

Smooth Coneflower (*Echinacea laevigata*)

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



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

5-YEAR REVIEW
Smooth coneflower (*Echinacea laevigata*)

I. GENERAL INFORMATION

A. Methodology used to complete the review

The information used to prepare this report was gathered from peer reviewed scientific publications, a status survey by Gaddy (1991), current data from the Georgia Natural Heritage Program (GANHP), North Carolina Natural Heritage Program (NCNHP), South Carolina Heritage Trust Program (SCHTP), and Virginia Natural Heritage Program (VANHP), correspondence from botanists and land managers who are knowledgeable of the species and personal field observations. The review was completed by the lead recovery biologist for *Echinacea laevigata* in the Raleigh, North Carolina Field Office of the U.S. Fish and Wildlife Service (Service). The recommendations resulting from this review are the result of thoroughly assessing the best available information on *Echinacea laevigata*. Comments and suggestions regarding the review were received from peer reviewers within and outside the Service. A detailed summary of the peer review process is provided in Appendix A. No part of the review was contracted to an outside party. Public notice of this review was provided in the *Federal Register* on July 29, 2008, and a 60-day public comment period was opened (73 FR 43947). No comments were received during the comment period; however, the Service received population specific information at a later time from various individuals and agencies when requested by the lead recovery biologist. That information is provided in this review.

B. Reviewers

Lead Region: Kelly Bibb, Southeast Region, Atlanta, GA, 404-679-7132

Lead Biologist and Field Office:

Dale Suiter, Raleigh Ecological Services Field Office, Raleigh, NC, 919-856-4520
extension 18

Cooperating Offices:

Athens Field Office, Athens, GA

Charleston Field Office, Charleston, SC

Gloucester Field Office, Gloucester, VA (Region 5, Northeast Region, Hadley, MA)

C. Background

1. Federal Register Notice citation announcing initiation of this review:

July 29, 2008 (73 FR 43947)

2. Species status:

In the 2010 Recovery Data Call, the status of *Echinacea laevigata* was listed as stable. Many new populations and subpopulations have been found since the species was listed as Endangered in 1992. For example, in

Montgomery County, Virginia (VA), a new population of *Echinacea laevigata* was found in 2007 and a subpopulation was found in 2010. Two new populations were found in Durham County, North Carolina (NC), one each in 2006 and 2007, and one new population was found on Joe Ridge in South Carolina (SC) in 2007. The last status survey was completed in 1990 (Gaddy 1991). A status survey has not been completed since the species was listed as endangered. Based on survey information gathered at individual populations throughout the range of the species, it appears that the *Echinacea laevigata* is stable.

3. Recovery achieved:

Echinacea laevigata = 2 (26% - 50% recovery objectives achieved). See section II.B. below for more information about the progress of recovery for this species.

4. Listing history:

Original Listing

FR notice: 57 FR 46430

Date listed: October 8, 1992

Entity listed: Species

Classification: Endangered

5. Review History:

Since *Echinacea laevigata* was listed as endangered in 1992, no five-year reviews have been conducted for this species. The last comprehensive status survey of this plant was completed in 1990 prior to the species being listed (Gaddy 1991). Subsequent information related to the status or health of individual populations is mostly in the form of updates on individual populations that have been submitted to the appropriate state Natural Heritage Program offices. One meeting involving biologists and land managers from throughout the species' range was held at the NC Botanical Garden in March 2003. An attempt to hold a similar meeting in 2008 was unsuccessful. In recent years, researchers at NC State University have studied the genetics and pollination ecology of this species and the seed bank at two *Echinacea laevigata* populations (Peters 2005, Gadd 2006, Walker 2009).

6. Species' Recovery Priority Number at start of review (48 FR 43098):

Echinacea laevigata has been assigned a recovery priority number of 5, indicating a high degree of threat, a low potential for recovery, and a taxonomic status of full species.

7. Recovery Plan or Outline:

The *Echinacea laevigata* Recovery Plan was approved on April 18, 1995.

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment policy

The Endangered Species Act (Act) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing distinct population segments (DPS) to only vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes

2. Adequacy of recovery criteria

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Yes

3. List the recovery criteria as they appear in the recovery plan and discuss how each criterion has or has not been met, citing information.

Echinacea laevigata will be considered for reclassification from endangered to threatened when the following criteria are met:

- 1.) 12 geographically distinct, self-sustaining populations are protected across the species' range, including some populations in at least two counties in VA, two counties in NC and two counties in SC and one county in GA; [Progress: most likely complete. There are currently a total of 79 occurrences or sub-populations throughout the species' range which are considered protected. Forty-five of these populations (57%) are ranked A, B or C, indicating that they have excellent, good or fair estimated viability; three are ranked as CD or D, indicating that they have fair-poor or poor viability; 22 are ranked as E (extant), indicating that their viability has not been assessed. These protected sites occur in one county in GA, three counties in NC, three counties in SC and four counties in VA. See Table 2 and Appendix C.]
- 2.) when managers have been designated for each population; [Progress: complete. Each protected site occurs on Federal, state, county or private land, such as nature preserves owned by The Nature Conservancy and each has an assigned land manager. See Appendix C.]

- 3.) when management plans have been developed and implemented; [Progress: partially complete. Although each protected population does not have a management plan in place, many do and we are making good progress toward developing management plans for each protected site. Although we did not survey the land managers for this review, it is likely that management plans have been developed and implemented for at least 12 geographically distinct, protected populations] and
- 4.) when populations have been maintained at stable or increasing levels for five years [Progress: Regular, consistent monitoring has not been conducted at all protected sites; however general observations indicate that many populations are stable or increasing].

At least nine of these populations must be in areas within the species' native ecosystem (not in gardens) that are in permanent conservation ownership and management [Progress: complete. All protected sites are in natural areas.]

Echinacea laevigata shall be considered for removal from the Federal list when the following criteria are met:

- 1.) at least 15 geographically distinct, self sustaining populations are protected in at least two counties in VA, two counties in NC, two counties in SC and one county in Georgia (GA); [Progress: complete. See B.3-1 above.]
- 2.) management plans have been developed and implemented for each site; [Progress: incomplete. See B.3-3 above.]
- 3.) populations (as measured by number of adult plants) have been stable or increasing for 10 years; and, [Progress: unknown. Regular, consistent monitoring has not been conducted at many protected sites; however general observations indicate that many populations are stable or increasing]
- 4.) permanent conservation ownership and management of at least 10 populations are assured by legally binding instruments [Progress: completed. All 45 A, B and C-ranked populations occur on land that is protected by federal, state or county governments or private conservation groups such as The Nature Conservancy for conservation purposes.]

C. Updated Information and Current Species Status

1. Biology and Habitat:

a. Abundance, population trends, demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Echinacea laevigata was described in 1903 (Boynton and Beadle 1903, Gaddy 1991). Between 2005 and 2010, NC Plant Conservation Program (NCPCP) and/or NC Natural Heritage Program (NCNHP) staff or other

knowledgeable botanists have visited nearly all of the 22 extant *Echinacea laevigata* occurrences in NC. Since 2004, flowering stems have been counted annually at most NC populations; however, there is still not enough data to determine population trends (Robert Evans, NC Plant Conservation Program, Raleigh, NC, pers. comm., August 25, 2010).

The sites on U.S. Forest Service (USFS) land in Oconee County, SC have been monitored on an irregular schedule since 1980. While no statistical analysis has been conducted on this data, it appears that most of these populations are stable and six have been stable or increasing for at least 10 years (Robin Mackie, USFS, SC, pers. comm., Feb. 24, 2009).

Despite recent visits to many of the known subpopulations throughout the species' range, they have not been monitored in enough detail or with sufficient frequency to predict long-term population trends. However, at least 45 protected populations are ranked A, B or C, by their respective Natural Heritage Program.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

A genetic diversity study was recently completed by Peters et al. (2009) on *Echinacea laevigata*. They found that the species displays a relatively high level of diversity based on analyses across the range of populations. To determine the population structure and outcrossing rate across the range of the species, the researchers used amplified fragment length polymorphisms (AFLP) markers to conduct an analysis using four primer combinations for 22 populations across the range of the species. Their results yielded significant genetic diversity. There also was a significant population genetic differentiation suggesting that a majority of the genetic variance is attributed to variation within populations. An isolation by distance analysis indicated that genetic differentiation among populations was a function of geographic distance. This could be due to pollinators not traveling the distance between populations or barriers such as urban encroachment, causing populations to be more isolated. Based on an analysis of relatedness between populations using the neighbor-joining method, long-distance gene dispersal between some populations is possible and geographic distance does not seem to be problematic. An estimate of the outcrossing rate based on genotypes of progenies from six of the 22 populations using the multilocus method from the multi-locus tandem repeats (MLTR) program suggested that the species is predominantly outcrossing.

These results are encouraging for conservation, signifying that populations may be able to respond to selection pressures and persist due to continued genetic exchange sustained by the outcrossing mating system of the species. One goal of future management efforts should be to ensure

continued levels of gene flow and high levels of diversity across the range of this species, keeping in mind that any loss of habitat can create geographic isolation, thereby posing potential risks to species by limiting gene flow among populations.

c. Taxonomic classification or changes in nomenclature:

There have been no changes to the taxonomic classification or nomenclature since *Echinacea laevigata* was listed as endangered in 1989.

d. Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

When the recovery plan was written in 1995, there were 24 known populations of *Echinacea laevigata*, consisting of 40 individual locations or sub-populations range-wide. Seven populations were known from VA, six from NC, eight from SC and three from GA. Since then, additional occurrences have been found in all four states. The GANHP database currently lists 11 populations [Principal Element Occurrences (EO)] (30 subpopulations) as extant, five of which are introductions. NCNHP records currently indicate a total of eight extant populations made up of 22 element occurrences. An additional 12 sites in NC are now considered historical or extirpated. The SC Heritage Trust Program database indicates that there are 33 occurrences of *Echinacea laevigata* extant within the state, five of which are of unknown status. SC records have not combined occurrences into Principal EOs as they have in other states. Thirteen additional occurrences are now considered historical or extirpated. While there has been some speculation that the sandhills populations in SC may be introduced, Albert Pittman (Botanist, SC Heritage Trust pers. comm.), believes these sites are artifacts of fire suppression rather than the result of propagation and introduction. In VA, the Natural Heritage Program database indicates that there are 16 extant populations (Principal EOs) and there are six historical or extirpated sites. This information is summarized in Table 1 and additional information about each EO and subpopulation is included in Appendix C.

According to Reveal and Broome (1982), the one collection of this species from Maryland may represent an introduction. One herbarium specimen from Chester County, Pennsylvania (PA) has been identified, although no additional collections have been made from that state. The PA Natural Heritage Program (PANHP) considers this species to be extirpated in the State (John Kunsman, Botanist, PANHP, Middletown, PA, pers. comm.). There has been no major expansion in the range of the species.

Table 1. Number of extant and historical populations of *Echinacea laevigata* at the time of listing (October 8, 1992) and current (December 2010).

	GA	NC	SC*	VA	Total
No. of extant populations in 1995 (recovery plan)	3	6	8	7	24
No. of extant populations (principal EOs) in 2010*	11	8	33	16	68
No. historical and extirpated populations as of 2010	1	12	13	6	32

*Note that the number of populations listed between States is not necessarily comparable. While some states consider each distinct site as a population or “element occurrence; EO” and assign that site a unique identifying number, other states use NatureServe’s Habitat-based Plant Element Occurrence Delimitation Guidance to determine what constitutes a population. This results in some occurrences that are in close proximity to each other being merged into principal EOs. Since NatureServe has not developed Specific Population / Occurrence Delineation for *Echinacea laevigata*, the default is that all sites within 2 km of each other are considered part of one population as long as there is not an area of unsuitable habitat greater than 1 km wide or another separation barrier present. NatureServe’s Habitat-based Plant Element Occurrence Delimitation Guidance is online at http://www.natureserve.org/explorer/decision_tree.htm. The GA, NC and VA records have been lumped based on this guidance (2 km separation distance), while the records from SC have not.

e. Habitat conditions:

All of the known *Echinacea laevigata* populations occur in the Piedmont or Mountain physiographic provinces. The recovery plan states that this species is typically found in open woods, cedar barrens, roadsides, clear cuts, dry limestone bluffs and power line rights-of-way. The species is usually found on magnesium and calcium rich soils associated with amphibolite, dolomite or limestone (in VA), gabbro (in NC and VA), diabase (in NC and SC) and marble (in SC). The best *Echinacea laevigata* populations receive abundant sunlight and little competition from other plant species (Gaddy 1991). According to Albert Pittman (Botanist, SC Heritage Trust pers. comm.), *Echinacea laevigata* occupies a number of distinct physiographic provinces and habitats in SC including open woodlands over marble, sandy loams, chert and amphibolites. Many of the populations are being managed with prescribed fire to maintain preferred growing conditions for *Echinacea laevigata*.

f. Other relevant information about the species (propagation, etc.):

The NC Botanical Garden is the designated Center for Plant Conservation repository for *Echinacea laevigata*. Seeds from two NC populations (NHP sub-EOs 24.1, 24.8, 24.19, 24.21, 24.22, 24.28, 26.3, 4 and 3) and two VA populations (NHP EOs 1, 27) are stored there for long term preservation of genetic material to be used for research and reintroduction.

The NC Botanical Garden hopes to increase seed accessions and conduct research on seed production, seed ecology, storage and germination as funds become available. In addition, they also have several plants in cultivation that are used for educational purposes. The NC Botanical Garden also has live plants in conservation from NCNHP sub-EOs 24.8, 26.3, and 37. The NC Botanical Garden is also conducting experimental introductions on protected land (U.S. Army Corps of Engineers). A small trial of 112 individuals was planted at Penny's Bend Nature Preserve (near Durham, NC) in 2004. Approximately 75% of the individuals have survived to date and recruitment of new individuals was observed for the first time in 2009, when at least 74 year-one plants were observed. A larger experiment was started at Penny's Bend Nature Preserve in 2007 to compare the success of introducing 575 one year old plants vs. directly sowing 575 seeds in the field. The plants are located within 0.5 km of the parent population and several natural and introduced sub-populations. Approximately 70% of seedlings and 10% of seeds have survived to date. Recruitment of new individuals, some true seedlings, was first observed in 2010 (Michael Kunz, Conservation Ecologist, NC Botanical Garden, email, December 20, 2010).

The NC Zoo cultivates both common and rare native plants within their natural habitat exhibits for educational purposes. They have 300-400 clumps of *Echinacea* that they believe to be hybrids of *E. laevigata* and *E. purpurea*. They are in the process of propagating *Echinacea laevigata* seeds obtained from the NC Botanical Garden and plan to replace the existing hybrids with the true species (Nell Allen, Horticulturalist, NC Zoo, email, December 17, 2010).

According to Heather Alley (Botanist, State Botanical Garden of Georgia, pers. comm.) the State Botanical Garden of GA has been propagating *Echinacea laevigata* for over 10 years for reintroduction onto USFS land and for educational habitat gardens at the State Botanical Garden of GA and at Tallulah Gorge State Park. Two additional education gardens are being planned, one at the USFS Visitor Center in Clayton, GA and one at Camp Toccoa in Stephens County, GA. In addition, the Atlanta Botanical Garden cultivates *Echinacea laevigata* in their conservation garden (Ron Determann, Horticulturist, Atlanta Botanical Garden, pers. comm.).

In SC, the USFS restored a population of *Echinacea laevigata* at a site called Long Nose from seed collected from the Pine Mountain site, less than one mile away (Robin Mackie, USFS, Columbia, SC, email, February 24, 2009).

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms):

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

Several populations and subpopulations of *Echinacea laevigata* have suffered from habitat modification and/or destruction. *Echinacea laevigata* is threatened range-wide by the suppression of fire and the ecological succession (competition and/or shading by woody species) that occurs in areas that are not burned on a regular basis. *Echinacea laevigata* also is threatened by timber operations. Sites located within utility rights-of-way are threatened by herbicide use and/or mowing during critical growth periods. The destruction of habitat, resulting from development or land conversion also threatens this species, but to a lesser degree than the factors listed above. The invasive plant, *Pueraria lobata* (kudzu), occurs at one *Echinacea laevigata* population in SC. *Lespedeza cuneata* (Sericea lespedeza) is problematic at some roadside locations in NC.

Several *Echinacea laevigata* populations are considered protected. For the purposes of determining how many populations are protected for this report, Natural Heritage Program records were reviewed for ownership and management information. Those sites owned or managed by state or federal government agencies with a conservation mission or a legal obligation to protect listed species (USFS, Department of Defense, U.S. Army Corps of Engineers, etc.) are considered protected, although the level of attention to management varies widely among sites, land owners and managers.

A total of 79 occurrences or sub-populations throughout the species range are considered protected. Forty-five of these populations (57%) are ranked A, B or C, indicating that they have excellent, good or fair estimated viability; three are ranked as CD or D, indicating that they have fair-poor or poor viability; 22 are ranked as E (extant), indicating that their viability has not been assessed. These sites occur in one county in GA, three counties in NC, three counties in SC and four counties in VA. Nine populations on conservation lands are considered historical or extirpated. More than half of the known populations are considered to have at least fair viability and, given their emphasis on rare plant management it is likely that many of the 22 populations on the Chattahoochee NF are of A, B or C rank. The Nature Conservancy also protects one A-ranked population in VA (Table 2).

Table 2. A summary of natural protected *Echinacea laevigata* sites by NatureServe ranks, as defined at www.natureserve.org/explorer/eorankguide.htm. Those land managers marked with an asterisk have implemented management plans for *Echinacea laevigata*.

Land Manager	Rank Category										
	A	AB	B	BC	C	CD	D	E	F	H	X
Dept. of Defense:											
Corps of Engineers(NC)*	2			1	2						
Fort Jackson (SC)*					1						
Savanna River Site(SC)			1								
US Forest Service											
Chattahoochee NF (GA)*				1	2			22			3
Sumter NF (SC)*			7	9	4					5	
Washington/Jefferson (VA)*	1				1						
Local Government (NC)*				1	1						
State of NC*	2				1		2				1
State of SC		4									
State of VA	1	1	1								
TNC (VA)*	1					1					
Total	7	5	9	12	12	1	2	22	0	5	4

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

While some species of *Echinacea* are collected and sold for medicinal purposes, others are collected for horticultural uses. Land managers have identified sites where *Echinacea laevigata* plants have been poached or stolen from natural locations (GANHP database). Collections used for research purposes are permitted by the Service and are limited to volumes of plant parts that are believed to be insignificant and will not jeopardize any particular population. It does not appear that this species is being overutilized for any recreational, scientific or educational purposes.

Some sites in North Carolina are popular field trip locations, as they occur near a major population center in the Durham area. While there are some reports of poaching or attempted poaching from these populations, effects due to visitation from scientists, students, or hikers seem to be minimal.

c. Disease or predation:

The non-native longhorn beetle (*Hemierana marginata*) has been identified at some *Echinacea laevigata* populations in NC. This beetle chews into the flowering stems causing flowers to die before they produce viable seeds. The insect also may burrow into the base of the plant killing

the plant (Laura Gadd, NC Plant Conservation Program, Raleigh, NC, pers. comm.).

d. Inadequacy of existing regulatory mechanisms:

Echinacea laevigata is protected on Federal lands including sites owned by the USFS in GA, SC and VA, the U.S. Army Corps of Engineers in NC and the U.S. Army at Fort Jackson and the Savannah River Site in SC. *Echinacea laevigata* is listed as state endangered in NC under the Plant Protection and Conservation Act of 1979, but this protection is largely limited to the regulation of collection and trade (NC Department of Agriculture 02 NCAC 48F .0301) (Buchanan and Finnegan 2010). The Act authorizes the NC Plant Conservation Program to establish nature preserves for protected species and their habitat, but that agency has not yet created any nature preserves for this species. GA has laws protecting rare plants (Ga. Code Ann. Secs. 27-3-130 et seq.) and animals (Secs. 12-6-171 et seq.) Listing under both acts is limited to scientific and commercial criteria. Habitat acquisition is authorized but not required. The acts do not require recovery plans or agency consultation. Violations constitute a misdemeanor. In addition, the GA Environmental Policy Act requires the assessment of major proposed agency impacts on biological resources (Ga. Code Ann. Sec. 12-16-1 et seq.) (Center for Wildlife Law, <http://wildlifelaw.unm.edu/statbio/georgia.html>). VA and SC do not have State laws to protect rare plants.

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

No other natural or manmade factors affecting the continued existence of *Echinacea laevigata* are known at this time.

D. Synthesis

Based on monitoring efforts and survey information gathered at individual *Echinacea laevigata* sites in recent years, it appears that the species is stable. In 1995, when the recovery plan was written, *Echinacea laevigata* was known from 24 sites (or what are now considered element occurrences) in GA, NC, SC and VA. Since that time, additional sites or sub-populations have been discovered within the historic range of the species. A total of 68 populations are considered extant while 32 populations are believed to be extirpated or historical. There is no evidence that this species occurs in Maryland or Pennsylvania.

Seventy-nine subpopulations of *Echinacea laevigata* occur on protected land, 45 of which (57%) are ranked A, B or C, indicating that they have excellent, good or fair estimated viability. An additional 22 sites are protected on the Chattahoochee NF in GA. Based on the aggressive management practices by the U.S. Forest Service there, it is likely that

these sites, currently ranked as E (extant), are actually A, B or C-ranked sites.

Threats to the species include habitat loss from fire suppression and subsequent ecological succession, forestry practices, development and inadequate regulatory mechanisms to protect listed plants on privately owned uplands. In addition, there is some evidence that this species has been collected for horticultural purposes from roadside locations in GA. The non-native longhorn beetle has been identified on some *Echinacea laevigata* populations in NC. None of these threats appear to be serious obstacles toward recovery.

Given the substantial increase in the number of known populations since the time of listing as endangered (24 to 68), the large number of viable sites (45 A, B and C-ranked) that are in long-term conservation ownership and spread across the range of the species, all with designated site managers and many with management plans in place, the Service believes that it is appropriate to consider reclassifying this species from Endangered to Threatened status.

III. RESULTS

A. Recommended Classification:

X Downlist to Threatened

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

Recommended actions that will contribute to the recovery of *Echinacea laevigata* include:

- revisit known populations that have not been visited in the past three years in order to monitor the population size, habitat conditions and to document any potential threats to the viability of each site; discuss conservation options with landowners and managers where appropriate; report findings to the appropriate NHP,
- search for additional populations in appropriate habitat,
- identify those populations/subpopulations that will contribute toward long term recovery and determine their status (increasing, stable or decreasing),
- prioritize protection of unprotected sites that are critical for recovery and protect them,
- develop conservation agreements with applicable landowners to ensure recovery objectives are met,
- determine which sites have management plans and how they are being implemented and develop and implement management plans for the remaining sites that are deemed to be critical to the recovery of the species,
- develop monitoring protocols and initiate long-term population monitoring that will demonstrate if a site is stable or not,

- determine the management techniques for sustaining populations, such as fire frequency and seasonality,
- conduct further genetic analysis of populations not included in the research by Peters, et al (2009),
- organize a meeting of land managers, researchers and other interested parties to discuss the recovery of this species,
- collect seeds and develop propagation protocols according to Center for Plant Conservation guidelines,
- conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship), and
- secure funding to accomplish the actions listed above.

V. REFERENCES

Boynton, C.L. and Beadle. 1903. *In* Small, J.K. 1903. Flora of the southeastern United States, being descriptions of the seed-plants, ferns and fern-allies growing naturally in North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, and in Oklahoma and Texas east of the one hundredth meridian. Published by the author, New York, NY.

Buchanan, M.F. and J.T. Finnegan. 2010. Natural Heritage Program List of the Rare Plant Species of North Carolina. NC Natural Heritage Program, Raleigh, NC.

Center for Wildlife Law. 2009. <http://wildlifelaw.unm.edu/statbio/georgia.html>

Gadd, L.E. 2006. Pollination biology of the federally endangered *Echinacea laevigata* (Boynton and Beadle) Blake, smooth coneflower, in small isolated populations. Dissertation, North Carolina State University.

Gaddy, L.L. 1991. The Status of *Echinacea laevigata* (Boynton and Beadle) Blake. Cooperative Agreement report between U.S. Fish and Wildlife Service, Asheville, NC and NC Natural Heritage Program, Raleigh, NC.

Peters, M. 2005. Genetic analysis of the federally endangered *Echinacea laevigata* using amplified fragment length polymorphisms (AFLP)—Inferences in population genetic structure and mating system. Master's thesis. North Carolina State University.

Peters, M.D, Q. Xiang, D.T. Thomas, J. Stucky, and N.K. Whiteman. 2009. Genetic analyses of the federally endangered *Echinacea laevigata* using amplified fragment length polymorphisms (AFLP)—Inferences in population genetic structure and mating system. *Conservation Genetics* 10(1): 1-14.

Reveal, J.L. and C.R. Broome. 1982. Comments on the proposed endangered and threatened vascular plants of Maryland, USA. *Castanea* 47(2) 191-200.

A complete bibliography of reports, articles, papers and books referencing *Echinacea laevigata* can be found in Appendix B.

**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF SMOOTH CONEFLOWER (*ECHINACEA LAEVIGATA*)**

Current Classification Endangered
Recommendation resulting from the 5-Year Review

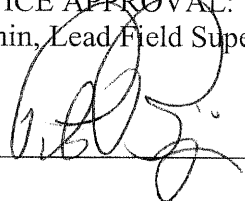
- Downlist to Threatened**
- Uplist to Endangered**
- Delist**
- No change is needed**

Appropriate Listing/Reclassification Priority Number, if applicable N/A

Review Conducted By Dale Suiter, Fish and Wildlife Biologist

FIELD OFFICE APPROVAL:

Pete Benjamin, Lead Field Supervisor, Fish and Wildlife Service

Approve  Date 1/10/11

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve  Date 8/2/11

Cooperating Regional Director, Fish and Wildlife Service

Approve  Date 7/25/11
Acting Regional Director

APPENDIX A
Summary of peer review for the 5-year review of
Smooth coneflower (*Echinacea laevigata*)

A. Peer Review Method:

In June 2009, a draft copy of the five year review was emailed to botanists with the North Carolina (NC) Plant Conservation Program, NC Natural Heritage Program, Georgia (GA) Natural Heritage Program, South Carolina (SC) Heritage Trust Program and the Virginia (VA) Natural Heritage Program. Since *Echinacea laevigata* occurs within the work area of four other Service Ecological Service offices, the Athens, GA, Charleston, SC, Asheville, NC and Gloucester, VA Field Offices and Fort Jackson, SC and the USFS in SC were asked to review this document. Reviewers provided comments by email, modifications to the original document and/or in “track changes.” All of the peer reviewers know the species and are familiar with the habitats where the species occurs and the threats to its long term survival. Other reviewers are familiar with the general flora of the areas where the species occurs and they are also familiar with state and federal regulations, plant conservation issues and the threats to rare species.

B. Peer Review Charge:

Peer reviewers were asked to provide written comments on the information presented in our analysis of the status of *Echinacea laevigata* and to provide comments on the validity of the data. Peer reviewers were asked not to provide recommendations on the legal status of the species.

C. Summary of Peer Review Comments/Report:

One reviewer, a site manager for *Echinacea laevigata* sites in VA reviewed the document and agreed with the comments related to populations under her jurisdiction. She had no additional information to add. A botanist with the NC Natural Heritage Program provided various comments throughout the document, but the most substantial was a recommendation to focus on principal EOs rather than sub-EOs since many sub-EOs are just extensions of previously known principal EOs and they might falsely imply that there are many more populations now than at the time of listing or at the completion of the recovery plan. One reviewer from the NC Botanical Garden provided minor corrections and comments throughout the document. The botanist with the NC Plant Conservation Program provided comments throughout, but the most substantial comments were to Appendix D, where she provided additional ownership information. The botanist from the SC Heritage Trust Program provided additional information on the locations in SC including some sites that are of questionable origin. All reviewers suggested some changes in wording that greatly improved the overall quality of the document.

D. Response to Peer Review:

The author accepted all comments provided by the reviewers and attempted to incorporate them into the document where appropriate.

APPENDIX B

Bibliography of documents referencing *Echinacea laevigata* (Smooth Coneflower)

- Alley, H. 2002. Saving the Smooth Coneflower. State Botanical Garden of Georgia, Athens, GA. Garden News 18(4).
- Alley, H. and J. Affolter. 2004. Experimental Comparison of Reintroduction Methods for the Endangered *Echinacea laevigata* (Boyton and Beadle) Blake. Natural Areas Journal 24 (4):345-350.
- Alley, H., M. Rieger and J.M. Affolter. 2005. Effects of Developmental light levels on photosynthesis and biomass production in *Echinacea laevigata*, a federally listed endangered species. Natural Areas Journal 25 (2).
- Apsit, V.J., & P. M. Dixon. 2001. Genetic Diversity and Population Structure in *Echinacea laevigata* (Boyton and Beadle) Blake, an Endangered Plant Species. Natural Areas Journal 21: 71-77.
- Arnold, J.E., L.G. Edwards, T.P. Spira, T.P. and J.L. Walker. 1998. Efforts to Save an Endangered Species - *Echinacea laevigata* (Smooth Coneflower). Clemson University. http://virtual.clemson.edu/groups/hort/sctop/pdf_docs/BSec/BSec-13.pdf. Accessed: 2002.
- Barden, L. 1997. Historic Prairies in the Piedmont of North and South Carolina, USA. Natural Areas Journal 17(2):149-152.
- Barnett-Lawrence, M. 1994. Smooth Coneflower, *Echinacea laevigata* (Boynton & Beadle) Blake, experimental management and monitoring for 1993. Raleigh, NC: Report to the North Carolina Plant Conservation Program. 65 pp.
- Barnett-Lawrence, M. 1995. Smooth Coneflower, *Echinacea laevigata* (Boynton & Beadle) Blake, experimental management and monitoring for 1994 and 1995. Raleigh, NC: Report to the North Carolina Plant Conservation Program. 28 pp. + appendices.
- Benjamin, S., E. Drozda, A. Goode, R. Martin. 1991. An evaluation of management alternatives for the Smooth Coneflowers sites at Falls Lake Reservoir. Duke University, Durham, NC: Project Completed for FES 316-Case Studies in Environmental Management, School of Forestry and Environmental Studies. 21 pp.
- Blake, S.F. 1929. New Asteraceae from the United States, Mexico, and Honduras. Journal of the Washington Academy of Sciences 19(13).
- Boynton, C.L. and Beadle. 1903. In Small, J.K. 1903. Flora of the southeastern United States, being descriptions of the seed-plants, ferns and fern-allies growing naturally in North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas,

Louisiana, and in Oklahoma and Texas east of the one hundredth meridian. Published by the author, New York, NY.

- Buchanan, M.F. and J.T. Finnegan. 2008. Natural Heritage Program List of the Rare Plant Species of North Carolina. NC Natural Heritage Program, Raleigh, NC.
- Cronquist, A. 1945. Notes on the Compositae of the Northeastern United States. II. Heliantheae and Helenieae. *Rhodora* December, 1945.
- Cronquist, A. 1980. Vascular flora of the southeastern United States. Vol. 1. Asteraceae. Chapel Hill: University of North Carolina Press. 261 pp.
- Davis, J.E., C. McRae, B.L. Estep, L.S. Barden and J.F. Matthews. 2002. Vascular Flora of Piedmont Prairies: Evidence from Several Prairie Remnants. *Castanea* 67(1):1-12.
- Dunscumb, J.K. and K.M. Korth. 1997. Results of monitoring for the smooth coneflower (*Echinacea laevigata*). Report from The Nature Conservancy, Charlottesville, VA to the VA Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.
- Edwards, L.G., T.P. Spira and J.L. Walker. 1995. Seed production and germination ecology of *Echinacea laevigata*, smooth coneflower: a federally endangered species. Poster presentation at Association of Southeastern Biologists Meeting, Knoxville, TN.
- Emanuel, C.M. 1996. Silvicultural options for recovering the endangered smooth coneflower, *Echinacea laevigata* (Boynton and Beadle) Blake. Masters Thesis. Clemson University.
- Emanuel, C.M., T.A. Waldrop, J.L. Walker, and D.H. Van Lear. 1995. Silvicultural options for recovering the endangered smooth coneflower: preliminary results. pp. 32-35 in: Edwards, M. Boyd, ed. Proceedings of the eighth biennial southern silvicultural research conference. 1994 November 1-2; Auburn, AL: Gen. Tech. Rep. SRS-1; Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.
- Evans, R.E., M. Pyne, and S. Hiltner. 2002. Remnant Diabase Vegetation in the North-Central North Carolina Piedmont. Presented by NatureServe for the 3rd Eastern Native Grass Symposium, Chapel Hill, NC.
- Gadd, L.E. 2006. Pollination biology of the federally endangered *Echinacea laevigata* (Boynton and Beadle) Blake, smooth coneflower, in small isolated populations. Dissertation, North Carolina State University.
- Gaddy, L.L. 1991. The status of *Echinacea laevigata* (Boynton & Beadle) Blake. Unpublished report to the U.S. Fish and Wildlife Service. Asheville, NC, 24 pp. + appendices and maps.

- Gaddy, L.L. 1992. Overview of the Pine Mountain Smooth Coneflower Management Plan. Unpublished report.
- Gaddy, L.L. 1992. Smooth coneflower survey report. Butner, North Carolina Federal Correctional Complex. Submitted by Louis Berger and Associates, Inc., Washington, D.C. to USFWS.
- Hefferman, K.E., A. Belden, Jr., M.J. Leahy, and R.K. Myers. 2002. Restoration of Habitat for smooth coneflower (*Echinacea laevigata*) in Virginia: Phase I – Population Surveys and Management Plan. Virginia Department of Conservation and Recreation, Richmond, VA. 43 pp.
- Hefferman, K.E., M.J. Leahy, and R.K. Myers. 2003. Restoration of Habitat for smooth coneflower (*Echinacea laevigata*) in Virginia: Phase II – Management and Monitoring. Virginia Department of Conservation and Recreation, Richmond, VA. 30 pp.
- Hurlburt, D. 1999. Endangered *Echinacea*--What Threat, Which Species, and Where?. United Plant Savers Newsletter (UPS Newsletter) 2,1:4-5.
- Juras, P. 1997. The presettlement Piedmont savanna: A model for landscape design and management. Masters thesis. University of Georgia. <http://philipjuras.com/thesis/>. accessed February 4, 2006.
- Kindscher, K. 2008. Distribution Maps for *Echinacea* Species. http://www.kbs.ku.edu/people/staff_www/kindscher/echinacea/e_laevigata_041905.htm
- Kral, R. 1983. Asteraceae: *Echinacea laevigata* (Boynt. & Beadle) Blake [Endangered species, perennial plants of open woodlands in Virginia, Georgia and Alabama]. Technical publication R8-TP - USDA Forest Service, Southern Region. Vol. 2 pt. 2.
- LeGrand, H.E., Jr. 1986. Picture Creek: Natural area reconnaissance. NC Natural Heritage Program, Raleigh, NC.
- Lipscomb, M. 2002. Population and community monitoring of smooth coneflower (*Echinacea laevigata*) in Montgomery County, Virginia Interim Report. Unpublished report.
- Lunsford, E. Undated, ca 2003. Smooth Coneflower, *Echinacea laevigata* (Boynton and Beadle) Blake monitoring and management 1998-2001. Unpublished report to the NC Plant Conservation Program and USFWS. 162 pp.
- McGregor, R.L. 1968. The taxonomy of the genus *Echinacea* (Compositae). University of Kansas Science Bulletin 48: 113-142.
- McKeown, K.A. 1999. *Echinacea* Gives the United States an Opportunity to Put Conservation Policies into Practice. Diversity. 15, 3: 17.

- McKeown, K.A. 1998. Collection of *Echinacea laevigata* and *Echinacea tennesseensis* Germplasm (Seed) in 1997. Report to U.S. Fish and Wildlife Service, Atlanta, GA.
- Nelson, J.B. 1992. Rare and Endangered Plant Survey: Fort Jackson Army Installation, Richmond County, South Carolina. Report prepared for the Nature Conservancy of South Carolina.
- North Carolina Botanical Garden. 1995. 1995 Annual report on taxa in the national collection for North Carolina Botanical Garden. Annual report to the Center for Plant Conservation. 1p.
- North Carolina Division of Parks and Recreation. 1993. Draft management plan for ecologically significant areas within Picture Creek Diabase Barrens. North Carolina Division of Parks and Recreation, Raleigh, NC.
- Patrick, T.S. 1999. Recovery of *Echinacea laevigata*. GPCAnews (Newsletter of the Georgia Plant Conservation Alliance). 2: 1, 8.
- Peters, M.D. 2005. Genetic analysis of the federally endangered *Echinacea laevigata* using amplified fragment length polymorphisms (AFLP)—Inferences in population genetic structure and mating system. Masters thesis. North Carolina State University.
- Peters, M.D, Q. Xiang, D.T. Thomas, J. Stucky, and N.K. Whiteman. 2009. Genetic analyses of the federally endangered *Echinacea laevigata* using amplified fragment length polymorphisms (AFLP)—Inferences in population genetic structure and mating system. *Conservation Genetics* 10(1):1-14.
- Radford, A.E., H.E. Ahles and C.R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill, NC
- Reveal, J.L. and C.R. Broome. 1982. Comments on the proposed endangered and threatened vascular plants of Maryland, USA. *Castanea* 47(2) 191-200.
- Russo, M. and J.M. Sweeney. 2000. Threatened and Endangered Species in Forests of North Carolina. 183 pp.
- Schafale, M.P. 1992. Xeric Hardpan Forests are uncommon in the Piedmont. *The Steward*. 6 (10) 9-10.
- Schafale, M. P. and A. Weakley. 1990. Classification of the Natural Communities of North Carolina. 3rd Approximation. North Carolina Natural Heritage Program. Division of Parks and Recreation Department of Environment, Health and Natural Resources.
- Slapcinsky, J. 1994. The Vegetation and soils associated with Diabase in Granville and Durham Counties, North Carolina. Masters thesis. North Carolina State University.

- Smith, C.W. 1986. The occurrence, distribution, and properties of dispersive soil and saprolite formed over diabase and contact metamorphic rock in a Piedmont landscape in North Carolina. Masters Thesis. North Carolina State University.
- Sutter, R.D. 1987. Inventory of the Natural Areas and Rare Species of Durham County. NC Plant Conservation Program, Raleigh, NC.
- U.S. Army Training Center and Fort Jackson. Undated, ca. 2007. Flora endangered species management component of the INRMP for Smooth coneflower and Rough-leaved loosestrife. U.S. Army Training Center and Fort Jackson. FY 2007-2011. 30 pp.
- USFWS. 1992. Endangered and threatened wildlife and plants: *Echinacea laevigata* (Smooth Coneflower) determined to be endangered. Federal Register 57:46340-46344
- USFWS. 1992. Regional News--Regions 2 & 4. Endangered Species Technical Bulletin. 17, 9-11: 9, 13-15.
- USFWS. 1995. Smooth Coneflower Recovery Plan. Atlanta, Georgia. 31 pp.
- University of Georgia's Savana River Ecology Laboratory. 2009. The Smooth Purple Coneflower on the SRS.
http://www.uga.edu/srel/Snapshots/smooth_purple_coneflower.htm. Accessed: 2009.
- Wagenius, S. 2006. Scale dependence of reproductive failure in fragmented *Echinacea* populations. Ecology 87:931-941.
- Weakley, A. 2007. Flora of the Carolinas, Virginia, Georgia and surrounding areas. Working Draft January 11, 2007. University of North Carolina, Chapel Hill.

APPENDIX C
Summary of populations of *Echinacea laevigata* (Smooth Coneflower)

Principal EO	Previous EO	County	Survey Site Name	Last Observed Date	EO Rank	Owner
Georgia						
3	0001	Stephens	N/A	1996-06	BC	F-USFS– Chattahoochee N.F.
2	0002	Stephens	N/A	1992-07-11	E	F-USFS– Chattahoochee N.F.
1	0003	Stephens	N/A	1989-12-19	E	F-USFS– Chattahoochee N.F.
8	0004	Stephens	N/A	1997-06	E	F-USFS– Chattahoochee N.F.
1	0005	Stephens	N/A	1987	X	F-USFS– Chattahoochee N.F.
8	0006	Stephens	N/A	1992	E	F-USFS– Chattahoochee N.F.
8	0007	Stephens	N/A	1992-06	E	F-USFS– Chattahoochee N.F.
8	0008	Stephens	N/A	2000-08-02	E	F-USFS– Chattahoochee N.F.
8	0009	Stephens	N/A	1992-06	E	F-USFS– Chattahoochee N.F.
6	0010	Stephens	N/A	1992-06	E	F-USFS– Chattahoochee N.F.
11	0011	Stephens	N/A	1991	X	F-USFS– Chattahoochee N.F.
5	0012	Stephens	N/A	1992-06	E	F-USFS– Chattahoochee N.F.
3	0013	Stephens	N/A	1997-06	E	F-USFS– Chattahoochee N.F.
4	0014	Stephens	N/A	1992-06	E	F-USFS– Chattahoochee N.F.
8	0015	Stephens	N/A	1991-07	X	F-USFS– Chattahoochee N.F.
6	0016	Stephens	N/A	1992-06	E	F-USFS– Chattahoochee N.F.
5	0017	Stephens	N/A	1996-06	E	F-USFS– Chattahoochee N.F.
1	0018	Stephens	N/A	1997-08-12	E	F-USFS– Chattahoochee N.F.
1	0019	Stephens	N/A	1989-12-19	E	F-USFS– Chattahoochee N.F.
8	0020	Stephens	N/A	1992-06	E	F-USFS– Chattahoochee N.F.
2	0021	Stephens	N/A	1997-07-14	E	F-USFS– Chattahoochee N.F.
2	0022	Stephens	N/A	1997-07-23	E	F-USFS– Chattahoochee N.F.
2	0023	Stephens	N/A	1997-07-31	E	F-USFS– Chattahoochee N.F.

9	0024	Stephens	N/A	1992-06	E	F-USFS– Chattahoochee N.F.
25	0025	Stephens	N/A	1996-06	E	F-USFS– Chattahoochee N.F.
7	0026	Stephens	N/A	2003	E	F-USFS– Chattahoochee N.F.
8	0027	Stephens	N/A	2008-12	Ei	F-USFS– Chattahoochee N.F.
8	0028	Stephens	N/A	2009-06	Ei	F-USFS– Chattahoochee N.F.
7	0029	Stephens	N/A	2008-12	Ei	F-USFS– Chattahoochee N.F.
3	0030	Stephens	N/A	2009-06	Ei	F-USFS– Chattahoochee N.F.
4	0031	Stephens	N/A	2009-06	Ei	F-USFS– Chattahoochee N.F.
10	0032	Stephens	N/A	2007	C	F-USFS– Chattahoochee N.F.
2	0033	Stephens	N/A	2001	C	F-USFS– Chattahoochee N.F.
North Carolina						
2	2	Granville	Northside Diabase Area, Falls Lake Natural Areas Macrosite	6/17/2008	C	F-USACE
4	4	Granville	Knap of Reeds Creek	6/17/2008	C	F-USACE
5	5	Granville	Boulding Creek	8/29/1963	H	?
6	6	Granville	Goshen Gabbro Forest: Trail Site (Sub EO of EO 027).	5/11/1986	H	P
9	9	Orange	Chapel Hill, near Old Raleigh Road [Not Mapped]	6/12/1928	X	?
10	10	Durham, Orange	Booker Creek	5/27/1922	X	?
11	11	Montgomery	Troy, 7 miles north	6/18/1963	H	?
12	12	Durham	South of Duke Nurses Home Woodlot [Not Mapped]	6/14/1954	X	?
13	13	Durham	Duke Forest [Not Mapped]	6/7/1931	X	?
14	14	Mecklenburg	Charlotte [Not Mapped]	1900-PRE	X	?
15	15	Orange	Chapel Hill [Not Mapped]	6/3/1933	X	?
16	16	Orange	Hillsborough [Not Mapped]	6/24/1940	X?	?
17	17	Rockingham	Fitzgerald Woodland	7/3/1994	X	?
18	18	Granville	Goshen Gabbro Forest: Powerline Site (Sub EO of EO 027)	2005	C	P
20	20	Mecklenburg	Shuffletown Powerline	6/19/2008	C	Mecklenburg County Parks and Recreation, private

24	24	Durham	North Durham: Parent EO. This occurrence was created to link together all sub EOs/patches within the Penny's Bend area. This record does not contain any unique information.	6/11/2008	A	F-USACE
24.1	1	Durham	North Durham: Harrelson Property (Sub EO of EO 024).	6/11/2008	A	S-NCDA&CS-PCP; proposed for Dedicated Heritage Area
24.7	7	Durham	North Durham: Infinity Road (west] (Sub EO of EO 024)	6/11/2008	D	P
24.8	8	Durham	North Durham: Hebron Road (Sub EO of EO 024).	6/11/2008	C	S-NCDA&CS; proposed for Dedicated Heritage Area, within ROW managed by NCDOT and Duke Energy
24.19	19	Durham	North Durham: Catsburg Natural Area, Lutravil Corporation Site (Sub EO of EO 024)	6/11/2008	BC	The Lutravil Company, Durham, NC
24.21	21	Durham	North Durham: Lakeside Drive (Sub EO of EO 024).	6/11/2008	CD	P
24.22	22	Durham	North Durahm: Briardale Road (Sub EO of EO 024)	6/11/2008	C	P
24.23	23	Durham	North Durham: Old Oxford Roadside (Sub EO of EO 024)	6/11/2008	D	S-NCDA&CS-PCP; proposed for Dedicated Heritage Area; ROW managed by NCDOT
24.28	28	Durham	North Durham: Penny's Bend Nature Preserve, Re-introduction Site W of pond (Sub EO of EO 024)	6/11/2008	BC	F-USACE, (managed by NCBG); Registered Heritage Area
24.31	31	Durham	North Durham: Infinity Road (East) (Sub EO of EO 024).	6/11/2008	D?	S-NCDA&CS-PCP; proposed foro Dedicated Heritage Area; NCDOT ROW
24.33	33	Durham	North Durham: Pennys Bend Nature Preserve, East of Pond (Sub EO of EO 024).	6/11/2008	C- i	F-USACE (managed by NCBG); Registered Heritage Area
24.34	34	Durham	North Durham: Penny's Bend Nature Preserve, Front Field Near Entrance Sign (Sub EO of EO 024).	6/11/2008	C	F-USACE (managed by NCBG); Registered Heritage Area

24.35	35	Durham	North Durham: Pennys Bend Introduction Site (Sub EO of EO 024)	12/20/2007	A?- i	F-USACE (managed by NCBG); Registered Heritage Area
26	26	Granville	Butner Area: Parent EO, This occurrence was created to link together all sub EOs/patches within the Butner area. This record does not contain any unique information.	6/17/2008	A	?
26.3	3	Granville	Butner Area: Picture Creek Diabase Barrens (Sub EO of EO 026)	6/17/2008	A	S-NCDA&CS- Research Div., Dedicated Nature Preserve; Progress Energy ROW is also a Registered Heritage Area
26.25	25	Granville	Butner Area: Murdoch Center (Sub EO of EO 026)	6/17/2008	C	?
27	27	Granville	Goshen Gabbro Forest: Parent EO	2005	C	P
30	30	Mecklenburg	McDowell Nature Preserve, McDowell Prairie Restoration Site	6/19/2008	BC - i	Mecklenburg County Parks and Recreation; Dedicated Nature Preserve
36	36	Granville	Holt Lake (Lake Butner) Introduction Site	1990s	X - i	S-NCDA&CS
37	37	Durham	209 Nottingham Road	1992	X	
South Carolina						
1		Oconee	No Site Name	1985-01-01	BD (C)	F-USFS-Sumter National Forest, Andrew Pickens District
2		Oconee	No Site Name	1973-06-29	H	P-?-Sumter National Forest, Andrew Pickens District, Inholding
3		Aiken	No Site Name	1963-05	H	
4		Pickens	No Site Name	1966-07-02	H	
5		Aiken	No Site Name	1982-06-23	H?	F-DOE-Savannah River Site
6		Lancaster	No Site Name	1973-06-04	H?	S-DNR-Forty Acre Rock Heritage Preserve

7		Oconee	No Site Name	1979-06-15	H	P-?-Sumter National Forest, Andrew Pickens District, Inholding
8		Oconee	No Site Name	1979-01-01	H?	F-USFS Sumter National Forest, Andrew Pickens District
9		Oconee	No Site Name	1979-06-15	H?	F-USFS Sumter National Forest, Andrew Pickens District
10		Oconee	No Site Name	2008-07-23	C	F-USFS Sumter National Forest, Andrew Pickens District
11		Oconee	No Site Name	1993-06	BD (C)	F-USFS Sumter National Forest, Andrew Pickens District
12		Oconee	No Site Name	1979	H?	F-USFS Sumter National Forest, Andrew Pickens District
13		Allendale	No Site Name	1987-05-29	U	private
14		Oconee	No Site Name	1991-04-03	BD (C)	F-USFS Sumter National Forest, Andrew Pickens District
15		Oconee	No Site Name	1991	AC (B)	F-USFS Sumter National Forest, Andrew Pickens District
16		Oconee	No Site Name	1991-07-01	AC (B)	F-USFS Sumter National Forest, Andrew Pickens District
17		Oconee	No Site Name	1991-07-01	AC (B)	F-USFS Sumter National Forest, Andrew Pickens District
18		Oconee	No Site Name	1990-07	AC (B)	F-USFS Sumter National Forest, Andrew Pickens District
19		Richland	No Site Name	1995-07-01	BD (C)	F-DOD-Fort Jackson
20		Anderson	No Site Name	1991	CD	S-CU-Clemson South Forest

21		Oconee	No Site Name	1993-04-14	BD (C)	P
22		Oconee	No Site Name	1993-08	AC (B)	S-DNR-Buzzard Roost Heritage Preserve
23		Oconee	No Site Name	1993	AC (B)	S-DNR-Buzzard Roost Heritage Preserve
24		Oconee	No Site Name	1993	AC (B)	S-DNR-Buzzard Roost Heritage Preserve
25		Oconee	No Site Name	1993-06-17	BD (C)	F-USFS-Sumter National Forest, Andrew Pickens District
26		Oconee	No Site Name	1993	AB (B)	S-DNR-Buzzard Roost Heritage Preserve
27		Oconee	No Site Name	1982-08-10	H	
28		Oconee	No Site Name	1994-05-10	BD (C)	F-USFS-Sumter National Forest, Andrew Pickens District
29		Oconee	No Site Name	1888-06	H	
30		Barnwell	No Site Name	1994-06-16	AC (B)	F-DOE-Savannah River Site
31		Oconee, Pickens	No Site Name	NO DATE	X	
32		Oconee	No Site Name	1989-06-04	BD (C)	F-USFS-Sumter National Forest, Andrew Pickens District
33		Oconee	No Site Name	1973-06-22	H	F-USFS-Sumter National Forest, Andrew Pickens District
34		Oconee	No Site Name	1993-06	BC	F-USFS-Sumter National Forest, Andrew Pickens District
35		Oconee	No Site Name	1993-06	BC	F-USFS-Sumter National Forest, Andrew Pickens District
36		Oconee	No Site Name	1993-06	BC	F-USFS-Sumter National Forest, Andrew Pickens District

37		Oconee	No Site Name	1993-06	BC	F-USFS-Sumter National Forest, Andrew Pickens District
38		Oconee	No Site Name	1993-06	BC	F-USFS-Sumter National Forest, Andrew Pickens District
39		Oconee	No Site Name	1993-06	BC	F-USFS-Sumter National Forest, Andrew Pickens District
40		Oconee	No Site Name	1993-06	BC	F-USFS-Sumter National Forest, Andrew Pickens District
41		Allendale	No Site Name	1998-05-28	U	P-COR-Westvaco
42		Oconee	No Site Name	2000-06-19	BC	F-USFS-Sumter National Forest, Andrew Pickens District
43		Oconee	No Site Name	2002-06-19	BC	F-USFS-Sumter National Forest, Andrew Pickens District
44		Allendale	No Site Name	2002-10-12	U	P-?
45		Allendale	No Site Name	2002-10-12	U	
47		Oconee	No Site Name	2009	U	
Virginia						
1	1, 12	Franklin	Grassy Hill	9/17/2007	A	S-DCR/DNH, VDOT, Private individual
2	2, 9, 39	Campbell	Castle Craig Depressions	7/24/1990	BC	P
3		Montgomery	Walnut Hill	8/3/2005	CD	P-The Nature Conservancy
4		Pulaski	Claytor Lake Bluff	10/15/2001	BC	P
5		Nottoway		7/3/1937	H	
6		Montgomery		6/28/1945	H	
8		Montgomery		6/00/1937	H	
10		Roanoke		7/13/1942	H	
11		Campbell/Lynchburg City		7/7/1950	H	
13		Alleghany	Harrington Roadside	6/22/1993	C	F-USFS

14	14, 15, 37, 48, 50, 52, 53, 54, 55, 56, 57, 80	Montgomery	Den Creek Spur, Den Creek Woodland, Den Hill, Falls Ridge Corner Glade, Montgomery Marl Meadow and Glades, Route 641 Roadbank, Slaughterpen Hollow, Sweet Spring Hollow, Wilson Creek Bluffs	7/12/2007	A	P-The Nature Conservancy, Private individuals, Private organization - Isaac Walton League of America
16	16, 17, 18, 19, 26	Montgomery	Coffee Valley, Valley View Glade, Seneca Hollow Woodland	5/23/2007	A	P
21		Wythe		6/15/1878	H	
22	22, 23, 24, 25, 29, 42, 58	Montgomery	Elliston Glades, Little Rock Glade	5/9/2005	AB	S-DCR/DNH, Private individuals
27		Halifax	Difficult Creek	6/25/2008	B	S-DCR/DNH
35	35, 36	Montgomery	Upper Mill Creek	6/21/1995	BC	
38		Alleghany	Johnsons Creek	6/22/2000	A	F-USFS
44		Botetourt	Dry Branch Woodland	5/16/2001	D	P-Corporation – Westvacco
46		Botetourt	Catawba Creek Slopes	5/16/2001	B	P-Corporation - Westvacco
47		Amherst	Shrader Lake	10/10/2000	BC	P-Corporation – Westvacco
59		Botetourt	Slate Branch	9/21/2004	A	P
61		Montgomery	Shawsville Long Hollow	5/24/2007	D?	P-Corporation - Long Hollow LLC

Definitions:

Principal EO - Principal Element Occurrence number, as assigned by the respective state Natural Heritage Program

Previous EO - Element Occurrence number, as assigned by the respective state Natural Heritage Program

County – Name of the county where the occurrence is located

Survey Site Name – Name of the site, as assigned by the respective state Natural Heritage Program

Last Observed Date – the date the species was last observed at this site

EO Rank – Element Occurrence rank, as assigned by the respective state Natural Heritage Program

Definitions for EO Ranks follow NCNHP methodology:

EO Rank -Description

A - Excellent estimated viability/ecological integrity

A? - Possibly excellent estimated viability/ecological integrity

AB - Excellent or good estimated viability/ecological integrity

AC - Excellent, good, or fair estimated viability/ecological integrity

B - Good estimated viability/ecological integrity

B? - Possibly good estimated viability/ecological integrity

BC - Good or fair estimated viability/ecological integrity
BD - Good, fair, or poor estimated viability/ecological integrity
C - Fair estimated viability/ecological integrity
C? - Possibly fair estimated viability/ecological integrity
CD - Fair or poor estimated viability/ecological integrity
D - Poor estimated viability/ecological integrity
D? - Possibly poor estimated viability/ecological integrity
E - Verified extant (viability/ecological integrity not assessed)
F - Failed to find
F? - Possibly failed to find
H - Historical
H? - Possibly historical
X - Extirpated
X? - Possibly extirpated
U - Unrankable
NR - Not ranked
i – Introduced population

Owner – the owner of the site as recorded with the respective state Natural Heritage Program [F-Federal, S-State, P-Private]