Conservation Plan for the Virginia Big-eared Bat (*Corynorhinus townsendii virginianus*) in North Carolina

Figure 1. A hibernating Virginia big-eared bat (Corynorhinus townsendii virginianus).

SEPTEMBER 8, 2023

NC WILDLIFE RESOURCES COMMISSION

Conservation Plan for the Virginia Big-eared Bat (*Corynorhinus townsendii virginianus*) in North Carolina

DRAFT August 2023

Table of Contents

EXECUTIVE SUMMARY

The Virginia big-eared bat (VBEB; *Corynorhinus towsendii virginianus*) is a federally and state listed endangered subspecies of the Townsend's big-eared bat. This subspecies is found in North Carolina, Tennessee, Virginia, West Virginia, and Kentucky. Populations of VBEB occur in four genetically and geographically isolated regions (U.S. Fish and Wildlife Service 2008, 2019). North Carolina's VBEB population occurs primarily in Avery and Watauga counties with a few records on the border between Caldwell and Avery counties (Fig. 1). The VBEB was federally listed in 1979 due to habitat loss and increased human visitation to maternity roosts and hibernacula. Virginia big-eared bats were discovered in North Carolina in 1981 in a winter hibernaculum in Avery County, and this hibernaculum is considered the primary hibernaculum for the species in the state. A bat-friendly gate was installed on the hibernaculum in 1986 to prevent human disturbance. Despite much effort, a maternity cave was not discovered until summer 2013 when researchers tracked bats to a small Watauga County cave. In 2017, N.C. State Parks put the cave under protective status as a State Natural Area. Additional hibernacula records of VBEB have been found on the border of Caldwell and Avery counties. North Carolina Wildlife Resources Commission's population monitoring efforts consist of biennial counts at the primary hibernaculum on Grandfather Mountain in Avery County, and two emergence counts per summer at the maternity cave. Small hibernacula (<10 bats) are surveyed at least every four years. Population trends show stability despite fluctuations over time. North Carolina's VBEB have the potential for population growth due to protection of the primary hibernaculum and maternity cave and consistent monitoring should reveal any population changes. Targeted investigation into additional hibernacula and summer roosts will help identify key sites to protect as this population grows.

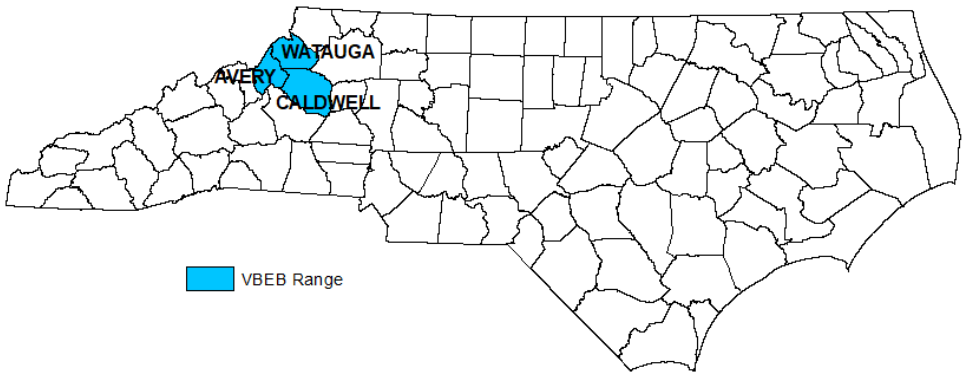

FIGURE 1 – VIRGINIA BIG-EARED BAT RANGE IN NORTH CAROLINA.

BIOLOGICAL INFORMATION

Introduction

The VBEB was listed as endangered by the U.S. Fish and Wildlife Service in 1979 due to habitat loss, vandalism to caves, and increased human visitation to maternity roosts and hibernacula (U.S. Fish and Wildlife Service 2008). This species was discovered in North Carolina during winter 1981 in a protected cave in Avery County (Clark 1987), and this site is considered the primary hibernaculum for VBEB in North Carolina. Virginia big-eared bats were largely absent from this cave during summer, and the maternity cave remained a mystery until Indiana State University (ISU) researchers tracked bats via radiotelemetry to a Watauga County cave in 2013 (Weber et al. 2016). The cave came under state protection in 2017 as a N.C. State Parks Natural Area. Though these two protected caves host the bulk of the North Carolina population, VBEB also rely on secondary roosts in other caves, rock shelters, and buildings. The 2013-2014 ISU radiotelemetry study identified over 30 secondary roosts, many of which are under private ownership. This study also found that tagged bats forage in areas surrounding roost locations (Weber et al. 2016). This conservation plan serves to describe the North Carolina population of the VBEB and identify methods to encourage population growth through land conservation and acquisition, and conservation of roosts and surrounding foraging habitat.

Listing Status

State

- State Listed Endangered
- S1, Critically Imperiled

Federal/Global

- Federally Listed Endangered
- G4T4, Apparently Secure Subspecies

Description and Taxonomic Classification

The Virginia big-eared bat is a medium-sized bat (9 to 11.2 cm [3.5 to 4.4 inches] in length), 5 to 13 g [0.18 to 0.46 ounces]) with ears over 2.5 cm [0.98 inches] in length (Handley 1959). Virginia big-eared bats have brown fur on the dorsal region and tan fur on the ventral region and prominent glandular lumps on the muzzle (Barbour and Davis 1969, Handley 1959).

Virginia big-eared bats belong to the order Chiroptera (Blumenbach 1779), family Vespertilionidae (Gray 1821), and genus Corynorhinus (Tumlison and Douglas 1992; formerly Plecotus). The VBEB is one of two subspecies of Townsend's big-eared bat (*Corynorhinus townsendii*), which is distributed throughout western North America from British Columbia, Canada to Oaxaca, Mexico. The Ozark big-eared bat (*Corynorhinus townsendii ingens*) is also a subspecies of Townsend's big-eared bat in northeastern Oklahoma and north-central Arkansas.

Life History and Habitat

Virginia big-eared bats are colonial, cave-dependent, non-migratory bats (Fig. 2). In winter, bats aggregate in 10 primary hibernacula across their range, one of which is in Avery County, North

Carolina (U.S. Fish and Wildlife Service 2019). In early spring, pregnant VBEB emerge from hibernacula and move to maternity roosts where they give birth to and rear their single pups (Pearson et al. 1952). Males are mostly solitary during the warmer months (Pearson et al. 1952, Barbour and Davis 1969, Humphrey and Kunz 1976).

FIGURE 2 – A CLUSTER OF HIBERNATING VIRGINIA BIG-EARED BATS.

In North Carolina, the primary hibernaculum is 14.4 km (8.9 miles) from the maternity roost (Weber et al. 2016). Weber et al. (2016) discovered the maternity cave and 32 secondary roosts during the ISU study in 2013 and 2014. These secondary roosts consisted of 23 natural rock structures (caves or rock shelters) and 10 artificial structures (barns or other buildings). The hibernaculum and maternity cave were used by hundreds of VBEB and had cooler, more stable temperatures, little airflow, and ample space compared to secondary roosts. Secondary roosts were used by 1-9 bats and had warmer, more variable temperatures and less space. Elsewhere VBEB use limestone caves (Barbour and Davis 1969), but North Carolina's known natural roosts are in granitic gneiss and metasedimentary rocks (Weber et al. 2016) perhaps due to a scarcity of limestone caves.

Forests surrounding roosts consist of southern and central Appalachian oak, oak montane, and cove forests (Weber et al. 2016). The diet of VBEB is more than 90% moths (Dalton et al. 1986, Bauer 1992, Sample and Whitmore 1993), many of which are dependent on forest plants for larval growth (Burford and Lacki 1999). Virginia big-eared bats also eat insects in the orders Neuroptera, Coleoptera, Diptera, and Hymenoptera (Hamilton 1943, Ross 1967, Whitaker et al. 1977). The ISU study found that VBEB foraged within 4.7 km [2.9 miles] of roosts (Weber et al. 2016). This species may glean prey from surfaces of vegetation or catch prey in flight (Kunz and Martin 1982). Virginia

big-eared bats forage along cliffs and within forests (Adam et al. 1994) and in areas with a mix of open and forested habitats (McGrath and Marsh 1997, Stihler 2011a).

Distribution and Population Status

Virginia big-eared bats were initially found in North Carolina in winter 1981, hibernating in a cave on Grandfather Mountain (Clark 1987), and this site is the primary hibernaculum. Subsequent surveys yielded just a few males at this site during summer, prompting the first study on the distribution of VBEB in North Carolina in 1986. Clark (1987) searched more than 100 caves and 20 mines in Watauga and Avery counties but found no new VBEB roosts. McGrath and Marsh (1996) conducted a 2-year radio telemetry study and tracked VBEB to eight new cave and rock shelter roosts; however, the maternity roost remained unknown. The N.C. Department of Transportation funded a study of VBEB to investigate possible impacts to the population from proposed widening of NC-105 (approximately 3.3 km [2 miles] from the primary hibernaculum), and researchers discovered the maternity cave in Watauga County in 2013 (Weber et al. 2016). This study also identified more than 30 roosts across Avery and Watauga counties in North Carolina, and Carter and Johnson counties in eastern Tennessee (Fig. 3).

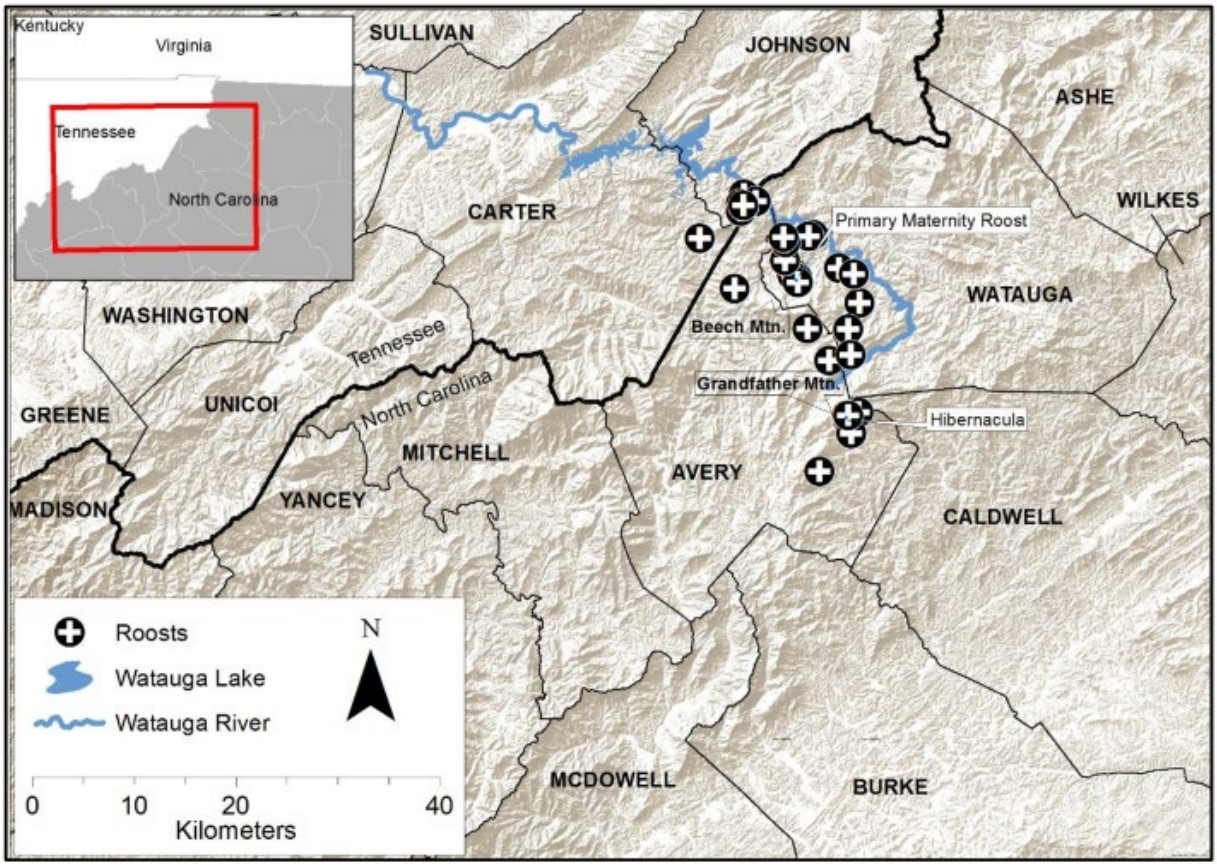

FIGURE 3 – VIRGINIA BIG-EARED BAT ROOST LOCATIONS (WEBER ET AL. 2016).

The primary hibernaculum contained 34 hibernating VBEB when the species was discovered in 1981 (Clark 1987). Periodic winter counts have been conducted at the primary hibernaculum and a nearby cave that has harbored a small number of VBEB since 2007 and, though counts fluctuate, a general

increase has occurred over time (Figs. 5, 6). The highest count on record occurred in 2023 with 462 VBEB. The ISU researchers noted that an unaccounted-for hibernaculum may exist upslope on Grandfather Mountain because nine tagged bats left the primary hibernaculum and their signals led to this area (Weber et al. 2016). Searches for the hibernaculum were unsuccessful due to ice and snow on steep, rocky terrain (Weber et al. 2016).

FIGURE 4 – VIRGINIA BIG-EARED BAT HIBERNACULUM SURVEY.

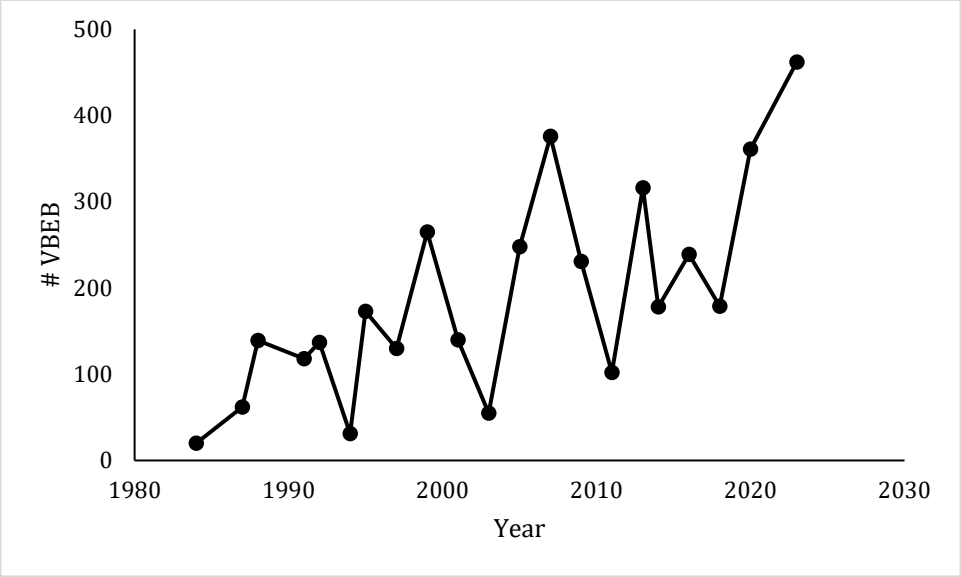

FIGURE 5. VIRGINIA BIG-EARED BAT (VBEB) WINTER COUNTS BY YEAR AT THE PRIMARY HIBERNACULUM IN AVERY COUNTY, N.C.

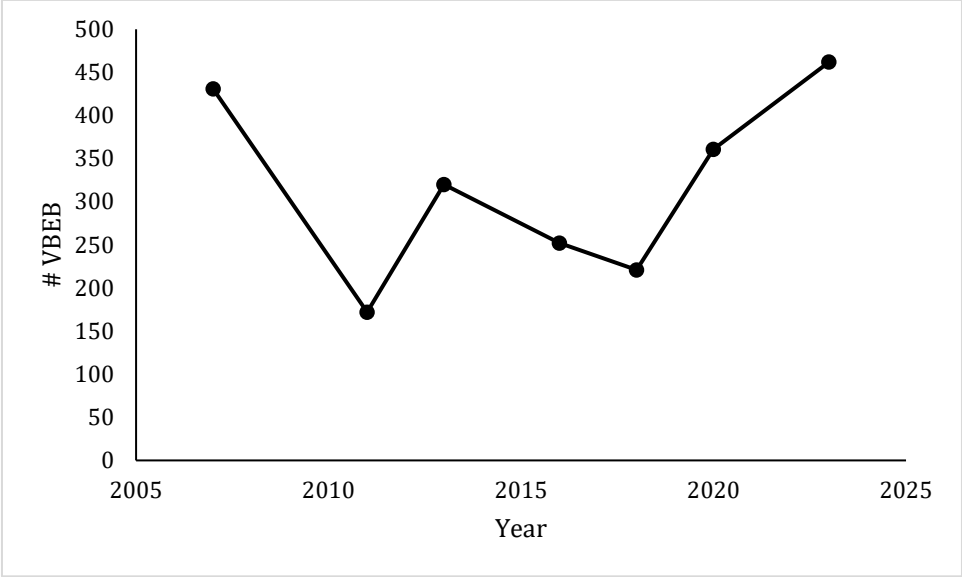

FIGURE 6. VIRGINIA BIG-EARED BAT (VBEB) WINTER COUNTS BY YEAR AT BOTH GRANDFATHER MOUNTAIN HIBERNACULA, AVERY COUNTY, N.C.

The maternity cave has been monitored since its discovery in 2013 using summer emergence counts. Counts fluctuate annually but appear relatively stable at around 350 VBEB or slightly increasing, with a recent 2022 record-breaking year (Fig. 7; min = 263, max = 533 VBEB). One criterion for downlisting the VBEB stated in the 2019 Recovery Plan is stable or increasing counts at both hibernacula and maternity sites over 16 years across each management unit. North Carolina counts have remained stable at the primary hibernaculum over the last 16 years and have increased at the primary maternity cave over the last 10 years (2013-2023).

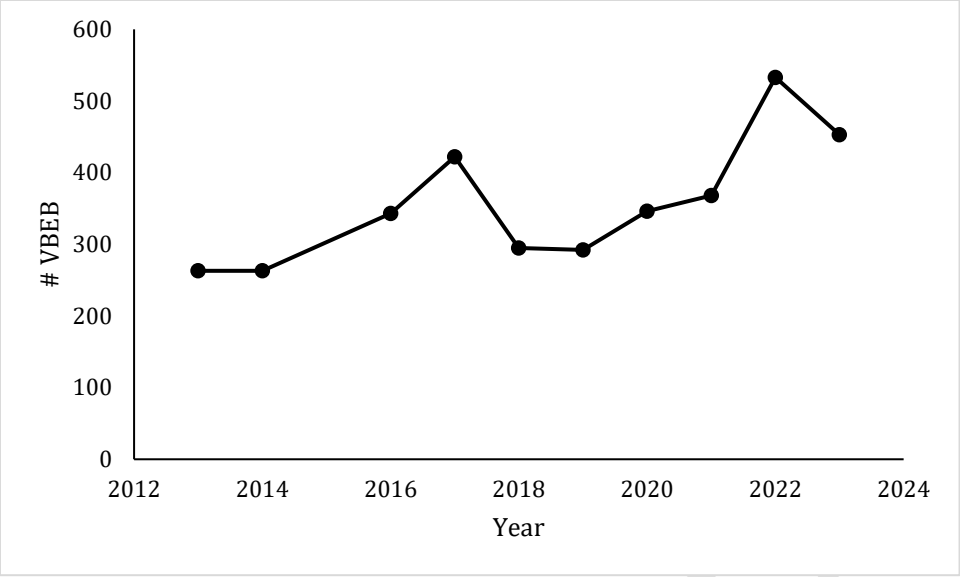

FIGURE 7. VIRGINIA BIG-EARED BAT (VBEB) MATERNITY CAVE EMERGENCE COUNTS BY YEAR IN WESTERN NORTH CAROLINA.

THREAT ASSESSMENT

Reason for Listing

The VBEB was listed as endangered by the U.S. Fish and Wildlife Service in 1979 due to loss of habitat, vandalism to caves, and increased human visitation to maternity roosts and hibernacula (U.S. Fish and Wildlife Service 1984). The bulk of the species' total population is concentrated in 10 hibernacula and 18 maternity sites because it requires caves or cave-like sites meeting specific microclimate conditions (U.S. Fish and Wildlife Service 1984, 2019). Additionally, the VBEB is highly sensitive to human disturbance and will abandon a roost entirely if disturbance becomes too great (Pearson et al. 1952, Graham 1966, Barbour and Davis 1969, Humphrey and Kunz 1976). The combination of large VBEB aggregations at just a few isolated sites with high sensitivity to human disturbance leave them vulnerable to threats. In North Carolina, the VBEB is listed as endangered (15A NCAC 10I .0103(a)(F)) and is a Wildlife Action Plan Species of Greatest Conservation Need (N.C. Wildlife Resources Commission 2015, 2021).

Present and Anticipated Threats

The 2008 Virginia big-eared bat 5-year review documented a range-wide population increase since the initial listing (U.S. Fish and Wildlife Service 2008). As a result of cave closures and installations of gates and fences, a 77% increase at maternity colonies was noted in West Virginia, which houses most of the VBEB population (Stihler 2011b). Despite range-wide increases, little connectivity exists among populations and the populations each contain genetic distinctions (Fig 8; Piaggio et al. 2009).

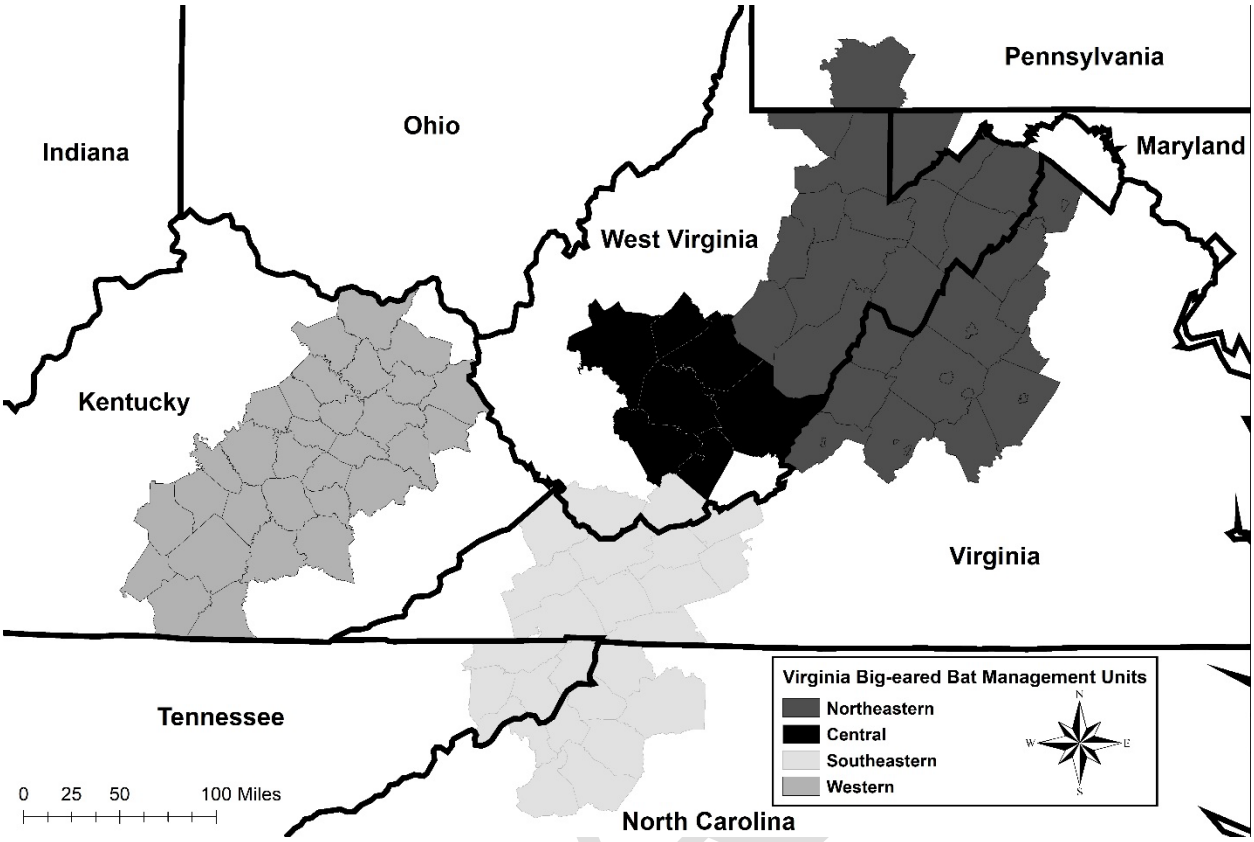

FIGURE 8. POPULATIONS OF VBEB THROUGHOUT THE SPECIES' RANGE (U.S. FISH AND WILDLIFE SERVICE 2019).

Threats identified by the 2019 Recovery Plan include "degradation and fragmentation of foraging areas, activities that could damage or degrade surface or subsurface areas of caves, barriers to migration and activities that reduce connectivity between roosting and foraging areas, as well as sources of direct mortality such as predation, roads, wind farms, and oil and brine pits. The effects of small population size and low genetic variability may also be threats" (U.S. Fish and Wildlife Service 2019).

In North Carolina, the concentration of this species in just two primary caves leaves the population vulnerable to local extinction from threats like human disturbance, predation (Fig. 9), or alteration of cave microclimates. Weber et al. (2016) documented presence of seven potential predators of bats at the entrance to the maternity cave during 2013 - 2015 (black bear, bobcat, coyote/domestic dog, long-tailed weasel, raccoon, striped skunk, and Virginia opossum). Racoons were captured on camera ten times more often than any other potential predator and were most often present during the hours (2100 – 0400) and months (April – September) bats were most active (Weber et al. 2016). Evidence of a predation attempt was only observed in a video recording of a coyote attempting to bite bats from the air as they reentered the cave (Weber et al. 2016).

Additionally, increased development in the area has the potential to negatively impact foraging habitat and create a barrier for migration. Weber et al. (2016) hypothesized road construction could negatively impact VBEB due to vehicle collisions, degrading foraging or roosting habitat, or creating a barrier between summer and winter habitats.

FIGURE 9. EXAMPLE OF PREDATOR PRESSURE AT THE ENTRANCE TO THE MATERNITY CAVE.

Summary of Threats

1. Low genetic variability and small population size due to minimal connectivity with other VBEB populations
2. Human disturbance
3. Predation
4. Microclimate alteration
5. Increased development

Historic and Ongoing Conservation Efforts

The primary hibernaculum is on property owned by the State of North Carolina and is protected from unauthorized entry by a bat friendly gate installed in 1986. This gate is the result of a cooperative effort between the U.S. Fish and Wildlife Service, Grandfather Mountain, Inc., and the National Park Service. In 2017, the maternity cave and adjacent parcels (totaling 174 acres [70 ha]) became an N.C. State Parks Natural Area through a coordinated effort among the Blue Ridge Conservancy, N.C. State Parks, the U.S. Fish and Wildlife Service, the N.C. Wildlife Resources Commission, Indiana State University, the N.C. Clean Water Management Trust Fund, and an anonymous philanthropist. Hibernacula in which small numbers of VBEB have been found are on properties owned by the National Park Service or N.C. State Parks.

Roosts found by Weber et al. (2016) are on properties owned by the National Park Service, N.C. State Parks, and the U.S. Forest Service in addition to over 10 roosts on private property. In 2017, flyers describing VBEB were distributed in Watauga and Avery counties requesting sightings be reported to the NCWRC, but no calls have been received at the time of this writing. In 2017, the VBEB species profile was updated on the NCWRC website.

Long-term protections must be in place at major maternity and hibernation sites to achieve downlisting of the VBEB (U.S. Fish and Wildlife Service 2019). The major North Carolina hibernacula and maternity site are owned by the State of North Carolina and are protected. Key foraging habitat must also be protected for downlisting of the species. Weber et al. (2016) conducted foraging telemetry on ten VBEB and only two bats foraged on protected lands near the maternity cave. The other eight VBEB foraged almost entirely on private lands and three of these bats foraged in areas along the Watauga River and Hwy 321 west of Hwy 421, suggesting this may be a key foraging area to focus future conservation efforts (Fig. 10).

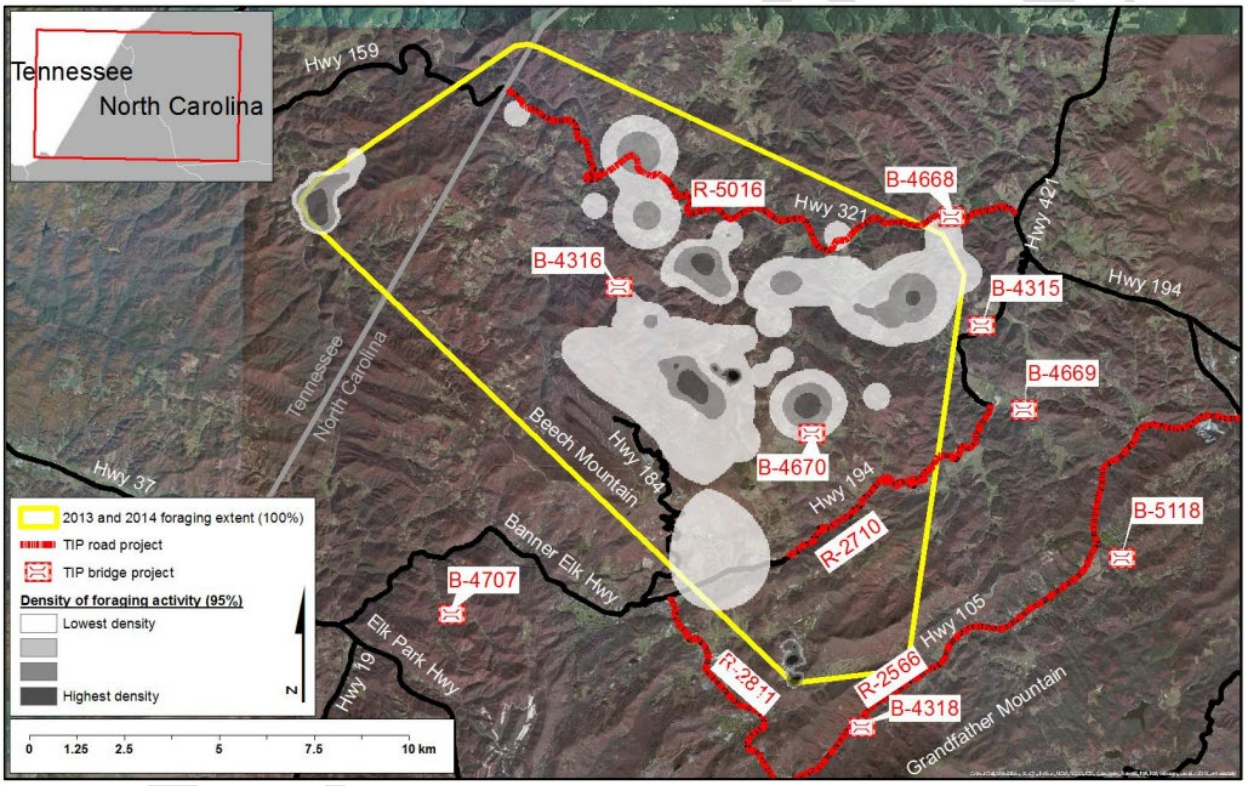

FIGURE 10. FORAGING ACTIVITY MAPS FOR 10 VIRGINIA BIG-EARED BATS (WEBER ET AL. 2016). TIP IS DEFINED AS TRANSPORTATION IMPROVEMENT PROGRAM BY THE N.C. DEPARTMENT OF TRANSPORTATION.

A short documentary film was released in 2019 by Appalachian State University and the Blue Ridge Conservancy which highlighted the discovery and subsequent protection of the VBEB maternity cave (Blue Ridge Conservancy 2019).

CONSERVATION GOALS

Overarching Goal

The goal of the Virginia big-eared bat conservation plan is to protect the species' roosting, foraging, and commuting habitats. The long-term goal is to encourage population growth in North Carolina and beyond and recovery of the species (U.S. Fish and Wildlife Service 2019).

Objectives

1. Identify additional key roosts for VBEB
2. Conserve foraging habitat
3. Conserve roosting habitat

CONSERVATION ACTIONS

Habitat Protection and Management

- Continue to monitor and maintain the existing cave gate at the primary hibernaculum. Use protocols detailed by Fant et al. (2009) to install gates or fences at sites threatened by human activities as determined by monitoring for vandalism and human visitation at VBEB caves.
- Secure long-term protection at newly found, important roost sites.
- Protect foraging habitat through land acquisition, private landowner participation in NCWRC's Wildlife Conservation Land Program, conservation easements, or partnerships.

Incentives (Tax break, Cost-sharing)

Wildlife Conservation Land Program. Reduces tax assessment for landowners with cave or mines on their property that have documented use by aggregations of bats. Restrictions must be made that reduce direct impacts (e.g., disturbance during bat hibernation) and indirect impacts (e.g., habitat changes that make the site unsuitable). This may require permanent gating of the site. A buffer must be created to minimize impacts to the site.

Conservation Easement. Provides federal tax benefits to landowners who donate conservation agreements on properties that protect natural habitats for fish, wildlife, and plants and preserve land for public outdoor recreation, educational opportunities, or as historically significant. Administered by non-profit Land Trusts.

Monitoring and Research

- Continue biennial winter counts at the primary hibernaculum.
- Continue periodic surveys at known hibernacula.
- Continue conducting two emergence counts per summer at the maternity cave.
- Continue trail camera monitoring at the maternity cave for signs of human entry or predation.
- Search for additional hibernacula and roosts.
- Periodically survey the maternity cave in winter to check for hibernation use.
- Investigate use of the primary hibernaculum as a maternity site.

- Monitor VBEB responses to transportation improvement projects near known roost or foraging sites.

Education and Outreach

- Continue sharing status updates with the N.C. Bat Working Group, Southeastern Bat Diversity Network, the U.S. Fish and Wildlife Service, and others as appropriate.
- Share the Appalachian State University VBEB documentary.
- Provide technical guidance or presentations on VBEB as requested.

SUMMARY OF ACTIONS NEEDED

TABLE 1. A SUMMARY OF CONSERVATION ACTIONS NEEDED TO ADDRESS THE GOALS, THE PARTNERS INVOLVED, AND THE DESIRED OUTCOMES OF EACH ACTION. THESE ACTIONS ARE LISTED GENERALLY IN ORDER OF PRIORITY, THOUGH ALL ACTIONS ARE CONSIDERED IMPORTANT AND NECESSARY.

#	ACTION	OBJECTIVE(S)	PARTNERS	DESIRED OUTCOMES	DATES ACTIONS PERFORMED
1	Continue to monitor and maintain the existing cave gate at the primary hibernaculum. Install gates or fences at sites with the threat of human disturbance	Prevent human disturbance in caves	N.C. State Parks, Grandfather Mountain Stewardship Foundation	Bats continue to hibernate and roost in caves	Yearly
2	Monitor activity at VBEB caves.	Detect human and predator visitation before bats become heavily disturbed	N.C. State Parks, Grandfather Mountain Stewardship Foundation	Address with gates or other measures	Yearly

3	Secure long-term protection at newly found important roost sites.	Ensure bats have long-term access to roost	TBD	Bats continue to use roost	TBD
4	Protect foraging habitat through land acquisition, WCLP participation, conservation easements, and partnerships.	Ensure bats have long-term access to foraging habitat	TBD	Bats continue to forage in priority areas	TBD
5	Continue biennial winter counts at the primary hibernaculum	Gather data	N.C. State Parks, Grandfather Mountain Stewardship Foundation	Use counts as a population monitoring tool	January or February of odd years
6	Continue periodic surveys at known hibernacula	Gather data	N.C. State Parks, National Park Service – Blue Ridge Parkway	Use counts as a population monitoring tool	Every 4 years
7	Continue conducting two emergence counts per summer at the maternity cave	Gather data	N.C. State Parks	Use counts as a population monitoring tool	Early June and late July/early August annually
8	Search for additional hibernacula and roosts	Gather data	TBD	Understand range expansion or detect other important habitats	TBD
9	Periodically survey the maternity cave in winter to check for hibernation use	Gather data	N.C. State Parks	Detect VBEB hibernating in maternity cave	Every 4 years

10	Investigate use of the primary hibernaculum as a maternity site	Gather data	N.C. State Parks, Grandfather Mountain Stewardship Foundation	Understand use of the hibernaculum as a potential maternity site	Summer survey every 4 years
11	Continue sharing status updates with the N.C. Bat Working Group, Southeastern Bat Diversity Network, the US Fish and Wildlife Service, and others as appropriate	Share information	TBD	Contribute to greater understanding of N.C. VBEB	Yearly
12	Share the Appalachian State University VBEB documentary	Share information	TBD	Contribute to greater understanding of N.C. VBEB	Yearly
13	Provide technical guidance or presentations on VBEB as requested	Share information	TBD	Contribute to greater understanding of N.C. VBEB	Yearly

GLOSSARY

Emergence Count: A count of the number of bats exiting a roost at night.

Hibernaculum: A shelter occupied during winter by a hibernating animal (i.e., caves and mines for hibernating bats).

Maternity Colony: A roost of females with pups.

Population: Group of individuals of a single species in a defined area.

Roost: A place where bats rest during the day.

Subspecies: A population of species in which individual shows the same structurally definable variation from other populations of the same species but are normally separated geographically or by habitat use.

LITERATURE CITED

Adam, M. D., M. J. Lacki, and T. G. Barnes. 1994. Foraging areas and habitat use of the Virginia big-eared bat in Kentucky. Wildlife Management 58: 462–469. Barbour, R. W., and W. J. Davis. 1969. Bats of America. Lexington, KY: The University Press of Kentucky. 286 p.

Bauer, E. D. 1992. The summer food habits of a bachelor colony of Virginia big-eared bats in eastern Kentucky with observations on associated feeding shelters. Thesis, Eastern Kentucky University, Richmond, USA.

Blumenbach, J. F. 1779. Handbuch der Naturgeschichte. Göttingen, Dieterich, 1830. https://www.biodiversitylibrary.org/bibliography/20551

Blue Ridge Conservancy. 2019. Saving the Virginia Big-eared Bat. https://vimeo.com/321050970 last accessed 2/13/2023 or https://youtu.be/rcdadwMDT_o last accessed 2/13/2023.

Burford, L. S., M. J. Lacki, and C. V. Covell. 1999. Occurrence of moths among habitats in a mixed mesophytic forest: implications for management of forest bats. Forest Science 45:323–332.

Clark, M. K. 1987. Results of a survey for the endangered Virginia big-eared bat (*Plecotus townsendii*) in western North Carolina. Final Report to North Carolina Wildlife Resources Commission on contract 86BAT01, Raleigh, North Carolina, USA.

Dalton, V. M., V. Brack, Jr., and P. M. McTeer. 1986. Food habits of the big-eared bat, *Plecotus townsendii virginianus*, in Virginia. Virginia Journal of Science 37:248–254.

Fant, J., J. Kennedy, R. Powers, and W. Elliot. 2009. Agency Guide to Cave and Mine Gates. Sponsored by the American Cave Conservation Association, Bat Conservation International, and Missouri Department of Conservation. http://www.batcon.org/pdfs/AgencyGuideCaveMineGating2009.pdf

Graham, R.E. 1966. Observations on the roosting habits of the big-eared bat, *Plecotus townsendii* in California limestone caves. Cave Notes, 8:17-22.

Hamilton, W. J., Jr. 1943. The mammals of eastern United States. Comstock Publishing Company, Ithaca, 432 pp.

Handley, C.O., Jr. 1959. A revision of American bats of the genera *Euderma* and *Plecotus*. Proceedings of the U.S. National Museum. 110: 95-246.

Humphrey, S. R., and T. H. Kunz. 1976. Ecology of a Pleistocene relict, the western big-eared bat (*Plecotus townsendii*), in the Southern Great Plains. Journal of Mammalogy 57:470-494.

Kunz, T. H., and R. A. Martin. 1982. *Plecotus townsendii*. Mammalian Species 175:1–6.

McGrath, C., and S. S. Marsh. 1997. A study to determine foraging area and maternity colony sites of Virginia big-eared bat. North Carolina Wildlife Resources Commission Report, Raleigh, North Carolina, USA.

N.C. Wildlife Resources Commission. 2015. North Carolina wildlife action plan. Raleigh (N.C.): N.C. Wildlife Resources Commission.

N.C. Wildlife Resources Commission. 2021 Protected wildlife species of North Carolina. Raleigh (N.C.): N.C. Wildlife Resources Commission.

Pearson, O. P., M. R. Koford, and A. K. Pearson. 1952. Reproduction of the lump-nosed bat (*Corynorhinus rafinesquei*) in California. Journal of Mammalogy 33:273-320.

Piaggio, A. J., K. W. Navo, and C. W. Stihler. 2009. Intraspecific comparison of population structure, genetic diversity, and dispersal among three subspecies of Townsend's big-eared bats, *Corynorhinus townsendii townsendii*, *C. t. pallescens*, and the endangered *C. t. virginianus*. Conservation Genetics 10:43-159.

Ross, A. 1967. Ecological aspects of the food habits of insectivorous bats. Proc. Western Found. Vert. Zool. 1:205-264.

Sample, B. E., and R. C. Whitmore. 1993. Food habits of the endangered Virginia big-eared bat in West Virginia. Journal of Mammalogy 74:428–435.

Stihler, C.W. 2011a. Radiotelemetry studies of female Virginia big-eared bats (*Corynorhinus townsendii virginianus)* in Pendleton County, West Virginia. In: Loeb, S.C.; M.J. Lacki, and D.A. Miller, eds. Proceedings of the symposium on the conservation and management of big-eared bats in the eastern United. States.. General Technical Report, USDA Forest Service Southeastern Experimental Station.

Stihler, C.W. 2011b. Status of the Virginia big-eared bat (*Corynorhinus townsendii virginianus*) in West Virginia: Twenty-seven years of monitoring cave roosts. In: Loeb, S.C., M.J. Lacki, and D.A. Miller, eds. Proceedings of the symposium on the conservation and management of big-eared bats in the eastern United States. General Technical Report, USDA Forest Service Southeastern Experimental Station.

Tumlison, R., and M. E. Douglas. 1992. Parsimony analysis and the phylogeny of the plecotine bats (Chiroptera: Vespertilionidae). Journal of Mammalogy 73:276-285.

U.S. Fish and Wildlife Service. 1984. Recovery Plan for the Ozark Big-eared Bat and Virginia Big-eared Bat. U.S. Fish and Wildlife Service, Twin Cities, MN.

U.S. Fish and Wildlife Service. 2008. Virginia Big-Eared Bat (*Corynorhinus townsendii virginianus*) 5-Year Review: Summary and Evaluation. Report prepared by the West Virginia Field Office.

U.S. Fish and Wildlife Service. 2019. Recovery plan for the Virginia Big-eared Bat (*Corynorhinus townsendii virginianus*) Draft Amendment 1. Report prepared by the WVFO.

Weber, J. A., J. M. O'Keefe, B. L. Walters, and R. J. Arndt. 2016. Ecology of Virginia big-eared bats in North Carolina and Tennessee. Report prepared for the North Carolina Department of Transportation. Indiana State University, Terre Haute, IN.

Whitaker, J. 0., Jr., C. Maser, and L. E. Keller. 1977. Food habits of bats of western Oregon. Northwest Sci., 51:46-55.