

Roan Mountain Bluet
Hedyotis purpurea var. *montana*
(= *Houstonia montana*)

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



Photo credit: Bill Lea

**U.S. Fish and Wildlife Service
Southeast Region
Asheville Ecological Services Field Office
Asheville, North Carolina
May 2023**

Roan Mountain Bluet 5-Year Review

5-YEAR REVIEW

Roan Mountain bluet, *Hedyotis purpurea* var. *montana* (= *Houstonia montana*)

GENERAL INFORMATION

Current Classification: Endangered

Lead Field Office / Review Author: Karla Quast, Asheville Ecological Services Field Office, 828-258-3939

Reviewers:

Lead Regional or Headquarters Office:

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Date of Original Listing: May 7, 1990 (55 FR 12793; April 5, 1990)

Methodology used to complete the review: In accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (Act), the purpose of a status review is to assess each threatened or endangered species to determine whether its status has changed and if it should be classified differently or removed from the Lists of Threatened and Endangered Wildlife and Plants (50 CFR 424.11). The U.S. Fish and Wildlife Service (Service) evaluated the biology, habitat, and threats of the Roan Mountain bluet (*Hedyotis purpurea* var. *montana*), hereafter called bluet, to inform this status review. The Federal Register notice announcing the initiation of this 5-year review was published on July 14, 2021 (86 FR 37178). No comments were received during the 60-day public comment period following this notice. However, the Service did receive additional information about the species from biologists familiar with the species, in response to requests for specific information.

FR Notice citation announcing initiation of this review: July 14, 2021 (86 FR 37178)

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Review History:

Five-year Review: 2017. A previous 5-year review for Roan Mountain bluet was conducted in 2017, which recommended maintaining the bluet's status as Endangered (Service 2017).

REVIEW ANALYSIS

Listed Entity

Taxonomy and nomenclature

An analysis of this variety of bluet, i.e., isolating mechanisms, interbreeding analysis with closely related varieties, and morphology, resulted in a change in taxonomic status from a variety (*Hedyotis purpurea* var. *montana*) to a full species *Hedyotis montana* (Service 1996 and references therein). Details of this taxonomic change were assessed in the following decades, and recent reviews and assessments of the species support the change to full species status. In addition to elevation to full species status, the genus that the species belongs to has changed from *Hedyotis* to *Houstonia*. Since 2008 Weakley, a noted expert in southeastern U.S. flora, has recognized the variety as a full species (Weakley 2008). As of 2022, Weakley and the Southeastern Flora Team recognized Roan Mountain bluet as *Houstonia montana* (Weakley and the Southeastern Flora Team 2022, page 1304). This updated nomenclature does not impact our assessment of the listed entity, and it is still considered a valid entity by the Service. Until we finalize a technical correction of the name, we will continue to reference the species using the name as it was listed.

Distinct Population Segment (DPS) ([61 FR 4722](#))

The Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing of a DPS to only vertebrate species. Because the species under review is not a vertebrate, the DPS policy does not apply.

Recovery Criteria

Final Recovery Plan for the Roan Mountain Bluet (*Hedyotis purpurea* (L.) Torrey & Gray var. *montana* (Small) Fosberg), May 13, 1996

Recovery plans are not regulatory documents but are intended to provide guidance to the Service, States, and other partners on methods of minimizing threats to listed species and on criteria that may be used to determine when recovery is achieved. If the recovery criteria defined in the plan are still valid, meeting recovery criteria can indicate that the species no longer requires protections under the Act. However, when recommending whether a listed species should be delisted, the Service must apply the factors in section 4(a) of the Act.

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 no longer qualifies for protection under the Endangered Species Act.

This criterion is not currently met. Data from the North Carolina National Heritage Program (NCNHP) was evaluated for population presence and protection status. It was established that 16 geographically distinct populations exist, 13 within North Carolina, two on the border between North Carolina and Tennessee, and one in Virginia (NCNHP 2021). Four of the 16 populations consist of multiple sites, only some of which are in protective ownership due to fragmentation. Portions of each population remain vulnerable to external threats such as trampling, climate change, and successional encroachment. In addition, the lack of consistency in survey data continues to constrain an objective analysis of potential self-sustaining population in this species.

Biology and Habitat Summary

Abundance, demographics, and spatial distribution

Roan Mountain bluet was federally listed in 1990. The listing rule referenced six populations in North Carolina, one of which occurs on the Tennessee/North Carolina border. The listing rule did not indicate the number of plants within the five populations entirely in North Carolina. By 1996, when a recovery plan was developed, two additional populations had been discovered within North Carolina, bringing the total to eight extant populations (Service 1996).

By the time of the 2017 5-year review, the number of known extant populations had increased from 8 to 17 (Service 2017). New populations were primarily found across rock outcrops at elevations above 1,400 meters within North Carolina, eastern Tennessee, and southwestern Virginia. Of the 17 populations, 10 consisted of a single occurrence, and the remaining seven populations were comprised of a total of 36 subpopulations (Service 2017).

By 2021, known extant populations had declined from 17 to 16 (Appendix A). One population in Yancey, North Carolina was removed in 2017 after survey efforts failed to find the species (NCNHP 2021; Table A). Population numbers in Tennessee and Virginia have remained the same since 2017 at one population each. A historical summary of extant populations is below (Table A).

Table A. Number of Extant Populations by State and Year

Year	North Carolina	Tennessee	Virginia	Total
1990	5	1	0	6
1996	7	1	0	8
2017	15	1	1	17
2021	14	1	1	16

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Of the 16 current populations, 12 consist of a single occurrence with no subpopulations, and the remaining 4 populations are comprised of subpopulations totaling 37 spatially discrete sublocations in which the bluet is known to occur or has historically occurred.

Grandfather Mountain and Roan Mountain continue to maintain the largest number of subpopulations (17 within Grandfather Mountain and 12 within Roan Mountain) and represent the largest known populations of the taxon. Current estimates of abundance for the populations vary due to survey efforts estimating abundance in terms of “clump,” “stem,” percentage based, or by counting “plants” without defining whether they were counting stems or clumps (NCNHP 2014, TNNHP 2014). Inconsistent and infrequent monitoring increases uncertainties associated with the species’ status and trends and the status of individual populations cannot be adequately assessed at this time.

Two of the single occurrence populations are classified as extirpated or failed to find (Table B). Surveys of three of the single occurrence populations have been completed within North Carolina since the 2017 5-year review. The 7 remaining single occurrence populations maintain the same latest observation date indicated on the 2017 5-year review, representing surveys conducted approximately between 1997 and 2013. Of the 12 populations, approximately 16% are considered extirpated or failed to find, 16% are in decline and 16% are considered in fair condition, the remaining 49% are rated good to excellent.

Table B. Population ranks of twelve populations with single occurrences

Rank*	Total	Percentage
A	2	16%
B	4	33%
C	2	16%
D	2	16%
Extirpated	1	8%
Failed to Find	1	8%

*EO Rank: A-Excellent, B-Good, C-Fair, D-Poor, E-Extant, F-Failed to Find. For populations which were dual ranked, the lower of the two ranking criteria is utilized.

The four multiple-occurrence populations comprise a collective total of 37 subpopulations. The number of subpopulations has increased by one from the previous five-year review due to the discovery of a new subpopulation in 2019. However, the new subpopulation is now considered extirpated after 2021 surveys did not find any plants at the site. These subpopulations are ranked individually in Table C. Of these subpopulations, over half are ranked poor, extirpated, or historical.

Table C. Subpopulation ranks for 4 multi-occurrence populations.

Rank	Total	Percentage
A	7	18.9%
B	7	18.9%
C	3	8%
D	10	27%
Extirpated	7	18.9%
Failed to Find	2	5%
Historic	1	2%

Genetics

Roan Mountain bluet is a distinct species that has significant genetic population differentiation also known as ‘population structure’ that might be linked to the disjointed populations ($\Phi_{st}=0.157$; Glennon et al. 2011). Glennon et al. (2011) used three microsatellite loci to distinguish Roan Mountain bluet from *H. purpurea* var. *purpurea* and determined the presence of hybridization between those species. This study determined that Roan Mountain bluet is a monophyletic taxa, not a sister taxa to *H. purpurea* var. *purpurea*. There is evidence of hybridization between those two species in Big Bald and Paddy Mountain populations based on morphological analyzes of seed size, floral, and vegetative traits, all individuals in both populations were classified as intermediate or hybrids (Glennon et al. 2011). Hybrid individuals are more genetically and morphologically similar to *H. purpurea* var. *purpurea* than Roan Mountain bluet, those two populations were excluded in the analyses for genetic population structure of Roan Mountain bluet (Glennon et al. 2011). A following study used microsatellites and flow cytometry analyzes to evaluate genetic diversity on populations of the North American genus *Houstonia*, section *Amphiotis* - east of the Mississippi, they determined that tetraploid populations of *Houstonia* are more genetically diverse than closely related diploids and suggested that hybridization occurred more often among tetraploid populations than among diploids (Glennon and Church, 2015). The two populations of Roan Mountain bluet evaluated for ploidy were found to be diploid, and observed heterozygosity was lower than expected ($H_O = 0.349$, $H_E = 0.639$, Glennon and Church, 2015).

Habitat or ecosystem conditions

Roan Mountain bluet is primarily located on high-elevation rocky summits and cliffs in the southern Appalachian Mountains. Due to its location climate change could exacerbate preexisting threats, such as invasive species and competition. Climate modeling depicts scenarios with reduced relative humidity, which is likely to result in reductions in population growth. Rare species, which are currently buffered from macroclimatic extremes due to their elevation, may see a reduction in population size as a result of the climate changing outcomes (Ulrey 2016).

Threats (Five-Factor Analysis) Summary

The status of a species is determined from an assessment of factors specified in section 4 (a)(1) of the Act. A summary of this assessment is detailed below.

Present or threatened destruction, modification or curtailment of its habitat or range (Factor A)

The 1996 recovery plan for Roan Mountain bluet identifies three types of habitat destruction as the most immediate threat to species located on privately owned lands. These three types of destruction include commercial, recreational, or residential development (Service 1996). Since the 2017 5-year review, the number of subpopulations located on privately owned lands has decreased from eight sites to five (representing 13.5

percent of currently extant subpopulations) due to habitat destruction which remains the primary threat to populations on private lands as of this review. Although, they are offered more protections, populations located on State-owned lands or National Forest lands (86.5 percent of extant subpopulations) still remain susceptible to trampling at accessible cliff or trailside locations as well as erosional loss of cliffside habitat (Service 1996). Some subpopulations are remotely located, but some occur within inches of established paths or popular destination points which put them at risk (Service 2017). Habitat modification is still considered one of the primary threats to this species with recreational use and climate change as the primary sources of habitat impacts given the proportion of subpopulations located on public vs. private lands.

Overutilization for commercial, recreational, scientific, or educational purposes (Factor B)

Although there was evidence of a single poaching event described in the 2017 5-year review (Service 2017), the Service has no information to suggest overutilization has become a significant threat to the continued existence of Roan Mountain bluet.

Disease or predation (Factor C)

The Service is not aware that disease or predation are a significant threat to the species.

Inadequacy of existing regulatory mechanisms (Factor D)

Of the 16 known populations of Roan Mountain bluet, 8 are located on State-owned lands and 4 are on U.S. Forest Service lands. These populations comprise a total of 32 extant subpopulations. On U.S. Forest Service lands, 36 CFR 261.9 prohibits removing or damaging any plant that is classified as threatened, endangered, sensitive, rare, or unique species. The North Carolina Plant Conservation and Protection Act (Chapter 106 §106-202.12 through 106-202.22 of the Code of North Carolina) lists Roan Mountain bluet as endangered, which provides limited protection from unauthorized collection and trade of plants listed under that statute. Roan Mountain bluet is protected under the Tennessee Rare Plant Protection Act of 1985 (T.C.A. 51 -90 I) and the Virginia Endangered Plant and Insect Species Act (Chapter 10§ 3.2-1000 through 1011 of the Code of Virginia, as amended). State and Federal statutes primarily regulate collection and trade in listed species and do not prohibit landowners from neglecting or otherwise impacting such species on their own properties or in conjunction with otherwise legal activities. Of the known populations, 75% (representing 86.5% of extant subpopulations) are located within boundaries of State or Federal lands, which protects the plants from many direct impacts, but there are limited resources to regulate activities that are in violation of Federal and State laws or for individuals who are unaware of the plant, its protections, or the law. Plants that occur on private lands have no regulatory protection.

Other natural or manmade factors affecting its continued existence (Factor E)

Roan Mountain bluet continues to occupy high elevation (over 5,000 feet above sea level) rocky summits and cliffs in the southern Appalachian Mountains. The bluet is rare and vulnerable due to its specialized habitat requirements. Most of the remaining populations are small in numbers of individuals and in terms of area covered by the plants. Therefore,

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little genetic variability exists in these species, making it more important to maintain as much habitat and as many of the remaining subpopulations as possible.

Climate change is expected to increase temperatures, create more intense droughts, increased rates of soil moisture loss, and increase intensity of storms and rainfall associated with hurricanes (Frankson et al. 2022, Runkle et al. 2022a, b). In addition, research suggests that climate change could create a phenological mismatch between blooming periods and common pollinators known to Roan Mountain bluet such as bees, flies, and ants. (Hegland et al. 2009, Visser and Gienapp 2019 for a detailed review).

There are three other federally listed rare plant species which are known to frequently occur within the vicinity of Roan Mountain bluet: Blue Ridge goldenrod (*Solidago spithamea*), Heller's blazingstar (*Liatris helleri*) and spreading avens (*Geum radiatum*) (Service 1996). Ulrey (2016) examined the influence of abiotic variables on the distribution and success of *Geum radiatum* within the southern Appalachian Mountains. Ulrey (2016) modeled a scenario with reduced relative humidity as might be seen with climate change and predicted reductions in population growth for *Geum radiatum*. This suggests that the rare species like the bluet which are currently buffered from macroclimatic extremes could see a 50% reduction in population size by 2050-2080, similar to the spreading avens modelled outcome (Ulrey 2016).

Synthesis

Roan Mountain bluet is a small perennial herb primarily located on high-elevation rocky summits and cliffs in the southern Appalachian Mountains. Available data suggests a decrease in overall abundance of the species. Since 2017, we have seen a reduction of populations from 17 to 16 populations and a reduction in the number of subpopulations (from 46 to 37 extant subpopulations). The known threats to the species include direct impacts to plants due to uncontrolled visitor use (trampling) being a primary threat even in protected lands, followed by commercial, recreational, and residential development especially to plants on private lands. Effects of climate change for high elevations constitutes an additional variable in future threats to the species. Because of the limited number of populations, the fact that almost half of the sub-populations are considered fair, poor, extirpated, or were not found, the specialized and limited habitat available to the species and the ongoing nature of primary threats, the Roan Mountain bluet should remain classified as endangered.

RECOMMENDATIONS FOR FUTURE ACTIVITIES

The 2017 5-year review included a list of recommendations to improve recovery of the species.

These activities, listed below, remain applicable to species recovery.

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*)

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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*).

Based on current scientific data, additional measures are recommended below:

1. Support research to determine hybrid vigor and determine ploidy of all populations.
2. Support research to determine ploidy of *H. purpurea* when cooccurring with Roan Mountain bluet.
3. Support additional microsatellite loci studies or support development of AFLP loci span the entire genome to evaluate hybridization patterns.

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RESULTS/SIGNATURES

U.S. FISH AND WILDLIFE SERVICE

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

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

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

Review Conducted By: Karla Quast, Asheville Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Asheville Ecological Services Field Office, U.S. Fish and Wildlife Service*

Approve _____

** Since 2014, Field Supervisors in the Region have been delegated authority to approve 5-year reviews that do not recommend a status change.*

COOPERATING REGIONAL OFFICE APPROVAL:

We emailed this 5-year review to the Northeast Regional Office for their concurrence prior to finalizing the document. We will retain any comments that we received, as well as verification of concurrence from other regions, in the administrative record for this 5-year review.

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APPENDIX A

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

EO Number	EO Rank ^a	Population Name	Number of Sub Population	State	County	Owner ^b
2	C/D	Big Bald	1	NC/TN	Yancey	USFS
6	A	Bluff Mountain	1	NC	Ashe	TNC
8	A/B	Potato Hill	1	NC	Watauga	Private
15	B	Three Top Mountain: Southwest	1	NC	Ashe	NCWRC
16	E	Phoenix Mountain	1	NC	Ashe	TNC
18	F	Paddy Mountain	1	NC	Ashe	NCDOA, PCP
21	D	Roan Mountain Massif: Houston Ridge	1	NC	Avery	USFS
22	B	Three Top Mountain: Jonasee Rock	1	NC	Ashe	Private
23	A	Long Hope Valley, Elk Knob, The Peak	1	NC	Ashe	NCDNCR
25	B?	DunVegan Mountain	1	NC	Avery	NCDNCR
26	B/C	Yellow Mountain / Raven Cliffs	1	NC	Mitchel	Private
28	A	Roan Mountain Massif	12	NC/TN	Mitchell NC / Carter TN	USFS
39	A	Roan Mountain Grassy Ridge	6	NC/TN	Mitchell/ Avery NC / Carter TN	USFS
44	A	Grandfather Mountain	17	NC	Avery/ Watauga	NCDENR
47	A	Hanging Rock	2	NC	Avery/ Watauga	Private
Unknown	C	Grayson Highlands State Park	1	VA	Grayson	VADCR

- a. Element Occurrence (EO) ranks are based on a combination population size, habitat condition, and landscape context observed at the last observation date. In situations in which the maximum estimate of population size is larger than the last available estimate, the corresponding EO rank may appear low, due to declines in the population observed at the last observation date.
- b. USFS = United States Forest Service, TNC = The Nature Conservancy, NCWRC = North Carolina Wildlife Resources Commission, NCDOA = North Carolina Department of Agriculture, PCP = Plant Conservation Preserves, NCDNCR = North Carolina Department of Natural and Cultural Resources, NCDENR = North Carolina Department of Environment and Natural Resources, VADCR = Virginia Department of Conservation.