perkins
Caney4	Cumberland	Pleasant Hill	Private	One plant	1980: Patrick, Whitten and Perkins
Caney5	Cumberland	Pleasant Hill	Private	Several small scattered plants	1980: Patrick, Whitten and Perkins
Caney6	Cumberland	Pleasant Hill	Private	One plant	1980: Patrick, Whitten and Perkins

Stream/River (Site Name)	County	Quad	Ownership	Population Data	Year of Data and Reporter
Caney7	Cumberland	Pleasant Hill	Private	One patch 4' dia., several widely scattered	1980: Patrick, Whitten and Perkins
Caney8	Cumberland	Pleasant Hill	Private	Several large healthy plants	1980: Patrick, Whitten and Perkins
Caney9	Cumberland	Pleasant Hill	Private	A few small scattered plants	1980: Patrick, Whitten and Perkins
Tarkiln Ford	Cumberland	Pleasant Hill	Private	Several large and small plants	1980: Patrick, Whitten and Perkins
Bee Creek	White	Lonewood	Private	One small colony	1980: Patrick, Whitten and Perkins
Caney12	White	Lonewood	Private	One plant	1979: Patrick and Whitten
Virgin Falls	White	Lonewood	Private	One plant	1961: Channell