Recovery Plan for the Virginia Big-eared Bat (*Corynorhinus townsendii virginianus*)

Original Available at: https://ecos.fws.gov/docs/recovery_plan/840508.pdf
Original Approved: 1984
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DRAFT AMENDMENT 1

We have identified best available information that indicates the need to amend the recovery criteria for the Virginia big-eared bat (VBEB) (*Corynorhinus townsendii virginianus*) since the recovery plan was completed. In this proposed modification, we synthesize the adequacy of the existing recovery criteria, show amended recovery criteria, and the rationale supporting the proposed recovery plan modification, and update the list of recovery tasks and priorities to address new information developed since the initial recovery plan was completed. The proposed modification is shown as an addendum that supplements the recovery plan, superseding Part II: Recovery, Section A on pages 28-29 of the recovery plan. Other changes consist of deleting two recovery actions that have been completed, substantially revising one action, adding one new action, making minor modifications to the wording of three actions, and changing the priority numbers of six actions.

For
U.S. Fish and Wildlife Service
Northeast Region
Hadley, MA

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METHODOLOGY USED TO COMPLETE THE RECOVERY PLAN AMENDMENT

The information in this amendment is based on new information about the species[1] that has become available since the original recovery plan was completed. This information is summarized in the 2008 and 2019 status reviews (Service 2008, Service 2019). State resource agencies and other partners provided information to develop those reviews, and provided comments on the drafts. Draft recovery criteria and plan amendments were initially developed during a meeting between the Service's West Virginia Field Office, recovery coordinators from the Northeast Regional Office and Headquarters Office, and the West Virginia Division of Natural Resources biologist who is a VBEB expert. Initial draft criteria were then discussed with biologists from state resource management agencies and cooperating Service Field Offices throughout the range. Subsequent calls and discussions focused on tailoring criteria to reflect information pertinent to each recovery unit. The recovery criteria were designed to be objective and measureable, and to constitute the conditions needed to ensure species viability through sustainment of populations in the wild that demonstrate resiliency, redundancy, and representation.

[1] The ESA (section 3) defines "species" to include any subspecies of fish, wildlife, or plants. Although the VBEB is a subspecies, this recovery plan amendment refers to it as a species.

Formal peer review of this draft recovery plan amendment will be conducted due to the substantial new information analyzed in the status reviews and used in the modification of the original downlisting criteria, the establishment of new delisting criteria where none existed in the original recovery plan, and modification of recovery actions.

ADEQUACY OF RECOVERY CRITERIA

Section 4(f)(1)(B)(ii) of the Endangered Species Act (ESA) requires that each recovery plan shall incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination…that the species be removed from the list." Legal challenges to recovery plans (see Fund for Animals v. Babbitt, 903 F. Supp. 96 (D.D.C. 1995)) and a Government Accountability Audit (GAO 2006) have also affirmed the need to frame recovery criteria in terms of threats assessed under the five threat factors (ESA 4(a)(1)).

Recovery Criteria

The original recovery criteria can be found on pages 28 to 29 of the 1984 recovery plan[2]. That plan lists four criteria for downlisting 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 original recovery plan did not include criteria for delisting. The plan concluded that it seemed unlikely the VBEB will ever recover to a point where it can be removed from the threatened list. This was primarily because large portions of the total population concentrate in a small number of caves during both winter and summer, making the species extremely vulnerable to human disturbance or catastrophic events.

Synthesis

The VBEB is a colonial species that congregates in groups in caves or cave-like habitats (e.g., abandoned mine portals, rock crevices) for roosting and raising young in the summer, breeding in the fall, and hibernating during the winter. The species may use different sites during these different seasons, and can migrate up to 40 miles when moving between sites (Service 1984). VBEBs are foraging specialists with lepidopterans (moths) making up greater than 80 percent of the prey (Lacki and Dodd 2011). Foraging areas are generally located within a few miles of 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 (Service 2019).

The current range of the species includes West Virginia, Virginia, Kentucky, North Carolina, and Tennessee. Archeological records suggest that the historical range of the species once also

[2] The 1984 Plan addressed both the VBEB and the Ozark big-eared bat (*Corynorhinis townsendii ingens*).

included Pennsylvania (Guilday 1961). In 2018, the total population estimate for the species was approximately 19,500 bats in hibernacula and 11,800 within the known maternity sites (Service 2019). The large majority of these bats are currently concentrated in 10 hibernacula and 18 maternity sites distributed among 4 genetically distinct populations located in geographically distinct regions (Piaggio et al. 2009, Service 2019).

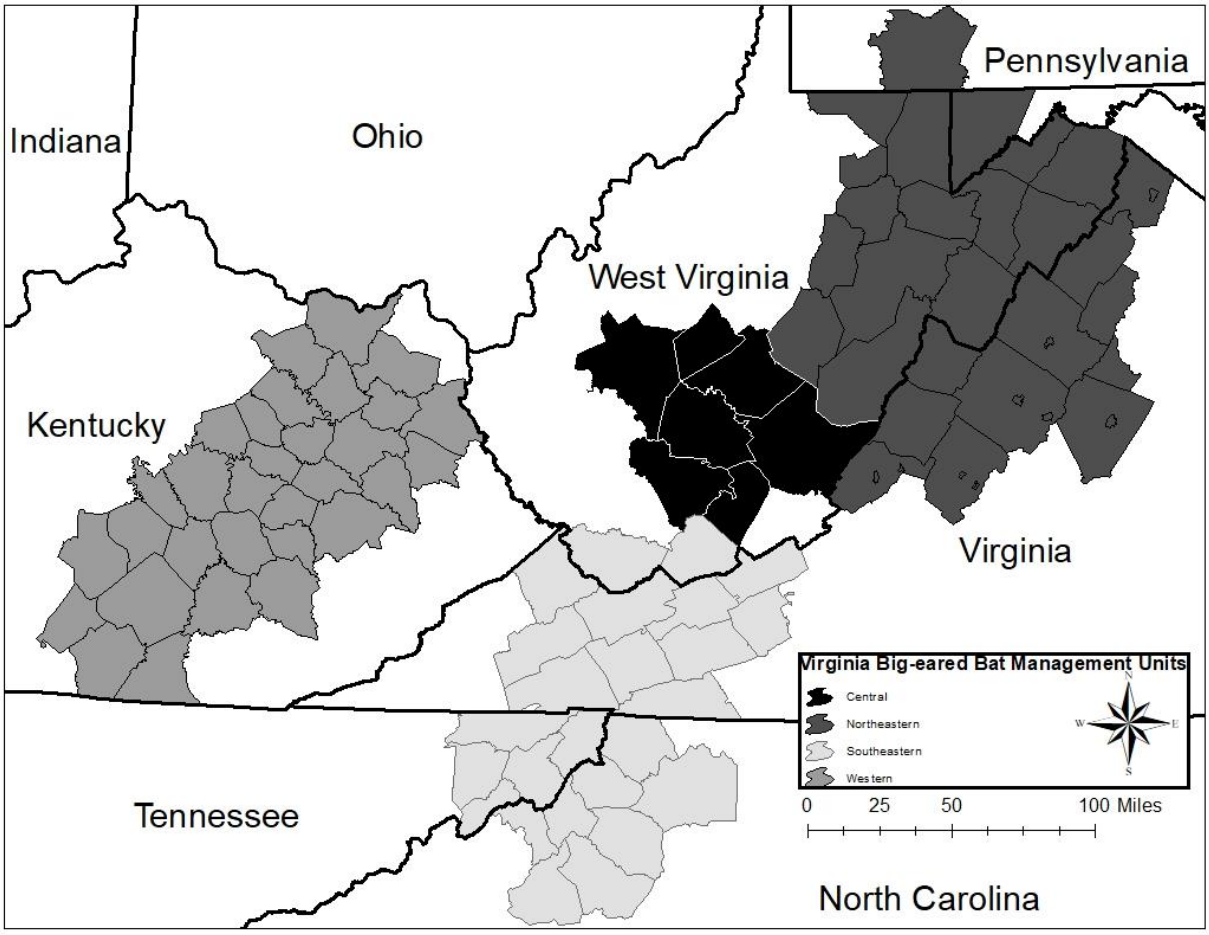
VBEBs require a narrow range of microclimatic conditions (e.g., temperatures, humidity) (Service 1984). This makes protecting and maintaining suitable sites highly important to the recovery of the species. The species is acutely sensitive to disturbance within sites, and can have increased mortality, have reduced reproductive success, or abandon sites completely as a result of disturbance or alteration of its habitats (Service 1984). This sensitivity and the species' concentration in a limited number of sites make it highly vulnerable to threats. The species is also threatened by the degradation and fragmentation of foraging areas, activities that could damage or degrade surface or subsurface areas of caves, barriers to migration and activities that reduce connectivity between roosting and foraging areas, as well as sources of direct mortality such as predation, roads, wind farms, and oil and brine pits (Service 2019). The effects of small population size and low genetic variability may also be threats (Service 2019).

The 2019 status review summarized the current information on the species, and is incorporated here by reference. That review identified new information, as well as some deficiencies in the 1984 recovery plan, including the recovery criteria.

ESTABLISHMENT OF MANAGEMENT UNITS

The 2008 and 2019 status reviews document that the VBEB population is segregated into four genetically and geographically distinct regions that each support an important share of the species' very limited genetic diversity and adaptive capacity (Service 2008, Service 2019). Genetic studies document that there is little to no connectivity among these regions and that VBEBs in each of these regions possess unique genetic resources that are not present in the other regions (Piaggio et al. 2009, Piaggio 2013). Overall genetic diversity of this species is already much lower than that of the two western big-eared bat subspecies, and maintaining the full extent of the current adaptive capacity is required to maintain the remaining evolutionary potential of the bats (Piaggio et al. 2009). In addition, there is no evidence (based on genetics and banding studies) of recent movement of VBEBs between regions, and distances between sites in adjacent regions are greater than the known migratory capacity of the VBEB (Service 2019). VBEBs from one region would not be able to move into or recolonize another region if populations in an adjacent region declined, or were extirpated. Together these four regions maintain the current and historical distribution of the species. In summary, each region is unique and discrete, and contributes to maintaining the viability, adaptive capacity, and distribution of the species. As a result, these regions are designated as four separate Management Units (MUs) as shown in figure 1. Boundaries of the MUs were delineated by mapping known and historical VBEB sites by county (Service 2019) and then buffering these areas to include adjacent counties to account for foraging and migratory dispersal potential, as well as the potential presence of additional sites.

Figure 1: Virginia Big-eared Bat Management Units



The VBEB MUs differ in terms of current and historical population size; numbers of current and historical sites; numbers of bats within sites; distribution of sites; and type of roosting and foraging habitat used (Service 2008, Service 2019). Therefore, establishment of MUs allows unit-specific recovery criteria tailored to these differences.

AMENDED RECOVERY CRITERIA

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the protections afforded by the ESA are no longer necessary and the species may be delisted. Delisting is the removal of a species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Downlisting is the reclassification of a species from an endangered species to a threatened species. The term "endangered species" means any species (species, subspecies, or Distinct Population Segment) which is in danger of extinction throughout all or a significant portion of its range. The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Revisions to the Lists, including delisting or downlisting a species, must reflect determinations made in accordance with sections 4(a)(1) and 4(b) of the ESA. Section 4(a)(1) requires that the Secretary determine whether a species is an endangered species or threatened species (or not)

because of threats to the species. Section 4(b) of the ESA requires that the determination be made "solely on the basis of the best scientific and commercial data available." Thus, while recovery plans provide important guidance to the Service, States, and other partners on methods of minimizing threats to listed species and measurable objectives against which to measure progress towards recovery, they are guidance and not regulatory documents.

Recovery criteria should help indicate when we would anticipate that an analysis of the species' status under section 4(a)(1) would result in a determination that the species is no longer an endangered species or threatened species. A decision to revise the status of or remove a species from the Federal Lists of Endangered and Threatened Wildlife and Plants, however, is ultimately based on an analysis of the best scientific and commercial data then available, regardless of whether that information differs from the recovery plan, which triggers rulemaking. When changing the status of a species, we first propose the action in the *Federal Register* to seek public comment and peer review, followed by a final decision announced in the *Federal Register*.

We provide downlisting criteria that will supersede those included in the recovery plan (Service 1984), as well as delisting criteria:

Downlisting Criteria
Downlisting for the VBEB may be considered when all of the following four criteria have been achieved:

1. A minimum number of maternity, hibernation, and bachelor sites and total abundance for each MU are attained as described in table 1:

Table 1: Minimum Number of Maternity, Hibernation, and Bachelor Sites and Total Population for Each Management Unit

Management Unit	Min. # of Major Protected Maternity Sites	Min. # of Major Protected Hibernation Sites	Min # of Major Protected Bachelor Sites	Definition of Major Site (Min # of VBEBs Per Site)	Min. # of VBEBs in All Protected Maternity Sites	Min. # of VBEBs in All Protected Hibernation Sites
Northeastern	12	6	3	200	10,000	20,000
Southeastern	6	4	-	200	1,500	3,000
Western (Option A)	6	4	-	200	3,250	6,500
(Option B)	8	8	-	100	3,250	6,500
(Option C)	5	5	-	Sites with highest 16 year average #	5,000	10,000
Central	TBD[3]	TBD	TBD	TBD	TBD	TBD

[3] To Be Determined (further explanation provided in the Rationale for Amended Recovery Criteria section).

Justification: The previous recovery criteria required protection of 95 percent of populations, and stable/increasing populations at 95 percent of sites. This created a moving target because if new sites were found or if populations increased, the required level of protection would also correspondingly increase. These revised criteria provide a more measurable, objective means of documenting that this recovery need has been met. This criterion also addresses the 3Rs required for conservation. MUs provide representation, the minimum number of protected sites provides redundancy, and the minimum protected population sizes provide resiliency. The basis for the numbers provided in this table is described in more detail in the Rationale for Amended Recovery Criteria section below.

2. For each MU, total population numbers for both hibernacula and maternity sites are stable or increasing for a timeframe approximately equal to the lifespan of a VBEB, (approximately 16 years), which encompasses multiple VBEB generations, and meet or exceed the minimum population numbers listed in table 1 for the most recent half of that timeframe. Numbers shall be based on biennial monitoring of hibernation sites and annual monitoring of maternity sites using Service-approved protocols.

   Justification: This criterion establishes that a resilient population within each MU exists over a sufficiently long timeframe to demonstrate that it is able to withstand the threat of demographic and environmental stochasticity. VBEBs are long lived, have low reproductive rates, and are especially sensitive to anthropogenic disturbances. These traits make the species vulnerable to population declines and severely limit its ability to respond quickly to perturbations. For example, it took over 20 years for VBEB numbers to recover to 75 percent of previous numbers after a vandalism event at a cave in West Virginia (Stihler 2011). Therefore, a reasonably long timeframe is needed to show steady trends and adequate reproduction/limited mortality. The current recovery plan goal of 5 years is too short; hibernacula surveys are conducted every other year providing only two data points over 5 years. We selected 16 years to encompass multiple generations and the estimated VBEB lifespan (Service 1984).

3. For all sites needed to support the minimum population numbers and distribution specified in table 1, long-termt management agreements are in place (finalized and fully implemented) with responsible land and resource management entities. Long-term protection is defined to include:
   a) The site is located on state or Federal lands with an established long-term management plan, or it is located on private lands with a signed enforceable management agreement that will transfer to new owners; and
   b) The management plan or agreement specifies that the area will be maintained for the benefit of the VBEB and ensures that habitat (including both the surface and subsurface features) sufficient to support all life functions at all life stages of the populations that utilize the area will be conserved; and
   c) Human access to the site is controlled by the installation of gates or fences, unless the site is located in a sufficiently remote location such that access violations are not expected. In addition, the site must be closed to access during all periods VBEBs are expected to be present (except for access needed to manage or

monitor the bats or the site). Signs are placed at the site to indicate access is prohibited.

Justification: This criterion addresses Factor A (present or threatened destruction, modification, or curtailment of its habitat or range). The importance of protecting colony sites was recognized in the original recovery plan. However, the previous recovery criteria did not define what constitutes long-term protection. This revised criterion provides a more measurable, objective means of documenting that this recovery need has been met. This criterion also incorporates the most current assessment of factors and threats that should be considered when defining long-term protection as identified in the most recent status reviews (Service 2008, Service 2019). Specific management actions or protections that management agreements need to address may vary by site. Factors that should be addressed include preserving the integrity of any roost entrances and passages, microclimatic conditions within roosts, management of surface areas to provide habitats that support and encourage VBEB use, and providing protection from disturbances.

4. Long-term management agreements are in place to protect features essential to all identified key foraging areas. Long-term management agreements must meet criteria 3a and 3b.

   New information that has become available since the 1984 recovery plan describes the types of habitat needed to support VBEB foraging and the distances that VBEBs are known to travel from roosts to foraging areas (Service 2008, Service 2019). Studies have documented that there are some similarities and differences in foraging habitat use between sites and between MUs. These similarities and differences should be considered in conducting site-specific evaluations to determine the type and extent of foraging habitat needed. This could be accomplished by conducting landscape-level analyses and habitat evaluations to identify key foraging areas using the best available data from other similar sites, by conducting additional telemetry work if warranted because existing data is insufficient for that particular site or MU, and/or by other methods as approved by the Service. The scope and extent of foraging areas needed to support populations may differ depending on the number of VBEBs or other bats present at the site, and the landscape surrounding the site. Activities needed to manage and protect these areas for the benefit of the species may also vary. These determinations shall be conducted in coordination with, and shall be approved by, the Service and associated state wildlife management agency(ies) where the site and foraging habitat is located.

   Justification: This criterion addresses Factor A. The importance of foraging habitat around roost sites was recognized in the original recovery plan. However, the previous recovery criterion aimed at protecting foraging habitat was vague because it was developed when the understanding of VBEB foraging habitat needs was limited. This revised criterion provides a more measurable, objective means of documenting that this recovery need has been met.

Delisting Recovery Criteria

Delisting for the VBEB may be considered when criteria 1 through 4 above are maintained[4] and when all of the following additional criteria are met:

5. Within each MU, all sites needed to support the minimum population numbers and distribution as specified in table 1 are connected by habitats that support travel between sites.

   Justification: This criterion addresses Factor A and Factor E (other natural and manmade factors). Barriers to movement (e.g., wind turbines, major highways) that could fragment habitats, impede migration between sites within each MU, or cause direct mortality have been identified as an increasing threat (Service 2019). Mating, hibernation, and reproduction are key life history phases for the VBEB. The bats use different sites for each of these phases. In addition, bats may shift between different maternity or hibernation sites. Therefore, the ability to move between sites within an MU is required to complete their life cycle and to ensure population resiliency.

6. Long-term mechanisms are in place to deter, monitor, detect, and enforce access violations; maintain any gates, fences, and other access controls; and ameliorate adverse effects (including predation) for all sites required to meet criterion 1. Effective monitoring programs are in place to detect access violations and damage to any gates or other access controls in a timely manner. Responsible management entities are identified and accountable for maintaining and repairing access controls, and for regulating and controlling threats from predation.

   Justification: This criterion addresses Factors A, E, D (inadequacy of existing regulatory mechanisms), and C (predation). This criterion would ensure that the protections needed to maintain recovery are continued absent the ESA. Because the VBEB is subject to threats that can be managed but not eliminated, it is considered a conservation-reliant species, (i.e., their long-term viability depends on continued management). Therefore, alternative mechanisms are needed after delisting to ensure that threats are adequately managed into the future. VBEB populations are concentrated in a small number of sites in the winter and summer. Disturbance to bats in roosts is one of the primary threats that resulted in the listing of the species. Protection of these sites is reliant upon gates, fences, and other structures that must be maintained to remain effective. Ongoing management and protection to prevent development, conversion, or degradation of surrounding foraging and migratory habitats is also required.

Rationale for Amended Recovery Criteria

In the development of these amended recovery criteria, we used the three conservation biology principles of resiliency, representation, and redundancy (Shaffer and Stein 2000). Briefly, resiliency supports the ability of the species to withstand environmental and demographic stochasticity; representation supports the ability of the species to adapt over time to long-term changes in the environment; and redundancy supports the ability of the species to withstand

[4] i.e., the minimum numbers in table 1 are met for the most recent 16- and 8-year time periods before delisting and long-term protections for sites and associated key foraging areas are still in place.

catastrophic events. Recovery criteria linked to threat abatement are also necessary. Determining whether a species is an endangered species or a threatened species involves evaluating not only the absolute numbers of individuals, sizes of their habitats, or other demographic and habitat measures, but also the stressors and threats attributed to five threat factors (ESA 4(a)(1)) that cause a species to be at risk of extinction. The ESA 4(a)(1) factors that cause a species to be an endangered species or a threatened species must be reduced, eliminated, or mitigated in order to recover such species, and "threats-based" criteria are required to reflect when threats have been ameliorated to a level and extent that allows for the ecological requirements of the species to be met. Therefore, criteria were also developed to address each of the 5 factors that are relevant to the species, including Factors A, B, C, and E (Service 2019).

The primary mechanism for assuring representation of VBEB is the establishment of the four MUs, each of which contains an important and distinct portion of the species' limited overall genetic legacy. The minimum numbers of VBEBs in protected sites that support essential functions (maternity, hibernation, and breeding/bachelor sites, as well as associated foraging areas) within each MU, as specified in table 1, provide resiliency. Redundancy is assured by distribution of VBEBs among the minimum numbers of major protected maternity, hibernation, and bachelor sites within each MU. Thus, criteria 1, 2, and 4 address representation, resiliency, and redundancy of VBEB.

Populations can increase to resilient numbers and even continue to grow because of recovery efforts that sufficiently reduce or neutralize the threats acting on the species. However, if the threats recur or increase after protections are removed or conservation actions are terminated, the species' condition is likely to degrade again. For this reason, delisting recovery criteria 3, 5, and 6 are required to abate threats and assure that they will not resurge following removal of ESA protections.

Based on the best available information that includes the input and data from species experts during our recovery criteria review, these amended recovery criteria provide quantifiable means to measure progress towards recovery and the ability to recognize when recovery has been achieved. They provide the basis for recovery actions and guide their implementation (locations and amount of recovery activity). Additional information on the rationale behind the numbers provided in table 1 is provided below.

Minimum Population Numbers: Minimum population numbers were derived by reviewing current and historical data to find the highest total population number in maternity or hibernation surveys for each MU that has been documented since listing (Service 1984, Service 2008, Service 2019). Numbers were rounded to the nearest 500 to account for natural variations in survey results and detection between surveys. There are indications that additional unidentified maternity and/or hibernation sites may exist in some of the MUs (Service 2019), as a result there are differences between MUs in whether hibernation or maternity count data are a better indicator of total population potential. The type of site that appeared to have the most complete total count was selected for each MU. A number for the alternative habitat type was then calculated by assuming a 1:1 ratio of females to males, so that the number from maternity counts was doubled to get the hibernation target, or the number from hibernacula counts was halved to

get the maternity target. (Highest numbers for each MU[5] were: Northeastern MU 10,173 at maternity sites; Southeastern MU 1,300 at maternity sites; Western MU 6,335 at hibernacula sites (Service 2019)).

In all cases, these maximum numbers were from postlisting time periods. Most of the available population data on VBEB prior to listing is from time periods after extensive caving and disturbance had already taken place, and when caves were already being abandoned; therefore, prelisting numbers of bats or colony sites are not appropriate to use as recovery targets. Recent population monitoring data in the Northeastern MU indicate that numbers are stable to increasing over the most recent 10-year period, and 2018 numbers are at the maximum ever recorded, suggesting that levels for this MU may currently be resilient. Abundance estimates in the Western and Southeastern MUs generally increased shortly after listing, but numbers in the past 10 years indicate a decline from peak numbers that were reached in 1990s to early 2000s (Service 2019). This indicates that populations in these MUs are not currently resilient and could at least increase back to these previous postlisting numbers.

Minimum Number of Major Protected Sites: Having multiple protected sites within each MU provides redundancy for each population and ensures that each MU is not dependent on a small number of sites for maintaining population numbers. This buffers sensitive VBEB populations against effects of changing site conditions, stochastic events (e.g., flooding, cave passage instability), or human disturbance, and allows surviving VBEBs the potential to reestablish themselves at alternative sites nearby. The team that developed the 1984 recovery plan decided that full delisting was not possible because populations were concentrated in a small number of sites. Therefore, increasing the number of protected sites above current levels or above levels known at the time of listing is necessary to achieve recovery, particularly for MUs where data indicate there are currently unidentified sites, populations have been declining, or sites continue to be abandoned (e.g., Southeastern, Central, and Western MUs).

The minimum number of protected sites for each MU, and the definition of a major site, was developed by reviewing existing data on all known VBEB sites. An assessment was then made as to: the number of currently or historically known sites of each habitat type (maternity, bachelor, hibernation) that have supported or have the capacity to support substantial numbers of bats; whether additional undiscovered sites of each type are likely to be present; whether additional sites are needed to support stable, resilient, and redundant populations; and what minimum number of VBEB indicates that a site provides consistent, relatively stable environmental conditions sufficient to support a self-sustaining colony.

Three bachelor sites must be protected in the Northeastern MU. Bachelor sites are used by male bats for roosting in the summer, and reproductively active females travel to these sites in the fall to breed (Service 2019). In the Northeastern MU, these known bachelor sites are not used during other times of the year (i.e., as major hibernation sites), hence they require independent protections. In the other three MUs, VBEBs are not known to use bachelor sites or the known bachelor colonies are located in caves that are also used as major VBEB hibernation sites. Therefore, the need for additional protections for this habitat type and life history function in the

[5] Numbers not available for the Central MU; see further explanation provided in the Rationale for Amended Recovery Criteria section.

other MUs has not been identified. However, if new information reveals that separate bachelor colony sites exist in the other MUs, this determination may be reconsidered.

Definition of a Major Site: Protected sites must have sufficient capacity and have consistently suitable habitat to support persistent and resilient VBEB populations (i.e., be considered major sites). Review of site monitoring data conducted since listing suggest that once colonies reach 200 or more VBEBs, these sites tend to be consistently used in future years, whereas smaller sites may demonstrate more dramatic fluctuations year-to-year and/or may not be consistently used each year. As a result, this number was used to define the minimum number of VBEB present for a site to be considered a "major" maternity, hibernation, or bachelor site for all MUs except as described below.

Northeastern MU: The VBEB population in this MU was and remains larger than the others. It also harbors the greatest genetic diversity, and therefore makes the largest contribution to the species' representation. The overall abundance and distribution targets for the Northeastern MU reflect current estimates. This MU historically had the most hibernation, maternity, and bachelor sites, and these sites tend to be larger caves and mines with substantial passages. Monitoring of this population indicates that VBEB are able to do some roost switching and still maintain overall stable/increasing population numbers, and there is no indication that any undocumented major sites currently exist. Maintaining the current number of sites and overall abundance of VBEBs is critical to the species' overall resilience and redundancy and to preventing future loss of genetic diversity.

Western MU: This MU currently has four hibernacula and six maternity colonies that could reasonably be expected to support 200 VBEB, based on either numbers at those sites in the past or because those sites could reach that number in the near future with reasonable population increases (Option A). However, this MU also has a total of 55 sites that support at least 1 VBEB, a greater number of sites with small numbers of VBEB than any other MU. Consequently, bats in this MU may be dispersed among more caves but with lower numbers in each cave compared to other MUs. Monitoring of this population also suggests that there may be additional undocumented sites in this MU. To account for these potential differences, State and Service Field Office biologists determined that additional flexibility in recovery criteria was appropriate for this MU. The proposed population numbers and number of protected sites from Option A were used as a starting point for deriving alternative protected population and site targets in Options B and C.

Option B was developed to account for the scenario where the population was spread (in low density) over a large number of sites. Redundancy, in this scenario, exceeds that of Option A. Because of this, we concluded that the minimum population number considered for delisting in Option A was sufficient. However, the number of hibernacula and maternity sites should be increased to account for the smaller number of bats within each site. A minimum of eight protected hibernacula and eight protected maternity sites were chosen based on the current number of known VBEB sites in Kentucky and their population trends throughout their survey history.

Option C provides for the scenario where VBEB numbers increased but the population was primarily concentrated in fewer caves than proposed in Option A or B. In this circumstance, there would be less redundancy of large hibernacula/maternity sites. Because of this, the total population number required was increased, thereby trading increased resiliency for some loss of redundancy. The numbers proposed (10,000 in the winter population and 5,000 in the maternity population) represent what the State resource agency and Service representatives determined was an achievable population based on Kentucky's current and historical population.

Southeastern MU: There is limited information available on the number of historical sites within this MU. Current monitoring indicates that some sites are being abandoned, and that additional undiscovered maternity and hibernation sites exist. Therefore, additional sites beyond those currently or historically known are needed before this MU can be recovered. Abundance and availability of suitable roost sites in this MU most closely approximate those described for Option A in the Western MU; therefore, those criteria were adopted for this MU.

Central MU: The VBEBs in the Central MU possess a number of unique characteristics indicating that this MU is important to the adaptive capacity of the species. VBEBs in this MU are using alternative habitat features (abandoned mines) that are atypical of sites used in other MUs. In addition, unlike other MUs, this area does not contain significant karst outcrops that would support an abundance of larger limestone caves that are typically used by VBEB. Instead, this area contains extensive cliff faces and rocky outcrops that are occasionally used by VBEB in other MUs, but are more typical of habitats used by other *Corynorhinus* species in the western portions of the United States. There is strong genetic evidence that this population is not of recent origin indicating that the bats were present in this area before the mines were made, suggesting that VBEB in this MU may be adapted to use cliff faces and rocky outcrops (Piaggio et al. 2009, Piaggio 2013, Piaggio, personal communication). This population also contains unique genetic alleles, and because the genetic diversity of the VBEB is already limited, maintaining the full extent of genetic diversity and adaptive capacity of the species is important to its survival and recovery (Piaggio et al. 2009, Piaggio 2013). All these factors suggest that maintaining this population as a separate MU is important to the conservation of this species.

Notwithstanding strong evidence of their contribution to representation, there is currently insufficient information about the size and distribution of VBEBs in the Central MU to establish quantitative population criteria. The majority of VBEBs documented in this MU have been captured at abandoned mine portals. Because it is not safe to enter these sites, survey techniques used in other MUs to establish numbers of hibernating bats cannot be used. Although no maternity sites have been located in this MU, the number of female captures at portals in the fall indicates that a maternity colony is located nearby (Johnson et al. 2005). Despite this lack of population information, the genetically effective population estimate for this MU is similar to those estimated for the Western and Southeastern MUs (Piaggio et al. 2009). This is evidence that there are many more VBEBs present in this MU than are currently known. Therefore, recovery actions 2 (search for undocumented sites of importance to VBEBs) and 1 (monitor population trends) are designated priority 1 actions for this MU. Once these additional data are gathered, quantitative population and distribution targets should be established for this MU.

ADDITIONAL SITE-SPECIFIC RECOVERY ACTIONS AND PRIORITY CHANGES

Review of the existing list of recovery actions as well as the 2008 and 2019 status reviews indicates that some recovery actions have been completed, and that there are new threats or recovery needs that have developed since that time, as described below. In addition, some minor modifications to the priority number or wording of the actions would be more reflective of current recovery needs, as described in table 2.

Cave Gates:
When the 1984 recovery plan was written, it was recognized that cave gates could control or limit human disturbance at sites. However, the response of VBEBs to cave gates was not well studied, and there were concerns that gates could alter VBEB behavior and increase predation rates. Therefore, the original plan included recovery actions to study the effects of these gates and then determine if gates should be recommended and, if so, what designs and specifications should be used (recovery actions 3.3.1 – 3.3.7). Many years of monitoring and testing have documented that VBEBs readily adapt to properly designed angle-iron bat gates that are constructed so as to not alter the entrance or airflow of the site. Therefore, recovery actions 3.3.1 – 3.3.7 are obsolete and the following new recovery actions have been developed:

3.3: Install and maintain cave gates.

> 3.3.1: VBEB sites that are threatened by human entrance and disturbance should be gated in accordance with gate designs, criteria, and specifications that have been shown to not adversely affect the VBEB. Currently these are described in Fant et al. (2009). Updated information and future revisions shall be reviewed and approved by the Service's VBEB Recovery Coordinator prior to implementation. Alternative gate designs should only be used in special cases where previously tested designs are not feasible, and should be tested and monitored (in consultation with the Service) in order to determine whether they are safe and effective for the VBEB.
>
> 3.3.2: All gates and fences installed around VBEB sites should be monitored, maintained, repaired, or replaced as needed to ensure their continued effectiveness.

Recovery Action 3.3 is considered a priority 1 recovery need.

Barriers to Movement and Sources of Direct Mortality
These threats were not known to be of concern when the 1984 recovery plan was written. However, the 2008 and 2019 status reviews identified these as increasing threats. Therefore, an additional recovery action has been identified.

9.0 Within each MU, avoid and/or minimize barriers to movement and sources of direct mortality to VBEB (e.g., roads, wind turbines, brine pits).

> 9.1 Conduct research to better understand the effects of barriers to movement and sources of direct mortality to the VBEB, and develop methods to reduce adverse effects.
>
> 9.2 Implement measures to reduce effects from existing and proposed barriers to movement and sources of direct mortality to VBEB. Avoid and/or minimize placement of

new barriers to movement and sources of direct mortality within foraging areas, or within commuting and migration distances from VBEB sites.

Recovery Action 9.0 is considered a priority 1 recovery need.

Table 2: Minor Modifications to the Wording or Priority of Recovery Actions

1984 Recovery Plan		2019 Recovery Plan Amendment		Rationale for Change
Recovery Action	**Priority Number**	**Revised Recovery Action**	**Revised Priority Number**	
1.1 Develop and refine a minimally disturbing census technique for maternity colonies.	2	1.1 Develop and refine techniques to monitor alterative roost sites (e.g., abandoned mines, cliff faces) and to effectively monitor habitat usage.	2	Minimally disturbing census techniques have been developed for maternity sites. However additional work is needed to understand how to monitor abandoned mines, detect VBEB presence during summer mist net surveys, and use dataloggers to better understand activities at roost sites (Service 2019).
1.2 Survey hibernacula every two years.	2	No change	1	Monitoring hibernacula is necessary to determine population trends.
2.1 Search for maternity colonies.	1/2	No change	1/2	This should be considered a priority 1 action for the Central, Western, and Southeastern MUs, and Priority 2 for the Northeastern MU. This was previously broken out by Service Regional boundaries which are not correlated with new MU boundaries.
2.2. Search for hibernacula.	1/2	No change	1/2	This should be considered a priority 1 action for the Central, Western, and Southeastern MUs, and Priority 2 for the Northeastern MU. Previous differences in priority were based on Service Regional boundaries, which are not correlated with new MU boundaries.
2.3 Search for caves providing habitat for solitary VBEB.	3	2.3 Search for bachelor colony/breeding sites.	1	Males were previously thought to roost solitarily in the summer. New information indicates that males form colonies and that sites used by males are also used for breeding. These sites are important to the life history of the species.

1984 Recovery Plan		2019 Recovery Plan Amendment		Rationale for Change
Recovery Action	**Priority Number**	**Revised Recovery Action**	**Revised Priority Number**	
3.2 Determine impact of human disturbance on colony population trends.	1	Deleted	NA	This has been completed. Human disturbance has a negative impact on colony population trends.
3.3 Study and manage cave gating (with associated sub-activities).	1	Modified as described in the narrative above.	1	See narrative, above.
3.6 Protection of caves providing solitary habitat for VBEB.	3	3.6 Protect bachelor colony/breeding sites.	1	See recovery action 2.3
5.1 Prevent adverse modification to the sub-surface, including cave entrances.	3	No change	1	Threats to subsurface habitat are increasing (Service 2019).
5.3 Identify essential surface habitat for each colony site.	2	No change	1	This action will facilitate achieving recovery criterion 4.
5.4 Protect essential surface habitat.	2	No change	1	This action will facilitate achieving recovery criterion 4.
5.8 Study prey species	3	Deleted	NA	This action has been completed.

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