# SMOOTH CONEFLOWER

## *(Echinacea laevigata)*

# Recovery Plan

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

# RECOVERY PLAN

for

# Smooth Coneflower (*Echinacea laevigata*)

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Date: April 18, 1995

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U.S. Fish and Wildlife Service. 1995. Smooth Coneflower Recovery Plan. Atlanta, GA. 31 pp.

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# EXECUTIVE SUMMARY

Current Species Status: *Echinacea laevigata* (smooth coneflower) is listed as endangered. There are 24 known populations--7 from Virginia, 6 from North Carolina, 8 from South Carolina, and 3 from Georgia.

Habitat Requirements and Limiting Factors: Smooth coneflower is currently known from open woods, cedar barrens, roadsides, dry limestone bluffs, utility line rights-of-way, and other sunny to partly sunny situations, usually on magnesium- and calcium-rich soils associated with underlying mafic rock. Although some of the glades supporting *E. laevigata* are naturally self-sustaining (especially in Virginia), historically, much of the species' habitat probably was prairielike habitat or post oak-blackjack oak savannas that were maintained by fires caused by lightning or set by native Americans. Loss of this open habitat to fire suppression and urbanization has resulted in the decline of the species and its reduction, in many cases, to marginal and highly vulnerable sites.

Recovery Objective: Reclassification to threatened, followed by delisting.

Recovery Criteria: *Echinacea laevigata* will be considered for reclassification from endangered to threatened when 12 geographically distinct, self-sustaining populations are protected in at least two counties in Virginia, two counties in North Carolina, two counties in South Carolina, and one county in Georgia; when managers have been designated for each population; when management plans have been developed and implemented; and when populations have been maintained at stable or increasing levels for 5 years. At least nine of the 12 populations must be in natural habitats, in permanent conservation ownerships and management. Delisting will be considered when at least 15 geographically distinct, self-sustaining populations are protected in at least two counties in Virginia, two counties in North Carolina, two counties in South Carolina, and one county in Georgia; when management plans have been implemented; when populations have been stable or increasing for 10 years; and when permanent conservation ownership and management of at least 10 populations are assured by legally binding instruments.

Actions Needed:

1. Implement protective management for extant populations.
2. Survey suitable habitat for additional populations and potential reintroduction sites; reestablish populations within the species' historic range.
3. Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.).
4. Monitor existing populations.

5. Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurs.
6. Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation.

Total Estimated Cost of Recovery ($000's): It is not possible to determine costs beyond estimates for the first few years; future costs will depend on the results of research conducted early in the recovery process.

| Year | Need 1 | Need 2 | Need 3 | Need 4 | Need 5 | Need 6 | Total |
|---|---|---|---|---|---|---|---|
| FY 1 | 30.0 | 15.0 | 40.0 | 30.0 | 30.0 | 10.0 | 155.0 |
| FY 2 | 30.0 | 20.0 | 40.0 | 15.0 | 15.0 | 5.0 | 125.0 |
| FY 3 | 40.0 | 25.0 | 40.0 | 15.0 | 15.0 | 5.0 | 140.0 |
| TOTAL | 100.0 | 60.0 | 120.0 | 60.0 | 60.0 | 20.0 | 420.0 |

Date of Recovery: Impossible to determine at this time.

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# PART I

# INTRODUCTION

## Description

Smooth coneflower (*Echinacea laevigata* [Boynton and Beadle] Blake) was federally listed as endangered on October 8, 1992 (U.S. Fish and Wildlife Service [Service] 1992). This rhizomatous perennial herb in the aster family (*Asteraceae*) was first described in 1903, under the name *Brauneria*, by Boynton and Beadle from material collected in South Carolina in 1888; it was transferred to the genus *Echinacea* in 1929 (Small 1933, McGregor 1968). Smooth coneflower grows up to 1.5 meters (59 inches) tall from a vertical root stock; stems are smooth, with few leaves. The largest leaves are the basal leaves, which reach 20 cm (7.8 inches) in length and 7.5 cm (2.9 inches) in width, have long petioles, and are elliptical to broadly lanceolate, taper to the base, and are smooth to slightly rough. The midstem leaves have shorter petioles, if petioles are present, and are smaller than the basal leaves. Flower heads are usually solitary. The ray flowers (petallike structures on the composite flower heads) are light pink to purplish, usually drooping, and 5 to 8 cm (1.9 to 3.1 inches) long. Disk flowers are about 5 mm (0.2 inches) long; have tubular purple corollas; and have mostly erect, short triangular teeth (Kral 1983, Radford *et al.* 1968, McGregor 1968, Cronquist 1980, Gaddy 1991, Wofford 1989). The smooth coneflower can be distinguished from its most similar relative, the purple coneflower (*E. purpurea*), by its leaves, which in the smooth coneflower are never cordate (heart-shaped) like those of the purple coneflower. In addition, the awn of the pale (chaffy scales at the base of the fruit) in the smooth coneflower is incurved, while that of *E. purpurea* is straight. The vertical rootstock of *E. laevigata* also distinguishes it from *E. purpurea*, which has a horizontal rootstock (Kral 1983, Gaddy 1991, Wofford 1989). The name *Echinacea* is derived from the Greek word *Echinos*, which is also used in the names for sea urchins and hedgehogs, referring to their spiny appearance. The dried seed heads on *Echinaceas* have a bristly appearance, owing to the sharp points of the shiny pales which remain intact long after the plant has finished flowering (Foster 1991, Kral 1983).

## Distribution

The reported historical range of smooth coneflower included Pennsylvania, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, and Arkansas. The species is now known to survive only in Virginia, North Carolina, South Carolina, and Georgia. (In this plan, the term "population" can refer to a group of subpopulations or occurrences, which are clustered within the same vicinity and are exposed to common threats and potentially exchange genetic material via common pollinators. For instance, South Carolina's eight "populations" consist of several dozen colonies or subpopulations clustered into eight centers of geographic distribution; Virginia's seven "populations" are comprised of

23 occurrences that are tracked separately by the Virginia Department of Conservation and Recreation, Division of Natural Heritage. Defining specific population boundaries for species such as this one, with fragmented distributions, is very difficult, particularly without data on population genetics and without knowing the identity of major pollinators. This definition of population centers may be revised once additional data is obtained.) Seven populations survive in Virginia, six in North Carolina, eight in South Carolina, and three in Georgia. Three additional populations in South Carolina (two in Aiken County and one in Allendale County) are believed by some authorities to be relicts of garden plantings rather than naturally occurring (Gaddy 1991).

A total of 62 populations of *Echinacea laevigata* have been reported historically from 26 counties in eight States. The reports from Alabama and Arkansas are now believed to have been misidentifications (Gaddy 1991). The remaining populations are located in Alleghany, Pulaski, Montgomery, Campbell, and Franklin Counties, Virginia; Durham, Granville, and Rockingham Counties, North Carolina; Oconee, Anderson, Richland, Aiken, and Barnwell Counties, South Carolina; and Stephens and Habersham Counties, Georgia. The sites in Aiken and Barnwell Counties, South Carolina, are believed by some authorities to have been planted. Of the 24 surviving populations, seven occur on land managed by the U.S. Forest Service, two are on U.S. Army Corps of Engineers land, one is on North Carolina Department of Agriculture land, one site is owned by the South Carolina Heritage Trust Program, one site is within a right-of-way maintained by the South Carolina Department of Highways and Public Transportation, one is on land managed by Clemson University, one is on a military reservation managed by the Department of the Army, and the remaining nine populations are on privately owned land. Several of these populations occur in or near transmission line corridors of various utility companies or near highway rights-of-way.

Habitat

The habitat of smooth coneflower consists of open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and power line rights-of-way, usually on magnesium- and calcium-rich soils associated with amphibolite, dolomite, or limestone (in Virginia) (Chris Ludwig, Virginia Department of Conservation and Recreation, Division of Natural Heritage, personal communication, 1994; Terwilliger 1991), gabbro (in North Carolina and Virginia), diabase (in North Carolina and South Carolina), and marble (in South Carolina and Georgia).

Smooth coneflower occurs in community types described by Schafale and Weakley (1990) as xeric hardpan forests and diabase glades or in Virginia dolomite woodlands or glades as described by Rawinski (1994). Xeric hardpan forests occur on upland flats and gentle slopes with an impermeable clay subsoil; however, water does not stand on them for extended periods. Diabase glades are similar but

are distinguished by the presence of solid rock near the soil surface and by a more open structure with a mixed physiognomy with herb, shrub, and woodland patches. Although diabase glades are xeric most of the year, water does pond on them during wet periods. The dynamics of diabase glades are not well understood, but openings are apparently maintained by the extreme shallowness and dryness of the soils and possibly also by soil shrink-swell. Soil series typical of both community types, usually underlain by mafic rock, are Iredell (Typic Hapludalf), Misenheimer (Aquic Dystrochrept), and Picture (Abruptic Argiaquoll). In Virginia, populations are often associated with Elbrook Formation dolomite, where they are part of a very species-rich community. These Virginia dolomite woodlands and glades retain much of their open character due to naturally harsh edaphic conditions. These woodlands occur on loamy dolomite soils of high magnesium content and friable consistency. The physical characteristics of the soil suggest a paucity of clay, which may cause more rapid drainage and diminished moisture retention. Woodland occurrences on steep side-slope or clifflike areas are rocky and are in a high energy colluvial environment that continually erodes and transports soil surface material. In addition, many occurrences are found on the crest or upper slopes of sunny southern aspects, and the possible influence of a climatic "rain shadow" may also create more prolonged periods of drought, further contributing to the persistence of these open communities (The Nature Conservancy 1994; Ludwig and Caren Caljouw, Virginia Department of Conservation and Recreation, Division of Natural Heritage, personal communication, 1994).

Dominant trees in smooth coneflower habitat (usually blackjack oak [*Quercus marilandica*] and post oak [*Q. stellata*] or chinquapin oak [*Q. muhlenbergii*) are usually stunted and the canopy is open. Other trees and shrubs sometimes found on these sites include red cedar (*Juniperus virginiana*), redbud (*Cercis canadensis*), persimmon (*Diospyros virginiana*), sparkleberry (*Vaccinium arboreum*), squaw huckleberry (*V. stamineum*), blueberry (*V. pallidum* [=*vacillans*]), winged elm (*Ulmus alata*), fringe-tree (*Chionanthus virginicus*), haw (*Viburnum rafinesquianum*), and black haw (*V. prunifolium*). The more common herb species include oat grass (*Danthonia spicata*), little bluestem (*Schizachyrium* [=*Andropogon*] *scoparium*), curlyheads (*Clematis ochroleuca*), white-topped aster (*Aster solidagineus*), rattlesnake-weed (*Hieracium venosum*), hawkweed (*Hieracium gronovii*), St. Andrew's cross (*Hypericum hypericoides*), *Aster dumosus*, *Lespedeza* spp., sundrops (*Oenothera fruticosa*), blazing star (*Liatris graminifolia*), rattlesnake master (*Eryngium yuccifolium*), nodding onion (*Allium cernuum*), silky bindweed (*Calystegia sericata*), and goldenrods (*Solidago* spp.).

On sites where woody succession is held in check by disturbance such as mowing or fire, the herbaceous flora is more diverse, characterized by a number of species with prairie affinities and including other rare plants such as smooth sunflower (*Helianthus laevigatus*) and Schweinitz's sunflower (*Helianthus schweinitzii*, also

federally listed as endangered). Although Schweinitz's sunflower and smooth coneflower occupy the same type of habitat, they are not known to occur together on any sites. Other associates include crested coralroot (*Hexalectris spicata*), smooth peavine (*Lathyrus venosus*), Earle's blazing star (*Liatris squarrulosa*), hoary puccoon (*Lithospermum canescens*), Carolina birdfoot-trefoil (*Lotus purshianus* var. *helleri*), wild quinine (*Parthenium integrifolium* var. *auriculatum*), prairie dock (*Silphium terebinthinaceum*), a liverwort (*Lophozia capitata*), and serpentine aster (*Aster depauperatus* [a candidate for Federal listing]). Additional species found in diabase glades include portulaca (*Portulaca smallii*), fameflower (*Talinum teretifolium*), buttonweed (*Diodea teres*), bluets (*Houstonia tenuifolia*), agave (*Manfreda* [=*Agave*] *virginica*), milkweed (*Asclepias verticillata*), prickly pear (*Opuntia compressa*), (*Crotonopsis elliptica*), blue curls (*Trichostema brachiatum*), dropseed (*Sporobolus clandestinus*), Indian currant (*Symphoricarpos orbiculatus*), fragrant sumac (*Rhus aromatica*), barberry (*Berberis canadensis*), (*Trachelospermum difforme*), and (*Matelea decipiens*).

In Virginia, smooth coneflower sites are sometimes shared with tall larkspur (*Delphinium exaltatum*) and Addison's leather flower (*Clematis addisonii*), both of which are candidates for Federal listing (Schafale and Weakley 1990; Tom Rawinski, Virginia Department of Conservation and Recreation, Division of Natural Heritage, personal communication, 1993; Gaddy 1991).

Optimal sites for smooth coneflower are characterized by abundant sunlight and little competition in the herbaceous layer (Gaddy 1991). Natural fires, as well as large herbivores, are part of the history of the vegetation in this species' range; many of the associated herbs are also cormophytic, sun-loving species, which depend on periodic disturbances to reduce the shade and competition of woody plants (Kral 1983, Gaddy 1991). Harsh conditions on these sites allow only slow recovery of woody cover from fire (Schafale and Weakley 1990), so even a limited historical fire frequency would have had long-lasting effects on this habitat.

## Life History/Ecology

Information on the life history and species biology of smooth coneflower is limited. Flowering occurs from May through July, and fruits develop from late June to September (Gaddy 1991). The fruit is a gray-brown, oblong-prismatic achene, usually four-angled, and 4 to 4.5 mm long; seeds are 0.5 cm long (Kral 1983, Gaddy 1991). Gaddy (1991) stated that reproduction was apparently only by sexual means and that no vegetative reproduction had been observed. However, vegetative reproduction has been reported from the Chattahoochee National Forest in Georgia (Robert Joslin, U.S. Forest Service, personal communication, 1994) and from the Sumter National Forest in South Carolina (Lonnette Edwards, U.S. Forest Service, personal communication, 1995). Pollinators for this species are unknown; however, Edwards and Madsen (1993) have documented a

preliminary list of insect visitors to South Carolina populations of smooth coneflower (see Appendix A). Seeds are probably dispersed by seed-eating birds or small mammals. Although data are unavailable regarding smooth coneflower, goldfinches, as well as white-tailed deer, have been observed feeding on the seed heads of the endangered Tennessee coneflower (*Echinacea tennesseensis*) (Currie and Somers 1989). Hemmerly (1976) found that seeds of the Tennessee coneflower were seldom dispersed by wind more than 3 feet beyond the parent plant. Preliminary investigations with *E. laevigata* have revealed similar patterns, with seedlings being observed only in the immediate vicinity of parent plants (Edwards, personal communication, 1995). Gaddy (1991) stated that reproductive success is generally poor in this species. Edwards (personal communication, 1995) observed few seedlings in wild populations and found low seed production rates in both wild and greenhouse plants. Edwards (personal communication, 1995) further observed that what appears to be individuals of this species "...arise from an underground caudex and may consist of lateral rhizomes as well, which produce above-ground shoots (rosettes)." These plants can consist of one to several rosettes, flowering leafy stems arising from a basal rosette, or a single leaf. Individual rhizomes can consist of combinations of all three of these forms. As Edwards states,

> This clonal growth form makes it difficult to distinguish physiologically independent plants, let alone individuals (genets). Genetic research could be of great benefit in determining not only how many "individuals" were represented in a given site, but also the distribution, frequency and persistence of certain genotypes/phenotypes in a population.

Smooth coneflower appears to need bare soil that is rich in magnesium and/or calcium for seedling germination and growth. Some form of disturbance (such as fire) is also essential. Gaddy further states:

> Where competition is absent and bare, disturbed soil is present, smooth coneflower populations may survive indefinitely. Most sites, however, do not exhibit these ideal habitat conditions. Smooth coneflower appears in habitat patches and survives there until its preferred conditions disappear. If it is unable to reach another suitable patch, the plant becomes locally extinct. It is not known if the seeds of *Echinacea laevigata* remain viable in the soil of sites where smooth coneflower plants no longer exist. If some of the historic sites were opened up and burned, more evidence on the long term viability of smooth coneflower seeds could be obtained.

For the Tennessee coneflower, Hemmerly (1976) found that a relatively high percentage (67 percent) of the seeds could be germinated under optimum conditions; these conditions were found to be 16 weeks of seed stratification at or about 41°F (50°C) followed by germination

in light at 59°F (15°C) to 77°F (25°C). Dry storage for up to 60 months resulted in only a moderate loss of viability. Recent studies by Feghahati and Reese (1994) on *E. angustifolia* have shown that a 2-week pre-chill treatment in combination with ethephon and continuous light, followed by a 2-week germination period in light (16 hours per day at 77°F [25°C]), could induce over 95 percent seed germination. This is a significantly higher germination percentage over a shorter period of time than has been achieved with any previously described method.

Gaddy (1991) found that smooth coneflower was always present in low densities at occupied sites; the highest percentage cover observed was approximately 30 percent (at the Walnut Hill site in Virginia). Frequency was sometimes high within small subpopulations but low when the entire community was sampled. Further research on this species is currently underway and should further define life history and species biology, as well as determine appropriate management measures (Edwards and Madsen 1993; Edwards, personal communication, 1995).

## Threats

Factors endangering smooth coneflower include habitat destruction and degradation, curtailment of range, collection, fire suppression, highway right-of-way maintenance, urbanization and suburbanization of the area of occurrence of the species, encroachment by exotic species, possible predation by insects, inadequacy of existing protection afforded by State laws, small population size, and lack of formal protection for all but a few of the known populations.

Since discovery of the species, 62 percent of the known populations have been extirpated, partly as a result of conversion of habitat for silvicultural and agricultural purposes and for industrial and residential development. Of the 38 populations that have been extirpated, one is known to have been eliminated by highway construction, another by construction of a gas pipeline, and a third by conversion of the site to pine plantation. Causes for the destruction of the other populations are undocumented. Of the 23 extant populations, 13 are currently declining in numbers of plants, only nine are considered stable, and one is increasing. Nineteen of the populations are currently threatened by habitat alterations (Gaddy 1991).

Half of the remaining populations survive along roadsides. In addition, three populations remain on utility line rights-of-way, another is along an abandoned railroad right-of-way, and a fifth is on the edge of a motorbike trail in a wooded area. Many of the populations are small, with 11 containing less than 100 plants each. Such small populations are inherently vulnerable to extirpation as a result of highway and right-of-way improvement, particularly if herbicides are used.

Highly restricted distribution, as well as the scarcity of seed sources and appropriate habitat, increases the severity of the threats faced by smooth coneflower. As stated, this species actually requires some form of disturbance to maintain its open habitat and can even withstand mowing and timber-harvesting operations, if properly done. However, it cannot withstand bulldozing or direct application of broadleaf herbicides. In addition, the small populations that survive on road edges could be easily destroyed by highway improvement projects or by right-of-way maintenance activities if these are not done in a manner consistent with protection of the species. In Virginia, a major highway project is proposed that may eliminate part of one of the State's occurrences of this species (Ludwig, personal communication, 1994).

Many of the more common native coneflowers are in demand for horticultural use and are a significant part of the commercial trade, but *Echinacea laevigata* is cultivated and offered for sale by only a few native plant nurseries. Cultivation of rare species such as the smooth coneflower, to supply market demand, reduces the pressure on wild populations and should be encouraged. Overshadowing the potential threat of collection of wild plants for horticultural purposes is the threat of commercial collection for the pharmaceutical trade. For over a century, Midwestern species in this genus have been harvested and sold in European and American markets under the trade name "Kansas snake root" (McGregor 1968). In Germany alone, over 280 products made from various species of this American genus are registered for medicinal use (Bauer and Wagner 1990). Steven Foster (Consultant, Eureka Springs, Arkansas, letter to Nora Murdock, 1990) made the following statement:

> The potential danger of inadvertent harvest of plants for commercial markets may be the greatest hidden danger to *Echinacea laevigata*...we have been able to document that three endemic species have also been harvested without proper attention to species identity in the Midwest. These include the Ozark endemics, *E. paradoxa* and *E. simulata*, as well as *E. atrorubens*.

Documented harvests have reached as high as 200,000 pounds (90,720 kg) collected from a single county in Kansas in 1 year. Given the fact that at least 8 to 10 dried roots are required to make up 1 pound (0.45 kg), this single harvest represented the collection of about two million roots. Dr. Ronald McGregor, director emeritus of the herbarium at the University of Kansas and the leading authority on the genus *Echinacea* (*in* Foster 1991), noted drastic declines in Kansas populations of *Echinacea pallida* as a result of commercial harvests in the 5 years prior to 1987. Although most of the commercial supply of *Echinacea purpurea* now comes from cultivated sources, the demand for the roots far outstrips the commercial supply and is resulting in increasing pressure on wild populations of nearly every species in the genus.

In 1987, seven thousand individuals of the Ozark endemic, *Echinacea paradoxa*, were stolen from a Missouri State park (Wallace 1987). Wallace further stated, "Diggers do not discriminate between species, collecting all *Echinaceas*." Foster (1991) states:

> Unfortunately, a number of the endemic and more unusual *Echinacea* species are entering commercial lots, dug by unwitting harvesters. In the Ozarks, this author has observed *Echinacea simulata*, harvested by the truck load. Roadside populations have decreased dramatically in South Central Missouri. The plant is much less common in northern Arkansas. Commercial harvest of this species from the wild cannot be sustained. If harvested at current levels over the next 10 years, its fate will be extinction.

Although such devastation of smooth coneflower populations for the commercial pharmaceutical trade has not yet been documented, almost two-thirds of the historically known populations of this species are gone. The remaining populations are almost all small, easily accessible, and highly vulnerable.

*Echinacea laevigata* is listed in North Carolina as endangered (Sutter 1990, Weakley 1993), in South Carolina as nationally threatened (Rayner *et al.* 1984), in Georgia as threatened (McCollum and Ettman 1987), in Alabama as endangered (Freeman *et al.* 1979); it is not listed in Virginia (Ludwig, personal communication, 1994). State prohibitions against taking are difficult to enforce and do not cover adverse alterations of habitats, such as exclusion of fire.

The current distribution of the species is ample evidence of its dependence on disturbance at most sites; 71 percent of the remaining populations are on roadsides, in utility or railroad rights-of-way, or adjacent to trails. Although some of the Virginia occurrences appear to be edaphically or climatically self-sustaining, fire or some other suitable form of disturbance, such as well-timed mowing (which simulates the effect of grazing by extirpated native herbivores) or careful clearing, is essential to maintaining most of the glade and prairie remnants occupied by *Echinacea laevigata*. Without such periodic disturbance, this type of habitat is gradually overtaken and eliminated by shrubs and trees of the adjacent woodlands. As the woody species increase in height and density, they overtop *E. laevigata*, which, like most other coneflowers, is intolerant of dense shade. In addition, some believe that the species requires bare soil for germination of seeds (Gaddy 1991).

*Echinacea angustifolia* is known to be a host plant for certain species of leaf beetle (family *Chrysomelidae*) (Wilcox 1979). Beetles in this family have been observed on *Echinacea laevigata* in North Carolina; it is not known what effect they have on the plants. Edwards (personal communication, 1995) has observed browsing of flowers and immature fruiting heads by grasshoppers and possibly white-tailed deer.

## Conservation Efforts

For the purposes of this recovery plan, geographically clustered subpopulations and colonies of smooth coneflower in Virginia have been grouped into seven population centers. In Virginia, one site is owned by The Nature Conservancy, and negotiations are underway with the landowners of at least two other sites for protection. The site owned by The Nature Conservancy was mowed in 1987 to manage for the coneflower and other rare associates; the mowing was followed by an initial depression in numbers of flowering plants, followed by an almost 100-percent increase in numbers of stems 4 years later. As mentioned earlier, a proposed highway project threatens one of the State's remaining occurrences.

The Virginia Department of Conservation and Recreation (Division of Natural Heritage) and The Nature Conservancy have recently initiated a landowner contact program for priority *Echinacea laevigata* sites in Montgomery County, which is a stronghold for *E. laevigata*. This project is sponsored by the Service and the Virginia Department of Agriculture and Consumer Services. Voluntary protection agreements have been secured with several key landowners, and negotiations for stronger protection continue. The Virginia Department of Conservation and Recreation (Division of Natural Heritage) and the Virginia Chapter of The Nature Conservancy have identified this area as a conservation focal area and hope to establish a natural area preserve system in Montgomery County (Ludwig and Caljouw, personal communication, 1994).

In North Carolina, one of the largest known populations of the species is located on land owned by the North Carolina Department of Agriculture. This site, known as the Picture Creek Barrens, was formerly proposed as a site for a hazardous waste incinerator; however, the site is not currently under active consideration for that project. In the spring of 1994, the North Carolina Department of Agriculture's Plant Conservation Program, with funding from the Service, initiated a prescribed-burning management program for this smooth coneflower site; initial monitoring has revealed a favorable response by the coneflowers (Barnett-Lawrence 1994). At another site near Falls Lake, the U.S. Army Corps of Engineers evaluated a series of management alternatives and selected mechanical removal of woody species every 4 years as a more logistically feasible alternative than fire. Regular monitoring is being conducted so that the management regime may be adjusted as necessary to more effectively benefit the species (Benjamin *et al.* 1991). In 1993, part of the coneflower population on the Falls Lake site was damaged by a logging operation. The Corps intervened to reduce the damage and took measures to prevent any future occurrences of this type (Steve Brown, U.S. Army Corps of Engineers, personal communication, 1993). The Service and the North Carolina Natural Heritage Program have worked with the North Carolina Department of Transportation to mark and protect roadside populations of this species from accidental

destruction or mowing at the wrong time of year (safe mowing dates are November to early March).

Most of the surviving populations of smooth coneflower in South Carolina occur on the Sumter National Forest, where the U.S. Forest Service began the first experimental management for this species using fire. The first prescribed burn was conducted in the late winter of 1992, following clearing of the woody vegetation from the site in the fall of 1991; the number of flowering stems of *E. laevigata* on the site quadrupled in the year following the burn (Perry Shatley, U.S. Forest Service, personal communication, 1992). However, 2 years later, plants on this site were beginning to experience considerable competition from hardwood sprouts, and additional management is needed. In an adjacent stand, which was burned without prior canopy removal, the response was a ten-fold increase in the number of *Echinacea* rosettes. These plants have little side competition and are suppressed only by the shade from overstory trees (Tom Waldrop, U.S. Forest Service, personal communication, 1994). The Southeastern Forest Experiment Station, Clemson, South Carolina, is conducting another series of experiments in management for this species on the Sumter National Forest involving various combinations of woody species removal and prescribed fire in winter. The first burns were conducted in late winter of 1994 (Joan Walker and Tom Waldrop, U.S. Forest Service, personal communication, 1994). On the Savannah River Site, the Department of Energy and the U.S. Forest Service are working to manage for *E. laevigata* with experimental canopy thinning and prescribed fire (Pat Jackson, Department of Energy, personal communication, 1992). A small population (five individuals) was recently discovered on Fort Jackson, where the Department of the Army is now protecting the site and is developing a management plan.

In Georgia, most of the smooth coneflower populations are located on the Chattahoochee National Forest, where the U.S. Forest Service is monitoring them and protecting the plants from mowing at the wrong season. Plans are underway to reestablish the species at a site there, using plants propagated from seeds from the reestablishment site. A burn was conducted in the winter of 1993-94, and the results are being monitored (Ben Sanders, U.S. Forest Service, personal communication, 1994; Doug Watson, U.S. Forest Service, personal communication, 1994). Management techniques must balance the plant's need for sunlight with its limited ability to compete with sprouts and vigorous pioneer species. This may necessitate the use of fire at different seasons and/or partial tree removal followed by some form of forest floor disturbance.

The North Carolina Botanical Garden has acquired seeds and/or plants from several of the North Carolina populations of *E. laevigata*, following the Center for Plant Conservation's guidelines for *ex situ*. conservation of genetic material. Part of this material is maintained as living plants (including one field-grown population at Penny's Bend State Park near Durham, North Carolina), and part is

being stored as seed. Seeds are also being maintained in long-term storage at the U.S. Department of Agriculture's National Seed Storage Laboratory in Ft. Collins, Colorado (Rob Gardner, North Carolina Botanical Garden, personal communication, 1994). If, as seems likely, currently extant wild populations of smooth coneflower are extirpated in the future, propagules gathered and stored could be used to reintroduce the species to sites where it has been extirpated. Although such a method of conservation of the species is not ideal, it serves as a prudent "backup" for this highly vulnerable species.

## Strategy for Recovery

A long-term, rangewide conservation strategy for smooth coneflower should be aimed at protecting and managing (where necessary) core sites and population centers, as well as including further inventory for viable populations of the species. Particularly important will be locating or reestablishing additional populations in natural habitat or in sites where natural habitat can be successfully and realistically restored and then managed and protected. Existing populations must be maintained and monitored, research must be conducted on population biology and ecology, and management techniques must be developed and implemented in conjunction with ongoing and expanded research efforts. Cultivated sources of germ plasm should be maintained at plant propagation facilities. Public education programs should be developed in areas within the species' range.

# PART II

# RECOVERY

## A. Recovery Objectives

*Echinacea laevigata* will be considered for reclassification from endangered to threatened when 12 geographically distinct, self-sustaining (stable or increasing for 10 years or more) populations (see Part I, "Distribution," for the definition of "population") are protected across the species' range, including some populations in at least two counties in Virginia, two counties in North Carolina, two counties in South Carolina, and one county in Georgia; when managers have been designated for each population; when management plans have been developed and implemented; and when populations have been maintained at stable or increasing levels for 5 years. Furthermore, at least nine of these populations must be in areas within the species' native ecosystem (not in gardens or similarly artificial settings) that are in permanent conservation ownership and management. Delisting the species will be considered when at least 15 geographically distinct, self-sustaining populations are protected in at least two counties in Virginia, two counties in North Carolina, two counties in South Carolina, and one county in Georgia; when management plans have been implemented; when populations (as measured by number of adult plants) have been stable or increasing for 10 years; and when permanent conservation ownership and management of at least ten populations are assured by legally binding instruments.

This recovery objective is considered an interim goal because of the lack of data on the biology and management requirements of the species. The number of self-sustaining populations required for the species' survival may require reassessment as more is learned about the species' biology, former and current range, and habitat requirements.

B. Narrative Outline

1. Implement protective management for extant populations. Only 23 populations of smooth coneflower are currently known, all in Virginia, North Carolina, South Carolina, and Georgia. Many of these are highly vulnerable to collection, habitat destruction, or detrimental management. The majority of these populations are on land owned and managed by highway departments or public utilities. Mowing of these populations at inappropriate times of the year should be prevented (safe mowing dates are November to early March), while assuring that yearly burning or bush-hogging of the sites (at appropriate times) does take place in order to control competing vegetation. Herbicides should be used with great care in order to protect nontarget species (e.g., applied by hand, not broadcast, to stumps and sprouts). Preliminary information indicates that periodic controlled burning in more natural sites, and either controlled burning or occasional bush-hogging of roadside sites, will be needed. The exact management techniques and timing to be used will be determined and refined by future research.

2. Survey suitable habitat for additional populations and potential reintroduction sites; reestablish populations within the species' historic range. Considerable effort has already been directed toward searches for this rare species, but new populations are still occasionally being found. Systematic and comprehensive surveys for additional populations are needed. The focus should be on locating remnant populations or suitable reintroduction sites in natural or seminatural conditions where population viability can be assured and where protection and management can be carried out most efficiently. Searches should use standard tools, such as soils maps, geological maps, and aerial photography. Populations in remnant glades, prairies, oak savannas, or Xeric Hardpan Forests will be especially difficult to locate and will require the extensive use of aerial photography or reconnaissance. These populations, however, will offer far superior opportunities for long-term viability than those occupying narrow strips of habitat on roadsides or other rights-of-way.

3. Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.). The full range of protection tools, including fee acquisition, tax-free land exchanges, signed management agreements, registry, and interagency memoranda of understanding, will be needed to protect and recover this species. Because of the need for active management of the habitat of smooth coneflower, a permanent means of protection (such as fee simple acquisition or conservation easements), accompanied by long-term provisions

for active stewardship/management of the site, is needed to assure population viability. Resources from a variety of agencies and private conservation organizations may be necessary.

4. Monitor existing populations. Monitor the size and vigor of known populations. Initially, this monitoring should be conducted annually and should include counts (and, in some cases, mapping) of all individuals in the population, if this is feasible. Where the dense concentrations of plants and the difficulty in defining "individuals" makes this impossible, permanent subplots can be used to measure density and coverage. In some populations permanent plots should be established to monitor seedling establishment and growth. The monitoring of populations will provide information on the efficacy of various management techniques. Once populations are stabilized, monitoring can be conducted less frequently.

5. Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurs. A basic understanding of the species biology of smooth coneflower is needed in order to manage populations of the species and to successfully recover it. A partial list of topics that need research includes habitat parameters (soils, geology, sun/shade, competition, etc.), reproductive biology (pollination, seed production, asexual reproduction via rhizomes, conditions and requirements for seedling establishment and survival, etc.), genetic analysis within and between populations, demographics, and an evaluation of management techniques, such as prescribed fire (including seasonality and frequency).

6. Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation. Collection of seeds or other plant material from all known populations should be accomplished (using the Center for Plant Conservation's standards) in order to preserve the full genetic diversity of the species and provide material for reintroductions in the event of the extirpation of populations.

7. Enforce laws protecting the species and its habitat. Smooth coneflower is currently part of the horticultural trade, but it is offered for sale by only a few native plant nurseries. A ready source of cultivated material should ease the threat of taking from wild populations. Nurseries should be encouraged and assisted in the development of cultivated stock. However, until a sufficient source is available, the taking of plants from the wild will continue to be a threat. The Endangered Species Act prohibits the taking of smooth coneflower from Federal lands without a permit and regulates

trade. Section 7 of the Act provides additional habitat protection from impacts related to federally funded or authorized projects. In addition, for listed plants, the 1988 amendments to the Act prohibit: (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.

In North Carolina, smooth coneflower is afforded legal protection by North Carolina general statutes, §106-202.122, 106-202.19 (Cum. Suppl. 1985). This legislation provides for protection from intrastate trade (without a permit), provides for monitoring and management of State-listed species, and prohibits the taking of plants without the written permission of landowners. In Georgia the species is afforded legal protection under the Wildflower Preservation Act of 1973, Code of Georgia Ann., Title 43, Section 43-1801 to 43-1806. Georgia legislation prohibits the taking of listed plants from public lands (without a permit) and regulates the sale and transport of plants within the State. Although South Carolina and Alabama recognize this species as nationally threatened and endangered, respectively, neither State offers legal protection for plants. Smooth coneflower is not listed by the State of Virginia.

8. Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of smooth coneflower could play an important part in encouraging landowner assistance and conservation efforts. This is especially true for those populations that occur in areas adversely affected by expanding urban development. Information materials should not identify the plant's specific locations so as to avoid increasing the threat of take. The U.S. Forest Service is already promoting public education on the species through news releases and slide presentations in communities near national forests where this species grows.

   8.1 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 major newspapers within the range of the species, as well as to smaller newspapers in the immediate vicinity of the species' habitat.

   8.2 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.

9. Annually assess success of recovery efforts for the species. 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**

COE - U.S. Army Corps of Engineers (Falls Lake)
CPC - Center for Plant Conservation
FWS - U.S. Fish and Wildlife Service
LE - Law Enforcement Division of the U.S. Fish and Wildlife Service
R4 - Region 4 (Southeast Region), U.S. Fish and Wildlife Service
R5 - Region 5 (Northeast Region), U.S. Fish and Wildlife Service
SCA - State Conservation Agencies - State plant conservation agencies of participating States. In North Carolina, these are the Plant Conservation Program (North Carolina Department of Agriculture) and the Natural Heritage Program (North Carolina Department of Environment, Health, and Natural Resources); in South Carolina, the Heritage Trust Program (South Carolina Department of Natural Resources); in Virginia, the Virginia Department of Conservation and Recreation, Division of Natural Heritage; and in Georgia, the Freshwater Wetlands and Heritage Inventory (Georgia Department of Natural Resources).
TE - Endangered Species Division, U.S. Fish and Wildlife Service
USFS - U.S. Forest Service (Sumter and Chattahoochee National Forests and Savannah River Forest Station)

SMOOTH CONEFLOWER IMPLEMENTATION SCHEDULE

| Priority | Task Number | Task Description | Task Duration | Responsible Agency FWS | Responsible Agency Other | Cost Estimates ($000's) FY1 | FY2 | FY3 | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | Implement protective management for extant populations. | 5 years | R4 and R5/TE | SCA, USFS, COE | 30.0 | 30.0 | 40.0 | |
| 1 | 3 | Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.). | Unknown | R4 and R5/TE | SCA, USFS | 40.0 | 40.0 | 40.0 | |
| 1 | 6 | Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation. | Ongoing | R4 and R5/TE | SCA, CPC, USFS | 10.0 | 5.0 | 5.0 | |
| 1 | 7 | Enforce laws protecting the species and its habitat. | Ongoing | R4 and R5/TE and LE | SCA, USFS, COE | 5.0 | 5.0 | 5.0 | |
| 2 | 2 | Survey suitable habitat for additional populations and potential reintroduction sites; reestablish populations within the species' historic range. | 3 years | R4 and R5/TE | SCA, USFS | 15.0 | 20.0 | 25.0 | |
| 2 | 4 | Monitor existing populations. | Ongoing | R4 and R5/TE | SCA, USFS, COE | 30.0 | 15.0 | 15.0 | |
| 2 | 5 | Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurs. | 5 years | R4 and R5/TE | SCA, USFS | 30.0 | 15.0 | 15.0 | |
| 3 | 8.1 | Prepare and distribute news releases and informational brochures. | Ongoing | R4 and R5/TE | SCA, USFS, COE | 2.0 | 1.0 | 1.0 | |
| 3 | 8.2 | Prepare articles for popular and scientific publications. | Ongoing | R4 and R5/TE | SCA, USFS | 1.0 | 0.5 | 0.5 | |
| 3 | 9 | Annually assess success of recovery efforts for the species. | Ongoing | R4 and R5/TE | SCA, USFS, COE | 0.5 | 0.5 | 0.5 | |

## PART IV

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APPENDIX

Insect Visitors to *Echinacea laevigata*

9 November 1993

TO: Carlen Emanuel, Department of Forest Resources, 261 Lehotsky Hall
FROM: Kevin Hoffman, Department of Entomology, 114 Long Hall K. M. Hoffman

Enclosed are the insects you brought over some time ago for identification. I've divided them out into separate vials for each species and enclosed an identification label, and I've banded together multiple vials which came out of a single sample vial (1-7). As you'll notice below, the immatures of many insects can't be reliably identified past family with the available literature.

| | Order | Family | Genus species | stage |
|---|---|---|---|---|
| Vial 1 - | Lepidoptera | Zygaenidae | *Acoloithus falsarius* Clemens | 1 male |
| Vial 2 - | Lepidoptera | Geometridae | undetermined | 1 larva |
| Vial 3 - | Homoptera | Flatidae | undetermined | 5 nymphs |
| | Heteroptera | Reduviidae | possibly *Sinea* sp. | 2 nymphs |
| | Coleoptera | Nitidulidae | *Meligethes* sp., possibly *nigrescens* Stephens | 1 adult |
| Vial 4 - | Coleoptera | Cantharidae | *Chauliognathus marginatus* Fabricius | 1 adult |
| | Orthoptera | Acrididae | *Melanoplus bivittatus* (Say) | 1 male |
| Vial 5 - | Coleoptera | Cerambycidae | *Typocerus zebra* (Olivier) | 2 adults |
| Vial 6 - | Lepidoptera | Nymphalidae | undetermined | 7 larvae |
| | Homoptera | Flatidae | undetermined | 1 nymph |
| Vial 7 - | Lepidoptera | Hesperiidae | *Polites origenes* (Fabricius) | 1 male |
| | Hymenoptera | Apidae | *Apis mellifera* Linnaeus | 1 worker |
| | Hymenoptera | Halictidae | *Agapostemum virescens* (Fabricius) | 1 female |
| | Hymenoptera | Halictidae | *Augochlorella striata* (Provancher) | 1 female |
| | Hymenoptera | Halictidae | *Halictus ligatus* Say | 1 female |

(Taken from Edwards and Madsen, 1993)