Virginia Big-Eared Bat
(Corynorhinus townsendii virginianus)
5-Year Review:
Summary and Evaluation

Photo by: C. Stihler

U.S. Fish and Wildlife Service
West Virginia Field Office
Elkins, West Virginia

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5-YEAR REVIEW
Virginia big-eared bat
(Corynorhinus townsendii virginianus)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional or Headquarters Office:
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Cooperating Field Office/Biologist(s):
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Cooperating Regional Office(s):
Region 4, Kelly Bibb, (404) 679-7132

1.2 Methodology used to complete the review:

The Virginia big-eared bat (VBEB) 5-year review was compiled primarily by the lead recovery biologist for this species. U.S. Fish and Wildlife Service (Service) field office and state natural resource agency personnel responsible for the recovery of this species were contacted for current information on occurrences, threats, and recovery activities in West Virginia, Virginia, North Carolina, Tennessee, and Kentucky. The Service appreciates the efforts of numerous biologists and volunteers who have assisted in gathering data and conducting surveys that were used in this review. We also appreciate the efforts of the following Federal and state agency biologists who provided detailed information that assisted this review:

- Craig Stihler, West Virginia Division of Natural Resources (WVDNR)
- Paul Lenza, New River Gorge National River (NRGNR)
- Traci Hemberger, Sunni Carr, and Zach Couch, Kentucky Department of Fish and Wildlife Resources (KYDFWR)
- Rick Reynolds, Virginia Department of Game and Inland Fisheries (VDGIF)
- Katherine Caldwell and Joey Weber, North Carolina Wildlife Resources Commission (NCWRC)

1.3 Background:

1.3.1 Federal Register (FR) notice announcing initiation of this review:
83 FR 39113-39115; August 8, 2018

Two public comments were received in response to this notice. One commenter provided non-substantive comments. The other provided comments on the distribution and threats to the VBEB in Virginia, and recommended that the species status should not be downgraded. This information has been evaluated and incorporated as appropriate in this review.

1.3.2 Listing history

Original Listing
FR notice: 44 FR 69206-69208
Date listed: November 30, 1979
Entity listed: This was a joint listing and critical habitat designation for the Ozark big-eared bat (OBEB)(*Plecotus townsendii ingens*) and the VBEB.
Classification: Endangered

1.3.3 Associated rulemakings:
A proposed listing and critical habitat designation was published on December 2, 1977 (42 FR 61290-61292). However because amendments were made to the Endangered Species Act (ESA) before a final action could be taken, the FR notice was revised on August 30, 1979 to address the new requirements for proposing critical habitat (44 FR 51144 51145). There have been no further rulemakings since that time.

1.3.4 Review History
The Virginia big-eared bat was included in cursory 5-year reviews for listed species, as follows: July 22, 1985 (50 FR 29901); July 7, 1987 (52 FR 25523); and November 6, 1991 (56 FR 56882). A detailed formal status review was completed on August 20, 2008. That review determined that the species should remain listed as endangered. The 2008 review also recommended that the Recovery Plan for the species should be updated to address current species information, including genetics, distribution, and threats. An important component of this was recognizing importance of and differences between the four geographic regions within the range of the species. This 2019 review summarizes new information that has become available since the 2008 review was completed.

1.3.5 Species' Recovery Priority Number at start of 5-year review: The VBEB currently has a recovery priority number of 9c, indicating a moderate degree of threat, high recovery potential, and conflict with economic development for this subspecies.

1.3.6 Recovery Plan or Outline

Name of plan or outline: Ozark & Virginia Big-Eared Bat Recovery Plan
Date issued: May 8, 1984
Dates of previous revisions, if applicable: On March 28, 1995, a Recovery Plan specifically for the OBEB was finalized. Therefore, the 1984 plan no longer applies to that sub-species. No revisions specific to the VBEB have been finalized. Recovery plan amendments are currently being planned.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

__X_ **Yes**
_____**No**

2.1.2 Is the species under review listed as a DPS?

____ **Yes**
_X_ **No**

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____ **Yes**
__X_ **No**

2.2 Recovery Criteria

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

_X_ **Yes, but only for reclassification.**
____ **No**

2.2.2 Adequacy of recovery criteria.

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

____ **Yes**
_X_ **No**

The recovery criteria do not reflect the most current information in regard to genetics and population structure of the species (See section 2.3.1.3).

2.2.2.2 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
_X_ No

The recovery criteria for downlisting do not directly address the need for adequate regulatory mechanisms to reduce threats from wind power, road construction, development, and quarry/mining activities in the absence of the ESA. Although the recovery criteria requiring "documented stable or increasing populations" may be an indirect measure of this, the criteria do not directly address threats as a result of modification or destruction of habitat, or "other factors" such as disturbance and vandalism.

In addition, no recovery criteria are provided for delisting the species.

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

The Recovery Plan lists four criteria for downlisting the VBEB to threatened status:

1. Documentation of long-term protection of 95 percent of all known active colony sites.

2. Documentation of stable or increasing populations at 95 percent of the known active maternity sites and hibernacula for a period of 5 years.

3. Foraging habitat for both subspecies must be identified, and restored as much as possible. However, a given amount of foraging habitat cannot be required in the objective at this time due to lack of information on colony needs.

4. Finally, a periodic monitoring program must be established to ensure a continued awareness of the status of these animals.

The Recovery Plan also concluded that "It seems unlikely that the Virginia big-eared bat will recover to a point where it can be removed from the threatened list. However, this matter should be reconsidered at the time its status is reduced from endangered to threatened."

Recovery Criterion 1: Documentation of long-term protection of 95 percent of all known active colony sites

This is a difficult criterion to measure, particularly for hibernacula, since there are a number of sites that are used by low numbers (e.g., less than 20) of VBEBs each year.

However, we can evaluate the status of the sites that house the majority of the current population, as shown in the table below. The 2008 status review considered a site to have documented long-term protection if it was: 1) signed as closed with no history of access violations and/or gated, fenced AND 2) was in private ownership with a signed conservation agreement that will transfer to new owners or is owned by Federal or state conservation agencies. This definition was used by previous recovery leads for the species (Service, unpublished data, 1996). The protection status of the major VBEB hibernacula and maternity sites as well as the number of VBEBs present at each site is shown in table 1. Major sites were previously defined in the 2008 status review as sites that have currently or in the past supported more than 200 VBEBs.

Table 1: Numbers and Protection Status of Major VBEB Hibernacula and Maternity Sites

Hibernacula							
# of VBEBs last status review (2007/2008)	**# of VBEBs prev. 5 years (2012/2013)**	**# of VBEBs most recent count (2017/2018)**	**Name**	**State**	**Gated**	**Ownership**	**Long-term protection?**
5,006	7,640	13,493	Hellhole	WV	Fenced	Private	No
3,121	4,668	3,609	Stillhouse	KY	Yes	USFS	Yes
1,285	885	660	Schoolhouse	WV	Yes	State	Yes
543	591	487	Cave Hollow/Arbogast	WV	Yes	USFS	Yes
1,160[1]	433	301	Higgenbotham	VA	Yes	State	Yes
87	146	258	Cliff	WV	No	Private	No
203	136	237	Minor Rexrode	WV	Yes	State	Yes
76	264	204	Sinnett/Thorne	WV	Yes	Private	No
376	316	179	Blackrock Cliff	NC	Yes	TNC	Yes
35	98	146	Johnson	KY	No	Private	No
11,892	**15,177**	**19,574**	**Total**				
Maternity							
910	1,165	1,517	Cliff	WV	No	Private	No
1,175	1,195	1,456	Hoffman School	WV	Yes	State	Yes
979	1,246	1,240	Peacock	WV	No	USFS	Yes
698	933	1,200	Cave Hollow/Arbogast	WV	Yes	USFS	Yes
361	841	1,050	Sinnitt/Thorn Mountain	WV	Yes	Private	No
630	905	912	Schoolhouse	WV	Yes	State	Yes
576	537	797	Mystic	WV	No	Private	No
NA	NA	760	Johnson	KY	No	Private	No
131	297	522	Mill Run	WV	No	Private	No
350	NA	474[1]	Arbegast	VA	Yes	Private	No
564	368	469	Cave Mountain	WV	Yes	USFS	Yes
450	791[2]	450[1]	MBC	VA	Yes	Private	Yes
NA	**NA**	301	Gale Warner	WV	No	Private	No
NA	NA	295	Mama's Cave	NC	No	State	No[3]
288	447	235	Lambert	WV	Yes	Private	No
57	270	111	Cave Hollow Pit	KY	No	USFS	Yes
299	203	22	Plecotus Pit	KY	No	USFS	Yes
350	12	8	Higgenbotham	VA	Yes	State	Yes
7,818	**9,210**	**11,819**	**Total**				

1: No surveys for the target window are available. These counts are for the closest survey period to the time period given.
2: This count likely includes volant young.
3. This site is owned by the State, however it is not signed so it does not meet the full definition of protected.

A total population of 19,574 VBEBs has been documented within the 10 major hibernacula. Six of these caves (60 percent) have documented long-term protection. These sites are owned by State resource agencies, the U. S. Forest Service (USFS) and The Nature Conservancy (TNC). However, the previously-used definition of long-term protection does not explicitly address the fact that access violations can occur even if a site is gated. Three of the six "protected" caves have been subject to vandalism of the cave gates, or had illegal entries in the last 5 years; therefore even these protected caves are still subject to continued threats from disturbance. In addition, 14,101 of the hibernating VBEBs (72 percent) use unprotected caves, therefore only 28 percent of the population is currently hibernating in caves that meet the previously-used definition of protected. Approximately 69 percent of the total range wide population hibernates in a single cave, Hellhole, which does not have long-term protection. Therefore, this criterion has not been met for VBEB hibernation sites.

Since the time of the 2008 status review, three hibernacula that had less than 100 bats have increased to over 200 bats (Johnson Cave, Cliff, and Sinnitt/Thorne). Two additional sites were also purchased by their respective states, Schoolhouse and Higgenbotham. At the time of the last status review, 57 percent of the major hibernacula were protected and these caves supported 37 percent of the population. As of 2018, a greater percentage of the hibernacula are protected caves, but these protected caves support a lesser percentage of the overall population.

There are 18 major VBEB maternity colony sites that support a total of 11,819 VBEBs. Nine of these caves (50 percent) are protected. These protected caves support 5,868 (49 percent) of the maternity population. Therefore, this criterion has not been met for maternity sites.

Since the 2008 status review, two new major maternity sites have been discovered (Mama's Cave and Johnson Cave) and one historical site has been restored and become occupied (Gale Warner). Numbers at two sites that previously supported more than 200 bats have dropped to less than 25 VBEBs (Plecotus Pit and Higgenbotham). In addition, Black Rock Cliff Cave in North Carolina, a known hibernacula, was documented to also support a maternity colony of 125 VBEB (including some young).

Recovery Criterion 2: Documentation of stable or increasing populations at 95 percent of the known active maternity sites and hibernacula for a period of 5 years.

The most recent monitoring data show a significant overall population increase since the time of the last status review and for the last 5 years as shown in table 1. Total population numbers have increased 30 percent and 28 percent over the past 5 years for hibernating and maternity sites, respectively. However, numbers within a single cave, Hellhole, are driving this overall increase. Over the past 5 years, numbers of VBEBs hibernating within Hellhole have increased by 5,853 bats, while the overall population has increased by only 4,397 bats. Outside of Hellhole, there has been some variation between regions and within specific caves. Six of the 10 major hibernacula have had numbers decline in the past 5 years, as have 5 of the 18 major maternity sites (60 percent

and 28 percent of hibernating and maternity caves declining). Some of these declines may be due to bats switching between roosts, but in some cases and regions, increases in some caves do not compensate for losses in others. For example, although the number of bats hibernating in Johnson Cave in Kentucky has increased by 48 bats, populations in Stillhouse Cave, the other major hibernacula in the state, have decreased by 1,059 bats. Additional information on cave and region-specific trends can be found in the Regional Summaries in Appendix A.

While overall population numbers appear to be steadily increasing, these increases are not consistent across sites and recent declines have been seen at a number of the major VBEB sites. Therefore, this recovery criterion has been partially met.

Recovery Criterion 3: Foraging habitat must be identified, and restored as much as possible.

When the Recovery Plan was written, very little information was known about VBEB foraging needs. However, the Recovery Plan acknowledged the importance of identifying and protecting this habitat through the establishment of this criteria. Since that time, substantial new information has been developed about this recovery need. The 2008 status review summarized new information on foraging habitats for the VBEB that had become available since the time of listing. That information is still valid except as supplemented or modified by new information below. Since the 2008 status review, new information is available on foraging strategies and prey selection, habitats used for foraging and roosting, and movement patterns between these areas.

Lacki and Dodd (2011) summarized foraging strategies and prey selection for *Corynorhinus* species including VBEB. These species are foraging specialists with lepidopterans (moths) comprising greater than 80 percent of the prey (Lacki and Dodd 2011). The bats use both aerial hawking and gleaning foraging strategies (meaning they capture prey in air or from the surface of objects) (Lacki and Dodd 2011). This genus of bats has a number of morphological features making them well-adapted to gleaning, which in turn can provide ecological advantages because gleaning bats are not dependent on having insects actively flying during foraging efforts (Lacki and Dodd 2011). They can therefore feed later at night, at cooler temperatures, and for a longer season, than bats that rely solely on aerial hawking (Lacki and Dodd 2011). Foraging tends to occur near forest/edge interfaces and along forested and riparian corridors in areas that have abrupt changes in vertical structure as well as both vertical and horizontal surface area for gleaning (Lacki and Dodd 2011). Lacki and Dodd (2011) also note that the majority of moth species that make up the primary prey base for *Corynorhinus* bats are dependent on woody plant hosts for larval development. They therefore recommend managing for landscapes with "sufficient acreage in forest while providing for corridors and other forest/edge interfaces;" although what constitutes "sufficient" has not yet be defined. These bats appear resilient to moderate levels of timber harvest, but do require a diversity and abundance of local plant species, which suggests that managing for woody plant diversity is required to provide an adequate prey base (Lacki and Dodd 2011). Summerville and Crist (2002) found that moth species richness was significantly lower in

clear-cut stands, but did not differ between selectively logged and unlogged stands. This is consistent with Stihler (1994) who found VBEBs did not use clearcuts during foraging. Thus, selective logging appears to be a better strategy for timber harvests to maintain Lepidoptera species richness.

Telemetry studies have been conducted on VBEBs in North Carolina, Kentucky, and West Virginia since the time of the last status review. These studies have provided additional information on VBEB foraging and movement.

The North Carolina study (Weber et al. 2016) tracked 10 bats captured at their hibernacula in early spring (mid-March through end of April). After the bats left the hibernacula, they appeared to stage at higher elevations (over 4,600 feet above mean sea level (MSL)) on nearby mountains for 1-9 days before moving towards a new maternity site that was located during this study. The maternity site is approximately 8.7 miles from the hibernacula. Bats moved up to 9.4 miles in a night and up to 15 miles between the hibernacula and spring roost sites. Foraging distance from daytime roosts ranged from 1.1 to 5 miles, with a mean of 1.7 miles. The bats moved across smaller roads while commuting to the primary maternity roost, but generally did not cross major roads during nighttime foraging bouts. Home range polygons were delineated for all the bats tracked. Mean home ranges were 1,169 acres (kernel density estimation) and 818 acres (minimum convex polygon). Land-use within the foraging areas consisted of forest and rock vegetation (mean probability of use was 76 percent), riparian vegetation/water (7 percent), developed (9 percent), and agriculture (9 percent). Bats used the different habitat types in close proportion to their availability on the landscape indicating that the bats did not specialize on any of the habitat types. The bats were also tracked to day roosts throughout their home ranges, which included natural rock shelters and overhangs; caves; and man-made structures such as barns, porch decks, and uninhabited houses.

Telemetry studies in Kentucky (Copperhead 2014, Copperhead 2012) included early spring tracking (mid-late March) of 3 female bats over 9 nights, and then 15 females over a 15-day period in May. These studies confirmed that a previously known VBEB cave is being used as a maternity site, and also documented the first known case of a summer colony using a rock shelter. The mean distance between roosts and foraging areas was 3.5 miles (range was 1.8 to 7 miles) and the mean foraging area size was 289 acres. The tracked bats had separate foraging areas. Foraging areas consisted of cliff line habitat, and upper reaches of forested valleys and ridges. Day roosts included small caves, rock shelters, and cliff lines within their foraging areas.

The West Virginia telemetry study (WVDOH 2017) included 1 female and 4 male VBEBs that were tracked after emerging from abandoned mine portals in the fall. This study was done to assess the effects of potential highway construction nearby; therefore, tracking was limited to the action area of the highway project. Mean delineated home range was 3,009 acres (95 percent kernel) and mean core-use area (50 percent kernel) was 501 acres. Most locations were within 1.9 miles of the portals and the furthest location was 3.9 miles away (although bats were not tracked outside the study area so greater distances are possible). The males often seemed to follow the female, which

would be consistent with breeding activity. Habitat composition of delineated home ranges was 77 percent forested, 22 percent open, >1 percent water/impervious surface. The area is characterized by native and restored upland prairie, wetlands, forest, and rocky outcrops. A number of perennial streams, ponds, and wetland-like areas are present. Day roosts included rock crevices and fissures as well as man-made structures such as porches, outbuildings, and barns.

These studies provide substantial information for identifying and managing VBEB foraging areas. These studies indicate that VBEB foraging areas are generally located within a few miles (less than 7 miles) of cave/mine roost sites and consist of a mix of primarily forested habitats interspersed with open fields/hay fields, cliff lines, rock shelters or outcrops, riparian areas, and water sources such as streams, ponds, and wetlands. Foraging areas should have a diversity of native woody plant species suitable to produce an ample amount of moths and other prey, and should be connected to the cave/mine site with suitable travel corridors. Foraging areas may include small-scale/limited residential or rural development, and VBEBs may use man-made structures for short-term day or night roosts. There are substantial differences between foraging area and home range sizes that were delineated between sites. This could indicate that there are differences between sites, as well as between areas used during maternity versus fall periods. Care must also be taken when comparing the size of delineated area, as different criteria and methods may have be used to between studies (e.g., home range versus foraging area).

Despite the progress made in identifying foraging habitat requirements for the VBEB in accordance with this criterion, to date, no coordinated efforts have been made to delineate the availability and quantity of these habitats within the vicinity of major VBEB caves, and there have been few efforts to pro-actively protect, manage, restore, improve, or maintain suitable VBEB foraging areas. Some lands around VBEB sites are publicly owned by the USFS, the National Park Service, or State land management agencies. Management plans for these areas generally include some measures to protect or manage for habitats that provide VBEB foraging, as described in the 2008 status review. The Service and the Monongahela National Forest have discussed developing a habitat management plan for areas around Cave Hollow/Arbogast in West Virginia, but this has not been completed. Therefore, while substantial progress has been made toward meeting this recovery criterion, it has not been fully met because we still have considerable work left to do in restoring, protecting, and managing foraging habitat.

Recovery Criterion 4: A periodic monitoring program must be established to ensure a continued awareness of the status of these animals.

Protocols for monitoring both maternity and hibernacula sites have been published. In 1985, Bagley and Jacobs published the summer monitoring protocol, which has remained in-place with the exception of the use of new technology as described in Stihler (2011). Hibernacula monitoring is conducted consistent with the Indiana Bat Hibernacula Survey Guidelines (Service 2007). Under these protocols, all maternity colonies should be monitored annually, and hibernacula should be monitored bi-annually.

Although some sites have not been surveyed due to safety or landowner access concerns, and in some cases, maternity surveys have been conducted later in the season than recommended, all States within the range of the species had generally been using these protocols until recently. Virginia recently switched methods for monitoring maternity caves from using emergence counts to using a bat call data recorder to document acoustic passage rates. Although these recorders will provide useful information, they are not able to determine number of bats present. Additional work is planned to video-record exit counts and then determine if there is an association with the passage rates detected on the acoustic recorders. However, until that is completed and a method of correlating results is established, results from the acoustic recorders cannot be compared with previous monitoring data, and population trends cannot be established.

Periodic monitoring has been conducted during the fall at abandoned mine portals in southern West Virginia that have been documented to have VBEBs. At this time, no protocols have been established to correlate fall trapping results with actual numbers of hibernating VBEBs.

Therefore, although a periodic monitoring program has been established, and this criterion has been substantially met, additional work may be needed to ensure that consistent, comparable results are obtained. These data are needed to determine whether Recovery Criteria 1 and 2 are met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:
See section 2.2.3, Recovery Criteria 3 regarding new information on VBEB foraging life history, and on newly documented cases of VBEB maternity use in rock crevices. In addition, new information on seasonal activities has been gathered from data loggers placed at the entrances to VBEB caves. New information on seasonal activities at bachelor colonies and the use of these sites as breeding sites in the fall has also been gathered.

Data loggers
Acoustic and temperature loggers placed at Schoolhouse Cave in West Virginia, have provided additional data on VBEB seasonal activities. This cave serves as both a maternity and a hibernacula site. These loggers detected some VBEB activity throughout the year including in January and February when maximum daily temperatures were below 50^{o}F and minimum nightly temperatures were below 20^{o}F. Activity was lowest between November and March. Activity substantially increased in late April and activity was highest in August.

Acoustic loggers at Blackrock Cliffs Cave, a hibernaculum in North Carolina, also documented that VBEBs were active during the winter (Weber et al. 2016).

Activity was highest on nights when temperatures were above 23°F, but activity was also documented on particularly cold nights when temperatures were 5°F. In 2013, activity was documented from late November through early January, but in 2014, activity was documented throughout the winter, even though the winter of 2014 had more days when temperatures were under 32°F.

Acoustic loggers placed at Arbegast Cave, a maternity site in Virginia, provide a detailed look at summer activity patterns (emergence and return rates, emergence in relation to climatic conditions, behavioral activity that may indicate birth times, date of first occupation, date of last occupation, etc.). An increase in the number of passes during emergence (1800-2200 hrs.), nightly (2201-0330 hrs.), and return (0331-0800 hrs.) periods in July suggest that young become volant at this time. By late August these numbers declined significantly suggesting the colony is dispersing at this time. Additional analysis of these data is ongoing.

Bachelor Colonies

In 2014 and 2015, fall and spring surveys were conducted in Trout Cave, a bachelor colony in West Virginia, to determine if there was a period during the year when access would minimize impacts to listed bats. Surveys were conducted 4 times between September 23 and October 23, 2014. VBEB numbers in the cave declined steadily over this period, from 86 to 11 (the numbers of Indiana bats present steadily increased over this time period from 0 to 69). This site is used as a hibernaculum by Indiana bats, but only occasionally used by VBEBs during the winter. Surveys on April 14, 2015 documented that 217 VBEBs had already moved into the cave from their winter roosts (WVDNR 2015).

Activities at Elkhorn Cave, a bachelor colony in Grant County, West Virginia were monitored from April through October (Stihler et al. 1997). A few VBEBs (3) were present the first week of April, and then numbers increased to 92 in mid-June. Mist-netting in early July captured 27 males and 2 non-reproductive males, confirming that this site was a bachelor colony. Numbers increased unexpectedly in late August when 159 VBEBs were observed. Mist-netting in mid-September captured 21 males and 17 females. When released, the males did not leave the capture site, but rather landed on the cages holding the females. Most bats had left the area by mid-October and the site is not used as a VBEB hibernaculum. The timing of VBEB use at Elkhorn Cave is consistent with that observed at Trout Cave, as described above.

These studies of Trout and Elkhorn Cave suggest that female VBEBs travel to bachelor sites to breed in the fall, and that bachelor sites are important to the breeding behavior of this species (Stihler et al. 1997). In addition, these studies further document that male bats may form colonies during the summer, whereas it was previously thought that males were solitary during summer (Service 1984).

2.3.1.2 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), or demographic trends:
See information provided in the Regional Summaries (Appendix A).

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

Genetic information gathered since the time of listing has documented that the VBEB has low overall genetic diversity and that the species' overall population is segregated into four distinct regions. Each region supports an important share of the remaining genetic and adaptive diversity of the species. Therefore, these studies concluded that all four areas should be protected and managed as discrete units (Piaggio et al. 2009, Piaggio 2013).

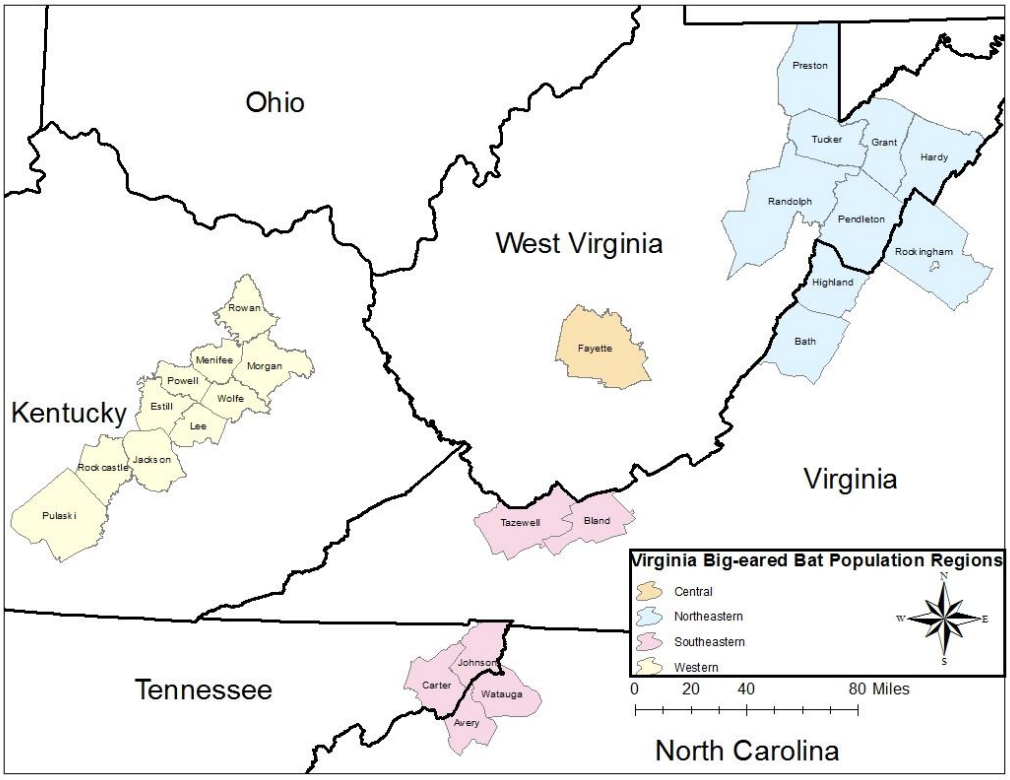
Piaggio (et al. 2009) evaluated mtDNA and autosomal microsatellites from VBEBs at sites in Pendleton, Grant, and Fayette counties, West Virginia; Tazewell County, Virginia; and Lee, Estill and Jackson counties, Kentucky. Following that effort, additional samples were gathered from Pendleton, Tucker and Fayette counties, West Virginia; and Avery County, North Carolina. These areas or sites were previously not sampled or were previously represented by a limited number of samples (Piaggio 2013). Genetic samples used in Piaggio et al. 2009 and Piaggio 2013 have been archived at the National Wildlife Research Center in Fort Collins, Colorado.

Combined results of both efforts indicate that VBEB populations are clustered into four genetically distinct regions roughly located in northern West Virginia/Virginia (Northeastern Region), southern West Virginia (Central Region), Kentucky (Western Region), and North Carolina/southern Virginia (Southeastern Region), as shown in figure 1. Both class of markers indicated almost complete loss of connectivity between these regional populations. Each region harbors unique genetic diversity (private alleles that were not present in other regions) and supports a portion of the remaining genetic diversity of the VBEB (Piaggio et al. 2009, Piaggio 2013).

Genetic diversity was greatest in the Northeastern Region. This region also includes haplotypes that were likely the source for genetic diversity in other regional populations and thus may have been a glacial refugium for the species (Piaggio 2013). The population within the Southeastern Region had the lowest overall diversity with haplotypes approaching fixation. The species' overall reduced genetic diversity means that genetic drift may be driving diversity within these populations and that the biodiversity and evolutionary potential of the VBEB has been diminished. The 2009 study estimated that the effective population size for the Northeastern Region was 936, while estimates for the remaining three regions ranged between 323 and 361.

The loss of genetic diversity, the degree of genetic separation, and low effective population sizes suggest that each of these four regions should be managed as separate units. The fact that these four areas are geographically distinct and are outside of the known dispersal distances of these bats, further supports the lack of connectivity and the need to manage these areas as discrete units. The study concluded that each of the four regions required protection because they represent the remaining evolutionary potential of the bats (Piaggio et al. 2009).

Figure 1: VBEB Regional Populations Based on Genetics and Geography



The results of the mtDNA analysis suggested that males and females are indeed philopatric to summer and winter roosts and that gene flow may occur by intermixing of males and females at transient fall roosts or by females moving over to bachelor colony sites in late summer/early fall, as has been indicated by monitoring data at these sites (Piaggio et al. 2009). These genetic results provide further support that protecting transient fall roosts and bachelor colony sites is important to the conservation of the species, as has also been suggested by surveys conducted at bachelor colonies as described in Section 2.3.1.1.

2.3.1.4 Taxonomic classification or changes in nomenclature:

No new information has become available since the 2008 status evaluation. The genus was previously changed from *Plecotus* to *Corynorhinus* (Bogdanowicz et al. 1998).

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

The range of the VBEB is shown in figure 1. Since the 2008 status review, there are new county records for:

- Watauga, North Carolina where a new maternity cave has been documented (Weber et al. 2016);
- Carter and Johnson Counties, Tennessee where VBEBs were tracked to day roost sites from known caves in adjacent counties (Weber et al. 2016);
- Bath County, Virginia where 4 VBEBs were found hibernating in 2 caves (VDGIF 2017 data); and
- Pulaski County, Kentucky where one male VBEB was found hibernating. This site is located 32.8 miles from the closest known VBEB site (Kiser 2016).

As described in the Regional Summaries, many of the counties within the range of the VBEB only support a small number of bats found in a few caves, similar to the records for Bath and Pulaski Counties. Hardy and Preston Counties, West Virginia and Rowan County, Kentucky have historical records for VBEBs, but are not currently occupied by the species.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):
See Section 2.2.3, Recovery Criteria 3, for new information on suitable foraging habitat conditions.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

The threats as described in the 2008 status review are all ongoing, with the exception of new information indicating that the threat from disease has been reduced, as described below. Additional information on ongoing or increasing threats is provided below.

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

<u>Quarries</u>
Limestone and rock quarries are a continuing threat, particularly near Hellhole and Schoolhouse Cave, as there is an active and expanding limestone quarry in that area. In addition, the entrance to Hellhole is currently privately owned and controlled by the quarry operator. As a result of negotiations between the quarry owner, the West Virginia Department of Environmental Protection (WVDEP), WVDNR, and the Service, the quarry is currently conducting activities in a

manner that is not adversely affecting these caves. However, modifications to project operations or further expansions could adversely affect these caves and the foraging habitat around them.

Oil and Gas Development

Oil and gas development and associated pipeline construction is an emerging threat. The Marcellus and Utica Shale formations underlie the range of the VBEB in West Virginia. Recent increasing development of these formations could threaten VBEB sites and foraging habitats. Improvements to drilling techniques (fracking) have allowed for the development of gas deposits in additional areas that underlay the range of the VBEB. These advanced drilling techniques can go horizontally, as well as deeper than previous techniques, which could affect the geological or hydrological integrity of caves and mines that support the VBEB. There is also an increase in pipeline construction associated with this gas development. Blasting and construction could affect caves and mines used by the species. Slips (the sliding of a mass of land down a slope or cliff) from construction on steep slopes could block or alter entrances and affect rock faces, forests, streams, and wetlands used by the species. Construction of gas wells, pipelines, and other associated facilities could degrade or destroy foraging habitat.

Coal Mining

Coal mining, particularly in the southern West Virginia Region may remove or degrade foraging and drinking habitat, and also destroy abandoned mine portals and passages used as roosting, hibernation, breeding, and maternity sites. Current mining and reclamation techniques are not likely to result in the creation and abandonment of mine portals that might be used by VBEBs in the future.

Roads

Major new roads have been proposed in the range of the species in West Virginia and North Carolina. These roads could remove or alter caves and mines used by the species, cause direct mortality through road kills, fragment VBEB habitats, and affect known roosting and foraging areas. As noted in the last status review, VBEB mortalities have been documented along smaller roads that are already present near VBEB sites. If mortality from collisions or reduced reproductive success occurs from increased road development, the VBEB may be slow to recover from population losses because of their life history strategy. Like most bats, this species is long-lived, has low reproductive rates, and requires larger than expected home range areas for its body size (Weber et al. 2016). Roads constructed between roosting and foraging sites, or between roost sites could also reduce foraging success, fragment habitats, and present a barrier to VBEB movement between key areas needed to support various life stages of the species. One design alternative for a proposed new four-lane road in West Virginia would directly affect and destroy an abandoned mine complex that is used by the VBEBs. It would also remove known foraging areas. A road-widening project in North Carolina is proposed in an area between known VBEB hibernacula and maternity sites. Telemetry data from North Carolina suggest that VBEBs may

move across smaller roads but generally did not cross major roads during nighttime foraging bouts (Weber et al. 2016). Studies from Europe suggest that roads can be a barrier to bat movement, but that effects may vary depending on species, landscape context, nearby tree cover, and level of traffic (Kerth and Melber 2009, Abbott et al. 2012). Therefore, additional site-specific work would be needed to properly design and site roads so that potential effects to VBEBs are avoided and minimized.

Development

As described in Section 2.2.3, many of the largest VBEB sites are located on private lands and are not protected. In addition, foraging habitat around both protected and unprotected sites is often on private lands. Development could impact foraging habitat, travel corridors, and roosting locations. This is an increasing threat especially in the vicinity of hibernaculum and maternity sites in North Carolina. Development and land-use changes may also result in old buildings that are used as day or night roosts being torn down. It can also result in increased predation from cats and other species adapted to human presence.

Other

As noted in the 2008 review, rock and tree falls, and invasive vegetation can block cave entrances and reduce numbers in caves. Abandoned mine entrances may also become unstable and collapse. These types of changes should be monitored and action taken to control vegetation or stabilize entrances and slopes where feasible. In addition, caves may be actively changing in ways that could alter habitat suitability or increase threats. Sinkholes may form creating new entrances, or interior breakdown may occur by changing interior microclimate or airflow. The extent of some caves and mine sites are not well-documented or not well known. Therefore, the ability to assess effects from projects or identify areas for protection is limited. The development of accurate baseline speleographic maps and the regular monitoring of caves would assist in addressing these threats (see Section 4.0).

There are likely additional sites that are used by VBEBs that have not yet been identified, particularly in the Western, Southeastern, and Central Regions. Surveys for additional sites are needed. No protocols have been established to survey caves or mine portals for potential summer VBEB use; therefore, their presence may not be detected during project reviews and assessments (e.g., quarries, oil and gas, coal mining, roads, and other developments).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

There is no evidence that VBEBs are being adversely affected by commercial or educational uses. Scientific uses are regulated through state and Federal collecting permits. It does not appear that these activities are having an adverse effect on VBEBs. Sites occupied by VBEB can be used by recreational cavers;

these threats are discussed in Section 2.3.2.5.

2.3.2.3 Disease or predation:

Disease

In the 2008 status review, White-nose Syndrome (WNS) was listed as an emerging threat to the VBEB. However, information developed since that time suggests that the species is not susceptible to the disease (Coleman 2014, Reeder and Moore 2013).

WNS is an infectious disease that is a serious threat to many cave-dependent bat species throughout the country. This disease is caused by the fungus *Pseudogymnoascus destructans (Pd)*, and affects hibernating bats. It first emerged in the winter of 2006-2007 in New York and by 2014, was estimated to have killed more than 5.5 million bats (Coleman 2014). By 2018, WNS had spread to 33 States and 8 Canadian Provinces and is present throughout the entire range of the VBEB (whitenosesyndrome.org 2018). Both the fungus and the resulting disease have been found in hibernacula used by VBEBs, and the fungus has been detected on VBEBs during hibernation. However, no VBEBs have been documented with WNS infection, and it appears that the species is not susceptible to the disease (Coleman 2014, Reeder and Moore 2013).

The reasons for the VBEB's lack of susceptibility to WNS are not understood, and research on this topic is ongoing. One theory is that as a larger-bodied bat species, VBEBs can store and carry more fat. The species also hibernates for shorter periods than affected species, and has lower surface area-to-volume ratios, which can slow heat loss. VBEBs also select colder roost sites within the hibernacula. These characteristics taken together could confer an advantage against *Pd* (Reeder and Moore 2013). It is also hypothesized that VBEBs may have some innate chemical resistance to the fungus, potentially associated with a yellow-oily substance they secrete from their parahinal glands, however this has not yet been confirmed (Danford et al. 2018).

Predation

VBEB continue to be vulnerable to predation. VBEBs are particularly vulnerable to predation because they must emerge from the cave entrance each night during the summer and the passages and openings that they must travel through are often confined spaces that make it conducive for predators to routinely catch emerging VBEBs. In addition, during the winter, VBEBs often roost in large clusters that may be on low ceilings within the cave that can be easily reached by predators. Therefore, one predator could have a significant impact on a colony. Predation is a potential problem at all VBEB caves. Incidences of predation by owls, raccoons, and cats have been noted at VBEB caves within the last 5 years. For example, in North Carolina raccoons were documented entering both hibernacula and maternity caves, and trail cameras documented coyotes attempting to prey on emerging bats. Predators may include raccoons, bobcats, house cats, skunks,

coyotes, owls, and snakes. Increased development around VBEB caves, particularly residential development, may increase predation associated with domestic cats.

Heavy infestations of parasitic strebilid flies have been noted at some caves recently. It is not clear whether they are affecting the health of the VBEB.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Existing regulatory mechanisms are inadequate to protect the VBEB in the absence of the ESA.

West Virginia has no state threatened and endangered species legislation. Kentucky also does not have a State endangered species list; however, they do have a regulation that prohibits the importation, transportation or possession of an endangered species or any part thereof without a permit (KRS 150.183). The Kentucky Department of Fish and Wildlife Resources may issue permits "for zoological, educational, or scientific purposes, and for the propagation of such wildlife in captivity for preservation purposes except as otherwise prohibited by law."

In Virginia, the VBEB is protected under State law (4 VAC 15-20-130). It is unlawful to "take, transport, process, sell, or offer for sell within the Commonwealth any threatened or endangered species of fish or wildlife except as authorized by law."

VBEBs are protected and listed as endangered by North Carolina. G.S. 113-337 states "It is unlawful to take, possess, transport, sell, barter, trade, exchange, or export, or give away for any purpose including advertising or other promotional purpose any animal on a protected wild animal list, except as authorized according to the regulations of the Commission, including those promulgated pursuant to G.S. 113-133(1).

While these laws do provide protection against collection, possession, or trade of the VBEB, these are not primary threats facing the species. In addition, although they provide some protection against direct take, these laws do not provide protection for habitats needed to support or recover the species.

Currently, there is no Federal oversight of wind power production, and State permitting and siting regulations are inconsistent. Therefore, there is a lack of formal means for the state and Federal resource agencies to participate in wind development planning. In addition, there is a lack of information regarding the effectiveness of mitigation measures for wind farms, particularly in regard to non-migratory species such as the VBEB.

In summary, in the absence of the ESA, protections for the VBEB are limited and current regulatory mechanisms are not adequate to protect VBEB populations from their primary threats.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Disturbance and Vandalism

Disturbance and vandalism at cave and roost sites is one of the primary threats facing this species. As described in Section 2.2.3, many of the largest VBEB sites are located on private lands and are not protected. These sites are threatened with continued human access that can make these caves less suitable or unsuitable to support the species. Even when caves are protected, significant threats to these caves remain. Vandalism of cave gates and illegal entry into caves on protected lands owned by State and Federal agencies has occurred at multiple sites within the last 5 years, as described in the Regional Summaries. As a result, disturbance and vandalism is an increasing and significant threat to the species. Disturbance within caves can result in direct mortality of bats, reduce survival of young, reduce survival of adult hibernating bats, and cause bats to abandon sites, all of which can result in long-term adverse effects to populations.

Rock climbers and other recreational users have been noted as a potential threat in Kentucky, West Virginia, and North Carolina. These users could disturb bats roosting on cliff faces, rock shelters and crevices. VBEB maternity activity has recently been documented in this habitat type in Kentucky, and rock climbing is very popular in the NRGNR in West Virginia. Repeated disturbance from recreational users could result in mortality to young or abandonment of sites.

Wind

The development of wind turbines near VBEB sites is a current and increasing threat. Although there are no documented occurrences of VBEBs being taken by wind turbines to-date, there are currently very few wind facilities within the range of the species, and the sites closest to VBEB sites are not actively monitoring for bat mortalities. High mortality of other bat species has been documented at wind turbine sites when monitoring has been conducted. For example, studies at the Mountaineer, West Virginia and Meyersdale, Pennsylvania sites documented between 30 and 38 bats killed per turbine during one 6-week period (Service 2006). It is estimated that the total number of bats killed annually at the Mountaineer site could approach 4,000 (Tuttle 2004). These sites are not located in the immediate proximity of any known VBEB sites. However, projects have been proposed in Pendleton County, West Virginia, and Highland County, Virginia. These proposed sites are located in close proximity to a number of major VBEB maternity and hibernacula caves and have an increased probability of impacts to this species (Service 2006). Foraging VBEBs or bats moving to and from maternity and hibernacula caves would be vulnerable to mortality at wind turbines.

Beech Ridge Wind Farm, located in Greenbrier County, WV completed a Habitat Conservation Plan (HCP) in 2013 that included take coverage for the VBEB (Beech Ridge Energy LLC 2013). This site is outside the known range of the species and there are no known VBEB sites within this county. However, adjacent counties contain VBEBs, and the sites is in between the Northeastern and Central Regions; therefore, the species could potentially occur there over the life of the project. Other projects near the edge of the range of the species are also considering HCPs that may include the VBEB.

Although there have been advances in measures used to reduce bat mortality from wind facilities, there are significant differences in behavior, migration and foraging patterns, distribution, and detection probabilities between other bat species that have been the focus of these conservation measures (e.g., Myotis species) and the VBEB. These differences must be considered when evaluating the applicability of existing wind related bat mortality and activity data, and the effectiveness of potential avoidance and minimization measures for the VBEB. For example, much of the data used to establish wind turbine curtailment below 6.9 m/s as an effective avoidance measure for Indiana bats were developed using acoustic monitoring to assess when the majority of bat activity occurs, or by looking at bat mortality data from existing wind facilities. Data assessing bat activity patterns using acoustical studies are not likely to capture most *Corynorhinus* activities because they produce low intensity calls that are difficult to detect (Piaggio and Sherman 2005, Britzke 2003, O'Farrell and Gannon1999). One study found that *C. townsendii* calls could only be detected when the bats were less than 5 meters from the detectors (O'Farrell and Gannon 1999), such as when the detectors are placed within restricted spaces like cave entrances. Even when *Corynorhinus* are detected, they may only make up a small proportion of total calls. For example, when acoustic detectors were used near OBEB caves, their calls never made up more than 0.4 percent of the total calls recorded at any site (Korman 2013). Therefore, additional assessments are needed to determine the extent to which existing acoustical and mortality data from wind projects can be used to develop effective avoidance measures for the VBEB (see Section 4.0).

In addition, VBEBs have different migration patterns and are active on the landscape longer than other hibernating bat species. Because *Corynorhinus* species mate from September through February, movements between hibernacula may occur during this late fall and winter time period (Barbour and Davis 1969). Data from closely-related OBEB and Rafinesque big-eared bats (RBEB)(*C. rafinesquii*) document that during the winter these bats moved between caves and/or other roosts located over 3.7 miles apart and that the number of bats present in individual hibernacula varied markedly from November, December, and February. These data indicate that relatively large numbers of bats were moving between caves during these time periods (Clark *et al*. 1997, Johnson *et al*. 2012). VBEBs also leave roosts during the winter to forage and drink. VBEBs arouse more frequently in the winter than some *Myotis* species (D. Reeder, personal communication) and evidence of winter foraging activity such as fresh

feces and moth wings, have been seen during VBEB winter hibernacula surveys (C. Stihler, personal communication). OBEBs and RBEBs have also been found to be active on the landscape during winter nights, including on nights that temperatures were near or below freezing (Clark *et al*. 2002, Johnson *et al*. 2012). This is consistent with the recent results from monitoring conducted at VBEB hibernacula discussed in Section 2.3.1.1. Big-eared bats may also begin moving from winter hibernacula into summer/maternity roosts earlier than the Indiana bat and the timing of colony formation in spring varies by year (Clark *et al*. 2002). WVDNR survey records from four caves show that by the beginning of April, hundreds of VBEBs had already migrated from winter to summer roosts (WVDNR unpublished data). Telemetry studies in North Carolina document that VBEBs leave hibernacula and arrive at springtime roosts by late March or early April (Weber et al. 2016). As a result, curtailment strategies limited to the "active season" for Myotis bats (April 1 to November 15) will not be sufficient to avoid periods when VBEBs are present on the landscape.

Other Sources of Direct Mortality

Direct mortality and injury from oil and brine separation pits, and other holding ponds are a continuing threat to the VBEB. These threats are described in the 2008 status review. The recent increase in gas development in West Virginia could increase the extent of this threat in that region.

Population Size and Genetic Health

The small size of colonies is the Southeastern and Central Regions is a concern. Numbers of bats within the Virginia caves is decreasing, and it is unclear why. The total number of bats within the Central Region is very low. Populations in these two regions may have restricted resiliency. Low genetic diversity may limit the VBEB's adaptive capacity. Minimum viable population size is not known. Additional research to evaluate the significance of these threats is needed.

2.4 Synthesis

The overall range-wide population of the VBEB within both hibernacula and maternity colonies has increased between 30 percent and 28 percent respectively since the time of the last status review. The current total population of the species is approximately 19,574 bats in hibernacula and 11,778 within the known maternity sites (Recovery Criterion 2). Within this overall population increase, there have been population declines within certain regions, and within some major sites. Research has established that there are four distinct population areas within the range of the species that are geographically and genetically differentiated, and that these regions should be managed as separate units. The Northeastern Region supports the largest population and encompasses all of the currently designated critical habitat. Overall numbers within this region have been on a consistently upward trend over the past 10 years, and are at their historical maximum although declines at some caves have been seen due to suspected roost switching, and human disturbance. Increases in the number of VBEB within a single cave in this region, Hellhole, are responsible for the overall population increase seen for the species range wide. The Western Region supports the next largest population. Overall numbers in this region have

declined since the late 1990s and early 2000s. Numbers have been trending back upward in the past few years, although there have been large fluctuations in both individual caves and overall numbers since 2008. Population fluctuations and declines have also been seen in many caves in the Southeastern Region. Although a new maternity cave has been discovered in this region, declines have occurred in the major hibernacula and other maternity sites, and some sites may have been abandoned. The reasons for these fluctuations/declines in these two regions including potential threats or potential unidentified roosts should be investigated. A total of 67 VBEBs have been found over 15 years of surveys in the Central Region. All these bats were found in abandoned mine portals. Additional work is needed to understand the abundance and distribution of VBEBs in this region, and to identify additional sites in this area.

Progress has been made in identifying and/or protecting additional VBEB caves since the 2008 status review, including the discovery or colonization of major new caves in Kentucky, North Carolina, and West Virginia, and the protection of additional caves in North Carolina, Virginia, and West Virginia. However, VBEB populations continue to be concentrated in a small number of caves, making them extremely vulnerable to disturbance and large-scale population losses from single catastrophic events. Throughout the four state range of the species, there are only 10 major hibernacula and 18 major maternity sites. Many of these sites are not protected. Only 28 percent of the overall hibernating population and 49 percent of the overall maternity population uses protected sites. Many "protected" sites are still subject to threats from human disturbance through vandalism and illegal access into gated sites. Significantly, approximately 69 percent of the total range wide population hibernates in a single cave, Hellhole, which is not considered protected and is threatened by limestone quarry development. The concentration of VBEBs into a small number of caves, and the lack of effective protection of these sites, makes this species particularly vulnerable to the continued threats of disturbance and loss of habitat that were the primary reasons for listing the species (Recovery Criterion 1).

Recent progress has been made in identifying foraging habitat requirements for the VBEB. However, to date, no coordinated efforts have been made to delineate the availability and quantity of these habitats within the vicinity of major VBEB sites, and there have been few efforts to pro-actively manage, restore, improve, or maintain suitable VBEB foraging areas (Recovery Criterion 3). Therefore, key foraging areas around VBEB sites are not protected, and the species continues to be threatened by loss and degradation of this habitat type which is required to support the species.

In addition to human disturbance and vandalism, and lack of effective long-term protection for foraging areas, threats to the species include loss of habitat from quarries, oil and gas development, coal mining, roads, and development; and mortalities from predation, roads, wind farms, and oil and brine pits. Small population size and reduced genetic variability may be a threat to populations in Southeastern and Central Regions. Existing regulatory mechanisms are not adequate to manage these threats in the absence of the ESA. There is no evidence that VBEBs are threatened by overutilization. Recent evidence suggests that VBEBs are no longer threatened by disease from WNS. Protocols for monitoring maternity and hibernation sites have been established and are generally being implemented (Recovery Criterion 4). These protocols allow for population trends to be effectively monitored.

Based on this analysis, Recovery Criteria 1 and 3 have not been met. Recovery Criterion 2 has been partially met, and Criterion 4 has been substantially met. The species does not meet the current criteria for downlisting. In addition, although overall population numbers have been increasing, significant threats to the species remain, and the species continues to be highly concentrated in a small number of caves, which makes it highly vulnerable to stochastic events and human disturbance. The species should continue to remain listed as endangered.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ No change is needed

3.2 New Recovery Priority Number: No change needed.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

This status review identified the highest priority threats to the VBEB as well as additional conservation planning, management/threat reduction measures, and survey and monitoring needs for the species. In some cases, additional research is needed to help identify appropriate management actions that would reduce these threats. The following is a list of priority future actions based on the results of this review.

Conservation Planning
The Recovery Plan and associated recovery criteria for the species needs to be updated to address current species information, including genetics, population structure, and threats. The four regional populations should be recognized as discrete units. New recovery criteria should be developed that provide VBEB resiliency, redundancy, and representation and address the five-factors and provide for adequate means to gauge and ensure long-term recovery. The recovery actions could also be updated to delete actions that have been completed since listing, and to add new actions or reprioritize existing actions to reflect current information on threats and recovery opportunities.

Management Actions/Threat Reduction
Long-term protection measures should be implemented at major VBEB sites. Permanent management agreements or purchase should be sought for major maternity, bachelor, and hibernacula sites. These agreements should seek to protect both surface and subsurface habitats that are required to support the species. Sites with smaller numbers of VBEBs may also warrant protection if data indicate they previously have supported, or could support increased numbers of VBEBs, or if they are important to maintaining the reproduction or distribution of the species.

Sites that are subject to uncontrolled human access should be gated or fenced using designs similar to those used on other VBEB sites that have been demonstrated to be effective.

Gates, fences, signs and closure dates should be routinely monitored and maintained to ensure that protection measures remain effective. If evidence of vandalism or inappropriate entry into sites is documented, remedial actions should be immediately taken, and law enforcement measures should be employed.

Habitats within commuting distances around VBEB caves/mines should be mapped to assess availability and distribution of suitable foraging areas. Land-use type and ownership should be assessed. Management plans should be developed that include measures to create, maintain, enhance, and protect VBEB foraging and commuting habitat. Permanent protection should be sought for areas that serve as important VBEB foraging habitat. Additional telemetry studies could be used to further identify VBEB foraging areas.

Numbers of VBEBs have been declining at some sites or regions as described above. The causes of these declines are not currently known. The causes of declines at established VBEB sites should be investigated, and mitigation measures for any causes should be implemented.

Efforts to reduce threats from habitat loss and degradation, and other natural and manmade factors should continue through the use of cooperative partnerships and regulatory means. Threats identified in this status review should be prioritized for action.

Research needs to be conducted to determine what types of siting and/or operational methods will eliminate or reduce bat mortality at wind farm projects that may be proposed in the vicinity of VBEB sites. The development of consistent guidelines and permitting requirements at either the state or Federal level would also assist in avoiding potential impacts from future project proposals. Project planning for any wind farms roads proposed near VBEB sites should include avoiding locations that are within foraging and migration areas for the VBEB as well as measures to avoid and minimize VBEB mortality.

The effects of roads and other barriers to movement should be investigated to determine what features or factors can reduce adverse effects, and research should be conducted to test the effectiveness of any measures that are developed. Project planning for any roads proposed near VBEB should include measures to avoid and minimize VBEB habitat fragmentation as well as the potential for direct mortality of bats through vehicle strikes.

Surveys and Monitoring

Data suggests there may be additional, as yet unidentified, sites that are serving as maternity, hibernacula, or bachelor colonies. Biologists should search for additional caves or roosts of importance to VBEBs particularly in the Central, Southeastern, and Western Regions. This should include additional telemetry work and searching for sites within rock outcrops or crevices.

Established summer maternity and winter hibernacula survey protocols should be continued to be used throughout all states in the range, with maternity sites surveyed annually and hibernacula surveyed biannually. Efforts to correlate results from new technologies (like acoustic loggers) with existing protocols should be undertaken.

Transient fall roosts and bachelor colony sites may be important to the conservation of the species. These sites may be primary locations for breeding and genetic interchange. Currently, most bachelor sites are not routinely monitored, and many are not protected. These sites should be included in monitoring efforts, perhaps at a less frequent interval than for maternity sites. These caves should also be protected and gated using the long-term protection measures described above.

The effectiveness of Indiana bat mist net survey protocols for detecting VBEB presence during the summer should be assessed. The timing of VBEB entrance to and emergence from hibernacula differs from the Indiana bat, so VBEB specific spring/fall emergence protocols to confirm winter use of portals should be developed. Standardized protocols for conducting summer surveys to determine maternity or bachelor site usage particularly at abandoned mine portals should be developed.

Population viability assessments or other similar measures should be conducted to help understand and manage for long-term sustainable population numbers. This is particularly important for regions where populations are small or not-well understood, such as the Southeastern and Central Regions.

Mapping of important caves or mines should be completed. Baseline maps of these subsurface habitats may help to assess natural changes over time or evaluate future threats from development such as mining or other construction.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF THE VIRGINIA BIG-EARED BAT

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Barbara Douglas, West Virginia Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 8/7/19

COOPERATING REGIONS

Acting **Region 4, Assistant Regional Director, Ecological Services, Fish and Wildlife Service**

__✓__ Concur _____ Do Not Concur

Signature _____ Date 2/12/19

5 YEAR REVIEW *for the*

VIRGINIA BIG-EARED BAT (Corynorhinus townsendii virginianus)

December 2018

Surname: _____ Date: 2/5/2019

DD ARD-ES, Region 5, U.S. Fish and Wildlife Service

Appendix A
Regional Summaries

- **Northeastern Region**
- **Central Region**
- **Southeastern Region**
- **Western Region**

Northeastern Region

The Northeastern Region includes caves or roosts within Grant, Hardy, Pendleton, Preston, Randolph, and Tucker counties, West Virginia; and Bath, Highland, and Rockingham counties, Virginia. All currently designated critical habitat for the VBEB occurs in this region. This region also supports the largest population of VBEB, has more VBEB caves/roosts than any other region. A list of major VBEB sites is shown in table 2.

There are 23 caves in this region that have been used by VBEBs during the winter in the past 10 years. However, only six of these have had more than 100 hibernating VBEBs: Cliff, Minor Rexrode, Schoolhouse, Hellhole, Sinnett/Thorne, and Cave Hollow/Arbogast. The last three are designated critical habitat. Cliff is not gated and is on private land, and is not considered protected. Hellhole is fenced and considered closed to access but it is on private lands and the entrance and surrounding area are controlled by a limestone quarry company. It is therefore, not protected. Sinnitt/Thorne is gated and on private land. Although there is no permanent conservation agreement, at this time it is actively managed for both recreation and conservation purposes. The other three caves are gated and located on public lands, and are considered protected. This information is summarized in table 2.

The total hibernating population of VBEB in this region has been steadily increasing and has more than doubled over the past 10 years from 7,311 at the time of the last status review in 2007 to 15,467 in 2018. This increase has primarily been driven from increases seen in a single cave: Hellhole. During that time the total population increased by 8,064 bats, while the numbers in Hellhole increased by 8,487. Therefore, decreases at other sites have been occurring despite increases at Hellhole. Currently, 13,493 VBEBs (87 percent of the regional population) hibernate in Hellhole and 15,339 (99 percent) occur in the six caves mentioned above. Therefore, hibernating VBEBs in this region are highly concentrated in a small number of caves, and the largest number of bats occurs in a single cave that does not have long-term protection, but is currently only afforded protections through the ESA.

There are 12 caves used as maternity sites in this region that support a total of 10,173 VBEBs. Four of these maternity caves are designated as critical habitat. Six of these caves (including three that are designated as critical habitat) are considered protected. These protected caves support approximately 52 percent of the maternity population. The total maternity population of VBEBs has been steadily increasing over the past 10 years from 6,614 at the time of the last status review in 2008 to 9,699 in 2018, a 42 percent increase. This is the highest total population recorded to date for this region.

While there have been some fluctuations in individual cave counts during this time period, overall most caves are steadily increasing with the exception of Cave Mountain and Lambert Caves. The declines seen in Lambert Cave may be related to the restoration and reoccupation of a historical maternity cave, Gale Warner, which is located only 0.2 miles away (WVDNR 2017). Although historical numbers are not available for Gale Warner Cave, records indicate that this cave supported a maternity colony during the late 1950s (WVDNR 2014). However, a previous owner blocked the entrance with debris. In 1999, the current cave owner and a local caving group removed the debris and restored the entrance. Then, in 2014, a cluster of 80 VBEBs was

documented in the cave, and subsequent surveys in 2015 confirmed that a maternity colony was present. There were 301 VBEBs in 2018. The re-establishment of this colony coincides with the decline seen in Lambert Cave. Numbers in Lambert Cave had been steadily increasing to a maximum of 517 in 2014 but then began to annually decrease to 137 in 2017. The combined number of bats from both caves was 597 in 2014 and 536 in 2018. Both Lambert and Gale Warner are privately owned, and only Lambert is gated. It is not clear why the VBEBs may be leaving Lambert for Gale Warner, or other sites.

The other maternity cave with notable declines, Cave Mountain, is designated as critical habitat and historically supported over 1,000 VBEBs in the summer. However, numbers in this cave have declined and it is now one of the smaller maternity sites in the region with 469 VBEBs (only Lambert and Gale Warner have fewer VBEBs). Although Cave Mountain is on public lands and is gated, it has been subject to significant vandalism over the years. Most recently, vandalism to the cave gate was discovered in June 2017 whereas this gate had previously been checked and was secure in February 2017. The June 2017 summer count showed a 16.6 percent decline from the previous year (from 483 to 403 bats)(WVDNR 2017).

Although Mystic Cave has seen an overall increase in the last 5 years, recent events indicate increasing threats to this cave. Mystic Cave is a privately owned cave that is currently not gated and is not considered protected. The previous owner of Mystic Cave lived close to the entrance and closed the cave to public access during the summer maternity season. She recently passed away and although the new owner is conservation-minded and does not allow public access to the cave, he does not live nearby. Monitoring of the entrance over the past year has documented a number of groups entering the cave including during times of year when the bats are present. The number of VBEBs in this cave declined from 845 VBEBs in 2017 to 797 in 2018.

This region also has at least four caves that support documented bachelor colonies of at least 100 bats: Elkhorn in Grant County; and Hellhole, Minor Rexrode, and Trout in Pendleton County. These caves are not monitored on a regular basis; therefore, information on current status and trends is not available. Elkhorn and Hellhole are not protected. Trout Cave is a new bachelor colony that has become established since the time of the last status review. Trout Cave was historically known to support up to 2,000 hibernating Indiana bats and was occasionally used by VBEBs in the winter and fall. There were no historical records of VBEBs using the cave in the summer (WVDNR 2014). Trout Cave is located in close proximity to a number of other caves known to be used by VBEBs during the summer and the winter. The cave is owned by the National Speleological Society and was heavily used for year-round recreation. In fall 2008, the cave was gated and closed to access in the winter to protect the hibernating Indiana bats. However, in January 2009, signs of WNS were detected in the cave. This was the first documented occurrence of WNS in WV (WVDNR 2011). As a result, the cave was closed to recreational access year-round. In June 2010, the cave manager noticed a “sizeable number” of VBEBs using the cave and a subsequent emergence count documented 159 VBEBs exiting the cave. In August, harp trapping at the entrance captured 15 VBEBs consisting of 14 males and one juvenile female, indicating that the cave was being used as a bachelor colony (WVDNR 2010). Another emergence count was conducted in July 2014, which documented 407 VBEBs exiting the cave (WVDNR 2014). The results of these surveys indicate that male VBEBs will readily move into nearby caves with suitable habitat after disturbance is reduced, particularly

when the cave was previously used by the species in even low numbers. It is not known which cave or caves these bachelor bats moved from.

Table 2: Major VBEB Maternity or Hibernacula Sites in the Northeastern Region

State	County	Cave Name	Protected	Most Recent Mat #	Most Recent Hib #
VA	Highland	Arbegast	Yes	474	7
WV	Grant	Peacock	Yes	1,240	38
WV	**Pendleton**	**Cave Mountain***	**Yes**	**469**	3
WV	Pendleton	Cliff	No	1,517	258
WV	Pendleton	Gale Warner	No	301	NA
WV	**Pendleton**	**Hoffman School***	**Yes**	**1,456**	**2**
WV	Pendleton	Lambert	No	235	NA
WV	Pendleton	Mill Run	No	522	NA
WV	Pendleton	Mystic	No	797	4
WV	Pendleton	Schoolhouse	Yes	912	660
WV	**Pendleton**	**Sinnitt/Thorn***	**No**	**1,050**	**204**
WV	**Pendleton**	**Hellhole**	**No**	**NA[1]**	**13,493**
WV	Pendleton	Minor Rexrode	Yes	NA	237
WV	**Tucker**	**Cave Hollow/Arbogast***	**Yes**	**1,200**	**487**
VA/WV	Various	Other Caves	NA	NA	74
		Total		**10,173**	**15,467**

***Designated critical habitat.**

Since the time of the last review, two historical sites Gale Warner (discussed above) and Smokehole, have been reoccupied, and one new portal complex has been discovered. None of these sites are considered protected. Smokehole in Pendelton County was historically occupied but had only been occasionally used by VBEBs in recent years. This cave is privately owned. In late June 2017, a bat biologist visiting the cave noted a cluster of VBEBs approximately 8-10" wide. Harp trapping conducted in late August 2017 captured 11 VBEBs including a post-lactating female, 5 juveniles, and 5 males. Because these surveys were conducted during the time of year that VBEBs may be moving between sites, it is not clear whether this cave is being used as a maternity colony site, or if it is a bachelor colony/fall swarming and breeding site. Additional surveys are needed to confirm the type and extent of VBEB use at this cave.

In 2014, VBEBs were documented using an abandoned mine complex in this region during the fall swarm. A total of 23 VBEBs were found using these sites over 3 years of surveys. Both males and females in approximately equal numbers were captured. Follow-up surveys did not document use during the summer or emergence during the spring, so this site may be used as a breeding and swarming area. This is the first documented use of abandoned mines by VBEBs in this region. These portals and the surrounding foraging areas are threatened by major highway development that could directly affect the mine passages and foraging areas.

[1] NA indicates that this site is not used for this purpose.

Threats to VBEB in the region and associated conservation needs include:

- Some significant sites within this region are currently not protected including major caves, and the foraging areas surrounding them. Measures to permanently protect and preserve these areas are needed. Even when caves are protected, significant threats to these caves remain. Vandalism of cave gates and illegal entry into caves is increasing and widespread threat within this region. The gates and/or fences of at least seven major VBEB caves have been vandalized in the last 6 years, including Hellhole, Cave Mountain, Cave Hollow/Arbogast, Mystic, Sinnitt/Thorne, Trout, and Hoffman School. Vandalism has included excavating under gates or fences, cutting gate bars or locks, and entry during closed periods. Law enforcement officers were able to successfully identify and close a case against perpetrators attempting to enter one of the caves. Additional investigations are ongoing. In some instances, it does not appear that attempts to enter the cave illegally were successful, although in other cases they were. In at least two caves (as described above), declines in VBEBs coincide with periods of illegal entry.

- The number of wind facilities in this region is increasing. There are a number of wind facilities located on the edge of the range of the species in this area and at least one major wind facility proposed in Pendleton County near where many of the major VBEB caves are located.

- There is at least one new major road proposed in close proximity to VBEB sites in this region. Roads constructed in between roosting and foraging sites, or between roost sites can cause direct mortality and could also reduce foraging success, fragment habitats, and present a barrier to VBEB movement between key areas needed to support various life stages of the species.

- Limestone and rock quarries are a continuing threat including near Hellhole and Schoolhouse Cave, as there is an active and expanding limestone quarry in that area. As a result of negotiations between the quarry owner, the WVDEP, WVDNR, and the Service, the quarry is currently conducting activities in a manner that is not adversely affecting the cave. However, if modifications to project operations or further expansions are planned, or if additional information on cave passages is developed, then this determination may be revised.

- Oil and gas development and associated pipeline construction is an emerging threat in this region. Recent improvements to drilling techniques (fracking) have allowed for the development of gas deposits in previously inaccessible areas that underlay the range of the VBEB. These advanced drilling techniques can go deeper as well as horizontally, which could affect the geological or hydrological integrity of caves and mines that support the VBEB. There is also an increase in pipeline construction associated with this gas development. Pipelines could affect roosting and foraging habitat for the VBEB, and blasting and construction could affect caves and mines used by the species. Slips from construction on steep slopes could block or alter entrances and affect rock faces, forests, streams, and wetlands used by the species.

- The extent of some caves and mine sites are not well-documented or not well known. Therefore the ability to assess effects from projects or identify areas for protection is limited. The Cave Research Foundation is currently working to map the Cave Hollow/Arbogast system. Additional mapping projects on key caves may be warranted.

- No protocols have been established to survey caves or mine portals for potential summer VBEB use, therefore these types of sites may not be detected during project reviews and assessments.

Central Region

Very little is known about the population of VBEBs within the Central Region. Surveys conducted between 2002 and 2017 have captured a total of 67 VBEBs at 20 abandoned mine portal entrances in Fayette County within the New River Gorge National River (NRGNR) (Lenza 2018, Johnson et al. 2003). Twelve of these portals have been gated and all are located on public lands. The majority of VBEB captures (64) occurred in the fall by trapping at portal entrances. The fall captures consisted of both males and females. The maximum number of VBEBs captured in one year was in 2002 when 26 were captured at 13 out of 36 sites surveyed. The maximum captured at any one site was eight at the Nuttallburg B portal in 2002. That year also had both the largest level of effort and largest number of sites sampled. The number of VBEBs detected each year has declined since then, with 16 detected in 2005, two detected each year between 2013 and 2015, and none detected in 2016 or 2017. However, the number of sites and locations surveyed has varied between years, making an assessment of overall trends difficult. It should also be noted that the level of effort associated with entrance trapping is not designed to capture or quantify the total number of bats using the site during the winter. Therefore, the total number of bats captured likely does not equal the total number of bats present within the area.

Ideally, internal surveys during the winter would be conducted to confirm use as hibernacula and allow for a more complete count of bats present. However, conducting fall entrance trapping is the best available method for determining whether an abandoned mine site may be used as a hibernaculum because it is not safe to enter mines due to site instability (Johnson et al. 2003). Therefore, it is assumed that sites with fall detections have been or are being used for both fall swarming and hibernation (Johnson et al. 2005). This is consistent with other studies that have shown that fall captures at caves indicates behavior typically associated with mating and hibernacula selection (Davis and Hitchcock 1965, and Fenton 1969 in Johnson et al. 2005). Although recent surveys at abandoned mine sites in the Northeastern Region indicate that some sites where VBEBs are present in the fall may not be used as hibernacula (WVDOH 2017). In that case, other known hibernacula are present nearby.

The number of female captures in the fall at NRGNR portals also indicates that a maternity colony may occur in the area (Johnson et al. 2005). However, to date, no maternity sites have been discovered within this region. Summer surveys targeting VBEBs have been limited. Summer trapping at portal entrances was conducted in 2002. Out of 36 sites surveyed, a total of three male VBEBs were captured at 2 sites. In addition, no VBEBs were captured during mist netting conducted in 2003 and 2004 at 41 sites within the Gauley, Bluestone and NRGNRs (Castleberry et al. 2005).

This area is geographically separated from other known VBEB sites by distances greater that the dispersal patterns these bats (Johnson et al. 2005) and genetic information indicates that this area is isolated from other surrounding populations (Piaggio 2013, Piaggio et al. 2009). These factors suggest that this area may support a separate and distinct VBEB population. Notwithstanding the small numbers of bats that have been found in this RU, there is strong genetic evidence that this population is not of recent origin (Piaggio et al 2009, Piaggio 2013, Piaggio, personal communication). This population also contains unique genetic legacies not found elsewhere

within the range, and the VBEB are using alternative habitat features (abandoned mines) that may provide additional adaptive capacity for the species. In addition, the estimated effective population is for this region (361) is similar to those estimated for the Western and Southeastern Regions (323 and 326, respectively) (Piaggio et al. 2009). All these factors suggest that there are more VBEB present in this region than are currently known.

It is likely that there are additional currently unknown sites used by the VBEBs in this region. Abandoned mine portals are common throughout the area in and around the NRGNR including in many surrounding counties (Johnson et al. 2005). VBEBs are known to use rock shelters and cliff faces as both roosting and maternity sites in other portions of the range, and this type of habitat is also abundant in the area (Johnson et al. 2005). In addition, the NRGNR provides large tracts of intact mature forest in close proximity to reliable water sources which provide foraging and drinking habitat for the VBEB (Johnson et al. 2003, Castleberry et al. 2005). Therefore, additional surveys both within and outside the NRGNR are warranted. Genetic samples should be gathered from any additional VBEBs that are captured in this area to help further evaluate the relationship between this and other regions.

Threats to VBEBs within the region include:

- Vandalism of cave gates and disturbance to ungated mine sites, rock shelters, or cliff faces used for roosting, hibernation or maternity sites.

- Many abandoned mines are inherently unstable and are degrading over time, therefore sites used by VBEBs may be subject to collapse potentially trapping or killing VBEBs inside and/or making the mines unsuitable for future use.

- Active coal mining in areas outside of the NRGNR may damage or destroy existing abandoned mine portals and passages used as roosting, hibernation, breeding, and maternity sites, and may remove or degrade foraging and drinking habitat. No protocols have been established to survey mine portals for potential summer VBEB use, therefore these types of sites may not be detected.

- Recreational rock-climbers and other users may inadvertently disturb VBEBs roosting on cliff faces, rock shelters, and crevices.

The primary conservation needs of this region are to continue to monitor sites that have documented VBEB use, periodically check and maintain existing openings and bat gates, further understand the relationship of this region to other regions through additional genetic testing or potential telemetry work, and to search for additional VBEB sites. Searches should include adjacent counties within the known dispersal distance of the bats.

Southeastern Region

The Southeastern Region includes caves or roosts within Avery and Watauga Counties, North Carolina; Carter and Johnson Counties, Tennessee; and Bland and Tazewell Counties, Virginia.

There are two major hibernacula within this population; Black Rock Cliffs Cave in Avery County, North Carolina, and Higgenbotham in Tazewell County, Virginia. Black Rock Cliffs Cave is owned by TNC, and Higgenbotham is owned by VDGIF. Both are gated and considered protected. There are eight other minor hibernacula. The total number of hibernating VBEBs in this population based on the last 2 years of data is 526. Numbers in both main hibernacula have fluctuated over time, and some confounding factors at each site make a determination of trends difficult.

Estimates from Higgenbotham in the 1980s indicated the colony was as large as 2,000 VBEBs. However, these counts were made from estimates of the cluster size (x' by x') multiplied by an average number per square foot. In the 1990s, greater effort was made to count individual bats, but the numbers fluctuated widely (from lows of 400-500 to a high of 1,600). Surveys were stopped in the late 1990s due to safety concerns about an unstable rock ledge near the entrance. After these concerns were addressed, surveys began again in 2011 using photography, which documented 892 VBEBs. The most recent survey conducted in 2017 documented 301 VBEBs. This survey was conducted during a very warm week and the bats were noted to be active with one cluster located closer to the entrance than previously noted. However, because of the lower counts during the past two surveys there are concerns about population declines.

The number of VBEBs at the main known hibernaculum in North Carolina, Black Rock Cliffs Cave, has fluctuated since discovery of the cave in 1981 when 34 bats were found within the cave. Subsequent surveys indicated an initial trend of increasing numbers in the first decade, but since the mid-1990s there have been some dramatic drops on several occasions (as low as 31 and 55 bats). At the time of the previous status review (2007), there were 376 VBEBs documented in this cave, which was the highest number recorded. The most recent survey conducted in 2018 documented 179 VBEBs. One other minor hibernaculum, Black Rock Mystery Hole, has seen similar fluctuations of between 70 and 4 bats over a 10-year period, with the most recent count in 2018 documenting 42 VBEBs. These fluctuations may be due to factors negatively affecting the species, or due to the complexity of the habitat. It is suspected that there are other areas where the bats overwinter as the surrounding mountain landscape is very rocky, with a multitude of crevices and openings yet unexplored or inaccessible to humans. Thus, it is difficult to determine the status of hibernating VBEBs in North Carolina.

No significant bachelor caves have been identified in this region. There are, or were, three major maternity sites in this population area: MBC (Cassel Farm #2) and Higgenbotham in Tazewell County, Virginia; and Mama's Cave in Watauga County, North Carolina. Black Rock Cliff Cave in Avery County, North Carolina is also a maternity cave as well as a hibernaculum. MBC is privately owned, while Higgenbotham and Mama's Cave are owned by State Agencies. Although Mama's Cave is not gated, the location is not widely known, which may reduce chances of visitation. VBEB use of Mama's Cave was first discovered in 2013 and it is now considered the primary maternity cave in North Carolina. This cave has been monitored

annually since it was discovered, and numbers have ranged from 292 in 2014 to 422 in 2017. The most recent count conducted in 2018 documented 295 VBEBs. Maternity activity at Black Rock Cliff Cave was first documented in 2013 when 30 VBEBs including young-of-year were seen. Numbers increased to 125 VBEBs and young in 2014.

Maternity counts were conducted at MBC in 2013 and 2016 with 346 and 450 VBEBs documented respectively. Higgenbotham was last monitored during the maternity season in 2013 when 8 VBEBs were seen. Prior to that, numbers were approximately 300, suggesting that this cave has been abandoned. Numbers at both Virginia maternity sites are down from maximums in the late 1990s when 656 were counted at MBC and 621 were counted at Higgenbotham.

In 2018, Virginia switched methods for monitoring maternity caves from using emergence counts to using a bat call data recorder to document acoustic passage rates. These recorders are not capable species identification, but do document emergence over time. These units may provide information on summer activity patterns (emergence in relation to climatic conditions, behavioral activity that may indicate birth times, date of first occupation, date of last occupation, etc.). However, they are not able to determine number of bats present, so results cannot be correlated with previous monitoring data. Additional work to video record exit counts to determine if there is an association with passage rates detected on the acoustic recorders is planned.

In summary, overall population trends for this region are unclear due to the history of fluctuations at primary sites; however, the status may be declining since numbers at both of the two major hibernacula have recently decreased, and as have numbers at two of the three maternity sites. All but one of these sites are publically owned and considered protected.

Threats and conservation needs within this region include:

- Although the primary maternity colony in North Carolina is considered protected, the areas where many of the secondary roosts and foraging areas are concentrated are popular for second home development and are being rapidly developed. This development and associated projects (e.g., road creation/widening) could impact foraging habitat, travel corridors, and roosting locations. It could also result in increased predation from cats and other species adapted to human presence. Protection and management of foraging and roosting habitat around primary roost sites is needed. The Service and other partners have already initiated outreach to local landowners regarding conservation needs of the VBEB, and continued work in this regard is needed.

- The small size of colonies is this region is also a concern. Genetic isolation may be an issue. It is also unclear why these colonies are not growing, given the protection of the main cave sites. Additional research to determine limiting factors is needed.

- Surveys for additional maternity/hibernacula roosts are needed. The last year that all three maternity sites were surveyed during the same season was in 2015 when a total of 934 VBEBs were documented. During that following winter, a total of 258 VBEBs were

counted in all the hibernacula, giving strong indication that additional undocumented hibernacula exist.

Western Region

The Western Region includes caves or roosts within Estill, Jackson, Lee, Menifee, Morgan, Powell, Rockcastle, Rowan, Wolfe, and Pulaski counties, Kentucky. However, many of these counties only have records of a few VBEBs. The major sites in Kentucky are in Jackson and Lee Counties.

Since the time of the last status review, one major new site, Johnson Cave, has been located in Jackson County, Kentucky. Use of this site by big-eared bats was first documented in June 1964, but at that time it could not be determined whether these bats were RBEBs or VBEBs. Intermittent winter surveys between 1969 and 1995 documented only occasional use by VBEBs with no more than eight present per year, as well as no more than 47 RBEBs. However, surveys since 2008 have documented a generally increasing trend in the number of VBEBs hibernating in the cave with 35 in 2008, 29 in 2010, 10 in 2011, 98 in 2012, 161 in 2014, 216 in 2016, and 146 in 2018. Large amounts of guano were first noticed during the 2011 survey, indicating that the cave was also being used by big-eared bats in the summer. Entrance surveys in May 2013 and May 2015 documented the presence of both RBEBs and VBEBs. Entrance, emergence, and harp trap surveys were conducted in June 2016. These surveys confirmed that both RBEBs and VBEBs are using this cave for maternity habitat. A total of 679 BEBs were counted emerging from the cave and of the 180 bats captured during the harp trap effort, 92.8 percent were VBEBs including 115 (68.9 percent) reproductive females, 6 (3.3 percent) non-reproductive females, and 46 (25.6 percent) males. These results confirm that the site is being used as both a winter hibernaculum and a summer maternity/bachelor site. Johnson Cave is privately owned and is not gated and therefore, is not considered protected.

There are six known active maternity sites in Kentucky. Three of these are or were major sites: Johnson, Cave Hollow Pit, and Plecotus Pit. While numbers have been generally been increasing at Johnson Cave, numbers have generally been decreasing at Cave Hollow Pit and Plecotus Pit. This may be a result of bats switching from these roost sites over to Johnson Cave. Johnson Cave now supports approximately 75 percent of Kentucky's maternity population. Both Cave Hollow Pit and Plecotus Pit are located on national forest lands and are posted with signs as closed but are not gated. These sites are located in remote areas of the forest and are difficult to access. Total numbers in maternity caves were 985 in 2018. This is a decline from the 1,116 documented in 2017 but still an overall increase in the last 5 years from 523 in 2013. These numbers are up from the 409 counted during the 2008 status review, primarily as a result of the discovery of a new maternity site. During this time, numbers declined at Stillhouse Cave, the major bachelor site from 422 in 2007 to 141 in 2018. This is a significant decline from the maximum number (1,153) of bats found in Stillhouse Cave in 1990.

Winter hibernacula are surveyed every other year, therefore a complete count of caves includes results over a two-year period. The total population of hibernating VBEBs has declined 16 percent over the last two complete survey periods, from 4,839 in 2015-2016 to 4,054 in 2017-2018. However, this is still a 22 percent increase from the time of the last status review, which documented a total of 3,166 VBEB in 2006-2007. Although there a total of 55 sites that have been documented to contain hibernating VBEBs, most VBEBs hibernate in two caves: Stillhouse

and Johnson. Stillhouse Cave, Kentucky's largest VBEB hibernacula, supports approximately 90 percent of Kentucky's hibernating population. This cave is on national forest lands, is gated and closed year-round, and has no recent history of vandalism, is therefore considered protected. The other caves supported a total of 299 bats in the last survey period (only 33 of the other caves were surveyed within the most recent two year period). The total number of bats at all monitored hibernation sites in 2017-2018 is less than the maximum number (6,335) of bats found hibernating in Stillhouse Cave in 2001.

In summary, the VBEB population in the Western Region has been on a generally increasing trend over the last 10 years, however there have been significant fluctuations within that time period. The discovery of new caves and bats switching between caves makes it difficult to determine clear trends. Overall numbers are down from the 1990s and early 2000s, even when incorporating data from new caves.

Threats to VBEBs in the region and associated conservation needs include:

- Variation in population trends indicates that there may be additional undiscovered caves in the region and/or that there are ongoing unidentified threats. Surveys should be conducted in other suitable habitats throughout the area, and existing known-use areas should be monitored for disturbances and other threats. Additional telemetry efforts may be useful in finding additional sites or understanding habitat usage in the area.

- Over half of the known roosting caves, sandstone rock shelters, and arches known to be used by VBEBs in Kentucky are located on national forest lands. Only 8 of those are currently gated from human access. Many of the ungated ones are in areas that are difficult to access. Existing forest management plans provide protections for VBEB habitat (e.g., rock shelters and caves). However, disturbance in caves on the national forest continues to be a threat. For example, horseback riders located one cave in 2016 and began riding their horses into the entrance. Efforts to reduce this situation are ongoing. Rock climbers may also disturb VBEBs roosting in rock shelters or on cliff faces. Of the 22 privately owned caves, rock shelters, and arches known to have been used by VBEBs, only one is currently gated. These areas could be targeted for protection measures such as gating, fencing, conservation easements, and/or purchase.

- There may be continued threats from oil and gas drilling as described in the 2008 status review.