

**Roan Mountain bluet**  
**(*Hedyotis purpurea* var. *montana*)**

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



Photo credit: USFWS

**U.S. Fish and Wildlife Service**  
**Asheville ES Field Office**  
**Asheville, North Carolina**

**5-YEAR REVIEW**  
**Roan Mountain bluet / *Hedyotis purpurea* var. *montana***

**I. GENERAL INFORMATION**

**A. Reviewers**

**Lead Regional or Headquarters Office:**

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**Lead Field Office:**

Mara Alexander, Asheville ES Field Office, phone (828) 258-3939, ext. 238

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**Cooperating Regional Office(s):**

Mary Parkin, Northeast Region, (617) 417-7331

**B. Methodology used to complete the review:**

Public notice of this 5-year review was given in the Federal Register on July 29, 2008 (FR 73 43947), and a 60-day comment period was opened. During the comment period, the U.S. Fish and Wildlife Service (USFWS) did not receive any additional information about *Hedyotis purpurea* var. *montana* in response to the FR notice. However, the USFWS did receive additional information about the taxon in response to our requests for specific information to biologists familiar with the taxon. Once all data was obtained, the review was completed by the USFWS's lead recovery biologist for the taxon in Asheville, North Carolina (Mara Alexander).

A draft of the entire 5-year review document was circulated to six peer reviewers. These persons were selected because of their familiarity with the species, their employment within applicable or affected natural resource agencies, or both. Responses were received from four reviewers. These comments were incorporated into this review as appropriate (see Appendix A for a summary of peer review).

**C. Background:**

**1. FR Notice citation announcing initiation of this review:**

July 29, 2008 (FR 73 43947)

**2. Listing history**

Original Listing

**FR notice:** FR 55 12793

**Date listed:** May 7, 1990

**Entity listed:** variety

**Classification:** endangered

### 3. Review History:

The USFWS files do not contain prior agency status reviews or prior 5-year reviews for this taxon. However, the USFWS files do contain other documents with relevant information on the taxon. These documents were consulted in the preparation of this review and are cited accordingly throughout. A complete list of works consulted (and on file with the USFWS's Asheville Field Office) follows the list of literature cited.

### 4. Species' Recovery Priority Number at start of 5-year review: 8

### 5. Recovery Plan or Outline

**Name of plan or outline:**

Recovery Plan for Roan Mountain Bluet (*Hedyotis purpurea* (L.) Torrey & Gray var. *montana* (Small) Fosberg)

**Date issued:** May 3, 1996

**Dates of previous revisions, if applicable:** n/a

### 6. Recovery Achieved: 1 (1= 0-25% of species' recovery objectives achieved)

## II. REVIEW ANALYSIS

### A. Application of the 1996 Distinct Population Segment policy

The Act defines species as including any subspecies of fish or wildlife or plant, and any distinct population segment (DPS) of any vertebrate wildlife. Therefore, the DPS policy applies to only vertebrate species of fish and wildlife. Because *Hedyotis purpurea* var. *montana* is a plant, the DPS policy is not applicable and is not addressed further in this review.

### B. Recovery Criteria

#### 1. Does the species have a final, approved recovery plan<sup>1</sup> containing objective, measurable criteria?

No. The taxon has a final, approved recovery plan with recovery criteria; however, the recovery plan only provides criteria for delisting (there are no intermediate criteria for reclassification to threatened status). The criteria are not objective and measurable beyond establishing a minimum number of populations to be protected (9). Although the plan requires these populations to be self-sustaining, a lack of knowledge of biology and demographic patterns in this taxon precluded establishment of objective, measurable criteria for self-sustaining populations. The recovery criteria in the 1996 plan were regarded as interim goals to be modified upon acquiring additional information (specific actions intended to address these information needs are identified among the recovery tasks).

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<sup>1</sup> Although the guidance generally directs the reviewer to consider criteria from final approved recovery plans, criteria in published draft recovery plans may be considered at the reviewer's discretion.

**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 (and is there no new information to consider regarding existing or new threats)?**

Yes. The existing recovery criteria could not be met without addressing the three listing factors still identified as significantly affecting the status of the taxon in the listing rule (habitat loss, the inadequacy of existing regulatory mechanisms, and other natural or manmade factors). There are no new threats affecting the taxon beyond those mentioned in the listing rule and the recovery plan. Accelerated global climate change is expected to exacerbate those threats already identified; this is discussed in Section 2.3.2 (Five-Factor Analysis).

**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:**

*Criterion 1: Delisting will be considered when at least nine self-sustaining populations exist, and they are protected to such a degree that the species [sic] no longer qualifies for protection under the Endangered Species Act.*

*A self-sustaining population is self-regenerating and maintains sufficient genetic variation to enable it to survive and respond to natural changes. Sexual reproduction and recruitment are vital elements of a self-sustaining population....*

*A population will be considered adequately protected when landowners and cooperating agencies have implemented the management actions necessary for population persistence and when the population is protected from present and foreseeable natural and human-related threats that might jeopardize its persistence.*

There are currently 17 populations of *H. montana*, ten of which occur on publicly owned lands or lands otherwise managed for conservation (Appendix A, Table A.1). Objective, measurable criteria have not been developed for self-sustaining populations. A lack of adequate monitoring data precludes a robust or meaningful assessment as to whether or not these populations have been stable over the past several years. It is also difficult to determine if the populations would be self-sustaining for the foreseeable future. Anecdotal observations suggest declines (some significant) at some populations, which make it unlikely that these populations are self-sustaining. It is currently unknown whether or not the declines reported at some sites are representative of trends within populations across the taxon's range.

**C. Updated Information and Current Species Status**

**1. Biology and Habitat**

**a. New information on the species' biology and life-history:**

Euliss et al. (2007a) compared growth rates and life-history traits of *H. montana* populations found on rock outcrops (the most common habitat type) with those occurring on grassy slopes.

On grassy slopes, growth began earlier in the season and led to taller plants occupying greater ground area, but neither reproductive output, number of leaves, or patterns of mycorrhizal associations differed consistently between these habitat types. *H. montana* emerged at least eight weeks earlier than all other species except *Solidago glomerata*, which suggests a strategy for minimizing light competition (*S. glomerata* was not co-dominant with *H. montana* in any plots examined for this study). However, the study confounds differences in habitat with large geographic distances between populations: the two grassy slope sites were at Roan Mountain (Mitchell and Avery Counties, NC), whereas the rock outcrop sites were at Grandfather Mountain (Avery and Watauga Counties, NC) and Bluff Mountain (Ashe County, NC). Thus, it is quite possible that the differences observed in growth pattern and life-history traits are the result, at least in part, of factors other than differences in grassy slope or rock outcrop habitat conditions. This study raises many interesting observations and bears repeating using subpopulations within populations in which grassy slope and rocky outcrop conditions can be directly compared.

These same investigators examined the effects of light and nitrogen levels upon below-ground allocation using plants established from tissue culture stock originating from the Roan Mountain population east of Carvers Gap at Grassy Ridge (Euliss et al. 2007b). They found that higher nitrogen levels reduced below-ground allocation (to roots and mycorrhizal colonization) but did not appreciably influence allocation to above-ground structures. Shading reduced whole-plant growth through reductions in root and above-ground biomass (though reductions in root biomass were greater), and reduced mycorrhizal colonization. The authors conclude that reduced allocation to roots and mycorrhizae is consistent with a resource optimization strategy aimed at adjusting carbon allocation to optimize light interception. It was further concluded that *H. montana* exhibits strong sensitivity to light levels that is not mitigated by increased nitrogen, which further supports the conventional view that light is a limiting factor in the growth of this species.

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

*Hedyotis purpurea* var. *montana* is an herbaceous, caespitose (growing in tufts or clumps) perennial that grows in clumps of one to several hundred stems (TNC 1996). The taxon is known to spread by horizontal rhizomes up to 5cm long; therefore, a stem does not usually, or is not likely, to represent a genetically distinct individual. Site observations and accompanying estimates of abundance in this taxon are widely inconsistent. Some observers estimate abundance in terms of stems, others in terms of clumps or patches, and still others counting or estimating "plants" without defining whether they were counting stems or clumps (NCNHP 2009, TNNHP 2009). Saunders (1992) offered two definitions for defining an individual in this taxon: a "stem bundle", defined as a bundle of stems radiating from a single crown  $\leq 5$ cm in diameter, and a "bounded clump", defined as a circumscribed cluster of stem bases. The Nature Conservancy (TNC, 1996) later proposed a single, common definition for clumps, which adopted Saunderson's "bounded clump" accompanied by a categorical assessment of stem density (classes of 1-10, 11-25, 25-50, 51-100, and  $> 100$  stems). Donaldson (assisted early on by Smith) followed a slightly modified version of TNC monitoring protocols during a multi-year monitoring project involving several populations (Donaldson 1999a, 1999b, 2002a, 2002b). However, Donaldson does not consistently provide stem counts (or stem classes) and occasionally forgoes clump estimates altogether in areas where he found *H. montana* to be especially dense. In this situation, observations were reported in terms of percent cover (within quadrats).

Inferring patterns in overall abundance and population trends is further complicated by different levels of survey effort applied at a given site, subpopulation, or population. In some instances, the level of survey effort and/or the spatial extent of a given search are not specified, which make inferences of trends all the more difficult.

The rugged, high elevation (4,500 to 6,000ft above sea level) rock outcrops and vertical to near-vertical cliffs occupied by this taxon present numerous survey challenges. Within these habitats, a single *H. montana* population (or subpopulation) may span several hundred feet in elevation with only a fraction of the plants accessible without vertical climbing gear or, at the very least, a precarious scramble over slick, steep and at times complexly fractured rock. Treacherous terrain and the lack of standardized survey protocol has made it difficult to distinguish varying levels of survey effort from actual trends in the plant populations (or subpopulations).

While conducting this 5-year review, the USFWS has attempted to verify the unit of measurement underlying estimates of abundance (stems, clusters, patches, or simply “plants”) and the spatial extent of all estimates used in inferring trends. The USFWS has also attempted to restrict inferences to those observations which we are reasonably confident can be meaningfully compared. Limitations in available data have been noted where appropriate.

The following assessment of abundance and population trends is derived from a review of the combined databases of the North Carolina, Tennessee, and Virginia Natural Heritage Programs (NCNHP 2014, TNNHP 2014, VANHP 2013) and additional data on file with the USFWS (cited as appropriate).

The recovery plan recognized eight extant populations of *H. montana* (USFWS 1996). As of 2014, there are 17 extant populations of this taxon (Appendix A, Table A.1). The 17 extant populations of *H. montana* are distributed across numerous rock outcrops on the highest peaks of western North Carolina, eastern Tennessee, and southwestern Virginia. In some populations, the taxon occurs diffusely scattered over multiple semi-discrete outcrops occurring as “islands” within a forest matrix, or within grassy or heath bald habitats. In other cases, the population is distributed over an extensive, nearly contiguous and solid mass of rock. Johnson (1997) estimated one of the larger rock formations supporting this species to be in excess of 10,000m<sup>2</sup>. In instances in which the taxon is dispersed across multiple rock outcroppings in relatively close proximity to one another, the USFWS has used a separation distance of 100m between these adjacent rock outcrops to define “subpopulations” of the taxon (Table A.1). While not meant to imply knowledge of dispersal distances or population genetic structure, this means of aggregating smaller occurrences into a unit smaller than a population is helpful for conveying a sense of the local abundance of the taxon and for communications with land managers (and other botanists) about specific portions of larger populations. Due to evolving changes in NHP element occurrence (EO) mapping methods, these “subpopulations” may correspond to an entire EO record, a portion of an EO, or an aggregation of multiple EOs. In some instances, NHP has mapped EOs as multipart polygons, assigning each polygon within the larger EO a unique identifier termed a “Source Feature.” Populations and subpopulations as recognized by the USFWS for purposes of this review are cross-referenced to NHP EO records in Table A.1.

Ten of the 17 populations of *H. montana* consist of a single occurrence with no subpopulations (Table A.1). The remaining seven populations consist of a total of 36 subpopulations with a given population having anywhere from two to eight subpopulations. Grandfather Mountain and Roan Mountain contain the largest number of subpopulations (eight each) and represent the largest known populations of the taxon (several 1,000 clumps each). For reasons noted above, estimates of overall abundance within populations (or their subpopulations) are lacking for most sites. This

is because available data merely indicate presence or because (as is more often the case) observers have visited only a portion of an area that is not representative of the subpopulation or population of which it is a part. However, if the maximum estimates for each site (subpopulation) are considered in aggregate regardless of observer or year, the populations range in size from fewer than 50 clumps to several hundred (or several 1,000) clumps (NCNHP 2014, TNNHP 2014, VANHP 2013).

Eight populations are characterized by insufficient data to allow a meaningful inference of short term trends, whereas two other populations appear to be in decline. At seven other populations where the taxon occurs at more than one subpopulation, trends are inconsistent. Some subpopulations appearing stable while others are either declining (two subpopulations), increasing (two subpopulations), or stable (three subpopulations). No populations appear to be increasing.

Donaldson (assisted early on by Smith) conducted monitoring of this and several other federally listed plant species at numerous sites in 1997-2001 (Donaldson 1999a, 1999b, 2002a, 2002b). Permanent monitoring plots were established within portions of seven populations (Bluff Mountain, Grandfather Mountain, Hanging Rock, Roan Mountain (two populations), Three Top, and Yellow Mountain/Raven Cliff) (Table A.1). The data represent fixed sampling points within larger occurrences of *H. montana* and in most cases cannot be used to estimate the total number of plants present in a subpopulation or population (Donaldson 1999b, 2002a, 2002b). Monitoring plots were established at one subpopulation at Bluff Mountain, two of seven subpopulations at Grandfather Mountain, one subpopulation at Hanging Rock Mountain, six of eight subpopulations at Roan Mountain, three of five subpopulations at Three Top, and at both subpopulations at Yellow Mountain/Raven Cliff (Table A.1). Unfortunately, Donaldson did not adhere to a consistent schedule for monitoring and occasionally expanded the size of plots from one year to the next (including additional plants not previously monitored). Data was provided in terms of clump counts at some sites during some years. In other instances, quadrats were used to estimate percent cover. Collectively, these issues make straightforward interpretation of the data difficult. Despite these issues, data suggest modest declines in *H. montana* at five populations (Bluff Mountain, Grandfather Mountain, Hanging Rock Mountain, Roan Mountain at Grassy Ridge, and Yellow Mountain/Raven Cliff). At two other populations (Roan Mountain west of Carvers Gap and Three Top), the taxon appears to be stable or improving based upon his data.

The U.S. Forest Service (USFS) erected a formal closure order at one subpopulation (within the Roan Mountain population west of Carvers Gap) in the early 1990s in response to impacts and declines in the rare species found there (including *H. montana*). All accounts by those familiar with the site conditions before the closure suggest that it has been largely successful and that numbers of most rare plant species have rebounded to (or near) historical levels (Danley 2004 pers. comm., Donaldson 1999a, 1999b, 2002b).

In 2005 and 2006, the USFS deployed hidden trail counters at this site in response to observations that many visitors were violating the closure order by entering closed areas (USFS 2007). The purpose of this investigation was to determine the level of visitation to the observation platform, and the percentage of visitors who climbed over established barricades (fences) and entered rare plant habitat. Trail counter data revealed approximately 2,300 visitors to the platform in 2005 and 2,000 visitors in 2006. In each year, an average of two persons per day violated the closure order. Although no discernable impacts were observed to rare plant species, *H. montana* is not monitored at this location, which makes it difficult to know for sure whether or not plants were trampled or killed from these impacts. However, at this location, *H. montana* co-occurs with *Geum radiatum*, another federally listed plant species that is monitored annually by the USFS.

The *G. radiatum* monitoring data obtained between 2005 and 2014 has demonstrated that the subpopulation of that species has remained stable over this time period. Although *H. montana* and *G. radiatum* occur in subtly different microhabitats and are likely subject to different limiting factors due to differences in biology and life-history (e.g., life span, pollination, seed set, dispersal and seedling recruitment), the USFWS assumes trampling pressures do not disproportionately affect one taxon more than the other. The absence of obvious declines or sources of trampling-related impacts within *G. radiatum* suggests that such impacts are not currently affecting *H. montana*.<sup>2</sup> Regardless, the volume of visitors (and violation of the closure order) demonstrates the potential magnitude of this threat and the need for continued monitoring and management to ensure that it does not reach critical levels of impacts within this or other *H. montana* populations.

Demographic-level monitoring has not been conducted at any population.

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

Glennon et al. (2011) explored the case for hybridization between *H. montana* and a congener, *H. purpurea* (following the taxonomy of *Houstonia purpurea* var. *montana* (Small) Terrell and *H. purpurea* var. *purpurea* (L.)). These investigators also characterized levels of population genetic structure within select *H. montana* populations. The genetic analyses employed the use of amplified fragment length polymorphisms (AFLP).

Glennon et al. (2011) sampled from six of the 17 populations recognized in this 5-year review.<sup>3</sup> Evidence was found to support *H. purpurea* and *H. montana* as distinct lineages with hybridization evident at two sites (Paddy Mountain in Ashe County, NC and Big Bald in Yancey County, NC). No evidence of hybridization was found at any other populations of *H. montana* sampled. Paddy Mountain hybrids showed evidence (in molecular markers and morphological traits) of backcrossing with *H. montana*, and Glennon theorizes that this could be contributing to declines in this *H. montana* population reported (to Glennon) by Donaldson (Donaldson 2002a and prior reports contain no mention of declines at this site).

Glennon et al. (2011) also found high levels of genetic variation within, and little differentiation between, other *H. montana* populations. This has been interpreted as support for larger population levels in the recent past. Evidence was found to suggest that the Grandfather Mountain population may have undergone a recent range expansion.

**d. Taxonomic classification or changes in nomenclature:**

The recovery plan discusses the taxonomy of this taxon at length. It acknowledges numerous disagreements ranging from the generic name (*Hedyotis* or *Houstonia*) to the issue of whether the taxon should be recognized as a full species or as a variety of *purpurea*. The USFWS listed the taxon as *Hedyotis purpurea* (L.) Torrey & Gray var. *montana* (Small) Fosberg, but the recovery plan acknowledged that the emerging consensus favoring treatment as a full species, *Houstonia montana* Small.

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<sup>2</sup> The USFWS and USFS have discussed the need to monitor the Roan Mountain population of *H. montana*, and the USFS has committed to the implementation of some level of monitoring of this species' population in the near future.

<sup>3</sup> Populations sampled include Bluff Mountain, Grandfather Mountain, Paddy Mountain, Roan Mountain at Grassy Ridge, and Roan Mountain west of Carvers Gap.



Weakley (2008) treats the taxon as *Houstonia montana* Small. Glennon et al. (2011) conclude that the patterns of genetic variation, morphological differences, and distribution along an elevational gradient (with *H. purpurea* occurring lower than 4,400ft and *H. montana* higher than 4,800ft in their sampled populations) support recognition of *H. montana* as a distinct species.

The USFWS submitted a technical revision to the list of Endangered and Threatened Species to the Regional Office in 2008 (Currie 2008, pers. comm.) proposing to recognize this taxon as a full species (*Houstonia montana* Small). To date, this change has not been published in the Federal Register and has not taken effect.

**e. 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.):**

The recovery plan described eight extant populations. All are on mountain peaks in northwestern North Carolina (in Ashe, Avery, Watauga, and Mitchell Counties). A site in Yancey County, North Carolina was presumed extirpated, and the Tennessee portion of the Roan Mountain population was regarded as possibly extirpated.

As of 2014, the current range consists of 17 populations of the taxon. The Yancey County, North Carolina population has been relocated and determined to be comprised of apparent hybrids between *H. montana* and *H. purpurea* (Glennon 2009, pers. comm.). This population is included in the tally of 17 extant populations; however, additional data may suggest it more appropriate to exclude this population from known populations of *H. montana*. The Tennessee portion of the Roan Mountain population has been confirmed extant and is also included in the tally of 17 populations. A population in Virginia was discovered in 2013, extending the known range to the north. The current county distribution of *H. montana* includes Ashe, Avery, Mitchell, Watauga, and Yancey Counties, North Carolina; Carter County, Tennessee; and Grayson County, Virginia (Table A.1).

In recognizing populations, the USFWS has typically deferred to the respective Natural Heritage Programs, who have mapped principal and sub element occurrences in accordance with NatureServe element mapping standards for delimiting rare plant element occurrences (EOs) (NatureServe 2004). In most instances, a "population" for purposes of this review is either a stand-alone EO or a parent EO containing multiple sub-EOs (Table A.1).

Ten of the 17 populations of *H. montana* consist of a single occurrence with no subpopulations (Table A.1). The remaining seven populations comprise a collective total of 36 subpopulations with a given population having anywhere from two to eight subpopulations. Additional information on these subpopulations (and the criteria for delineating them) is provided above.

**f. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):**

*H. montana* occupies high elevation (over 5,000ft above sea level) rocky summits and cliffs in the southern Appalachian mountains of western North Carolina, extreme eastern Tennessee, and southwestern Virginia. These rocky summits and cliffs usually appear as smaller-scale, patchy habitats usually embedded within a larger forested landscape consisting of spruce-fir or northern hardwood forest (occasionally high elevation red oak forest). But, they can also appear as smaller outcrops; or over patches of talus or scree embedded within a grassy or heath bald habitat.

Wiser et al. (1998) explored the habitat requirements of four southern Appalachian endemic plants (including *H. montana*) by devising predictive models of occurrence using parametric and nonparametric regression. Models were constructed at two scales (100m<sup>2</sup> and 1m<sup>2</sup>) and significant predictors were identified for *H. montana* at both scales. At the 100m<sup>2</sup> scale, potential solar radiation (inverse correlation with the presence of this taxon) and soil iron availability were significant predictors for this taxon. At the 1m<sup>2</sup> scale, vegetation height, soil cations, and the interaction of these factors were significantly correlated with the probability of occurrence of this taxon. Probability of the species increased with cation (iron) availability until vegetation height exceeded 50cm. As noted by the authors, the importance of soil iron in these models reflects underlying differences in the geology of the mountain ranges where this taxon occurs (soil iron-axis scores distinguishing mafic from felsic bedrock, and in turn correlating with differences in boron and copper content). *H. montana* occurs only on mafic bedrock or on felsic bedrock where mafic minerals occur as intrusions in nearby veins suggesting that suitable habitat for this taxon can vary on a very fine spatial scale.

The authors emphasize the need to examine habitat at an appropriate spatial scale in high elevation rock outcrop. Taxa like *H. montana* occupy rugged geologic formations that frequently exhibit considerable heterogeneity in elevation, aspect, solar radiation, soil depth, and chemistry within a few square meters. While these findings suggest that it will not usually be possible to predict the occurrence of this taxon from site parameters that can be inferred remotely, these models have considerable utility in evaluating microhabitats for future introduction efforts.

## **2. Five-Factor Analysis**

### **(a) Present or threatened destruction, modification or curtailment of its habitat or range:**

Although species-specific management agreements do not exist for any population of *H. montana*, the majority of landowners at the eight protected populations are cooperative and have expressed willingness to work with the USFWS and its partners toward the management and recovery of this taxon. A significant portion of the Grandfather Mountain population has been acquired by the State of North Carolina for inclusion in the North Carolina State Park system. The remainder of this population occurs on lands retained by Grandfather Mountain Inc., which is a 501(3)(c) devoted to education, outreach, and environmental stewardship (Pope 2009, pers. comm.). The USFWS has a long history of working with this landowner in the conservation of the rare species found there. The USFWS is actively working with staff from the North Carolina Division of State Parks and Recreation to conserve populations of federally listed plants on their other properties (including *H. montana*).

USFS manages the populations at Big Bald and Roan Mountain as part of the Pisgah and Cherokee National Forests. The USFWS works actively with the USFS to identify and address concerns relating to populations of federally listed plants across Roan Mountain, which is a popular destination for recreational visitors from across the country and beyond. The population at Big Bald has been rediscovered recently and (as noted above) appears to consist primarily or exclusively of hybrids between *H. purpurea* and *H. montana*. Regardless, at both populations, *H. montana* receives protection under the Endangered Species Act's provisions requiring federal agencies to assist in the recovery of federally listed species and avoid jeopardizing their continued existence through actions proposed, funded, or authorized by such agencies.

The principal source of habitat destruction affecting *H. montana* is the recreating public, who seek out high elevation views, adventurous rock climbing, boulder-hopping, or even just a flat and sparsely vegetated picnic spot. Trampling compacts the plant's rhizome and can shear plants from the rocks in

which they are anchored. In the process, soils that have developed over geologic time frames can also be destroyed, making recolonization of these sites (by this or other taxa) exceedingly difficult. Trampling is a significant threat to *H. montana*, having contributed to significant declines at one subpopulation<sup>4</sup> and continues to threaten the long-term viability of several others.

A related concern stems from the construction of facilities intended to control or direct visitor use. These facilities must be sited and constructed appropriately in order to avoid impacts to *H. montana*.

Protection of sites through public ownership can (and usually does) lead to increased visitation by the recreating public, thereby increasing the potential for impacts from trampling or construction of recreation-related facilities. Fortunately, many of the subpopulations are located in remote areas not frequented by most recreational visitors; however, there are notable exceptions. Some subpopulations occur within inches of established paths or popular destination points. These areas are frequented by visitors who are largely unaware that their decision to venture off-trail can result in the destruction of rare species and globally imperiled habitats. Passive interpretation involving the use of signs (and even barricades) has proven only moderately successful. In most cases, these measures must be supplemented by active efforts at education, outreach, and enforcement using on-the-ground presence of uniformed personnel.

Encouraging landowners to maintain the remote and inaccessible character of other areas, by discouraging the construction of trails directing visitors to these locations, will be beneficial for populations of *H. montana*. However, periodic monitoring of all sites is needed in order to ensure that visitor access is not posing a problem and that populations of *H. montana* are not succumbing to this or other threats. At present, monitoring is only occurring in a very qualitative manner at a few subpopulations and is insufficient for providing an early indication of impacts to this taxon.

**(b) Overutilization for commercial, recreational, scientific, or educational purposes:**

This factor was mentioned in the listing rule as a potential threat. A poaching incident was documented for this species in the summer of 2014 (Estep 2014, pers. comm.). Ten to 20 percent (two clumps) of USFWS population number eight (Table A.1) in Watauga County was dug and removed in July of 2014. The USFWS has no additional information to suggest overutilization has become a significant threat to the continued existence of *H. montana*.

**(c) Disease or predation:**

This factor was not regarded as a significant threat to the taxon in the listing rule or recovery plan. The USFWS has no additional information to suggest that it now poses a concern for the continued existence of *H. montana*.

**(d) Inadequacy of existing regulatory mechanisms:**

This factor was acknowledged as a threat in the listing rule and recovery plan, and remains a threat to the taxon. State laws protecting rare plant species have limited authorities, and neither North Carolina, Tennessee, nor Virginia rare plant statutes protect the species from habitat destruction from recreational use of federal lands (where four populations occur and remain vulnerable to this threat).

*Hedyotis purpurea* var. *montana* is state-listed as endangered in North Carolina and Tennessee. The North

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<sup>4</sup> This statement is in reference to the Roan Mountain population, and specifically the Roan High Bluff subpopulation.

Carolina Plant Conservation and Protection Act (North Carolina Code Article 19B, § 106-202.12) provides limited protection from unauthorized collection and trade of plants listed under that statute. However, the statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities. *Hedyotis purpurea* var. *montana* is protected under the Tennessee Rare Plant Protection Act of 1985 (T.C.A. 51-901), which forbids persons from knowingly uprooting, digging, taking, removing, damaging, destroying, possessing, or otherwise disturbing for any purpose, any endangered species from private or public land without the written permission of the landowner. The Virginia Endangered Plant and Insect Species Act (Chapter 10 § 3.2-1000 through 1011 of the Code of Virginia, as amended) primarily regulates collection and trade in listed species and does not prohibit landowners from neglecting or otherwise impacting such species on their own property or in conjunction with otherwise legal activities.

**(e) Other natural or manmade factors affecting its continued existence:**

The listing rule identified woody succession and natural rock slides as additional threats to the taxon. In reality, natural rock slides may also serve to open up additional areas of newly available habitat for an early successional taxa like *H. montana*. Thus, as with many factors, the frequency and severity of these disturbance events needs to be better understood for a meaningful evaluation of their effects upon the continued existence of this taxon.

Accelerated global climate change is likely to disrupt patterns of climate variability to which *H. montana* has become adapted and as such is likely to exacerbate threats already mentioned. However, the current scale of most global models of climate change offers little insight into the specific changes that will likely occur on southern Appalachian high peaks.

**3. Synthesis**

All protected populations are threatened by uncontrolled visitor use (trampling), which has resulted in demonstrable declines to the taxon and its habitat at some locations. However, the subpopulation with the most obvious declines has since been closed to the public by the USFS and appears to be recovering. An associated threat is the construction of recreation-related facilities within occupied habitat. Although intended to manage visitor use, such facilities, if poorly sited, can be destructive to *H. montana* populations. Vegetation succession is a potential threat at many sites; this threat may be exacerbated by accelerated climate change.

The USFWS listed the taxon as a variety of *Hedyotis purpurea*; however, the emerging consensus is to recognize the taxon as a full species (under the name *Houstonia montana* Small, a synonym reviewed and recognized in the recovery plan). This name change should qualify as a technical revision to the lists at 50 CFR 17.12; however, corrections to this list previously submitted by the USFWS's recovery lead (Currie 2008, pers. comm.) have not taken effect.

The number of extant populations has increased from eight to 17. However, available data suggest some populations (and portions of others) may be in decline. Due to the limited number of known populations and ongoing threats to its existence, the taxon continues to meet the criteria for endangered status.

No change in the status of the taxon is recommended.

### III. RESULTS

- 3.1 **Recommended Classification:** *Given your responses to previous sections, particularly section 2.4. Synthesis, make a recommendation with regard to the listing classification of the species*

☐ **Downlist to Threatened**

☐ **Uplist to Endangered**

☐ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11*):

☐ *Extinction*

☐ *Recovery*

☐ *Original data for classification in error*

☒ **No change is needed**

- 3.2 **New Recovery Priority Number:**

**Brief Rationale:**

- 3.3 **Listing and Reclassification Priority Number:** n/a

#### IV. RECOMMENDATIONS FOR FUTURE ACTIONS

If completed, the existing set of Recovery Tasks identified for this taxon would ensure the recovery of this taxon. Rather than drafting additional action items, those Recovery Tasks deemed most urgent and most likely to deliver the greatest end result have been identified and listed below in order of relative priority.

1. Work with appropriate partners to evaluate protection alternatives at unprotected populations, including the use of voluntary landowner agreements (*Recovery Task 1.4*).
2. Develop interim research and management plans in conjunction with cooperative landowners, especially the U.S. Forest Service (in affirmation of their Section 7(a)(1) and 7(a)(2) responsibilities as a federal agency under the Act). (*Recovery Task 1.1*)
3. Implement monitoring at a representative number of populations and subpopulations, for purposes of assessing status and trends and acquiring life-history information needed to inform future recovery efforts (*Recovery Tasks 2, 2.1, 2.2, 2.3, and 2.4*).
4. Use monitoring data to define criteria for self-sustaining populations (*Recovery Task 2.5*) and implement appropriate management techniques (*Recovery Task 2.6*).
5. Develop techniques to reestablish populations within suitable habitat (*Recovery Task 2.7*) and provide for long-term maintenance of selected populations in cultivation (long-term seed storage) (*Recovery Task 3*).
6. Collaborate with appropriate partners to begin stepping down global climate change models to a meaningful scale for purposes of projecting impacts to high elevation southern Appalachian rocky summits and cliffs. Devise and evaluate potential adaptation scenarios for *H. montana* (*Recovery Tasks 1.3 and 1.4*).

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of *Hedyotis purpurea* var. *montana* (Roan Mountain bluet)

Current Classification:

Recommendation resulting from the 5-Year Review:

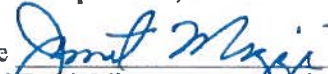
☐ Downlist to Threatened  
☐ Uplist to Endangered  
☐ Delist  
☒ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By:

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve  Date 4/27/10  
*The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.*

REGIONAL OFFICE APPROVAL:

*The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.*

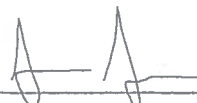
for Assistant  
Lead Regional Director, Fish and Wildlife Service

Approve  Date 9-1-17  
MATTHEW P. DEKAR

*The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. Written concurrence from other regions is required.*

Cooperating Regional Director, Fish and Wildlife Service

☒ Concur ☐ Do Not Concur

Signature  Date 07/10/17  
Acting R5 ARD-ES

**Appendix A. Summary of peer review for the 5-year review of Roan Mountain bluet (*Hedyotis purpurea* var. *montana*)**

**A. Peer Review Method:**

A draft 5-year review was sent to six reviewers, as an attachment to an email, requesting their review and any changes or additions that should be included in the document. All reviewers have extensive knowledge of *Hedyotis purpurea* var. *montana* and similar species. The following individuals responded to our peer review request:

**Peer Reviewers:**

- Geoff Call (Region 4, TN FWS Field Office)
- Shane Hanlon (Region 5, Southwestern VA FWS Field Office)
- Gary Kauffman (U.S. Forest Service)
- David Danley (U.S. Forest Service)

**B. Peer Review Charge:**

Peer reviewers were asked to conduct a scientific review of technical information presented. Reviewers were not asked to review the legal status determination.

**C. Summary of Peer Review Comments:**

Reviewers responded by email. All reviewers agreed that the information in the document provided to them was accurate.

**D. Response to Peer Review:**

Recommendations from the reviewers were incorporated into the document as appropriate. These consisted primarily of additional information concerning the status of certain populations, threats to the species, and recommendations for future actions.

**Table A.1. Cross-reference of USFWS populations to Natural Heritage Program element occurrence (EO) records for *Hedysotis purpurea* var. *montana* (Roan Mountain bluet).**

| USFWS pop ID | County, State            | Ownership <sup>a</sup> | Population name                    | Subpopulation name <sup>b</sup>   | Short term trend <sup>c</sup>   | NHP EO number <sup>d</sup>   | First/Last Observation Date (year)   |
|--------------|--------------------------|------------------------|------------------------------------|---|---------------------------------|--|--|
| 1            | Avery/Watauga, NC        | Private                | Hanging Rock                       | Northeast outcrop<br>Summit ridgeline<br>Hanging Rock Peak  | ?<br>?<br>↓                     | <NHP*47.045<br><NHP*47.045<br>NCHP*47.004  | 1998/1999<br>1998/1999<br>1986/1999  |
| 2            | Ashe, NC                 | NCDENR                 | The Peak                           | n/a   | ?                               | NCHP*023   | 1997/2001  |
| 3            | Ashe, NC                 | TNC                    | Bluff Mountain                     | Cowface Terrace & Ridge<br>Cowface Ridge to Perkins Rock <sup>f</sup>   | ↓<br>↓                          | <NCHP*006<br><NCHP*006   | 1842/2012<br>1842/2012   |
| 4            | Avery, NC                | Private                | Dun Vogan Mountain                 | Corner Pavement<br>Looking Off Place<br>n/a   | ?<br>?<br>?                     | <NCHP*006<br><NCHP*006<br>NCHP*025   | 1842/2012<br>1842/2012<br>1998/1998  |
| 5            | Avery/Watauga, NC        | NCDENR                 | Grandfather Mountain               | Linville Peak/Swinging Bridge to Hang Glide Cliff <sup>g</sup><br>Indian House Cave Gap <sup>h</sup><br>Dead Man's Gap <sup>h</sup><br>Haystack Rock/Calloway Peak/Watauga View <sup>i</sup><br>HBCP Tract<br>White Rocks Ridge<br>Quarry Ridge<br>Summit Ridge (north end) | ?<br>?<br>↔<br>?<br>?<br>?<br>? | <NCHP*44.017<br><NCHP*44.017<br>>NCHP*44.010, >44.013, >44.014<br>NCHP*44.019<br>NCHP*44.011<br>NCHP*44.012<br>NCHP*44.020<br>NCHP*018<br>NCHP*016 | 1986/2006<br><br>1989/2001<br>1989/2001<br>1890/1992<br>1994/1994<br>1988/2004<br>1988/1994<br>1994/1994<br>1994/2008<br>1989/1997 |
| 6            | Ashe, NC                 | NCPCP; Private         | Paddy Mountain <sup>g</sup>        | n/a   | ↔                               | NCHP*018   | 1994/2008  |
| 7            | Ashe, NC                 | Private                | Phoenix Mountain                   | n/a   | ?                               | NCHP*016   | 1989/1997  |
| 8            | Watauga, NC              | Private                | Potato Hill                        | n/a   | ↓                               | NCHP*008   | 1972/2014  |
| 9            | Mitchell, NC; Carter, TN | USFS                   | Roan Mountain west of Carver's Gap | Eagle Cliff <sup>f</sup><br>Roan High Bluff <sup>f</sup><br>Cloudland Trail/Loop Road <sup>f</sup><br>Brown's Bluff <sup>f</sup><br>Rhododendron Gardens  | ↔<br>↑<br>?<br>↔<br>?           | NCHP*28.009<br>NCHP*28.001<br>>NCHP*28.007, >28.030-28.033<br>NCHP*28.024<br>NCHP*28.034   | 1988/2006<br>1841/2013<br>1947/2005<br>1997/2001<br>1970/1989  |

|    |                       |               |   |                  |  |   |
|----|-----------------------|---------------|---|------------------|--|---|
|    |                       |               | Cloudland Hotel <sup>f</sup><br>Roan High Knob, SW<br>slope | ↔<br>?           | NCHP*28.029<br>NCHP*28.027   | 1995/2014<br>2004/2004  |
| 10 | Avery/Mitchell,<br>NC | USFS; Private | Roan Mountain:<br>Grassy Ridge                              | ↔<br>↓<br>↓<br>? | NCHP*28.041; TNHP*001<br><NCHP*39.003<br><NCHP*39.003, 39.037<br>NCHP*39.038<br>NCHP*39.035<br>NCHP*39.036<br>NCHP*021 | 1992/2007<br>1956/2010<br>1996/2010<br>1996/1996<br>1996/1996<br>1996/1996<br>1995/1995 |
| 11 | Avery, NC             | USFS          | Roan Mountain:<br>Houston Ridge                             | ?                | n/a  |   |
| 12 | Ashe, NC              | NCWRC         | Three Top<br>Mountain:<br>southwest                         | ?                | Little Rock<br>Middle Rock<br>Big Rock <sup>f</sup>  | 1990/2008<br>1990/2008<br>1990/2008   |
| 13 | Ashe, NC              | Private       | Three Top<br>Mountain: Jonassee<br>Rock                     | ?                | Huckleberry Rock<br>South Ridge Terraces<br>Looming Rock<br>n/a  | 1990/2008<br>1990/2008<br>1990/2008<br>1980/2008  |
| 14 | Avery/Mitchell,<br>NC | Private       | Yellow Mountain/<br>Raven Cliffs                            | ↓<br>↓           | Main Cliff<br>West Cliff   | 1996/2012<br>1996/2012  |
| 15 | Yancey, NC            | USFS          | Big Bald <sup>g</sup>                                       | ?                | n/a  | 1841/2010   |
| 16 | Yancey, NC            | Private       | Ogle Meadows  | ?                | n/a  | 2010/2010   |
| 17 | Grayson County,<br>VA | VADCR         | Grayson<br>Highlands State<br>Park                          | ?                | NCHP*056<br>VAHP*001   | 2013/2013   |

\*NCDPR = North Carolina Division of Parks and Recreation; NCWRC = North Carolina Wildlife Resources Commission; TNC = The Nature Conservancy

<sup>b</sup> For purposes of this review, USFWS delineated subpopulations using a separation distance of 100 meters (colonies occurring within 100 meters of one another were treated as members of the same subpopulation). Some subpopulations consist of multiple discretely mapped colonies.

<sup>c</sup> Short term trends as suggested by an examination of available data (in NHP records as well as Service files). Symbols: '↑' = data is inadequate for inferring trends, '↔' = apparently increasing, '↓' = apparently declining. See notes in main text regarding the limits of inferring trends from available data.

<sup>d</sup> Natural Heritage Element Occurrence Numbers as assigned by North Carolina Natural Heritage (NCJHP) or Tennessee Natural Heritage (TNIHP), as of June, 2009.

<sup>e</sup> Donaldson established monitoring plots at one or more locations within this subpopulation (Donaldson 1999a, 1999b, 2002a, 2002b).

<sup>f</sup> There are significant issues (confusion) with place names here, due in part to Donaldson's text and maps being inconsistent in assigning names to this pair of locations. However, this needs reconciliation (USFWS will pursue further with NHP and Donaldson).

<sup>g</sup> Glennon (2009, pers. comm.) has found that these two populations contain genetically and morphologically intermediate individuals, and thus may consist entirely of hybrids between *H. purpurea* and *H. montana*.