

Federally-Listed Wildlife Species

Ten federally-endangered (E) or threatened (T) wildlife species are known to occur on or immediately adjacent to the Nantahala and Pisgah National Forests (hereafter, the Nantahala and Pisgah NFs). These include four small mammals, two terrestrial invertebrates, three freshwater mussels, and one fish (Table 1). Additionally, two endangered species historically occurred on or adjacent to the Forest, but are considered extirpated, or absent, from North Carolina and are no longer tracked by the North Carolina Natural Heritage Program (Table 1).

Table 1. Federally-listed wildlife species known to occur or historically occurring on or immediately adjacent to the Nantahala and Pisgah National Forests.

Common Name	Scientific Name	Federal Status
Small Mammals		
Carolina northern flying squirrel	<i>Glaucomys sabrinus coloratus</i>	Endangered
Gray myotis	<i>Myotis grisescens</i>	Endangered
Virginia big-eared bat	<i>Corynorhinus townsendii virginianus</i>	Endangered
Northern long-eared bat	<i>Myotis septentrionalis</i>	Endangered*
Indiana bat	<i>Myotis sodalis</i>	Endangered
Terrestrial Invertebrates		
Spruce-fir moss spider	<i>Microhexura montivaga</i>	Endangered
noonday globe	<i>Patera clarki Nantahala</i>	Threatened
Freshwater Mussels		
Appalachian elktoe	<i>Alasmidonta raveneliana</i>	Endangered
Little-wing pearl mussel	<i>Pegius fabula</i>	Endangered
Cumberland bean	<i>Villosa trabilis</i>	Endangered
Spotfin chub	<i>Erimonax monachus</i>	Threatened
Species Considered Extirpated From North Carolina		
American burying beetle	<i>Nicrophorous americanus</i>	Endangered
Eastern cougar	<i>Puma concolor cougar</i>	Endangered

*Pending final listing following the 12-month finding published in the Federal Register, October 2, 2013.

Additionally, the United States Fish and Wildlife Service (USFWS) is addressing petitions to federally list two aquatic species known to occur on or immediately adjacent to Nantahala and Pisgah NFs: eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*), a large aquatic salamander, and sicklefin redhorse (*Moxostoma species 2*), a fish. Petitions are also being addressed for four small mammals (bats: northern long-eared bat (*Myotis septentrionalis*), eastern small-footed bat (*Myotis leibii*), little brown bat (*Myotis lucifugus*), and tri-colored bat (*Perimyotis subflavus*)).

On October 2, 2013, the USFWS published the 12-month finding to list the northern long-eared bat as endangered in the Federal Register (USFWS 2013). It is likely that action to list this species will take place during this planning process. Therefore, the northern long-eared bat will

be included in this assessment as an endangered species. However, The USFWS did not find enough evidence to warrant listing the eastern small-footed bat as threatened or endangered. This species will be included as a species of conservation concern (SCC) in this assessment and planning process.

Information in this section is taken largely from NatureServe (2013), with specific references highlighted. Additional references have been added where applicable. This section is meant to provide a general overview of the species' range, distribution, and habitat requirements. It is not intended to provide a detailed species account.

SMALL MAMMALS

Carolina northern flying squirrel

The northern flying squirrel, *Glaucomys sabrinus*, is a small, nocturnal, non-hibernating mammal that occurs in the forested regions of North America. The range of the species is continuous across Canada, and includes disjunct populations in the southern Appalachian Mountains, southern Rocky Mountains, and Sierra Nevada Mountains (Wells-Gosling and Heaney 1984). Two subspecies, *G. s. fuscus* and *G. s. coloratus* occur only at high elevations in the Appalachian Mountains of North Carolina, Tennessee, Virginia and West Virginia (Payne et al. 1989). The Carolina northern flying squirrel, *Glaucomys sabrinus coloratus* (CNFS), is the subspecies relevant to this forest plan revision.

The habitat of *Glaucomys sabrinus coloratus* in the southern Appalachian Mountains is represented by a group of high elevation mountainous "islands" separated by low elevation hardwood forest. These populations are imperiled by isolated gene pools and limited dispersal ability, similar to populations of mammals on islands in marine environments (Crowell 1986). In a study of mammals of the mountaintops of the Great Basin of North America, Brown (1971) found that small boreal species had reached mountaintop communities during the Pleistocene and since that time there had been serial extinctions but no further colonization.

In North Carolina, increased knowledge about the species and its habitat requirements combined with extensive inventory and monitoring efforts have expanded the known range of the species (NCWRC 2012). It is not known whether this represents true range expansion (recolonization) or merely reflects the amount of effort spent studying the species. CNFS is known to live in eight areas in North Carolina, five (63%) of which are within or immediately adjacent to the Nantahala or Pisgah NFs (Figure 1).

CNFSs prefer high elevation coniferous and mixed forest, but will also utilize deciduous and riparian woods. Ideal habitat conditions include cool, moist, mature forest with abundant standing and down snags. CNFS occupy tree cavities, leaf and twig nests, and underground burrows but seem to prefer cavities in mature trees as den sites. The species will use artificial nest boxes.

CNFS diet consists of both plant and animal material, including insects, nuts, lichens, fungi, buds, seeds, and fruit when available, but can subsist on lichens and fungi for extended periods of time. The species spends considerable time foraging on ground.

Gray myotis

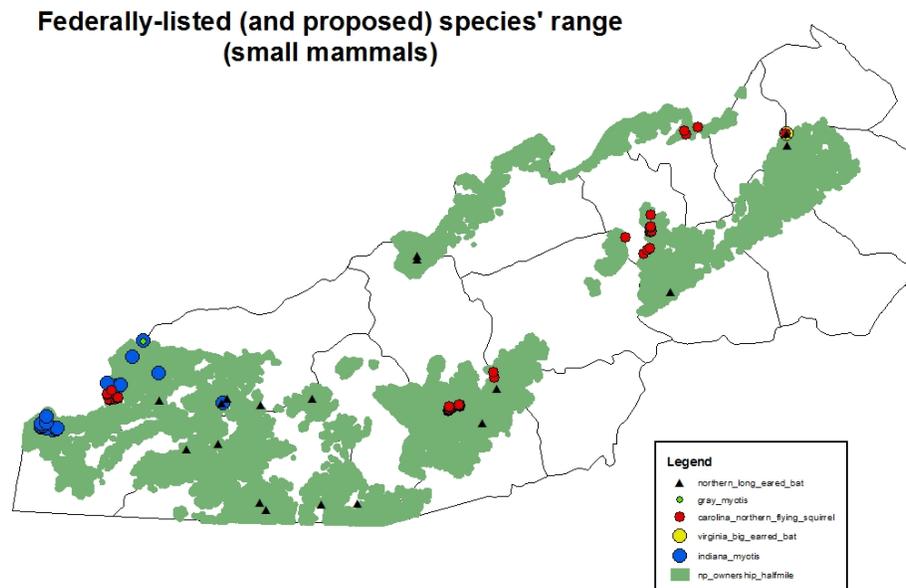
The gray myotis, commonly referred to as the gray bat, is a cave-dwelling bat species, known to occur from southeastern Kansas and central Oklahoma, east to western Virginia and western North Carolina, and from Missouri, Illinois, and Indiana south to southern Alabama and northwestern Florida (Decher and Choate 1995). The species occurs primarily in the cave region of Missouri, Arkansas, Kentucky, Tennessee, and Alabama, with similar summer and winter ranges.

Roost sites are almost exclusively caves throughout the year (Hall and Wilson 1966; Barbour and Davis 1969), though only a few percent of available caves are thought to be suitable (Tuttle 1979). Winter roosts are in deep vertical caves with domed halls. Large summer colonies utilize caves that trap warm air and provide restricted rooms or domed ceilings; maternity caves often have a stream flowing through them and are separate from the caves used in summer by males. There are occasional reports of mines, buildings, and storm sewers being used as roost sites.

Tuttle (1979) showed that forested areas along the banks of streams and lakes provide important protection for adults and young. Young often feed and take shelter in forest areas near the entrance to cave roosts (Tuttle 1979), and do not feed in areas along rivers or reservoirs where the forest has been cleared. Foraging is generally parallel to streams, over the water at heights of 2 to 3 m (LaVal et al. 1977).

The gray bat is known from one area in North Carolina. This area is within or immediately adjacent to the Nantahala NF (Figure 1).

Figure 1. Federally-listed species' range (small mammals) on the Nantahala and Pisgah National Forests.



Virginia big-eared bat

The known range of the Virginia big-eared bat (*Corynorhinus townsendii virginianus*) includes the Appalachian Mountains in Virginia, West Virginia, North Carolina, and eastern Kentucky. The species presently occurs in decreased numbers throughout much of its historic range. The largest known colonies of this species are associated with several caves in West Virginia, where some caves serve as both hibernation and maternity sites.

The Virginia big-eared bat (*Corynorhinus townsendii virginianus*) is known in four areas in North Carolina, one (25%) of which is within or immediately adjacent to the Pisgah NF (Figure 1).

Caves used by Virginia big-eared bats are typically located in limestone karst regions dominated by mature hardwood forests of hickory, beech, maple, and hemlock. The species prefers cool, well-ventilated caves for hibernation (Matthews and Moseley 1990), with roost sites near cave entrances or in places where there is considerable air movement (Handley 1991). Maternity colonies settle deep within caves, far from entrance (Matthews and Moseley 1990). These caves are warmer than those used for hibernation.

In Kentucky, Virginia big-eared bats have been detected foraging in old fields and above cliffs (Burford and Lacki 1995). This indicates that the species depends, at least in part, on open habitats.

Northern long-eared bat

The known range of the northern long-eared bat (*Myotis septentrionalis*) includes the eastern and north-central United States and much of southern Canada, but the species is most abundant, but relatively rare, in the northern part of this range, and frequently comprises less than 10% of the bat community. Recently, significant declines associated with rapidly spreading white-nose syndrome have occurred in eastern North America, and some habitat has been lost, degraded, or fragmented, primarily through the disturbance of their hibernation sites and land development. Mortality caused by wind turbines is expected to increase.

This bat generally is associated with old-growth forests composed of trees 100 years old or older. It relies on intact interior forest habitat, with low edge-to-interior ratios. Relevant late-successional forest features include a high percentage of old trees, uneven forest structure (resulting in multilayered vertical structure), single and multiple tree-fall gaps, standing snags, and woody debris. These late-successional forest characteristics may be favored for several reasons, including the large number of partially dead or decaying trees that the species uses for breeding, summer day roosting, and foraging.

Hibernation occurs in caves, mines, and tunnels from late fall through early spring (Griffin 1940; Mumford and Cope 1964). Hibernators frequently roost in crevices, drill holes, and similar sites (Griffin 1940; Pearson 1962), but roosting in the open is not uncommon. Hibernation sites vary considerably among areas, depending upon their quality and availability. The principal requirements of a suitable hibernation site are winter-long, low temperatures above freezing, high humidity, and lack of disturbances such as natural floods and anthropogenic visitation (Hitchcock 1949; Barbour and Davis 1969). There appears to be a high degree of philopatry, or returning to the same hibernation sites year after year.

Maternity roosts are warm sites that maximize the growth rate of young while providing protection from predation and the weather. Cool summer temperatures can slow juvenile growth, thereby reducing the fat accumulation period prior to hibernation, and ultimately increasing the risk of overwintering mortality in juveniles (McNab 1982).

Small, highly fragmented, or young forests that provide limited areas of subcanopy foraging habitat may not be suitable. Young forests may also lack appropriate nursery sites. A lack of suitable hibernation sites may prevent occupancy of areas that otherwise have adequate habitat (Kurta 1982).

Indiana myotis

The range of the Indiana myotis (*Myotis sodalis*), often referred to as the Indiana bat, extends from the western Ozark region in eastern Oklahoma and Iowa, north and east to Michigan, New York, New England, and northern New Jersey, and south to northern Alabama and Arkansas. The species has disappeared from or greatly declined in most of its former range in the northeastern United States (Trombulak et al. 2001). The species winters and hibernates in caves within this range.

Summer maternity colonies of the Indiana myotis are known in four areas in North Carolina, three (75%) of which are within or immediately adjacent to the Nantahala NF (Figure 1).

Most known maternity sites have been located in small forested areas within agriculturally dominated landscapes (USFWS 1999), but maternity colonies also exist to the south in heavily forested regions to at least eastern Tennessee and western North Carolina (Britzke et al. 2003). Since there are no known Indiana bat hibernation sites (over-wintering caves) in North Carolina, summer maternity habitat will be addressed from this point.

In summer, habitat consists of wooded or semi-wooded areas, often along streams (Menzel et al. 2001; Menzel et al. 2005). Solitary females or small maternity colonies bear their offspring in hollow trees or under loose bark of living or dead trees (Humphrey et al. 1977; Garner and Gardner 1992). Humphrey et al. (1977) determined that dead trees are preferred roost sites and that trees standing in sunny openings are attractive because the air spaces and crevices under the bark are warmer. Though maternity sites have been reported mainly in riparian and floodplain forests (Humphrey et al. 1977; Garner and Gardner 1992), recent studies indicate that upland habitats are used by maternity colonies much more extensively than previously reported. Roosts were not found in forests with open canopies (10-30% canopy cover) or in old fields with less than or equal to 10% canopy cover. In eastern Tennessee and western North Carolina, several maternity colonies were in sun-exposed conifer snags, where roost sites were above the surrounding canopy (Britzke et al. 2003). In Illinois, Indiana bats used the same roost sites in successive summers. Recapture of the same individuals within traditional roost sites during subsequent summers suggests site fidelity (Garner and Gardner 1992; Gardner et al. 1996).

TERRESTRIAL INVERTEBRATES

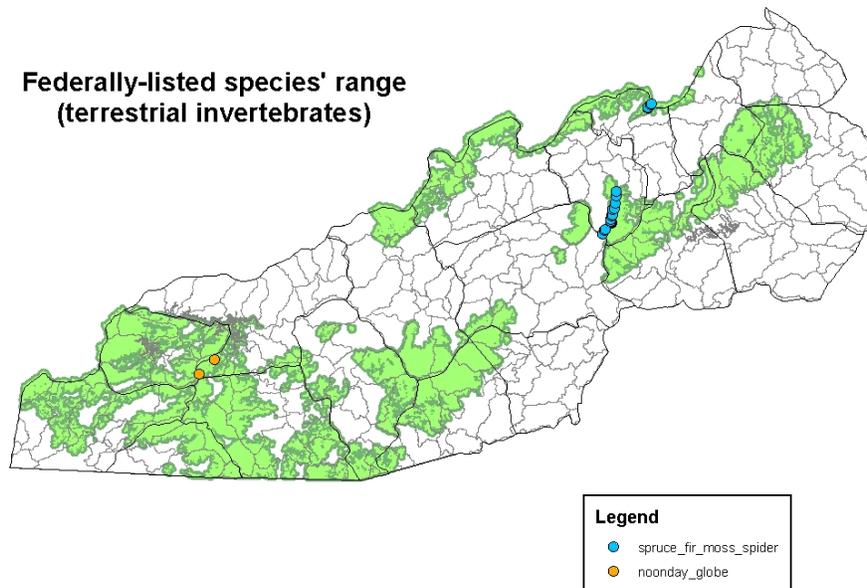
Spruce-fir moss spider

The spruce-fir moss spider (SMFS) (*Microhexura montivaga*) is historically known in four mountain peaks in western North Carolina and one in eastern Tennessee (Coyle 1981). While recent inventory efforts have expanded this range slightly, the SFMS remains one of the most range-restricted, environmentally vulnerable species on the Forest.

The SFMS is currently known in five areas in North Carolina, two (40%) of which are within or immediately adjacent to the Nantahala or Pisgah NFs (Figure 2).

The species lives in high-elevation spruce-fir forests on moist but well-drained moss growing on rocks and boulders in well-shaded locations. They are known in conifer forests dominated by red spruce and Fraser fir (USFWS 1998). Relatively speaking, very little is known about the life history of this species.

Figure 2. Federally-listed species' range (terrestrial invertebrates) on the Nantahala and Pisgah National Forests.



Noonday globe

The noonday globe (*Patera clarki nantahala*) is endemic to a small area in the extreme western part of North Carolina. Within this small area, the species occupies high cliff ridges where elevation ranges from 1900 to 3100 feet (NCNHP 2010). These cliffs are mesic (moderately moist), with many small streams and waterfalls. Exposed rock is common and the forest floor often has a thick humus layer (USFWS 1984).

The noonday globe is known in one area in North Carolina. This area is within or immediately adjacent to the Nantahala NF.

No population estimates have been made but suitable habitat exists for several square miles within the NF, which are higher up on the cliffs than has been surveyed (USFWS 1984). Very little is known about the habitat requirements or life history of this species.

FRESHWATER MUSSELS

Appalachian elktoe

The Appalachian elktoe (*Alasmidonta raveneliana*) is a freshwater mussel historically endemic to the upper Tennessee River system in western North Carolina and eastern Tennessee (Parmalee and Bogan 1998; NCNHP 2010). This species once lived in the majority of the rivers and larger creeks of the upper Tennessee River system in North Carolina, with the possible exception of the

Hiwassee and Watauga River systems. In Tennessee, the species is known only in its present range in the main stem of the Nolichucky River (USFWS 2002). It has been extirpated from much of its former range including the French Broad, Little, Pigeon, and Swannanoa Rivers in the French Broad River system and most of the Little Tennessee River system (USFWS 1996). While recent inventory efforts have expanded the known range of the species in North Carolina, overall species' range loss keeps the Appalachian elktoe in peril.

The Appalachian elktoe is known in eleven areas in North Carolina, three (27%) of which are within or immediately adjacent to the Nantahala or Pisgah NFs (Figure 3).

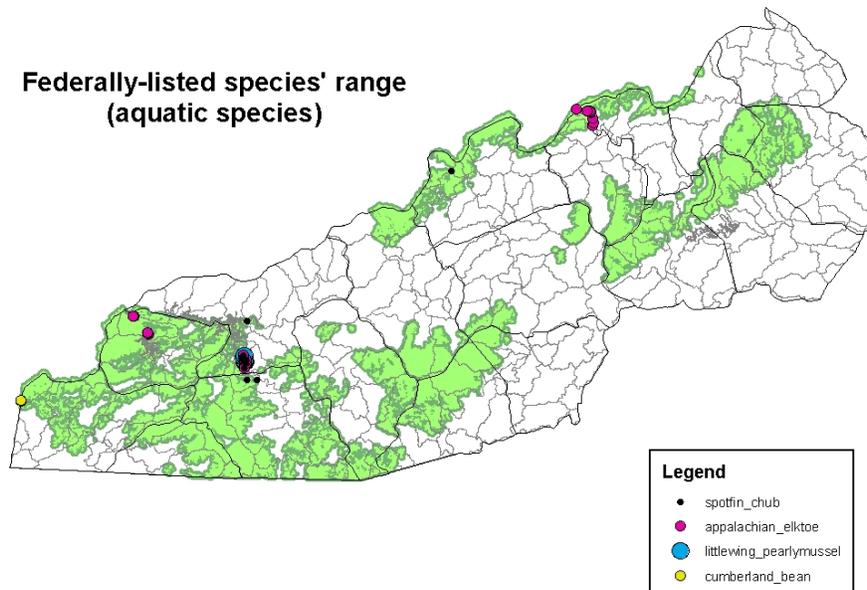
Appalachian elktoes have been found in gravelly substrate, often mixed with cobble and boulder, or in cracks in bedrock. Water depth in occupied areas is typically shallow, with moderate to swift current. The species occupies medium-sized creeks and rivers with cool, well-oxygenated water, and is found most often in riffles, runs, and shallow pools with stable, silt-free, coarse sand and gravel mixed with cobble, boulders, or bedrock. The stability of substrate is critical (USFWS 1996a; USFWS 2002).

Littlewing pearl mussel

The littlewing pearl mussel (*Pegius fabula*), a historically widespread freshwater mussel, is now uncommon within the Tennessee and Cumberland River systems in Alabama, North Carolina, Tennessee, Kentucky, and Virginia (USFWS 1989). The species is likely extirpated entirely from Alabama, and possibly from several other major Tennessee River tributaries (USFWS 1989). Surveys in 1986 found this species at only six locations within the Tennessee and Cumberland River basins although over 55 potential or historic locations were searched. The species is known in one area in North Carolina. This area is within or adjacent to the Nantahala NF (Figure 3).

This species is most often found at the head of riffles, but is also found in and below riffles on sand and gravel substrates with scattered cobbles (Parmalee and Bogan 1983). It occupies sand pockets between rocks, cobbles and boulders (Gordon and Layzer 1989). It is restricted to small, cool streams and is usually found lying on top or partially buried in sand and fine gravel between cobble in shallow water.

Figure 3. Federally-listed species' range (aquatic species) on the Nantahala and Pisgah National Forests.



Cumberland bean

The range of the Cumberland bean (*Villosa trabalis*), a freshwater mussel, is difficult to determine due to confusion in the literature with the related species, *V. perpurpurea*. The historic range of the species is restricted to parts of the Tennessee River system and upper tributaries to the Cumberland River (Bogan and Parmalee 1983). Its current range includes four locations in Kentucky, and a recently identified location in North Carolina. It has been extirpated from Virginia, Alabama, and the mainstem of the Cumberland River in Kentucky (Mirarchi et al. 2004). The Cumberland bean is known in one area in North Carolina. This area is within or adjacent to the Nantahala NF (Figure 3).

The Cumberland bean is found in sand, gravel, and cobble substrates in waters with moderate to swift currents and depths less than 1 meter (Gordon and Layzer 1989). The species is most often observed in clean, fast-flowing water in substrate which contain relatively firm rubble, gravel, and sand swept-free from siltation; usually buried in shallow riffle and shoal areas (USFWS 1984; USFWS 2010). Typically, *V. trabalis* is found buried in shallow riffle and shoal areas, often located under large rocks that must be removed by hand to inspect the habitat underneath (USFWS 2010).

FISH

Spotfin chub

The spotfin chub (*Erimonax monachus*) is a small freshwater fish, a member of the minnow family. The species was once widespread within the upper and middle Tennessee River system, but is now considered extirpated from Alabama, Georgia and Virginia. Disjunct relict populations remain present in North Carolina (Menhinick 1991), Tennessee (Etnier and Starnes 1993), and Virginia (Jenkins and Burkhead 1994). The species now survives in only five isolated tributary systems. The species has been reintroduced successfully into at least three rivers, and there are plans for more in the future.

The spotfin chub is known in ten areas (watersheds) in North Carolina, five (50%) of which are within or immediately adjacent to the Nantahala or Pisgah NFs.

Habitat for the spotfin chub includes cool and warm, typically clear, large creeks or medium-sized rivers of moderate gradient, in upland and montane areas, generally in or near moderate and swift currents over gravel to bedrock, rarely over sand or silt (Lee et al. 1980; Burkhead and Jenkins 1991). Eggs are laid in stone cracks, crevices, or in the narrow space between two touching rocks (Burkhead and Jenkins 1991). Jenkins and Burkhead (1994) reported breeding sites in moderate current of shallow portions of runs, in areas with unsilted rubble and boulders.

ENDANGERED SPECIES CONSIDERED EXTIRPATED FROM NORTH CAROLINA

The following discussion summarizes habitat requirements for two species that are federally-listed, historically known in areas on or adjacent to the Nantahala and Pisgah NFs, but now considered extirpated from North Carolina. This discussion will be expanded if new information becomes available that determines they should be included (i.e. the species is found on or adjacent to the Nantahala and Pisgah NFs).

The American burying beetle (*Nicrophorous americanus*) exhibits broad vegetational tolerances, although its natural habitat may be mature forests. The species has been recorded in grassland, old field shrubland, hardwood and conifer forest, and even maritime forest and scrub-shrub habitats. Specifically, suitable habitat ranges from large mowed and grazed fields to dense shrub thickets, deciduous oak-hickory and coniferous forests atop ridges or hillsides to deciduous riparian corridors and pasturelands on valley floors. Soil characteristics are important to the beetle's ability to bury carrion. Extremely dry, saturated, or loose sandy soils are unsuitable for these activities.

The eastern cougar (*Puma concolor cougar*) occupied a wide variety of habitats with good cover (brush or woodlands), from coastal swamps to the western mountains of North Carolina. The species was highly opportunistic and ate mainly various large and small mammals (deer, livestock, coyote, squirrels, rabbits, mice, etc.), insects, and reptiles.

WILDLIFE SPECIES PROPOSED FOR FEDERAL LISTING

Eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*), sicklefin redhose (*Moxostoma species 2*), little brown bat (*Myotis lucifugus*), and tri-colored bat (*Perimyotis subflavus*) are discussed in the Species of Conservation Concern portion of this assessment.

Federally Listed Plant Species

Currently the Nantahala and Pisgah NFs tracks 14 federally threatened or endangered plant species (Table 2). Of these eight have known populations, one has not been seen for a number of years, and five were thought to have suitable habitat during the 1994 amendment. Discussions with the Asheville field office of the U.S. Fish and Wildlife Service (USFWS) determined the need to change the previous list for the current planning area.

Table 2. List of existing federally threatened and endangered plant species analyzed for the Nantahala and Pisgah NFs land management plan review.

USFWS Status	Species	Common Name	Form	Presence	G-Rank	Keep for Plan update
Endangered	<i>Geum radiatum</i>	Cliff Avens	Vascular plant	yes	G2	Retain
Endangered	<i>Gymnoderma lineare</i>	Rock Gnome Lichen	Lichen	yes	G2	Retain
Endangered	<i>Houstonia montana</i>	Mountain Bluet	Vascular plant	yes	G2	Retain
Endangered	<i>Sagittaria fasciculata</i>	Bunched Arrowhead	Vascular plant	no	G2	Retain
Endangered	<i>Sarracenia jonesii</i>	Mountain Sweet Pitcher Plant	Vascular plant	no	G4T2	Retain
Endangered	<i>Sarracenia oreophila</i>	Green Pitcher Plant	Vascular plant	no	G2	Drop
Endangered	<i>Sisyrinchium dichotomum</i>	White Irisette	Vascular plant	no	G2	Drop
Threatened	<i>Helonias bullata</i>	Swamp Pink	Vascular plant	yes	G3	Retain
Threatened	<i>Hexastylis naniflora</i>	Dwarf-flowered Heartleaf	Vascular plant	no	G3	Drop
Threatened	<i>Hudsonia montana</i>	Mountain Golden-heather	Vascular plant	yes	G1	Retain
Threatened	<i>Isotria medeoloides</i>	Small Whorled Pogonia	Vascular plant	no?	G2	Retain
Threatened	<i>Liatrix helleri</i>	Heller's Blazing Star	Vascular plant	yes	G2	Retain
Threatened	<i>Solidago spithamaea</i>	Blue Ridge Goldenrod	Vascular plant	yes	G1	Retain
Threatened	<i>Spiraea virginiana</i>	Virginia Spiraea	Vascular plant	yes	G2	Retain

It was determined that three species could be dropped. *Sarracenia oreophila* is only known from the southern portion of Clay County within a low mountain seepage bog (Biotics 2013). While it is within 0.7 miles of USFS land surrounding Lake Chatuge, it is currently believed there are no similar seepage bogs on national forest lands. If they had been there, it is speculated they

would have been destroyed with construction of the reservoir. *Sisyrinchium dichotomum* is known from oak-hickory forests within the North Carolina foothills and upper Piedmont. The closest population is over 10 aerial miles from the closest land in the Pisgah NF. The North Carolina range for the other dropped species, *Hexastylis naniflora*, is also from the foothills and upper Piedmont. The closest known population is roughly 2 miles south of the eastern edge of the Grandfather Ranger District. Surveys within this portion of the forest have located one other rare *Hexastylis* species, *H. contracta*, but never *H. naniflora*. Given the previous surveys and the presence of this species further east, it was determined there is no suitable habitat on the national forest.

Nine federally listed threatened and endangered (T&E) plant species have been documented across the Nantahala and Pisgah NFs. Two hundred forty-one discrete T&E plant subpopulations have been documented for these nine species (Table 1). As expected of the rarest species, the nine federally listed plants are unevenly distributed across the two forests. All nine species have been documented on the Pisgah NF and four species across the Nantahala NF. The Appalachian Ranger district has the greatest number of species, five, as well as number of subpopulations, 71. Both the Nantahala and the Grandfather Ranger Districts have four species, even though the Grandfather has twice the number of subpopulations as the Nantahala. Most of the other districts have from 20-30 subpopulations, these representing either one or two species. Currently there are no documented federally listed plant species on the Tusquitee, although two species are known nearby on private property. The number of subpopulations varies by species ranging from 4 for the possibly extirpated orchid, *Isotria medeloides*, to 80 for *Gymnoderma lineare*. (Table 3).

Table 3. Distribution of federally listed threatened and endangered (T&E) plant species across the Nantahala and Pisgah NFs.

Species	Subpopulations	Forest	Districts
<i>Cetradonia lineare</i> (= <i>Gymnoderma lineare</i>)	80	Pisgah, Nantahala	Cheoah, Nantahala, Pisgah, Appalachian, Grandfather
<i>Isotria medeloides</i>	4*	Pisgah, Nantahala	Nantahala, Grandfather
<i>Spiraea virginiana</i>	39	Pisgah, Nantahala	Cheoah, Nantahala, Appalachian
<i>Hudsonia montana</i>	33	Pisgah	Grandfather
<i>Helonias bullata</i>	16	Pisgah	Pisgah
<i>Houstonia montana</i>	20	Pisgah	Appalachian
<i>Geum radiatum</i>	22	Pisgah	Appalachian
<i>Solidago spithamea</i>	8	Pisgah	Appalachian
<i>Liatris helleri</i>	19	Pisgah	Grandfather

*have not been relocated for five or more years within these sites

Blue Ridge goldenrod

Blue Ridge goldenrod, *Solidago spithamea*, is a perennial herbaceous plant in the aster family occurring in high elevation rocky summits in the southern Appalachians restricted to North Carolina and Tennessee (Weakley 2012). Only one population is known from Tennessee at

Roan Mountain; all the remaining populations are present in North Carolina. There are three centers of populations, at Roan Mountain, Grandfather Mountain, and Hanging Rock Mountain. One population was previously documented in the Craggy Mountains, but has not been verified there since the original determination in 1990 (Dr. Chris Ulrey, plant ecologist, Blue Ridge Parkway, personal communication). Another population at High Peak in Ashe County has not been recently verified (USFWS 2011). Blue Ridge goldenrod has a global rank of G1. It was listed as threatened under the Endangered Species Act on March 28, 1995.

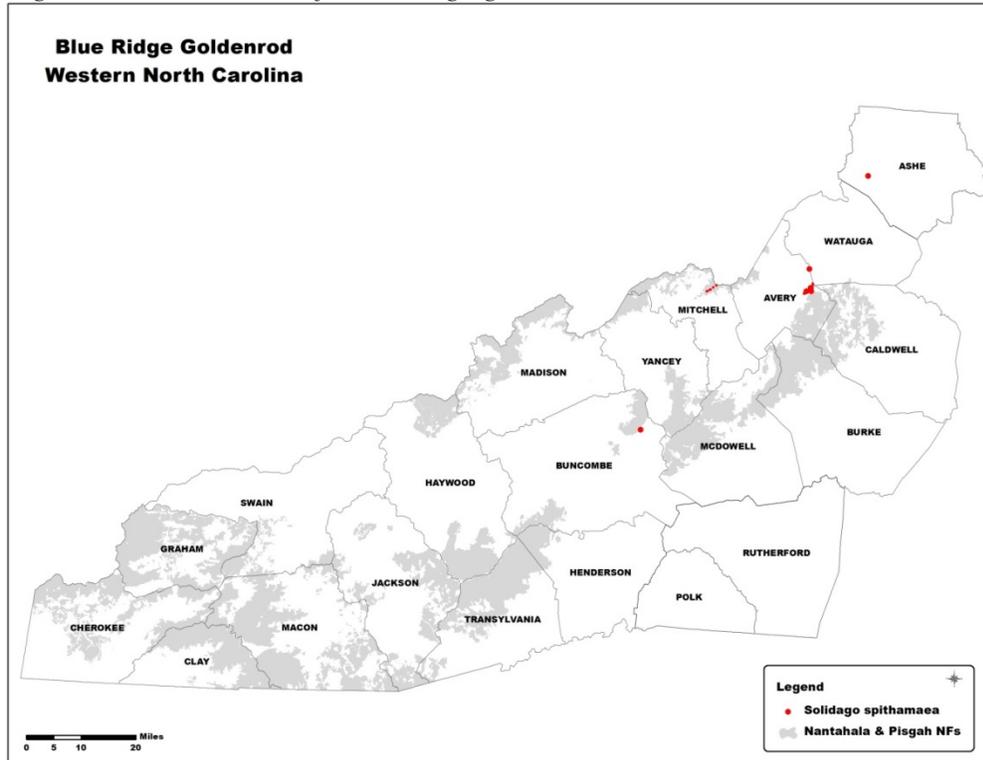
Eight subpopulations of this unique goldenrod were historically documented on the Nantahala and Pisgah NFs, all on Roan Mountain. All of these subpopulations are within the designated area on Roan Mountain. Seven are known to currently exist, clustered either at Roan High Bluff or Eagle Cliff. It is uncertain why the extirpated subpopulation died since all of the existing information on its extent is unclear.

The primary threat to the species is trampling from recreational activity (NatureServe 2013). As other high elevation rocky summit species, Blue Ridge goldenrod is thought to be persisting on small high elevation “islands”, where the climate still remains cool and moist. It is uncertain what population changes will result to this species from global warming.

In 1996 due to the recreational threats to existing subpopulations at Roan Mountain, two closure orders were issued; one for the area at Roan High Bluff and west, the other area from the approach to Eagle Cliff and the Cliff. Anecdotal observations and post monitoring following the closures indicate these populations have recovered at Roan High Bluff and maintained their abundance at Eagle Cliff (Donaldson 1999a, 1999b, 2002b; David Danley, Pisgah NF botanist, personal communication).

A limited amount of monitoring has been completed within two of the subpopulations west of Roan High Bluff. For three years, two of the smaller subpopulations were tracked by counting the number of clumps and rosettes. During that time this species has remained fairly constant, with the same number of clumps, while declining less than 3% from the original rosette count in 2008-2009. Observations in 2012 at all of the sites indicate the persistence of all seven subpopulations on the Pisgah NF (Figure 4). Monitoring has been limited across more of the subpopulations since juvenile individuals of a co-occurring species, skunk goldenrod (*Solidago glomerata*), is very difficult to distinguish from mature Blue Ridge goldenrod, which is a shorter species relative to skunk goldenrod.

Figure 4. Distribution of Blue Ridge goldenrod in North Carolina.



Increased searches for the species in the mid 2000's located two new subpopulations, in total with more than 70 clumps, of Blue Ridge Goldenrod. While it may still be possible to locate more subpopulations via rappel lines, the amount of searchable suitable habitat is limited.

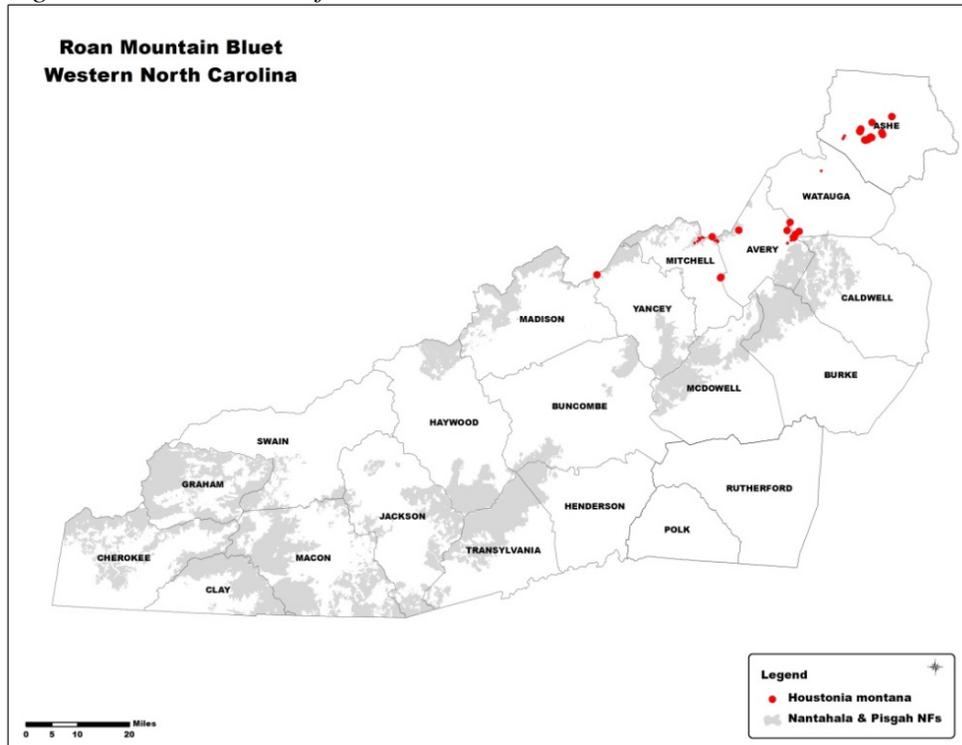
Roan Mountain bluet

Roan Mountain bluet (*Houstonia montana*) is a short clumped perennial herbaceous plant in the bedstraw family that occurs in high elevation rocky summits and grassy balds with thin, gravelly soils or embedded rocks (Weakley 2012). It is a southern Appalachian endemic with primary occurrences in North Carolina and one occurrence in Tennessee on Roan Mountain. A new population was recently located in southern Virginia, extending the range to the north (Virginia Botanical Associates 2014). Roan Mountain bluet has a global rank of G2 (Gadd and Finnegan 2012). It was listed as endangered under the Endangered Species Act on April 5, 1990. A recovery plan was approved for the species in 1996 (USFWS 1996b). Specific tasks to the Pisgah NF included searching for additional populations and monitoring existing subpopulations.

Houstonia montana is known across three separate areas (Carvers Gap west, Grassy Ridge, and Houston Ridge) on USFS lands on Roan Mountain and one area, Big Bald, in Madison County. The three separate areas on Roan Mountain are treated as three populations based on separation distance of at least two kilometers. The three populations vary significantly in the number of subpopulations and numbers of individuals. Subpopulation numbers and overall population size increase from Houston Ridge to Grassy Ridge to west of Carvers Gap. Only a single subpopulation occurs at Big Bald. Recent genetic work completed on the Big Bald population

indicated the plants represent a stable hybrid between *H. montana* and the more common species, *H. purpurea* (Church and Taylor 2005; Glennon, Donaldson and Church 2011). There was no evidence of either “true-type” *H. montana* or *H. purpurea* at this site. In total 20 subpopulations have been documented in the Pisgah NF. One was introduced on the loop road in the 1970s by J.D. Yelton (Jamey T. Donaldson, botanical consultant, personal communication). This contrasts with 56 other subpopulations known across NC in 3 northern mountain counties (Figure 5). All except 2 of the USFS subpopulations, including the one at Big Bald, are not within existing designated areas.

Figure 5. Distribution of Roan Mountain Bluet in North Carolina.



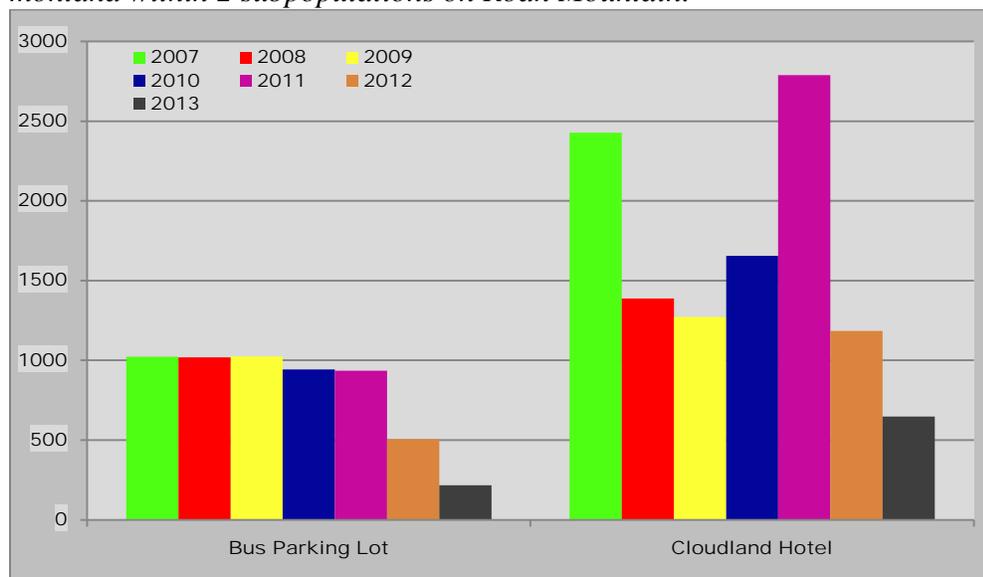
Threats to *Houstonia montana* include recreational activities (primarily trampling and rock climbing), ski slope development, and woody plant encroachment. As indicated for Blue Ridge goldenrod, Roan Mountain bluet is restricted to scattered high elevation sites and could be impacted by global warming in the future. In 1996, due to the recreational threats to federally listed plant species at Roan Mountain two closure orders were issued; one for the area at Roan High Bluff and west, the other area from the approach to Eagle Cliff and the Cliff. These closure areas have two subpopulations of *Houstonia montana*. Anecdotal observations and post monitoring following the closures indicate these populations have recovered at Roan High Bluff and maintained their abundance at Eagle Cliff (Donaldson 1999a, 1999b, 2002b; David Danley, Pisgah NF botanist, personal communication).

Monitoring has been variable across the 20 subpopulations. All have been visited at least once or searched for during the last 10 years. Three small subpopulations may no longer be present, probably to woody plant encroachment. The other 17 subpopulations are present although the majority are not being regularly monitored. The largest one on Roan Mountain at Roan High

Bluff has been visited every year for the past 10 years and anecdotally appears quite robust. In contrast, the larger population on Grassy Ridge has been visited every year and anecdotally appears to be in rapid decline. Habitat surrounding the two subpopulations differs from a high elevation summit at Roan High Bluff to a grassy bald with thin soil on Grassy Ridge. Woody plant and tall herb encroachment is occurring at the Grassy Ridge site but the population was still observed to be in decline after cutting back the encroaching plants.

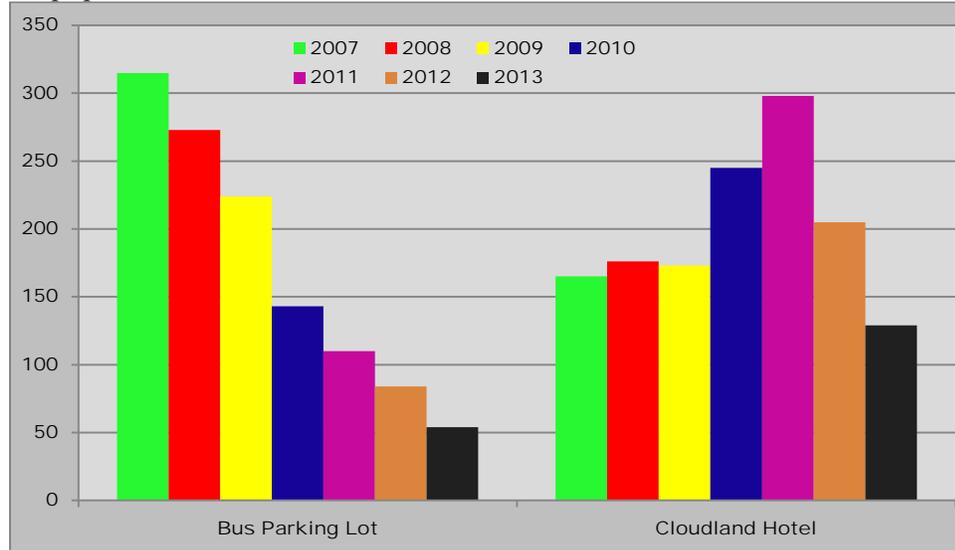
Two subpopulations on Roan Mountain have been monitored more intensely for seven consecutive years. The population trends within the two subpopulations have varied, but for the last two years both are in sharp decline (Figures 6 and 7).

*Figure 6. Change in area coverage (centimeters square) from 2007-2013 for *Houstonia montana* within 2 subpopulations on Roan Mountain.*



The bus parking lot subpopulation was mostly stable, fluctuating less than 10%, in total extent from 2007 to 2011, even though the number of occupied monitor plots decreased by almost three fold. However in the last 2 years the total coverage has decreased 4-fold while also decreasing the number of occupied plots. The Cloudland Hotel site has been more variable and actually increased in size from 2007 to 2011. The fluctuations in size generally correlated with the number of occupied plots. This site is also experiencing a population decline during the last two years.

Figure 7. Change in occupied plots from 2007-2013 for *Houstonia montana* within 2 subpopulations on Roan Mountain.



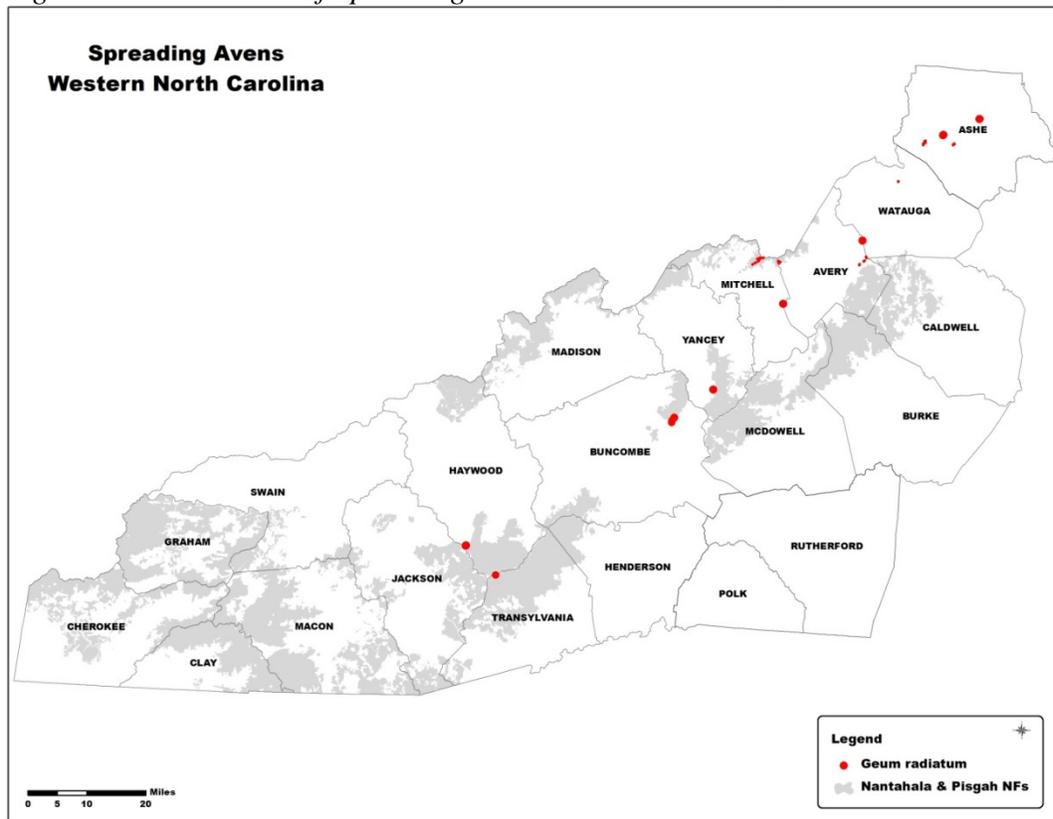
Spreading avens

Spreading avens (*Geum radiatum*) is a medium height, up to 20 inches, herbaceous perennial plant in the rose family with basal rosettes of leaves and showy yellow flowers in July and August (Weakley 2012; NatureServe 2013). It principally occurs on flat and vertical portions of high elevation rocky summits and occasionally in grassy balds with thin, gravelly soils or embedded rocks. Spreading avens is a southern Appalachian endemic restricted to North Carolina and Tennessee. The majority of occupied sites occur across eight counties in North Carolina (Biotics 2013, Figure 8). In Tennessee, spreading avens is restricted to two sites, Mount Leconte and Roan Mountain, where it occurs with the other cluster of NC Roan Mountain populations. Spreading avens has a global rank of G2 (NatureServe 2013). The species was listed as endangered under the Endangered Species Act on April 5, 1990.

Geum radiatum is only known in the two NC forest units at Roan Mountain. There are twenty-two subpopulations on the Pisgah NF at Roan Mountain. In comparison there are 30 subpopulations across the remainder of North Carolina. With the two other subpopulations on the Cherokee NF at Roan Mountain, this represents the largest concentration of this species across its range. All of the *Geum radiatum* subpopulations are within existing designated areas.

Threats to the species include trampling, rock climbing, horticultural and herbarium collections, development, possibly acid deposition, and poor seed production (Prince and Morse 1985; NatureServe 2013). As other high elevation rocky summit species, spreading avens is thought to be persisting on small high elevation “islands,” where the climate still remains cool and moist. It is uncertain what population changes will occur to this species as a result of global warming.

Figure 8. Distribution of Spreading Avens in North Carolina



In 1996, due to the recreational threats to federally threatened and endangered subpopulations at Roan Mountain, two closure orders were issued; one for the area at Roan High Bluff and west, the other area from the approach to Eagle Cliff and the Cliff. Five *Geum radiatum* subpopulations occur within the closure areas. Anecdotal observations and post monitoring, including demographic data at Roan High Bluff and Roan High Bluff west from 2005-2013, following the closures indicate the populations have recovered at Roan High Bluff and maintained their abundance at Eagle Cliff and Roan High Bluff West (Donaldson 1999a, 1999b, 2002b; David Danley, Pisgah NF botanist, personal communication).

Different monitoring intensity has been implemented across the 22 subpopulations. All have been visited at least once during the last 10 years, most two to three times to record their presence and clump numbers. With incorporation in a demographic study administered by Dr. Chris Ulrey, ecologist for the Blue Ridge Parkway, clumps for five of the subpopulations have been tracked for the last six to nine years. Data recorded within the demographic study include clumps, denoted by a separation distance of at least 25 centimeters, number of rosettes per clump, and number of flowers per clump. Four of the five sites do not vary greatly in the number of clumps from year to year. Some declines have been recorded but is primarily a result of two previously separate clumps merging into a single clump or from yearling deaths. One site has a decline, representing less than 10% of the recorded clumps, which is probably a result of impacts from freeze and thawing which dislodged fragmented rocks, with adhering *Geum radiatum* clumps, off the cliff face during the winter. Rosette numbers tend to be more variable

from year to year but did not vary in total by more than 5-10% from the total numbers recorded across the 5 sites.

New plants can be produced through sexual or asexual means. Evidence of both types of reproduction is present at some of the sites on Roan Mountain although sexually reproduced seedlings are quite rarely encountered across the five sites.

Heller's blazing-star

Heller's blazing-star (*Liatris helleri*) is a medium height, perennial herbaceous plant in the aster family with narrow lily-like leaves. It occurs within low and high elevation rocky summits and mountainous acidic cliffs (Biotics 2013). *Liatris helleri* is a southern Appalachian endemic only known to occur within North Carolina. Heller's Blazing star was formally listed as federally threatened on November 19, 1987 (USFWS1989).

In a herbarium study of this species and a congener, *Liatris turgida*, Guy Nesom has questioned the validity of both species and recommended subsuming them into a single taxon, *L. helleri* (Nesom 2005). As such this would substantially increase the range of *L. helleri* and thereby undermine the need to maintain it on the endangered species list. Patrick Suillens has recently completed a masters study at Appalachian State University examining genetic differentiation between the two taxa. He found each species had unique chlorotypes although they also shared two chlorotypes suggesting incomplete lineage sorting between the two (Dr. Eva Gonzales, St. Louis University assistant professor and advisor to *Liatris* study, personal communication). As such they believe it is premature to subsume the two species.

There are 23 separate populations of *Liatris helleri* in NC with concentrations at Linville Gorge Wilderness, Grandfather Mountain, and Ashe County. *Liatris helleri* is known across 19 subpopulations representing 4 separate populations on USFS lands in North Carolina. All four populations are included within existing designated areas. The four populations vary from a low of 60 clumps to more than 600 clumps. The last comprehensive survey of the three populations in Linville Gorge Wilderness was in 2002, with the Cove Cliff site surveyed in 2007. Other counts have been completed within the last few years across separate subpopulations; however, a recent comprehensive count has not been completed.

Threats to this species include poaching for specialized native plant usage, shrub encroachment, and trampling by hikers and/or rappellers. Separate subpopulations of all four populations have been affected by various activities during the last 20 years. These effects include: (1) poaching of mature plants at one of the Cove Cliff subpopulations, (2) periodic prescribed burning and/or wildfires at several subpopulations in the Chimneys and Shortoff Mountain, (3) augmentation of the subpopulation on Table Rock, and (4) area closures for *Hudsonia montana* subpopulations where *Liatris helleri* clumps co-occur. These activities are believed to have been beneficial based on periodic nonquantitative observations for the later three and harmful from the first, based on clump recounts after the poaching event.

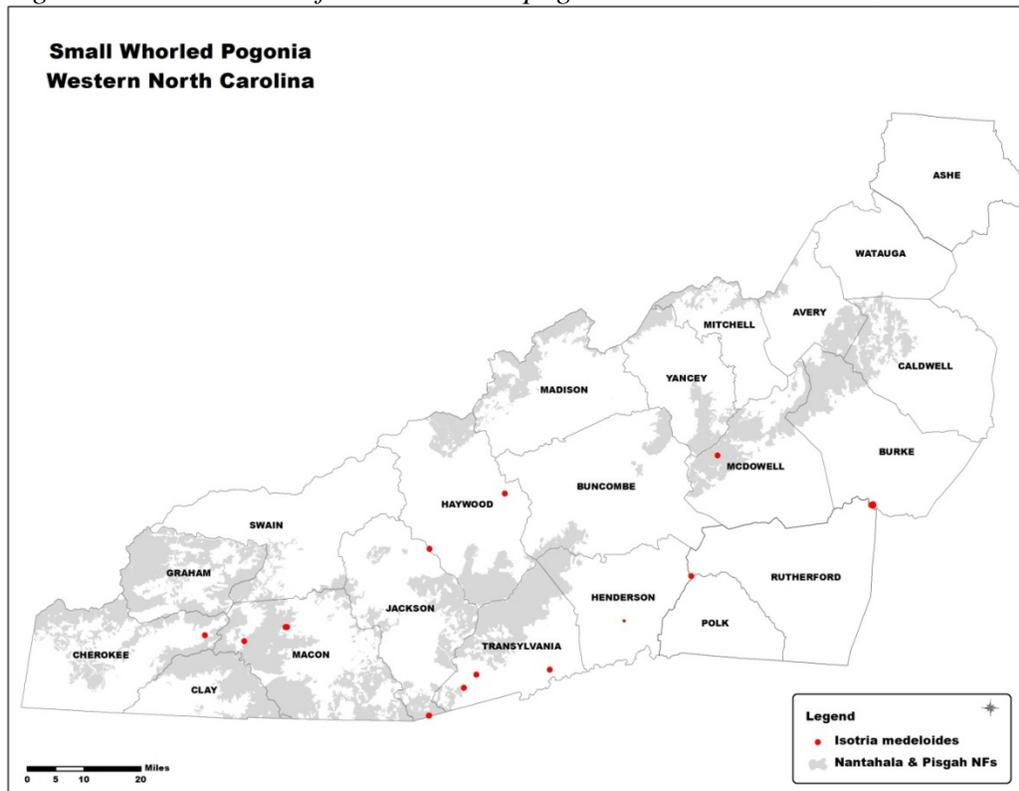
Small whorled pogonia

Small whorled pogonia (*Isotria medeoides*) is a short, up to 12 inches, perennial herb with solitary flowers within the orchid family (Von Oettingen 1992). Three distinct ranges occur for

the species, the northern New England states and southeastern Ontario, the southern Appalachians, and the coastal plain and piedmont of Virginia, Delaware, and New Jersey (NatureServe 2013). Small whorled pogonia has not been located recently among previously documented sites in Ontario, New York, Maryland, and Missouri, and the species is believed to have been extirpated in Vermont and the District of Columbia. In the southern Appalachians small whorled pogonia is known from Georgia, Tennessee, South Carolina, North Carolina, and southern Virginia (NatureServe 2013). Typically these populations are small, often with fewer than 20 individuals. *Isotria medeoides* was listed as federally endangered in 1982 (Von Oettingen 1992). In 1994, it was downgraded to a federally threatened status as a result of more recently discovered populations and since 25% of the known populations, with a mean population size of 20 individuals, were protected (USFWS 1994).

In North Carolina, the continued status of *Isotria medeoides* is tenuous at best. Sixteen small whorled pogonia populations have previously been documented within 11 North Carolina counties (Biotics 2013, Figure 9). Two of these populations are believed to be extirpated while eight others have not been relocated for several years and may be extirpated. Only one of the six recently observed *Isotria medeoides* populations within North Carolina have been observed with more than 10 individuals. Four of these populations are in decline in terms of population size. This small orchid is known historically across 4 subpopulations on the Nantahala and Grandfather Ranger Districts.

Figure 9. Distribution of small whorled pogonia in Western North Carolina



Recent experimental manipulation of the canopy in order to increase light levels to plants of *I. medeoides* in the northeastern US has resulted in an increase in population numbers. One-third of the

surrounding canopy and sub-canopy trees were recently felled across two of the historic subpopulations to increase light levels at the forest floor and thereby improve suitable habitat. Searches across these two sites as well as the remaining two subpopulations within the Nantahala NF have not been successful. No plants of this species have been seen within these four subpopulations for 5 years. None of the four sites with previous individuals is within an existing designated area.

Rock gnome lichen

For the purposes of this report rock gnome lichen will still be referred to as *Gymnoderma lineare* as the US Fish and Wildlife Service still refer to it. A taxonomic revision of the genus including this species was completed in 2002, resulting in the change to *Cetradonia linearis*. Until the new binomial is changed in the integrated taxonomic information system, the USFWS will maintain the older binomial (USFWS 2012).

Gymnoderma lineare is a lichen with a narrow strap-shaped olive-grey thallus which grades to a blackened base (Evans 1947). Apothecia, the fruiting bodies, occur from July through September. Rock gnome lichen is a narrow Southern Appalachian endemic primarily occurring in the North Carolina mountains with small peripheral populations in the mountains of Tennessee, Georgia, South Carolina, and Virginia (NatureServe 2013, Weakley 2013). The lichen was federally listed as endangered in the Federal Register in 1995 (USFWS 1995) and currently has a G2 global rank.

The lichen occurs on sloping to vertical rock faces with some seepage at higher elevations, generally above 5000 feet. Typically it occurs on rock outcrops partially shaded by spruce-fir forests and occasionally northern hardwood forest. In portions of its range it occurs on partially shaded high elevation rocky summits. The species has also been located in riparian areas on boulders within and adjacent to streams. These streamside populations occur both within the very headwaters, some occurring above 5,500 feet, as well as larger 5th to 6th order streams. Populations vary in density from tiny dispersed clumps, barely one centimeter square, to dense colonies, greater than four meters square in extent. The populations on Fowler Creek and the east bank of the Chattooga River represent the lowest elevation, approximately 2,240 feet, located for the species across its range.

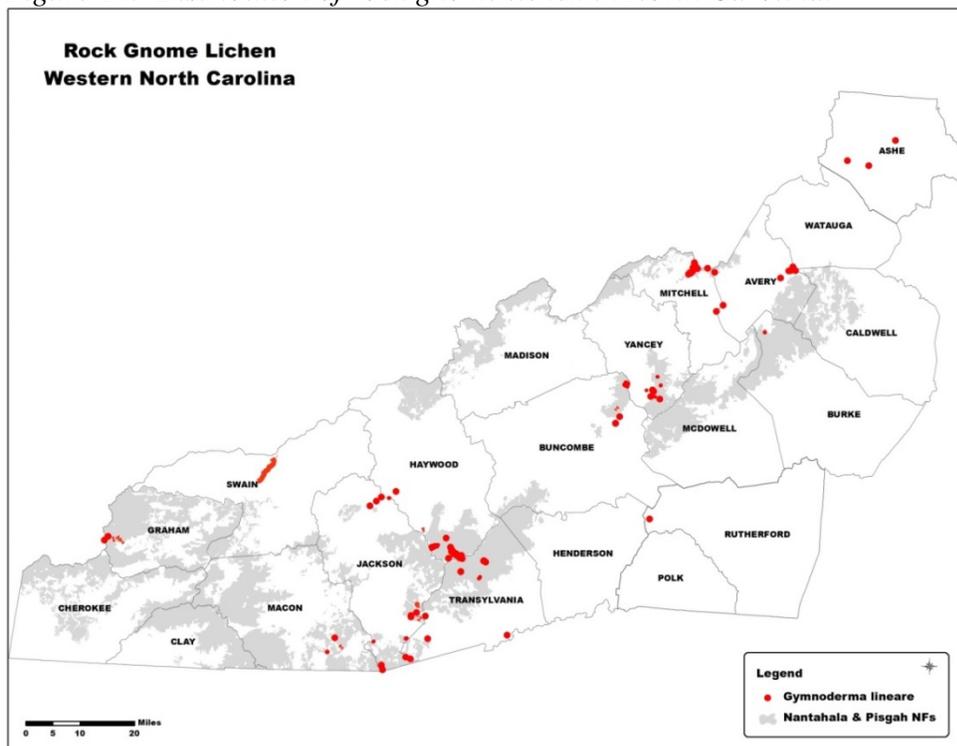
As previously indicated, the vast majority of the populations for this species occur within western NC. There is some uncertainty on the delineation, or range, of the populations, these varying based on different criteria for separation distance or occurrence in separate subwatersheds. The 5-year review denoted 85, with 75 in North Carolina. It is uncertain how many of these populations were delineated on the Nantahala or Pisgah NFs. Based on separate delineations, 45-50% of the NC populations occur on the two forest units. Currently there are 80 subpopulations known on the Nantahala and Pisgah NFs. This represents at least 60% of the subpopulations known across 13 counties within western North Carolina (Figure 10). Rock gnome lichen occurs within 10 separate counties within the Nantahala and Pisgah NFs.

Gymnoderma lineare is assumed to have been restricted to the same geographic range as it presently occurs. Several populations are believed to have been extirpated or reduced in size

during the last 25 years. It is not specifically known why certain populations of this lichen have declined, although recreational use, pathogens impacting canopy trees previously providing shade, road construction, and high sulfur levels have been documented in the same areas (Martin and Noble 1996; USFWS 1997).

Intermittent monitoring has occurred within various rock gnome lichen subpopulations across both national forests. All except four of the occupied sites on the two forest units have been revisited at least once in the last 15 years with brief observations on their presence and health recorded. Within these revisited sites all except one population or subpopulation was relocated. The one un-relocated population, in Wright Creek in Graham County, is believed to have been negatively affected and potentially locally extirpated as a result of sedimentation from the construction of the Cherokee Skyway. Most subpopulations with more frequent visitation are relatively stable in their covered extent. However, three subpopulations have been impacted either by unsubstantiated (potentially ozone damage) events or by recent tree falls.

Figure 10. Distribution of rock gnome lichen in North Carolina.



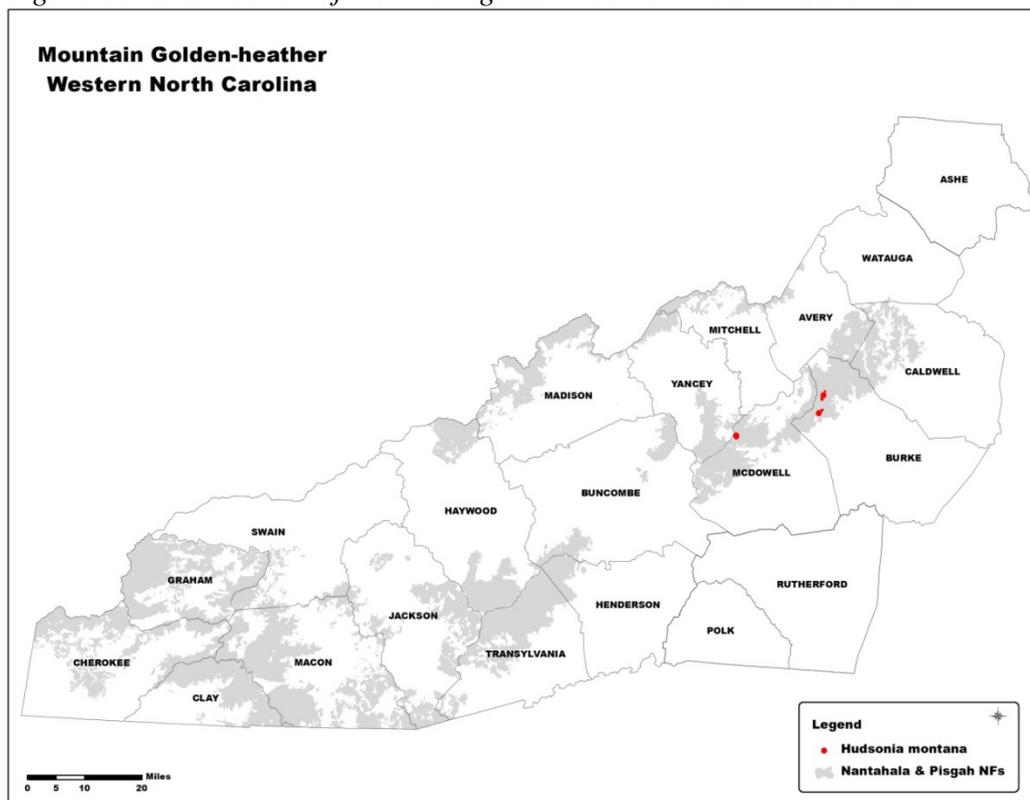
Mountain golden-heather

Mountain golden-heather (*Hudsonia montana*) is a very short shrub, up to 6 inches in height, in the rockrose family that occurs in low elevation rocky summits. *Hudsonia montana* is a narrow endemic North Carolina species, restricted to two primary areas separated by about 20 aerial miles, Linville Gorge Wilderness and Woods Mountain, on the Grandfather Ranger District (Figure 11, NatureServe 2013). Mountain golden-heather has a global rank of G1. The species

was listed as threatened under the Endangered Species Act on October 20, 1980. A recovery plan was approved in 1983 (USFWS 1983).

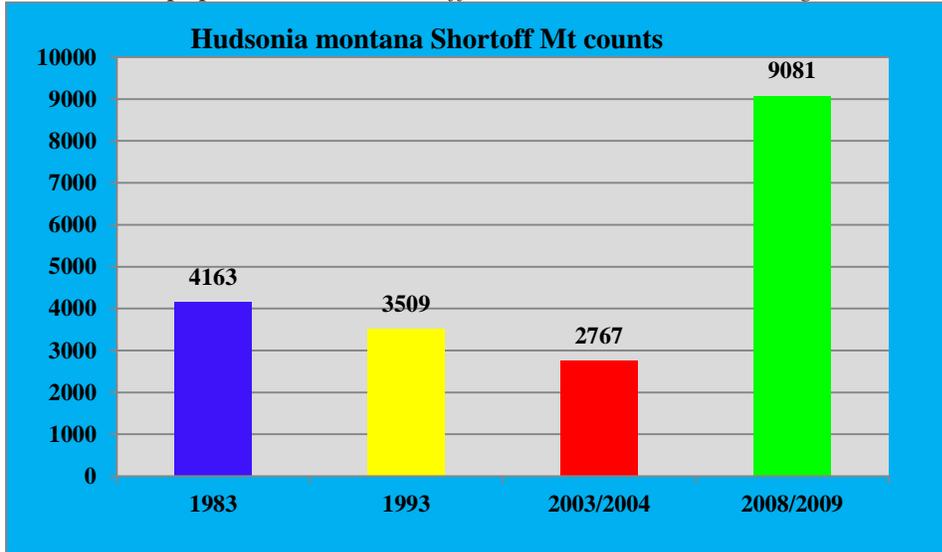
Thirty-three subpopulations, representing four or five populations depending on separation criteria, of mountain golden-heather are currently documented on the Grandfather Ranger District. All of these subpopulations are within existing designated areas. A complete census of the subpopulations has been completed approximately every 10 years since 1982. As a result, various previously delineated subpopulations have not been relocated for some of the later counts (Donaldson 2004). This may be due to subpopulations merging or serious declines as a result of woody plant encroachment. Figures 9 and 10 indicate the range in population numbers during the censuses across the four population areas.

Figure 11. Distribution of mountain golden-heather in North Carolina.



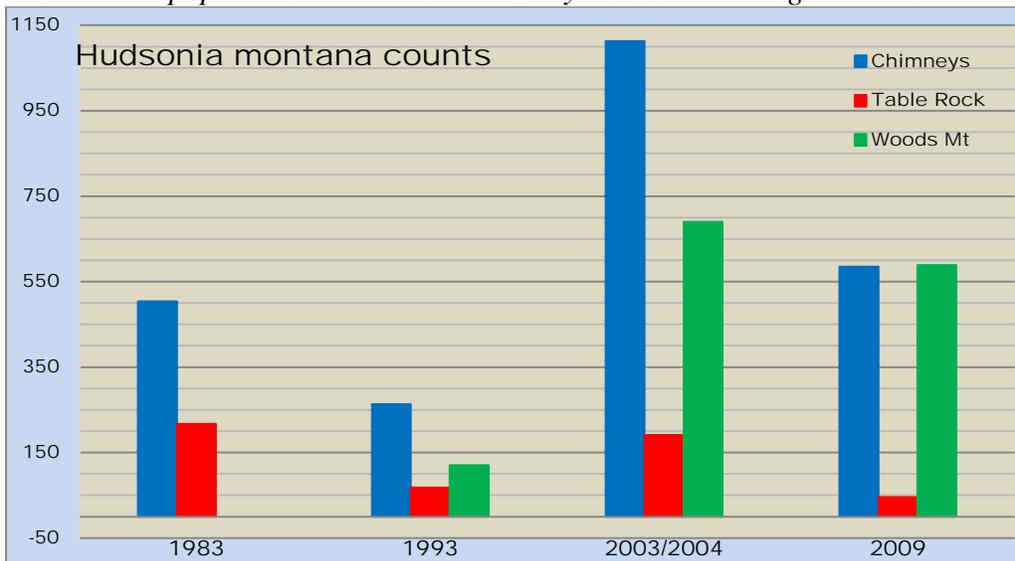
Threats to the species occur from trampling by recreational users who camp, and fire suppression which allows woody shrub encroachment and does not promote seedling recruitment (USFWS 2012). A 5-year experimental management study determined that fire, at a frequency from 5 to 15 years, was most effective in reducing competing shrubs and exposing mineral soil to encourage seedling establishment (Frost 1990).

Figure 12. Population census (discrete clumps) from 1982 to 2008 and 2009 for 16 *Hudsonia montana* subpopulations on Shortoff Mountain in Linville Gorge Wilderness.



The latest update to the periodic census was completed in 2008 and early 2009 on Shortoff Mountain to document any changes 1 year after a large stand replacement duff-burning, lightning-set fire. The fire increased suitable habitat and more than doubled the previous high tally recorded for these 16 subpopulations (Figure 12). These increases are reflective of large increases in the smallest size class category, seedlings, recorded for the census.

Figure 13. Population census (discrete clumps) from 1982 to 2008 and 2009 for 19 *Hudsonia montana* subpopulations across the Chimneys in Linville Gorge Wilderness.



All the remaining *Hudsonia montana* subpopulations were also counted in 2009. This includes 13 subpopulations on the Chimneys, the single subpopulation on Table Rock, and the two subpopulations at Woods Mountain. In contrast to the increasing population numbers recorded at Shortoff Mountain, there has been a 2-fold decline in *Hudsonia montana* clumps across the

subpopulations surrounding the Chimneys and Chimney Gap in Linville Gorge Wilderness (Figure 13). A four-fold decline in abundance (191 reduced to 46) was recorded at Table Rock, while less of a decline (from 690 to 589 clumps) occurred at Woods Mountain during the last 5 years. Both the Chimneys and Table Rock subpopulations have not had a prescribed burn within the surrounding plant community for at least 7 years, some for more than 10 years. In 2012, a prescribed burn was conducted across the Table Rock subpopulations. The plant recount later that year did not result in an increase in individuals from the previous 2009 count. As a result, in 2013 mechanical vegetation clearing including exposing mineral soil was completed near the subpopulations to improve suitable habitat.

In the mid 1990's due to the recreational threats to existing subpopulations, a closure order was issued across a few Chimney subpopulations. It is uncertain if this resulted in less damage since these subpopulations have continued to decline although no wildfires occurred across these subpopulations since the closure. One subpopulation appears to be still experiencing some camping impacts, primarily campfires.

Swamp pink

Swamp pink (*Helonias bullata*) is a perennial herb with a basal rosette of evergreen leaves, with pink flowers in early spring. The species occurs within acidic seeps, seepage swamps, bogs, and swamp forest-bog complexes (Weakley, Ludwig, and Townsend 2013; Weakley 2012).

Helonias bullata is known from the Coastal Plain of New Jersey, Delaware, Maryland, and Virginia (formerly also Staten Island, NY, where now extirpated), as well as from higher elevations in northern New Jersey, Virginia, North Carolina, South Carolina, and Georgia (Weakley 2012; NatureServe 2013). Considering the broader range, this species has a global rank of G3. Swamp pink was listed as a threatened species under the Endangered Species Act on September 9, 1988. A recovery plan was approved for the species in 1991..

In North Carolina the species is restricted to four counties (Gadd and Finnegan 2012). Sixteen subpopulations of swamp pink have been documented across the Pink Beds on the Pisgah Ranger District. An additional 15 subpopulations have been historically delineated within the same area since the early to late 1970s. Since the data was collected prior to GPS instruments, the resolution may be too coarse to precisely relocate and differentiate with currently known subpopulations. In the last seven years, all of these historical subpopulations have been carefully searched for. Only a few have been relocated representing the currently delineated 16 subpopulations. All of these subpopulations are within existing designated areas. Twenty-seven additional subpopulations have been located within North Carolina with one on the boundary of the Nantahala Ranger District and possibly on USFS lands. The Pink Beds subpopulations represent the largest concentration of the species within North Carolina.

Threats to the species result from degraded habitat primarily by hydrological changes, non-native invasive plant species, all-terrain vehicles, deer browsing, trampling, horticultural collections, flooding from beaver activity, limited seed dispersal, and poor seedling establishment. It is uncertain if too dense shade is a threat although some shady sites are known to have very low levels of flowering (Dr. Chris Ulrey, personal communication)

Periodic monitoring every three to five years has been completed within all existing Pink Beds subpopulations, recording any threats and assessing population sizes either by an exact count if 100 or less or an estimate in hundreds if more. The subpopulations vary in size from 14 to 50,000 or more individuals.

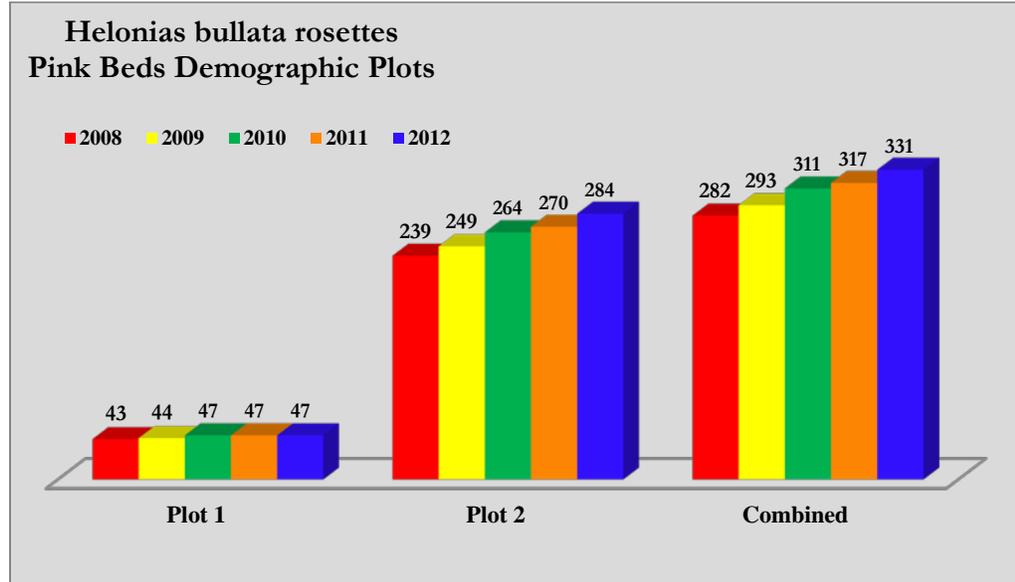
More intensive monitoring has been completed to document any potential construction impacts across one subpopulation located downslope of the Cradle of Forestry amphitheater which was constructed in 2006. Rosette counts have been periodically estimated along 50 meter lengths within the larger drain downslope of the amphitheater since 1991 (Table 4). The rosette number estimates have declined from the first count from 4025 to 3662 in 2012. In contrast, flowering has been quite variable. After the first count there was a subwatershed flood that impacted the subpopulation resulting in dislodging and burying of numerous rosettes (Nora Murdock, NPS biologist, former USFWS biologist, personal communication). Since that time, the subpopulation has slowly recovered. And the recent counts since the amphitheater construction have not varied more than 10% and is probably within the margin of error of the estimate. The data suggests the subpopulation here is stable.

Table 4. Periodic changes in Helonias bullata rosette estimates along a small stream segment from 1991-2010 within the Pink Beds.

Year	Rosette Estimate	Flowering Stems
1991	4025	96
1998	2195	Survey timing inappropriate for observing flowers
2000	2819	2
2008	2943	5
2010	3762	18
2011	3402	112
2012	3662	56

In addition, two macroplots were established in 2008 within a portion of this stream segment. All rosettes were numbered and tagged and the number of leaves and flowering stems were recorded. The total number of patches (rosettes) monitored from 2008 to 2012 slowly increased (17%) with the largest count in 2012 (Figure 14). This data from the five sampling dates indicates an increasing trend and indicates no adverse trends from the amphitheater construction and the more recent, 2010, construction of a roof overtopping a portion of the amphitheater. While the numbers of leaves have varied more than the rosettes, there has also been an increase in numbers with the latest counts in 2012. As also recorded with the stream count estimates, the number of flowering stems have varied from year to year and may be indicative of the limitations of the species or weather patterns for any single year since other researchers have also noted an increase in number of flowering stems in 2009 (Dr. Chris Ulrey, personal communication).

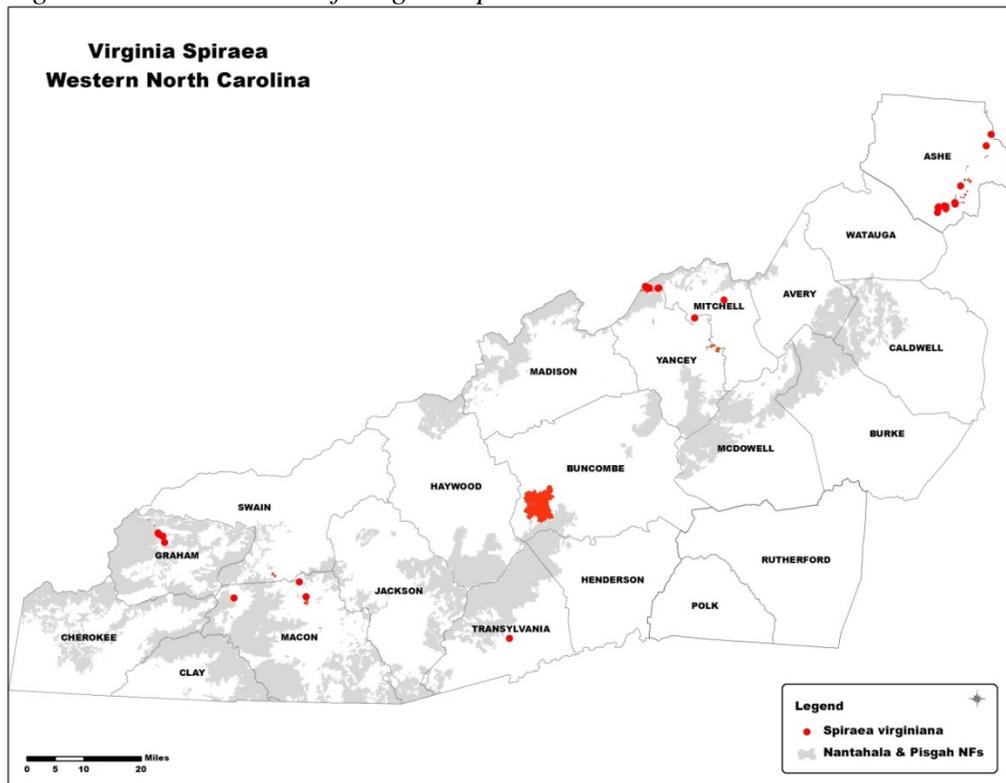
Figure 14. Change from 2008 to 2012 in *Helonias bullata* in rosette numbers in two macro plots in the Pink Beds.



Virginia spiraea

Virginia spiraea (*Spiraea virginiana*) is a medium height, up to 6 feet, shrub perennial plant in the rose family with showy yellow flowers in July and August (Weakley 2012, NatureServe 2013). It is typically located in disturbed areas along high gradient sections of rivers and streams or braided features of lower reaches. Occasionally it is located along road corridors. *Spiraea virginiana* has been recently documented or relocated along the Appalachian Mountains from Ohio and West Virginia south to northwestern Georgia. It occurred in Pennsylvania historically but is thought to be extirpated (NatureServe 2013). Virginia Spiraea is known currently to occur in Ashe, Graham, Macon, Mitchell, Swain and Yancey Counties within three river basins (French Broad, New and Little Tennessee) in North Carolina (Biotics 2013, Figure 15). Virginia Spiraea was listed as a federally threatened species in 1990 (USFWS 1990). Virginia Spiraea has a global rank of G2. The species was listed as endangered under the Endangered Species Act on April 5, 1990.

Figure 15. Distribution of *Virginia spiraea* in Western North Carolina.



The shrub is known across 39 subpopulations in both of the forest units within the Nolichucky River Gorge, in the Cheoah River, and in Whiteoak Creek. The majority of the subpopulations are in existing designated areas. Threats to the species include competition from surrounding vegetation including non-native invasive plants (NNIPs), inundation, beaver herbivory, and clearing vegetation in the riparian area including adjacent roadside edge (USFWS 2009). Non-native invasive (NNIS) plants are threatening all 39 of these subpopulations. NNIS were treated across two of the occupied sites in the Nolichucky Gorge, the one site at Whiteoak Creek, and 20 sites along the Cheoah River. The NNIS control work in 2012 and 2013 was the fifth consecutive year along the Cheoah River, and the third treatments within the Nolichucky River and Whiteoak Creek.

In the Nolichucky River Gorge, 2 of the 4 recently relocated subpopulations have been monitored. The two subpopulations were covering the same aerial extent as previously recorded. The same aerial extent was assessed at five of the subpopulations along the Cheoah River. This coarse estimate did not vary from the previously recorded numbers for these subpopulations. One remaining *Spiraea virginiana* clump with 1 visible stem was recorded at the Whiteoak Creek site in spring of 2011. This population continues to decline as a result of a Japanese knotweed infestation and apparently from a heavy storm event in 2010 that scoured the stream bank. Based on similar observations following herbicide NNIS treatments near another Virginia *Spiraea* population along the Little Tennessee River (not on USFS lands), it may be that the herbicide can translocate into Virginia *spiraea* rhizomes that touch the targeted NNIS roots.

Bunched arrowhead

Bunched arrowhead, *Sagittaria fasciculata*, is an aquatic perennial herbaceous plant that occurs in continuously flowing seepage areas with cool, clear water (Newberry 1991; NatureServe 2013). It can be located in bogs, ditches adjacent to drained bogs, and wooded seepage areas (Weakley 2012). Light levels vary across sites. The presence of the continuous slow flowing seepage is considered the most limiting environmental factor (NatureServe 2013).

There are no known populations of this species on either the Nantahala or Pisgah NFs. However the species has been located within similar bogs that occur on the Pisgah NF and could potentially occur within this forest in the future. A recent 5-year review of the species indicates only two of the known populations are stable; all the remaining ones are declining.

Mountain sweet pitcher plant

Mountain sweet pitcher plant (*Sarracenia jonesii*) is a carnivorous plant in the pitcher plant family that grows in southern Appalachian Bogs in the southern Appalachian. The species is a Carolina endemic, restricted to a 3-county area in North Carolina and in two South Carolina Counties (NatureServe 2013). Historically there were 16 populations known across this area; 12 are presently known (USFWS 2013). The species was formally listed as endangered under the Endangered Species Act on October 31, 1988. An approved recovery plan was issued on August 13, 1990.

There are no known populations of this species on either the Nantahala or Pisgah NFs. However the species has been located within similar bogs that occur on the Pisgah NF and could potentially occur within this forest in the future. A recent 5-year review of the species indicates only two of the known populations are stable; all the remaining ones are declining.

REFERENCES

- Barbour, R. W. and W. H. Davis. (1969). Bats of America. The University of Kentucky Press. Lexington Kentucky.
- Bogan, A. E. and P. W. Parmalee. (1983). Tennessee's rare wildlife. Vol. 2: The mollusks. Tennessee Wildlife Resources Agency and the Tennessee Conservation Department: Nashville, Tennessee.
- Britzke, E. R., M. J. Harvey, and S. C. Loeb. (2003). Indiana bat, *Myotis sodalis*, maternity roosts in the southern United States. *Southeastern Naturalist* 2,235-242.
- Brown, J. H. (1971). Mammals on mountaintops: nonequilibrium insular biogeography. *American Midland Naturalist*, 105,467-478.
- Brumback, W. E. and C. W. Fyler. (1984). Monitoring study of *Isotria medeloides* in East Alton, New Hampshire - 1984. Unpublished report, New England Wildflower Society. Framingham, MA.
- Burford, L. S. and M. J. Lacki. (1995). Habitat use by *Corynorhinus townsendii virginianus* in the Daniel Boone National Forest. *American Midland Naturalist*, 134, 340-345.
- Burkhead, N. M., and R. E. Jenkins. (1991). Fishes. In K. Terwilliger (coordinator), Virginia's Endangered Species: Proceedings of a Symposium (pp 321-409). McDonald and Woodward Publishing Company: Blacksburg, VA.
- Church, S. A. and D. R. Taylor. (2005). Speciation and hybridization among *Houstonia* (Rubiaceae) species: the influence of polyploidy on reticulate evolution. *American Journal of Botany*, 92(8), 1372-1380.
- Crowell, K. L. (1986). A comparison of relict versus equilibrium models for insular mammals of the Gulf of Maine. *Biological Journal of the Linnean Society*, 28, 37-64.
- Coyle, F. A. (1981). The mygalomorph spider genus *Microhexura* (Araneae, Dipluridae). *Bulletin of the American Museum of Natural History*, 170, 64-75.
- Cronquist, A. (1980). Asteraceae, Volume 1, Vascular flora of the Southeastern United States. University of North Carolina Press: Chapel Hill, NC.
- Decher, J. and J. R. Choate. (1995). *Myotis grisescens*. *Mammalian Species*, 510, 1-7.
- Donaldson, J. T. (2004). 2003 Mountain golden heather (*Hudsonia montana*) photo monitoring and third global inventory.
- Etnier, D. A., and W. C. Starnes. (1993). The fishes of Tennessee. University of Tennessee Press: Knoxville, TN.

- Frost, C. C. (1990). *Hudsonia montana* final report. Effects of fire, trampling, and interspecies competition. 1985-1989. Parts I (Final Report) and II (Appendices).
- Gadd, L. E. and J. T. Finnegan. (2012). Natural Heritage Program List of the Rare Plant Species of North Carolina. North Carolina Natural Heritage Program: Raleigh, NC.
- Gardner, J. E., J. E. Hofmann, and J. D. Garner. (1996). Summer distribution of the federally endangered Indiana bat (*Myotis sodalis*) in Illinois. Transactions of the Illinois State Academy of Science, 89, 187-196.
- Garner, J. D. and J. E. Gardner. (1992). Determination of summer distribution and habitat utilization of the Indiana bat (*Myotis sodalis*) in Illinois. Illinois Department of Conservation. Final Report, Project E-3. Springfield, IL.
- Glennon, K. L., J. T. Donaldson, and S. A. Church. (2011). Evidence for hybridization between the endangered Roan Mountain bluet, *Houstonia purpurea* var. *montana* (Rubiaceae) and its common congener. Journal of the Torrey Botanical Society, 138(3), 272-286.
- Gordon, M. E. and J. B. Layzer. (1989). Mussels (Bivalvia: Unionoidea) of the Cumberland River review of life histories and ecological relationships. U.S. Fish and Wildlife Service Biological Report, 89(15), 1-99.
- Griffin, D. R. (1940). Notes on the life histories of New England cave bats. Journal of Mammalogy, 21, 181-7.
- Hall, J. S., and N. Wilson. (1966). Season population movements of the gray bat in the Kentucky area. American Midland Naturalist, 75, 317-24.
- Hitchcock, H. B. (1949). Hibernation of bats in southeastern Ontario and adjacent Quebec. The Canadian Field Naturalist, 63(2), 47-59.
- Humphrey, S. R., A. R. Richter, and J. B. Cope. (1977). Summer habitat and ecology of the endangered Indiana bat, *Myotis sodalis*. Journal of Mammalogy, 58, 334-346.
- Handley, C. O., Jr. (1991). Mammals. In K. Terwilliger, (coordinator). Virginia's endangered species: proceedings of a symposium (pp. 539-616). McDonald and Woodward Publishing Company: Blacksburg, VA.
- Homoya, M. A. (1977). The distribution and ecology of the genus *Isotria* in Illinois. M.S. Thesis (104 pp). Southern Illinois University, Carbondale, IL.
- Jenkins, R. E., and N. M. Burkhead. (1994). Freshwater fishes of Virginia. American Fisheries Society: Bethesda, MD.

Kral, R. (1983). A report on some rare, threatened or endangered forest related vascular plants of the south. USFS technical publication R8-TP2, Atlanta, GA. Vol. 1.

LaVal, R. K., R. L. Clawson, M. L. LaVal, and W. Caire. (1977). Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis*. *Journal of Mammology*, 58, 592-599.

Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr. (1980). Atlas of North American freshwater fishes. North Carolina State Museum of Natural History: Raleigh, NC.

Matthews, J. R. and C. J. Moseley (eds.). (1990). The Official World Wildlife Fund Guide to Endangered Species of North America. Volume 1. Plants, Mammals. Volume 2. Birds, Reptiles, Amphibians, Fishes, Mussels, Crustaceans, Snails, Insects, and Arachnids. Beacham Publications, Inc.: Washington, DC.

Menzel, J. M., W. M. Ford, M. A. Menzel, T. Carter, J. E. Gardner, J. D. Garner, and J. E. Hofmann. (2005). Summer habitat use and home-range analysis of the endangered Indiana bat. *Journal of Wildlife Management*, 69, 430-436.

Menzel, M. A., J. M. Menzel, T. C. Carter, W. M. Ford, and J. W. Edwards. (2001). Review of the forest habitat relationships of the Indiana bat (*Myotis sodalis*). (General Technical Report NE-284). Newtown Square, PA: United States Department of Agriculture Forest Service, Northeastern Research Station.

McNab, B. K. (1982). Evolutionary alternatives in the physiological ecology of bats. In T. H. Kunz (editor). *Ecology of Bats* (pp. 151-200). Plenum Press: New York, NY.

Mehrhoff, L. A. (1989). The Dynamics of Declining Populations of an Endangered Orchid, *Isotria medeoloides*. *Ecology*, 70(3), 783-786.

Mirarchi, R. E., J. T. Garner, M. F. Mettee, and P. E. O'Neil. (2004). Alabama wildlife. Volume 2. Imperiled aquatic mollusks and fishes. University of Alabama Press: Tuscaloosa, AL.

Mumford, R. E. and J. B. Cope. (1964). Distribution and status of the Chiroptera of Indiana. *American Midland Naturalist*, 72(2), 473-489.

NatureServe. (2013). NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe: Arlington, VA. Retrieved on February 1, 2014 from: <http://www.NatureServe.org/explorer>.

Neesom, G. L. (2005). Broadened concept of *Liatris helleri* (Asteraceae: Eupatorieae). *Sida*, 21(3), 1323-1333.

Newberry, G. (1991). Factors affection the survival of the rare plant, *Sagittaria fasciculata* E.O. Beal (Alismataceae). *Castanea*, 56(1), 59-64.

North Carolina Natural Heritage Program (NCNHP). (2010). List of rare animal species of North Carolina. North Carolina Natural Heritage Program: Raleigh, NC.

North Carolina Wildlife Resources Commission (NCWRC). (2012). Annual Program Report: 2010-11, Wildlife Diversity Program, North Carolina Wildlife Resources Commission.

Parmalee, P. W. and A. E. Bogan. (1998). The Freshwater Mussels of Tennessee. University of Tennessee Press: Knoxville, TN.

Payne, J. L., D. R. Young, and J. F. Pagels. (1989). Plant community characteristics associated with the endangered northern flying squirrel, *Glaucomys sabrinus*, in the southern Appalachians. American Midlands Naturalist, 121, 285-292.

Pearson, E. W. (1962). Bats hibernating in silica mines in southern Illinois. Journal of Mammalogy, 43(1), 27-33.

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.

Schafale, M. P. and A. S. Weakley. (1990). Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program: Raleigh, NC.

Trombulak, S. C., P. E. Higuera, and M. DesMeules. (2001). Population trends of wintering bats in Vermont. Northeastern Naturalist, 8, 51-62.

Tuttle, M. D. (1979). Status, causes of decline, and management of endangered gray bats. Journal of Wildlife Management, 43, 1-17.

U.S. Fish and Wildlife Service (USFWS). (1983). Mountain Golden Heather Recovery Plan. Initial version prepared by Levester Pendergrass, Regional Botanist, United States Department of Agriculture Forest Service, Southeast Region. Final version with revisions by United States Department of the Interior Fish and Wildlife Service, Southeast Region, Atlanta, GA.

U.S. Fish and Wildlife Service (USFWS). (1984). Recovery Plan for the noonday snail *Mesodon clarki nantahala*. Atlanta, GA: United States Department of the Interior Fish and Wildlife Service..

U.S. Fish and Wildlife Service (USFWS). (1984). Recovery plan for the Cumberland Bean Pearly Mussel *Villosa trabalis* (Conrad, 1834). Atlanta, GA: United States Department of the Interior Fish and Wildlife Service, Region 4..

U.S. Fish and Wildlife Service (USFWS). (1987). The Blue Ridge Goldenrod Recovery Plan. Prepared by Shawn Oakley, February 1996.

U.S. Fish and Wildlife Service (USFWS). (1989). Little-wing pearly mussel recovery plan. Atlanta, GA: United States Department of the Interior Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). (1993). Spreading Avens Recovery Plan. Atlanta, GA: United States Department of the Interior Fish and Wildlife Service, Southeast Region.

U.S. Fish and Wildlife Service (USFWS). (1994). Final rule to reclassify the plant *Isotria medeoloides* (small whorled pogonia) from endangered to threatened. Federal Register, 59(193), 50852-50857.

U.S. Fish and Wildlife Service (USFWS). (1995). Endangered and Threatened Wildlife and Plants; determination of *Gymnoderma lineare* (rock gnome lichen) to be an endangered species. Federal Register, 60(11), 3557-3562.

U.S. Fish and Wildlife Service (USFWS). (1996a). Appalachian elktoe recovery plan. Atlanta, Georgia: United States Department of the Interior Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). (1996b). Recovery plan for Roan Mountain bluet (*Hedyotis purpurea* (L.) Torrey & Gray var. *montana* (Small) Fosberg). Prepared by Bruce Sanders, private consultant, approved by United States Department of the Interior Fish and Wildlife Service Atlanta, GA.

U.S. Fish and Wildlife Service (USFWS). (1997). Recovery Plan for Rock Gnome Lichen (*Gymnoderma lineare*) (Evans). Yoshimura and Sharp. Atlanta, Georgia: United States Department of the Interior Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). (1998). Recovery plan for the Spruce-fir Moss Spider. Atlanta, GA: United States Department of the Interior Fish and Wildlife Service

U.S. Fish and Wildlife Service (USFWS). (1999). Agency draft Indiana Bat (*Myotis sodalis*) revised recovery plan. Fort Snelling, MN: United States Department of the Interior Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). (2002). 50CFR Part 17, RIN 1018-AH33. Endangered and threatened wildlife and plants; designation of critical habitat for the Appalachian elktoe. Final Rule. Federal Register, 67(188), 61016-61040.

U.S. Fish and Wildlife Service (USFWS). (2010). Cumberland bean (*Villosa trabalis*) 5-year review: Summary and evaluation. Frankfort, KY: United States Department of the Interior Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). (2011). Blue Ridge Goldenrod (*Solidago spithamaea*) 5-Year Review, Summary and Evaluation. Asheville, NC: United States Department of the Interior Fish and Wildlife Service, Asheville Ecological Services Field Office.

U.S. Fish and Wildlife Service (USFWS). (2012). Mountain Golden Heather (*Hudsonia montana*) 5-Year Review, Summary and Evaluation. Asheville, NC: United States Department of the Interior Fish and Wildlife Service, Asheville Ecological Services Field Office.

U.S. Fish and Wildlife Service (USFWS). (2013). 50CFR Part 17, RIN 1018-AY98. Endangered and threatened wildlife and plants; 12-month finding on a petition to list the eastern small-footed bat and the northern long-eared bat as endangered or threatened species; listing the northern long-eared bat as an endangered species. Proposed Rules. Federal Register, 78(191), 61046-61080.

Virginia Botanical Associates. (2014). Digital Atlas of the Virginia Flora. Virginia Botanical Associates: Blacksburg, VA. Retrieved on February 1, 2014 from: <http://vaplantatlas.org>.

Von Oettingen, S. L. (1992). Small Whorled Pogonia (*Isotria medeoloides*) Recovery Plan, First Revision. Concord, New Hampshire: United States Department of the Interior Fish and Wildlife Service, New England Field Office.

Wei, J. C. and T. Ahti. (2002). Cetradonia, a new genus in the new family Cetradoniaceae (Lecanorales, Ascomycota). Lichenologist, 34(1), 19-31.

Wells-Gosling, N. and L. R. Heaney. (1984). *Glaucomys sabrinus*. American Society Of Mammalogists, Mammalian Species, 229.