Ozark Big-Eared Bat
(Corynorhinus townsendii ingens)

5-Year Review:
Summary and Evaluation

Townsend's big-eared bat (*Corynorhinus townsendii)*
Photo: Dr. Merlin Tuttle

Prepared by

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5-YEAR REVIEW

Species reviewed: Ozark Big-eared Bat (*Corynorhinus townsendii ingens*)

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1.0. GENERAL INFORMATION

1.1. Reviewers

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1.2. Methodology Used to Complete the Review

This 5-year review was prepared by Richard Stark of the Oklahoma Ecological Services Field Office. Biologists in Columbia, Missouri (Region 3) and Arkansas (Region 4) Ecological Services Field Offices provided assistance and information for this review. No part of this review was contracted to an outside party.

Recommendations resulting from this review are a result of thoroughly reviewing all available information on the Ozark big-eared bat (OBEB). Materials used in the analysis include the revised recovery plan (U.S. Fish and Wildlife Service 1995), peer-reviewed manuscripts, unpublished survey data and reports, and personal communication with species experts. Outreach consisted of a *Federal Register* Notice (71 FR 20714) that requested any new information about the OBEB related to population trends, distribution, habitat conditions, threats, and conservation measures from the public, concerned governmental agencies, Tribes, the scientific community, industry, non-profit conservation organizations, and any other interested parties. An “Interested Party Letter” also was mailed directly to 64 individuals, researchers, tribes, state and federal agencies, and nonprofit conservation organizations listed in the OBEB contact file maintained at the Oklahoma Field Office. Data and additional information was received from Blake Sasse (Non-Game Mammal Coordinator, Arkansas Game and Fish

Commission), Bill Puckette (Cave Biologist and Geologist), Steve Hensley (Manager, Ozark Plateau National Wildlife Refuge), Dr. Michael Harvey (Retired Biology Professor and Bat Researcher, Tennessee Tech University), and Doug Fletcher (Chief of Stewardship, Arkansas Natural Heritage Commission).

1.3. Background:

1.3.1. FR Notice Citation Announcing Initiation Of This Review:

April 21, 2006. 71 FR 20714.

1.3.2. Listing history:

Original Listing
FR notice: 44 FR 69206
Date listed: November 30, 1979
Entity listed: Subspecies (*Plecotus* townsendii ingens*)
Classification: Endangered

*****See Section 2.3.1.4 for explanation on taxonomic reclassification.

1.3.3. Associated rulemakings

Not applicable

1.3.4. Review History:

A 5-year review was initiated on July 22, 1985 (50 FR 29901) for all species listed before 1976, and in 1979-1980; a notice of completion with no change in status was published on July 7, 1987 (52 FR 25522). Another 5-year review was initiated on November 6, 1991 (56 FR 56882) for all species listed before 1991, but no document was prepared for this species.

Recovery Data Call: 2007 (Stable), 2006 (Stable), 2005 (Stable), 2004 (Stable), 2003 (Stable), 2002 (Stable), 2001 (Stable)

Clark, S.C., W.L. Puckette, B.K. Clark, and D.M. Leslie, Jr. 1997. Status of the Ozark big-eared bat (*Corynorhinus townsendii ingens*) in Oklahoma, 1957 to 1995. The Southwestern Naturalist 42:20-24.

Harvey, M.J., and S.W. Barkley. 1990. Management of the Ozark big-eared bat, *Plecotus townsendii ingens*, in Arkansas. Proc. Ark. Acad. Science 44:131-132.

Harvey, M.J., M.L. Kennedy, and V.R. McDaniel. 1978. Status of the Ozark big-eared bat (*Plecotus townsendii ingens)* in Arkansas. Proc. Ark. Acad. Science 32:89-90.

1.3.5. Species' Recovery Priority Number at start of 5-year review:
3 - The degree of threat is high, the potential for recovery is high, and the listed entity is a subspecies (48 FR 43098).

1.3.6. Recovery Plan or Outline

Name of plan: Ozark Big-Eared Bat (*Plecotus townsendii ingens*) Revised Recovery Plan

Date issued: March 28, 1995

Revision History: The original recovery plan was approved on May 8, 1984 (Bagley 1984). The recovery plan included both federally-listed subspecies of *Corynorhinus townsendii,* the Ozark big-eared bat (*C. townsendii ingens*) and the Virginia big-eared bat (*C. townsendii virginianus*). The original recovery plan was revised to specifically address and update biological information, management techniques, and identify new recovery tasks for the OBEB.

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?
Yes

2.1.2. Is the species under review listed as a DPS?
No

2.1.3 Was the DPS listed prior to 1996?
Not applicable

2.1.4. Is there relevant new information for this species regarding the application of the DPS policy?
No

2.2. Recovery Criteria

2.2.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?
Yes, the species has a final, approved recovery plan. However, delisting criteria need to be finalized in a measurable way.

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

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

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:

Note: Listing Factors[1] A, B, D, and E are addressed by Criteria 1 and 2 for downlisting to threatened status and Criteria 1, 2, and 4 for delisting. Listing Factor E also is addressed by Criterion 3 for delisting. Listing Factor C was not considered significant when the OBEB was listed and currently is not considered relevant to the conservation status.

Downlisting Criteria:

Criterion 1--Stable or increasing populations exist at all 14 essential caves, plus all other essential caves discovered during the 10-year period addressed in the recovery plan (1995-2005).

Has not been met:

Fourteen caves were considered essential (*i.e.*, used as a maternity site and/or hibernacula) to the continuing existence of the OBEB when the existing recovery plan was prepared in 1995. Most of these caves were discovered by Mr. William L. Puckette (Puckette 2007).

Since that time, Puckette (2007) has continued his cave search and inventory work for the U.S. Fish and Wildlife Service (Service) and U.S. Forest Service. Six additional essential caves (*i.e.*, a naturally occurring void, cavity or recess that occurs beneath the earth's surface or within a cliff or ledge, and includes limestone and sandstone talus caves) have been

[1] A) Present or threatened destruction, modification or curtailment of its habitat or range;
B) Overutilization for commercial, recreational, scientific, or educational purposes;
C) Disease or predation;
D) Inadqequacy of existing regulatory mechanisms;
E) Other natural or manmade factors affecting its continued existence.

located. These caves include one maternity cave (AD-25, see Table 1), one hibernaculum (AD-T1), and one cave used by large numbers of the OBEB during the fall in Oklahoma (CZ-18); and three additional maternity caves in Arkansas (WA-5202, CW-21 BT1a, and CW-29 BT 3).

The 20 caves currently considered essential are used by ten maternity colonies and eight winter colonies. Two of the caves are known to be used by OBEBs only during the fall (AD-16 and CZ-18).

Table 1. Population trend at each of the known essential OBEB maternity sites and hibernacula from 1995 to 2006.

Cave Code	State	Colony Type	Trend	P-Value (0.05)
AD-10	OK	Maternity	Undetectable	0.9449
AD-13/24/25	OK	Maternity	Undetectable	0.3115
AD-14/125	OK	Maternity	Undetectable	0.7884
AD-17/18	OK	Maternity	Undetectable	0.2149
AD-3	OK	Hibernaculum	Increasing	0.0157
AD-10	OK	Hibernaculum	Insufficient data	NA
AD-14	OK	Hibernaculum	Undetectable	0.0705
AD-15	OK	Hibernaculum	Undetectable	0.0960
AD-16	OK	Fall	Insufficient data	NA
AD-125	OK	Hibernaculum	Insufficient data	NA
AD-T1	OK	Hibernaculum	Undetectable	0.2618
CZ-18	OK	Fall	Insufficient data	NA
CW-29 BT3	AR	Maternity	Increasing	0.0044
WA-5202	AR	Maternity	Increasing	0.0002
MR-9702	AR	Maternity	Undetectable	0.2740
MR-0702	AR	Maternity	Undetectable	1.000
MR-979A	AR	Maternity	Undetectable	0.2426
CW-21 BT1a	AR	Maternity	Insufficient data	NA
Devil's Den	AR	Hibernaculum	Increasing	0.0005
MR-0702	AR	Hibernaculum	Undetectable	0.5251

Several essential caves are used as both a maternity site and a hibernaculum (AD-10, AD-14, AD-125, and MR-0702). Several essential caves serve as alternate roosts for the same maternity colony (AD-13, AD-24, and AD-25; AD-17 and AD-18; and AD-14 and AD-125.), with a colony moving among the alternate caves both during a given maternity season and between years.

OBEB populations at the essential caves have been monitored using minimal census techniques since each essential site was discovered (Puckette 2007; Harvey et al. 2006). Consequently, we have fewer years of data for the more recently discovered sites. Two techniques have been implemented to estimate the colony size at essential sites. The techniques used at maternity sites consisted of: 1) conducting an exit count as the bats emerged from the cave at night to forage, or 2) entering a cave and

counting the colony of bats. The latter technique also was used at hibernacula. The goal of each technique was to obtain data on population trends over time rather than exact counts. See section 2.3.1. Biology and Habitat for a more detailed discussion of monitoring efforts.

The technique used at a particular site and the surveyors conducting the census have generally remained consistent. However, in 2005, surveyors switched from entering the cave to count bats to the exit count technique at MR-9702, -979A, and -0702. Exit counts have not been conducted at the same time each year at all caves.

Trend analysis was examined for particular colonies rather than cave sites because several essential caves serve as alternate roosts for the same maternity colony (*i.e.*, one maternity colony utilizes caves AD-13, AD-24, and AD-25, and the colony may move among the alternate caves during both the maternity season and between years). The analysis was conducted for 15 colonies. The remaining five colonies were excluded from the population trend analysis. The two caves known to be used by OBEBs only during the fall (AD-16 and CZ-18) were excluded from the analysis because they have not been monitored annually. At AD-125, OBEBs typically winter in a largely inaccessible area that requires surveyors to tunnel into the chamber by removing large rocks. This site is rarely monitored during the winter to avoid disturbance of the colony, and also was not included in the analysis. Likewise, the wintering colony in AD-10 was not included due to a lack of data. This colony is difficult to monitor in the winter without disturbing the bats because the bats cluster under a ledge that is difficult to access. Counting the colony requires surveyors enter the cave by rappelling down a rope, which typically disturbs the colony. Because the maternity colony at CW-21 BT1a was discovered in 2006, this site was not included due to a lack of data.

Population estimates for each essential colony were tested using the Mann-Kendall test to determine trends (Hollander and Wolfe 1973, Thompson et al. 1998). Although the recovery criteria called for stable or increasing populations during the 10-year period addressed in the recovery plan (1995-2005), the analysis reported here includes the 1995-2006 count data due to its availability.

Four of the 15 essential sites/colonies analyzed showed a statistically significant increasing population trend (two of six hibernacula and two of nine maternity colonies). Eleven colonies (73.3%) showed no significant trends over the period of analysis (Table 1). This does not mean that these colonies were stable. It means that the data were too variable to make any sort of determination. We were not able to detect whether these 11 colonies were increasing, decreasing, or stable.

The inability to detect whether populations were increasing, decreasing, or stable at most of the essential sites is likely attributable to several factors. Not only is it inherently difficult to monitor a sensitive, nocturnal cave species, but OBEBs also are known to move among some caves (some of which may be unknown).

For example, bats are known to move among caves AD-13, -24, and -25; AD- 17 and -18; AD-14 and -125; and MR-9702, -0702, and -979A. Thus, a portion of the colony could be utilizing other sites when the summer exit counts are conducted.

The AD-14/125 maternity colony also is difficult to monitor. AD-14 is the largest known cave in Oklahoma (almost nine miles of passage have been mapped) and has eleven known entrances. Due to limited personnel and equipment (*i.e.*, costly night vision goggles and scopes), only a limited number of these entrances can be monitored simultaneously during the annual OBEB exit count. Thus, it is likely that all OBEBs roosting in AD-14 during the summer are not counted during the annual exit count. Monitoring additional entrances likely would provide a better estimate of the number of OBEBs utilizing this cave.

The apparent lack of a trend in the population and variation in the data from some of the sites in Oklahoma possibly could be attributable to exit count surveyors counting only adult females in some years, as intended, and unknowingly counting females plus newly volant young in others. Exit counts at all essential maternity caves in Oklahoma and Arkansas should be conducted during the same time frame every year to avoid this possibility. The timing should be such that the surveyors are certain of whether newly volant young are being counted and before break up of the maternity colony (see Recommendations for Future Actions section).

Achieving the criterion of stable or increasing populations at essential caves will require implementation of conservation measures designed to ensure adequate long-term protection of each cave and associated foraging areas. Fine-tuning the monitoring method, as described above, will allow us to better understand population trends and determine when that criterion has been met. Monitoring OBEB colonies at all essential maternity sites and hibernacula is necessary to assess the effect of conservation efforts. Monitoring efforts also will help provide insight regarding whether other natural or manmade factors may be affecting the OBEB.

Several essential cave sites and portions of foraging areas currently have been afforded protection. For example, in Oklahoma, five essential cave sites occur on the Ozark Plateau National Wildlife Refuge (NWR) or land owned by the National Speleological Society (NSS). In Arkansas, four

cave sites occur on tracts owned and managed by the Arkansas Natural Heritage Commission (ANHC), Arkansas Department of Parks and Tourism (ADPT), and the U.S. Forest Service. However, adequate protection measures have not been afforded for all essential sites (Table 2). Long-term protection measures are needed and could be provided through fee title acquisition, and/or perpetual conservation easements, from willing sellers or donors, voluntary landowner agreements, or other measures (*e.g.*, cave gating).

Listing Factors A, B, D, and E are addressed by this criterion.

Table 2. Ownership and protective status of all known essential OBEB caves.

Cave Code	Ownership	Form of Protection	Size of Protected Tract (Acres)
AD-3	NSS	Managed by the NSS.	40
AD-10	Ozark Plateau NWR	Cave entrance gated and managed by the Ozark Plateau NWR; Cooperative agreement with the Cherokee Nation on adjacent tract.	210 (90 Refuge and 120 Cherokee Nation)
AD-13	Private	Cave entrance gated through Section 6 of the Endangered Species Act in cooperation with Oklahoma Department of Wildlife Conservation	NA
AD-14	Ozark Plateau NWR and Private	Cave entrances (11) gated by Tulsa Regional Oklahoma Grotto (TROG) and Ozark Plateau NWR	2,180
AD-15	Private	Cave entrance gated through Section 6 of the Endangered Species Act in cooperation with Oklahoma Department of Wildlife Conservation	NA
AD-17	Private	None	NA
AD-18	Private	Conservation easement with the Ozark Plateau NWR	60
AD-24	Private	None	NA
AD-25	Private	None	NA
AD-125	Ozark Plateau NWR	Managed by the Ozark Plateau NWR	2,180
AD-T1	Private	None	NA
CZ-18	NSS	Cooperative management agreement with TROG, NSS, and Ozark Plateau NWR; gated through the Partners for Fish and Wildlife program	187
AR-55	ADPT	Managed by the ADPT	2,000
CW-21 BT1a	Private	None	NA
CW-29 BT3	Ozark National Forest	Revised Land and Resource Management Plan (2005)	Cave and foraging area within the Ozark National Forest (1.2 million acres)
WA-5202	Private	None	NA
MR-9702	Private	Cave entrance gated. The Nature Conservancy has a cooperative management agreement with landowner.	1
MR-0702	ANHC	Managed by the ANHC	200
MR-979A	ANHC	Managed by the ANHC	336

Criterion 2--The Oklahoma Bat Caves National Wildlife Refuge is operational with authority, funds, and manpower to a) enhance management of Refuge caves and properties, b) construct cave gates and fences where needed, c) monitor populations, d) deter human disturbance through law enforcement, e) implement cave management agreements with private landowners, and f) coordinate recovery efforts on an ecosystem basis across State and Fish and Wildlife Service regional boundaries.

Has not been met:

The first Ozark big-eared bat cave was purchased in 1985 and the Oklahoma Bat Caves National Wildlife Refuge was established April 1, 1986. Its purpose is to provide long term habitat protection to help assure the continuing existence and aid in recovery of the OBEB and other listed or at-risk cave species. In November 1995 this refuge officially became the Ozark Plateau NWR.

Sixteen tracts (eight units) totaling 3,748 acres of fee, easement, and cooperative management agreements have been acquired since 1985. The Nature Conservancy (TNC) has purchased most of the land for the Ozark Plateau NWR because it can work relatively quickly. The Service has eventually been able to acquire the land from TNC. Several high priority cave sites have been gated or fenced to prevent human vandalism and disturbance (Table 2), and additional sites are planned to be gated.

The Service approved expansion of the Ozark Plateau NWR in 2005. The refuge was approved to expand up to 15,000 acres within Adair, Delaware, Ottawa, Sequoyah, Craig, Mayes, and Cherokee counties, Oklahoma. The Environmental Assessment for the approved Expansion of the Ozark Plateau NWR (USFWS 2002) includes a land protection plan that identifies 1) important known habitat for the OBEB in need of long-term protection, 2) the preferred type of protection for each tract, 3) the minimum type of protection deemed necessary, and 4) a protection priority classification for each site. These sites potentially could be acquired as additions to the refuge through fee title acquisition or through conservation/management easements and agreements from willing sellers or donors.

Although the refuge is operational, has provided valuable protection to caves and foraging habitat for the past 20 years, and is approved for expansion, the refuge's ability to operate efficiently and implement necessary management actions is currently seriously limited by staffing and budget constraints. Current refuge staff consists of only one full-time biologist. The refuge budget consists of the biologist's salary plus $14,000/year. Consequently, many necessary refuge management actions

are delayed and/or rely on outside manpower and funds. For example, cave gating and mapping efforts often rely on unpredictable volunteer labor. Monitoring efforts often are accomplished with assistance from volunteers and staff from other Refuges and the Oklahoma Ecological Services Field Office. Furthermore, cooperative management agreements require a sustained effort to maintain positive working relationships with numerous private landowners and non-governmental organizations, a duty that alone requires a considerable time commitment.

Additional staff and funds would be required to facilitate sufficient operation of the refuge, especially as existing cave gates and fences require maintenance and repair, and the refuge enters into additional cooperative management agreements and acquires additional tracts through fee title or easement that contain caves and foraging habitat essential for the recovery of the OBEB. Without additional funding and staff, refuge operational efforts to achieve this recovery criterion will continue to be hampered.

Listing factors A, B, D, and E are addressed by this criterion.

Delisting Criteria

Note: The delisting criteria provided in the 1995 Recovery Plan were considered interim because the opportunity and potential for reestablishing additional OBEB populations was uncertain. Final delisting criteria should be prepared after all essential caves have been identified. Essential caves are those used as a maternity site and/or hibernacula.

Criterion 1--Protect all limited-use sites.

Has not been met:

Limited-use sites are those sites used by single individuals and small groups of OBEBs. These sites also provide important habitat for solitary males during the maternity season. Approximately 57 limited-use sites were known when the existing recovery plan was prepared in 1995. Most of these sites were discovered by Mr. William L. Puckette, a biologist under contract with the Service and U.S. Forest Service to perform cave search and inventory work. Since that time, data on additional caves that provide roosting habitat for solitary individuals and small groups have been collected.

Limited-use sites occur on the Ozark Plateau NWR in Oklahoma, the Ozark National Forest in Arkansas, and on private property in both states. Data on all known limited-use sites including the protective status (*e.g.,* gated, cooperative agreement, etc.) and location has not been compiled to

date. The sites that occur on the Ozark Plateau NWR and the Ozark National Forest are afforded protection by the U.S. Fish and Wildlife Service and Forest Service, respectively. The Forest Service has established a 200-foot buffer of undisturbed forest around all known OBEB sites wherein activities that may negatively impact the bats, such as trail and road construction, prescribed fire, and the development of pastures, are prohibited (USDA 2005). Several additional sites that occur on private lands have been protected through cave gating and landowner agreements. Some remote, little known sites do not currently require gating, fencing or other forms of active protection. Two limited-use sites that occur in Adair County, Oklahoma, will be gated in FY 2008 through the Service's Private Stewardship Grant program. As the human population in the area continues to grow and expand, gating may be warranted at other sites.

Listing factors A, B, D, and E are addressed by this criterion.

Criterion 2--Reestablish stable or increasing populations at all available historic caves in Oklahoma, Arkansas, and Missouri.

Has not been met:

The OBEB has not been recorded from several historically utilized caves in over 20 years. Because some caves have either been sealed or otherwise adversely altered, reestablishing populations at all historic locations will not be possible. However, natural reestablishment at remaining, suitable caves may occur as existing populations increase because of continued recovery efforts.

Recently, conservation measures have been implemented at two historic caves in Delaware County, Oklahoma. A cave gate was constructed at Cave DL-4, an historic hibernacula from which OBEBs have not been observed since the 1960s. A fence was constructed around Cave DL-21, a limited-use site from which OBEBs have not been recorded since 1987. Although OBEBs have not been found at these sites during recent monitoring efforts, the caves will continue to be monitored for natural reestablishment.

The OBEB has not been recorded from Missouri since 1971. Three surveys for the species have been conducted in Missouri by the Missouri Department of Conservation (MDC) since that time. Figg (1987) searched 17 caves, but did not find OBEBs at any sites. Figg and Lister (1989) searched an additional 80 caves, but also did not find OBEBs at any sites. The species also was not located during a survey conducted at 34 sites during the summer and fall of 1999 (Elliott et al. 1999). However, evidence of use, in the form of neatly clipped moth wings, was found at

two sites (see Foraging Ecology and Habitat section for a discussion of OBEB food habits). A list of the sites searched during the three survey efforts is available from the MDC. These sites should be re-visited periodically.

This criterion was considered interim due to the uncertainty regarding the opportunity and potential for re-establishing populations. The results of a recent population genetics study raises further uncertainty regarding whether re-colonization of historic sites would occur naturally. Weyandt et al. (2005) examined population genetic variability by comparing nuclear and mitochondrial DNA among bats from essential maternity caves in Oklahoma. No significant variation between nuclear satellite DNA was found. However, maternally inherited markers differed among sites, indicating very strong site fidelity, limited dispersal by females, and high natal philopatry. These results suggest that caves used by maternity colonies that experience a local extinction may not be naturally re-colonized.

Listing factors A, B, D, and E are addressed by this criterion.

Criterion 3--Determine self-sustaining population level in order to define delisting criteria.

Has not been met:

The recovery plan indicated that a Population Viability Analysis (PVA) should be conducted within ten years (by 2005) to determine a self-sustaining population level. However, conducting a PVA with suitable predictive power is not feasible at this time, as explained below.

There is considerable variation in the level of analysis and the amount and type of data required to conduct a PVA. A PVA typically is based on demographic data such as estimates of the variance in fecundity and survivorship of a population. Available mathematical models range from simple calculations of growth rate to complex computer programs that incorporate numerous aspects of the species' life history. The amount of data required depends on the questions being addressed. The higher the quality of the data included in the analysis, the higher the predictive value of the results.

Conducting an adequate PVA that would provide useful information regarding a self-sustaining population level for the OBEB and that could be used with confidence to refine future recovery tasks and delisting criteria would require a fairly data-inclusive, structured demographic PVA. Data on reproductive rates (*e.g.*, what percent of adult females produce no young) and mortality rates, both of which are not currently

available, would be an integral part of the analysis. The data currently available are annual counts of individuals at maternity sites and hibernacula. Obtaining the fecundity and survivorship data would require drastically increased encounters with the bats, such as through human entry of maternity caves, trapping with harp traps or mist nets, and handling of bats. Considering human disturbance at maternity sites and hibernacula are a major cause of decline, the benefit gained from conducting such a study likely would not outweigh the risk of increased bat harassment and/or cave abandonment that may occur as a result of the increased human encounters with the bats.

A simplified count-based PVA could be conducted with currently available data. However, without additional data on fecundity and survivorship, numerous assumptions regarding population growth and its variability would have to be made. The scarcity of appropriate data and the high level of uncertainty that would be involved in the analysis would limit the predictive power of the model and raise reservations regarding whether the results would be reliable enough to help refine future recovery tasks and delisting criteria. Thus, a PVA to determine the self-sustaining population level is not recommended at this time.

The results of a recent population genetics study further emphasize the need to focus conservation efforts on locating and protecting all essential caves, as called for by the downlisting criteria, rather than using a minimal sustainable population level as a conservation standard. Weyandt et al. (2005) found that maternally inherited markers differed among sites, indicating very strong site fidelity and limited dispersal by females, and high natal philopatry. These results suggest that failure to protect a maternity site may result in the loss of genetic variation. Furthermore, caves that experience a local extinction are unlikely to be naturally re-colonized. Establishing stable or increasing populations at all essential sites likely will be more beneficial to long-term survival than completion of a PVA.

Although not specifically discussed in the final rule, this recovery criterion addresses listing factor E. Species with small populations and a limited distribution face several inherent natural threats, such as a loss of genetic diversity through a genetic bottleneck and environmental catastrophes. They also are highly susceptible to habitat loss and modification. If the appropriate data were available or obtaining the data would not result in increased harassment, conducting a PVA could provide insight regarding how certain management actions and/or environmental catastrophes might affect the OBEB's continued existence.

Criterion 4--Provide long-term protection for the Ozark-big eared bat after delisting.

Has not been met:

Although significant recovery accomplishments for the OBEB have occurred over the past 28 years, recovery criteria to upgrade the species to threatened status have not yet been met. The species continues to be endangered because of its small population size, reduced distribution, and vulnerability to human disturbance. The Service also is uncertain as to whether all essential sites have been discovered.

Active management will be required to provide long-term protection after delisting. Conservation measures such as existing cave gates and fences will require continued maintenance and repair. The Ozark Plateau NWR also must be funded and staffed appropriately after delisting. Continued coordination and development of agreements for long-term management and protection also would be required of conservation organizations and government agencies that currently manage OBEB sites.

Listing factors A, B, D, and E are addressed by this criterion.

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:

The OBEB is endemic to the Ozark Highlands and Boston Mountains ecoregions (Omernik 1987) where it occurs in oak-hickory hardwood forests (Figure 1, Clark 1991, U.S. Fish and Wildlife Service 1995). This species is an obligate cave user year round and is known to utilize and roost in limestone and sandstone talus caves. Clark et al. (1996) and Wethington et al. (1997) found that habitat and land-use surrounding occupied and non-occupied caves did not differ significantly, indicating that surface habitat around caves may not be significant in cave selection. Surface habitat use is likely to be strongly influenced by prey distribution because the OBEB's relatively high level of flight maneuverability does not restrict use of habitat types (*e.g.*, clustered forests) as it does in other less maneuverable species (Wethington et al. 1996). Hibernating bats tend to occur in the coldest regions of the coldest caves (Wethington et al. 1997, Clark et al. 2002). The OBEB is known to move among caves during both the maternity season and winter (Clark et al. 2002), but generally return to the same maternity caves and hibernacula each year (Clark et al. 1996).

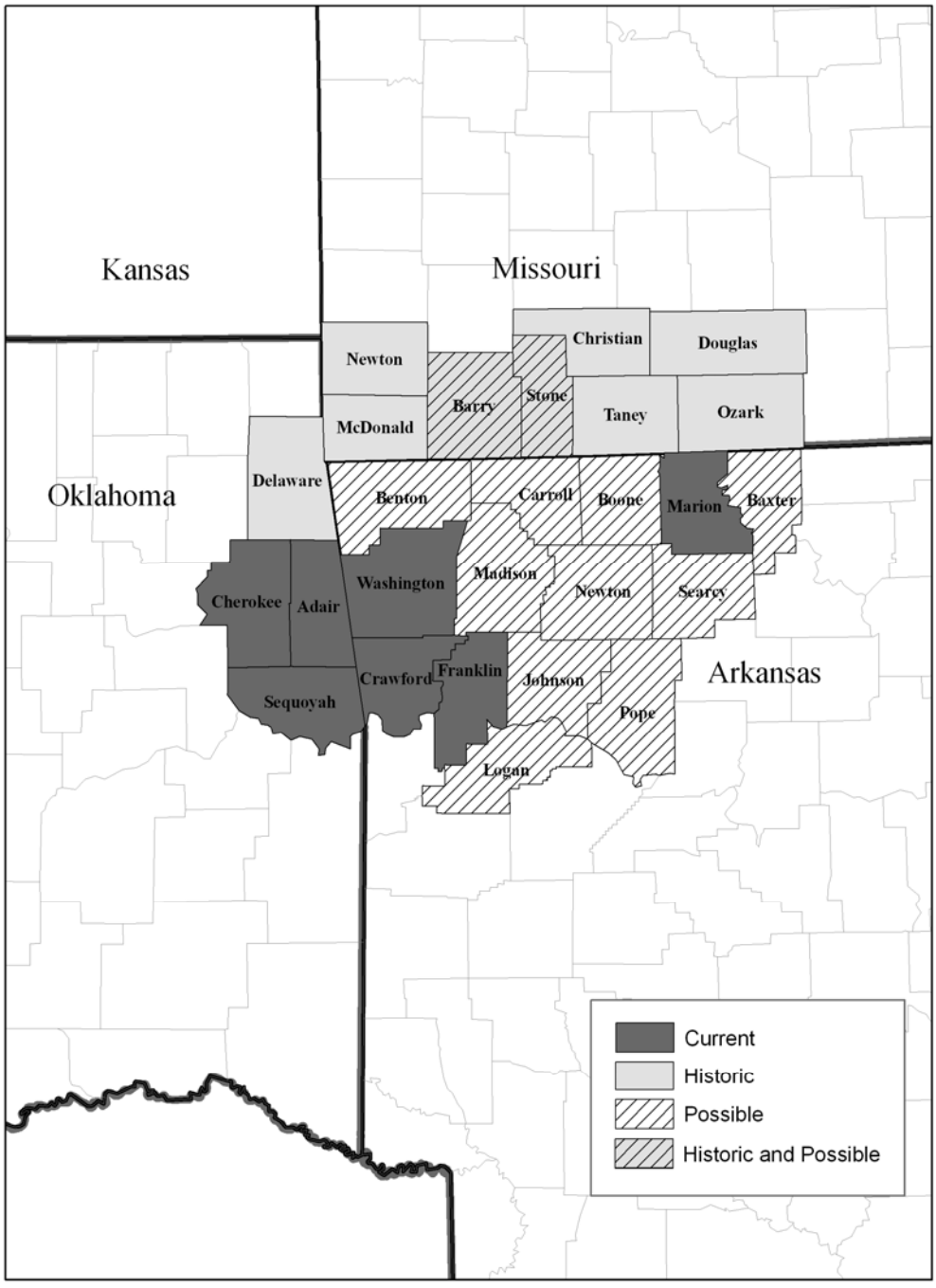

Figure 1. Current, Historic, and Possible Range of the OBEB

2.3.1.2 Abundance, population trends, demographic features:

OBEB populations at essential hibernacula and maternity sites have been monitored using minimal census techniques since each essential site was discovered to obtain estimates on colony size and population trends (Puckette 2007; Harvey et al. 2006). Although censusing each site annually would be ideal, this has not always been possible due to various complications involving staff and time constraints, weather complications, and inaccessibility. For example, AD-125 is an essential hibernaculum discovered in 1986. However, OBEBs typically winter in an inaccessible part of the cave. The hole into this portion of the cave is about one foot wide by six inches high. Surveyors tunneled into the chamber and counted 247 OBEBs in 1986. The hole was resealed with rocks and, to avoid disturbance to the colony, was not entered again until 2005.

Population estimates within hibernacula are conducted by briefly entering the cave to locate and count the colony of clustered bats. A primary assumption is that both male and female bats are counted, based on hibernacula data that indicate there are about an equal number of males and females at hibernacula (Harvey et al. 1981).

The techniques implemented by surveyors to estimate maternity colony size are not consistent among all sites. In Oklahoma, all annual maternity colony surveys consist of conducting exit counts at cave entrances using infrared lamps and night vision equipment. The counts are conducted in mid-June and assume that only adult females are counted (males live a largely solitary existence during the maternity season and young are assumed to be non-volant). In Arkansas, researchers briefly enter the Marion County maternity caves (MR-979A, -0702, and -9702) in July and count the colony of adult females and newly volant juveniles. Researchers began conducting July exit counts at these sites in 2005. An exit count is conducted at WA-5202 in mid-June, while CW-29 BT3 is entered in mid-June and an ocular estimate of the colony size (females and juveniles) is made.

During the maternity period, an estimate of the adult population size is derived from exit counts conducted in mid-June by doubling the exit count to account for solitary males. A similar estimate of the adult population size is derived using data collected when a cave was entered to count the colony or from an exit count conducted in July. In this method, biologists assume that each adult female gives birth to one pup each summer. The total count is then halved to remove juveniles from the count. The count is then subsequently multiplied by two to account for solitary adult males.

Monitoring data reveal a disparity between summer and winter population estimates. Numbers of OBEBs estimated from summer maternity counts

are larger than those found during winter hibernacula counts. For example, for the last year in which a representative count of both OBEB hibernacula and maternity sites occurred (2003), 701 bats were counted at hibernacula while maternity counts resulted in an estimate of about 1,600 bats (Figures 2 and 3). This indicates there likely are major OBEB hibernacula that have not yet been located.

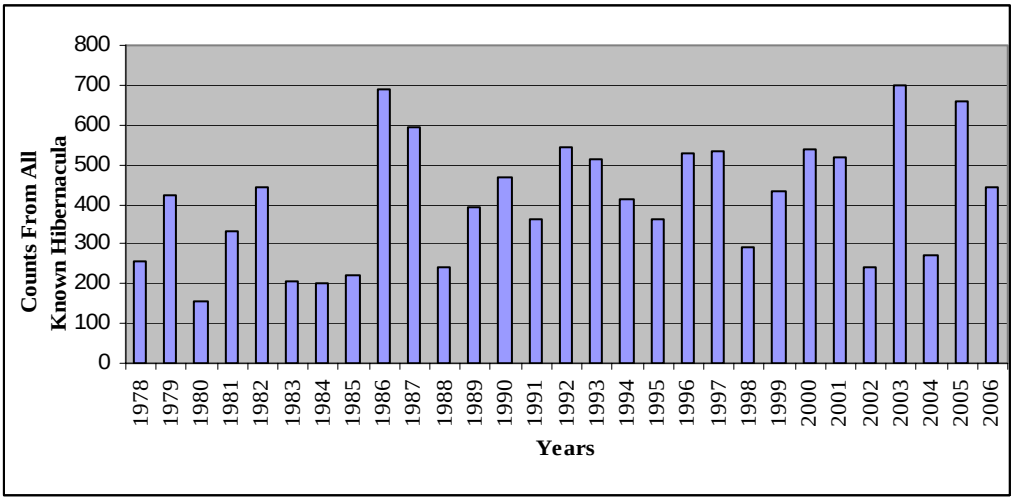

Figure 2. Annual OBEB counts from all known hibernacula. Because all sites typically were not counted each year, numbers per year do not represent the true population level from all known hibernacula.

The ongoing monitoring efforts provide insight regarding the overall population trend. Population estimates and trends presented below are for the adult breeding population and are based on maternity colony counts.

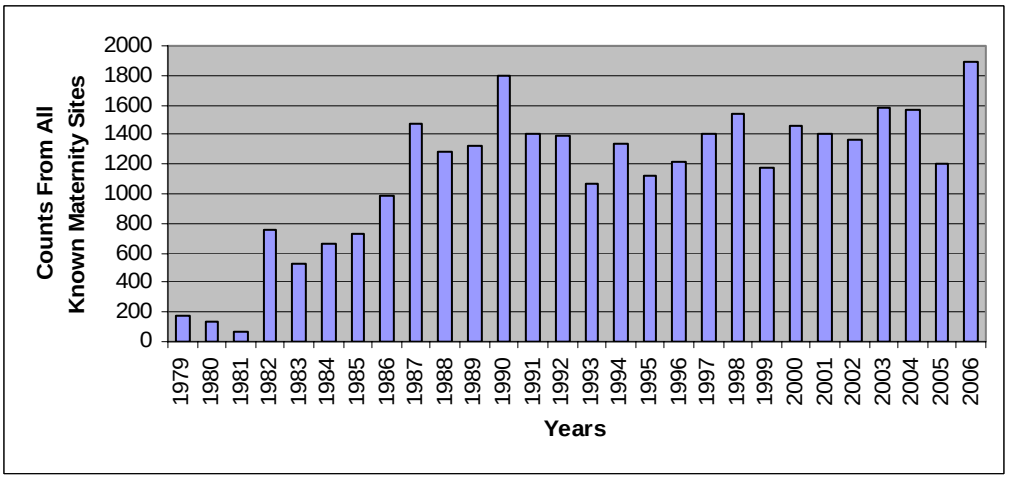

Figure 3. Annual OBEB estimates based on counts from all known maternity sites.

Census counts indicate that the overall population has remained fairly

stable since 1997, when the last discovered essential maternity site from which we have several years of population data (CW-29 BT3 in Arkansas) was added to the annual counts. The overall population estimate has averaged about 1,500 bats over this time period (Figure 4).

In 2005, the numbers were down primarily due to abnormally low counts at MR-979A in Arkansas and at AD-17/18 in Oklahoma. The private tract around AD-17 and adjoining AD-18 was timbered during May of the 2005 maternity season. The count at MR-979A was more typical in 2006, and higher than normal at CW-29 BT3 and AD-17/18. The estimated population increased to about 1,900 in 2006.

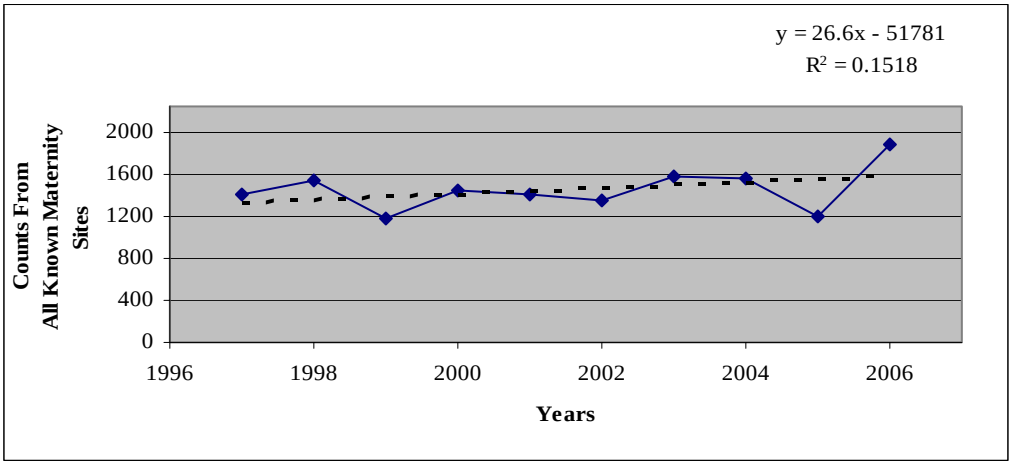

Figure 4. Overall OBEB population estimates based on summer counts from known maternity sites since 1997.

A statistically significant increasing population trend was observed over this time period when the data from Arkansas is considered alone (Mann-Kendall Test: P = 0.003; Figure 5). Annual counts indicated an average population size of about 260 bats from 1997 to 2001 and about 495 bats from 2002 through 2006. This increase is primarily attributable to higher counts that have occurred recently at maternity sites CW-29 BT3, WA-5202, and MR-979A. MR-9702 was not monitored in 1998 and 1999. MR-0702 was not monitored in 2006. Numbers were abnormally low in 2000 primarily because CW-29 BT3 was not monitored and low numbers were recorded at MR-979A.

CW-29 BT3 is a sandstone talus cave on the Ozark National Forest found in a remote location. The maternity colony size at this location averaged about 131 bats from 1997 to 2001. The average has increased to about 192 bats over the last five years. The average population at WA-5202, which occurs on private property, has increased from about 34 bats between 1997 and 2001 to about 45 bats over the last five years. MR-979A occurs on a 336-acre tract of property managed by the ANHC. The

population has increased from an average of about 72 bats between 1997 and 2001 to about 155 bats over the last five years.

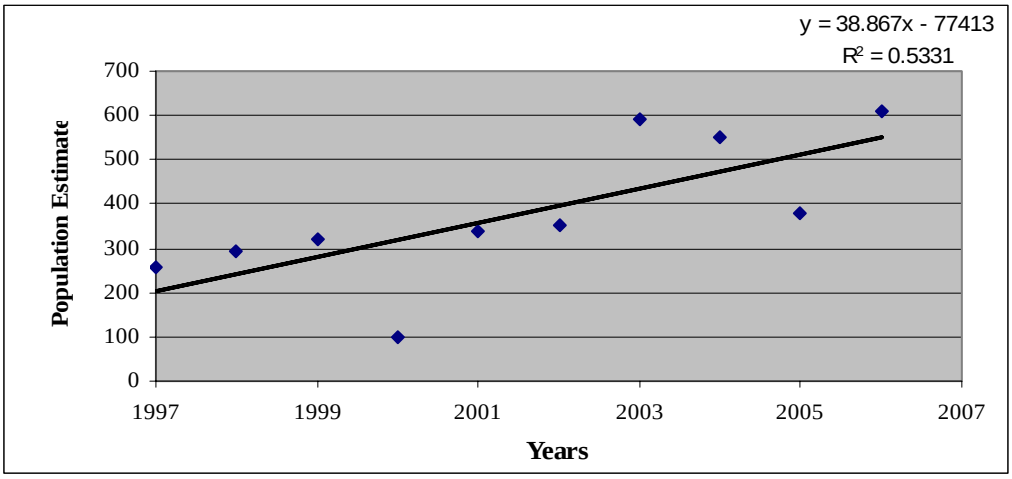

Figure 5. Arkansas OBEB population estimates based on summer counts from maternity sites in Arkansas from 1997 to 2006.

In contrast, estimates from exit count data for Oklahoma indicate that the average population size has declined slightly since 1987, the first year in which annual monitoring efforts included all known essential maternity sites (monitoring of the colony at AD-14/125 began in 1987; Mann Kendall Test: P = 0.07; Figure 6.). The bat colony utilizing site AD-13/24/25 could not be located in 1999. The colony utilizing site AD-14/125 could not be located in 2003 and 2004.

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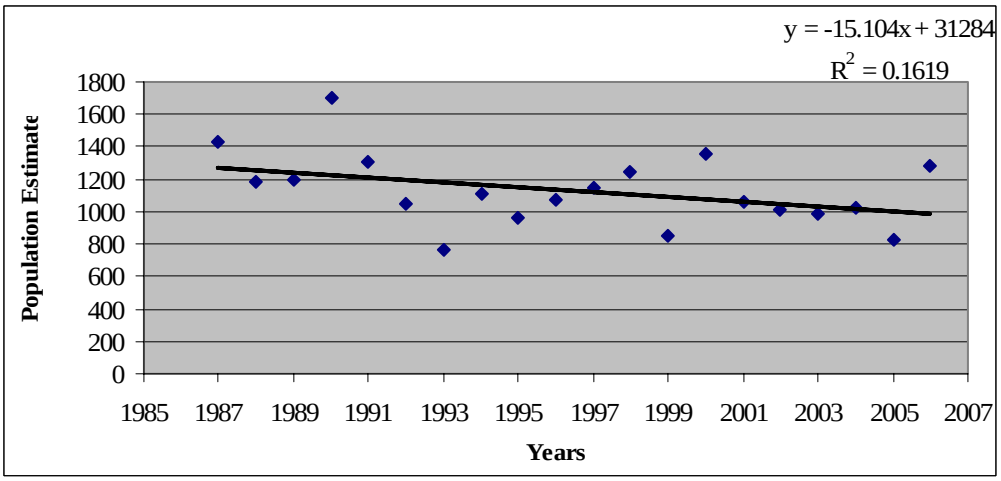

Figure 6. Oklahoma OBEB population estimates based on summer counts from maternity sites in Oklahoma from 1987 to 2006.

When 5-year averages are compared during the period from 1987 to 2006, a declining trend in population size continues to be evident. The five-year average was about 1,365 bats from 1987 to 1991; 993 bats from 1992 to

1996; and 1,135 bats from 1997 to 2001. The current five year average is about 1,027 bats (Figure 7).

Colonies that have shown declines since they were discovered include AD-13/24/25 and AD-14/125. The colony at AD-13/24/25 appears to have declined from an average of 113 bats from 1987 to 1991 to an average of only 58 bats over the last five years, while the colony at AD-14/125 appears to have declined from a high average of about 255 bats from 1987 to 1991 to only about 59 bats over the last five years for which we have count data: 2000-2002 and 2005-2006. The colony was not located at either AD-14 or AD-125 during monitoring efforts in 2003 and 2004.

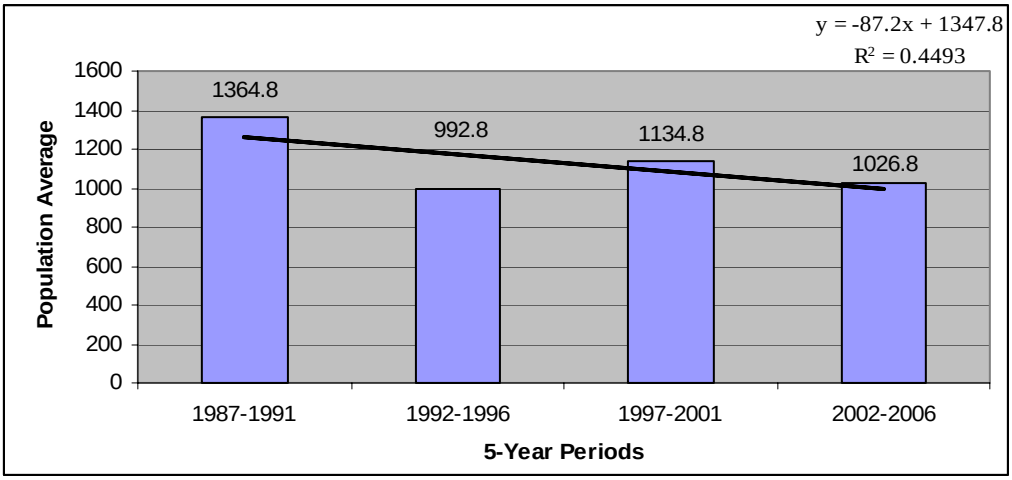

Figure 7. Five-year average population size of the OBEB in Oklahoma between 1987 and 2006.

Apparent OBEB population declines in Oklahoma may be attributable to movement among caves, including sites not known to us, and not an actual decrease in bat numbers. Several other caves currently considered limited use sites (AD-12, -16, -15, and -19) occur within close proximity to essential sites AD-13, -24 and -25. A portion of the colony could be utilizing these sites and are not counted when the exit counts are conducted at the primary site. Persistent small colony sizes at AD-13, -24 and -25 may warrant monitoring the nearby limited use sites to determine if the apparent decline is attributable to bats moving among the caves.

Apparent declines in the AD-14/125 colony may be due to the difficulty in monitoring bats at AD-14. This cave is the largest known cave in Oklahoma, having almost nine miles of passage and eleven known entrances. Only a limited number of these entrances can be monitored at any one time during the annual OBEB exit count due to limited manpower and equipment (*i.e.*, costly night vision goggles and scopes). Thus, it is likely that all OBEBs roosting in AD-14 during the summer are not

counted during the annual exit count. Simultaneously monitoring more entrances would likely provide a better estimate of the number of OBEBs utilizing this cave.

Results from the 2006 maternity colony census indicate increases over recent years in both Oklahoma and Arkansas assuming that impacts to unknown hibernacula are not occurring (Figures 5 and 6). The OBEB population currently is estimated to consist of about 1,300 individuals in Oklahoma and 600 individuals in Arkansas, for a total estimate of about 1,900 individuals (Figures 3, 4, 5, and 6). Overall, the long-term population trend for the species is considered to be stable.

2.3.1.3 Genetics and genetic variation

Weyandt et al. (2005) examined genetic variability in the OBEB population by comparing nuclear and mitochondrial DNA among bats from essential maternity caves in Oklahoma. No significant variation between nuclear satellite DNA was found. However, maternally inherited markers differed among sites, indicating very strong site fidelity and limited dispersal by females and high natal philopatry. These results suggest that failure to protect a maternity site may result in the loss of genetic variation across the species. Due to an inherent tendency for limited dispersal by female OBEBs and the apparent corresponding lack of connectivity among colonies, caves that experience a local extinction are unlikely to be naturally re-colonized. Weyandt et al. (2005) suspected that this may explain why several seemingly suitable caves in eastern Oklahoma are not utilized by the OBEB. The study found no evidence for a loss of genetic diversity that would occur due to a genetic bottleneck.

2.3.1.4 Taxonomic Classification or Changes in Nomenclature

The genus name at the time of listing and preparation of the revised recovery plan was *Plecotus* based on the revised taxonomy of North American bats by Handley (1959). Handley determined that the three species of North American big-eared bats did not differ enough morphologically from the European species of the genus *Plecotus* to warrant unique generic status. The bats were considered members of the genus *Plecotus* and subgenus *Corynorhinus*. *Corynorhinus* was subsequently elevated from subgeneric to full generic status and *Plecotus* was limited to species of the Palearctic as a result of additional studies based on morphology, karyotype, and mitochondrial DNA (Bogdanowicz et al. 1998, Fedyk and Ruprect 1983, Qumsiyeh and Bickmham 1993, Stock 1983, Tumlison and Douglas 1992, Volleth and Heller 1994). A recent study on the phylogeny of North American big-eared bats using mitochondrial and nuclear DNA sequences confirmed the designation of

three *Corynorhinus* species and corroborates the subspecies classification *Corynorhinus townsendii ingens* (Piaggio and Perkins 2005).

2.3.1.5 Spatial distribution

The OBEB currently is known to utilize caves in northeastern Oklahoma and northwestern Arkansas near the state line, and in north-central Arkansas. In Oklahoma, OBEBs are currently known to occur in Adair, Cherokee, and Sequoyah counties. They were historically known from two limited-use caves in Delaware County (DL-4 and DL-21), but have not been observed there recently. In Arkansas, the species is known to occur primarily in Crawford, Franklin, and Washington counties in northwestern Arkansas and in Marion County in north-central Arkansas. Based on proximity to known range, presence of suitable roosting and foraging habitat, and evidence of probable use (*i.e.*, neatly clipped moth wings and guano) discovered during cave searches for this species in Arkansas, the OBEB potentially may occur in Benton, Boone, Carroll, Searcy, Logan, Newton, Johnson, and Madison counties. The species is believed to have been extirpated from Missouri. However, evidence of use in two Missouri caves in Stone and Barry counties (Elliott et al. 1999) warrants further investigation (Figure 1).

2.3.1.6 Habitat and ecosystem conditions

The OBEB forages primarily on moths (USFWS 1995, Leslie and Clark 2002). A study on the diet of the OBEB and prey abundance in Arkansas found that OBEBs prey on a wide diversity of moth species, and that many of the species are dependent upon forest plants as a host (Dodd 2006). The study also found a positive correlation between woody species richness and moth occurrence. Conservation practices within the foraging radius of known caves should encourage a diversity of woody forest plant species to provide a rich prey base of moths.

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

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

The range of the OBEB occurs within the Ozarks Highlands and Boston Mountains Ecoregions (Omernick 1987). This region is under considerable development pressure and is one of the fastest growing areas in the country due to relatively inexpensive land prices and the aesthetics of the area. For example, the human population of Washington and Benton County, Arkansas, and Adair and Cherokee counties, Oklahoma, increased 39.0%, 59.0%, 14.2%, and 24.9%, respectively, from 1990 to

2000. Over the same period, the human population within the states of Oklahoma and Arkansas, and within the United States increased by only 9.7%, 13.7%, and 13.2% respectively (U.S. Census Bureau 2001). The Oklahoma Department of Commerce (ODOC) projects the human population of Adair and Cherokee counties, Oklahoma, to grow by about 35% over the next 23 years (ODOC 2002). Due to current and future human growth resulting in habitat fragmentation and loss, vandalism, and increased human activity at known, undiscovered maternity roosts, and hibernacula, significant threats remain.

Emergent counts for the OBEB reveal a disparity between summer and winter population estimates. This indicates there are likely major hibernacula that have not yet been located. Evidently, Ozark big-eared bats are using caves that have not been found. Thus, threats to unknown caves remain a concern. Survey efforts for these sites will be necessary to prevent unnecessary impacts to important habitat.

For example, the U.S. Army Corps of Engineers (COE) is currently conducting a General Reevaluation Study and Environmental Impact Statement (EIS) of the Pine Mountain Dam Project near Natural Dam, Arkansas. The proposed project, if completed, would flood some 3,000 acres of oak-hickory forest. During early consultation efforts, the Oklahoma Ecological Services (ES) office informed the COE that the OBEB and important cave and foraging habitat used by this species may occur within the project area. Subsequent surveys conducted during June 2006 found a previously unknown maternity colony of the OBEB within the project area. These early efforts justify the need for more comprehensive surveys for other maternity sites and hibernacula both in the Pine Mountain Dam project area and the entire Ozarks region. Identification of important roost habitat for the OBEB during early project planning stages would facilitate the development and implementation of appropriate conservation measures that could serve to avoid and minimize unnecessary impacts to the OBEB and its habitat.

Progress has been made on a number of conservation efforts that will help minimize the destruction, modification, and curtailment of the OBEB's habitat and range. The first OBEB cave (AD-10) was purchased in 1985 and the Ozark Plateau NWR was established on April 1, 1986 to provide long term habitat protection to help assure the continuing existence, and aid in recovery of the OBEB and other listed cave species. Sixteen tracts (eight management units) totaling 3,748 acres of fee, easement, and cooperative management agreements have been acquired since that time. TNC has purchased most the land for the OPNWR because it can work quickly and the Service has eventually been able to acquire the land from them. Several high priority cave sites have been gated or fenced to prevent human vandalism and disturbance, and additional sites are planned

to be gated (Table 2).

The Service also approved expansion of the refuge in 2005. The refuge was approved to expand up to a maximum of 15,000 acres within the region encompassed by Adair, Delaware, Ottawa, Sequoyah, Craig, Mayes, and Cherokee counties, Oklahoma.

The Oklahoma Department of Wildlife Conservation (ODWC), Arkansas Game and Fish Commission, and ANHC have made progress working together to benefit OBEB habitat. Through the Cooperative Endangered Species Conservation Fund, all three have secured Recovery Land Acquisition section 6 grant funding to attempt to acquire important OBEB habitat. These tracts provide foraging habitat, contain limited-use caves, and are located adjacent to existing protected areas, providing important linkages with other desirable habitats. In Oklahoma, the acquired tracts are located adjacent to the Ozark Plateau NWR, while in Arkansas the tracts are located adjacent to the Slippery Hollow and Garret Hollow Natural Areas managed by the ANHC. In FY 2005, the Service awarded the ODWC and ANHC another RLA grant in the amount of $425,850 and $405,190 respectively for the purchase of land in both states. In Oklahoma ODWC is purchasing 820 acres of upland oak-hickory forest. The tracts also are adjacent to existing tracts of the Ozark Plateau NWR and provide important foraging and cave habitat for the OBEB.

Local non-governmental organizations (NGOs) have played an important role in recovery. The Oklahoma and Arkansas Chapters of TNC have been instrumental in the protection of important caves and foraging habitat, and have developed and implemented management strategies for the OBEB. For nearly 20 years, the NSS's local chapter (Tulsa Regional Oklahoma Grotto**)** has provided cave information and volunteer help during cave gate construction, mapping, cleanup, and joint management of cave preserves used by the OBEB. Their help has been significant due to the Ozark Plateau NWR's limited budget.

The Cherokee Nation (CN) also has recently played a valuable role in OBEB recovery. After several limited-use sites were found on a tribal member's property, the CN purchased a conservation easement on the 40-acre tract that contained the caves.

The U.S. Forest Service also provides protection for OBEB caves and foraging habitat that occurs on the Ozark National Forest. The U.S. Forest Service has established a 200-foot buffer zone around all known OBEB roosts which prohibits activities that may adversely impact the bats (USDA 2005).

Land Legacy is working with the City of Tulsa and the Service to establish a number of conservation easements in the Spavinaw Creek watershed in Delaware County. These easements will help protect the City's water supply but also will protect sites that include historic OBEB cave and foraging habitat as well as habitat for federally listed threatened Ozark cavefish *Amblyopsis rosae* and species of concern Ozark cave crayfish *Cambarus tartarus*.

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

The human population in the Ozarks region is rapidly expanding. As more people occur in the area and cave sites become less remote due to human developments, human entry and recreational use at essential sites likely will increase. Recreational use and associated human disturbance at maternity caves and hibernacula remains a major threat.

Human entry can cause abandonment of the young during the maternity season or cause bats to expend vital energy reserves necessary for successful overwintering. Human disturbance also can result in cave abandonment. For example, two caves that occur in Delaware County that were historically used by the OBEB (DL-4 and DL-21) were abandoned before appropriate protective measures could be implemented. Although the exact causes of abandonment are not known, human vandalism is suspected due to a lack of protective measures and frequent human entry into these caves in the past. Recently, conservation measures (construction of gates and fences) have been implemented at these historic caves. Although OBEBs have not been found at these sites during recent monitoring efforts, the caves will continue to be monitored for natural reestablishment.

The measures most important to conserve listed cave species include obtaining and utilizing knowledge of the cave locations used by the species and limiting human disturbance to occupied caves. For example, all occupied caves that occur on the Ozark Plateau NWR are closed when being used by OBEBs (*e.g.*, during the maternity season and/or winter hibernation period). Fortunately, the Service has developed excellent working relationships with local recreational caving groups. Most members of these groups tend to understand the need to limit human disturbance at occupied caves. In fact, many members of these organizations even have provided information on previously unknown caves and have volunteered their time to assist in the construction of protective cave gates. (See Table 2 for a list of essential caves that have been gated to date).

The Service also has good working relationships with the regional

scientific research community. Research interests and needs are well communicated. Scientific research also is strictly regulated through the Endangered Species Act (ESA) section 10 permitting process.

Unfortunately, unauthorized entry sometimes occurs even at sites afforded protection through gating and fencing. The disparity between summer and winter counts also indicates there are caves that have not been found; as a result, these sites cannot be afforded protection from human disturbance.

2.3.2.3. Disease or predation:

Currently, disease and predation are not considered major factors for the endangered status of the OBEB. White-Nose Syndrome (WNS) is a new ailment causing mortality in hibernating bats in the northeastern part of the United States. Affected bats often have a white fungus growing on their muzzles (hence the name) and other parts of their body. Mortality in affected hibernacula caves has ranged from 80 to 100 percent. WNS has been confirmed in New York, Connecticut, Massachusetts, and Vermont. Affected bat species include the little brown, northern long-eared, small-footed, eastern pipistrelle, and the federally-listed endangered Indiana bat. The Service and other federal, state, and private researchers are actively investigating the potential causes of WNS. It is not yet known whether the fungus is causing the deaths or is symptomatic of some other underlying problem. Biologists also are uncertain if bats are transmitting WNS among themselves. WNS has not been observed within the range of the OBEB. WNS would represent a highly significant threat to the OBEB should it appear in bat populations in the Ozarks due to the high mortality rate of affected bats, small population size, limited range of the OBEB, and because females produce only one pup per year.

Likely predators of the OBEB include wildlife that are known to prey on other bat species such as snakes, owls, raccoons, bobcats, and feral house cats. However, predation is not considered a significant threat.

2.3.2.4. Inadequacy of existing regulatory mechanisms:

The OBEB is afforded protection under the ESA. The ESA prohibits activities that affect listed species unless authorized by a permit from the Service. Permits are required for scientific research and taking that is incidental to otherwise lawful federal and non-federal activities.

Section 7 of the ESA requires federal agencies to determine the effects of their actions on federally-listed threatened or endangered species to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any federally-listed species. Through the section 7 consultation process, the federal action agency and the Service

analyze the effects posed by proposed actions on listed species. Many projects within the range of the OBEB have undergone section 7 consultation with the Service. Recommended conservation measures for section 7 consultations include surveying project areas for important habitat, such as karst features, prior to disturbance or construction so that unnecessary impacts can be avoided or minimized.

In accordance with section 10 of the ESA, an incidental take permit is required for non-federal activities that would result in the take of a listed species. A Habitat Conservation Plan (HCP) must accompany the application for the permit and be approved by the Service to ensure that the effects associated with the activity would be adequately mitigated and minimized.

An HCP for the OBEB has not been required to date. However, as the human population and development increase within the range of the OBEB, the protections afforded to this species under the ESA will be important tools to avoid and reduce impacts (U.S. Census Bureau 2001, ODOC 2002).

The OBEB also is listed as endangered by the States of Oklahoma, Arkansas, and Missouri. The species was believed to have been extirpated from Missouri, but the status of the species is considered "State Endangered," according to the Missouri Species and Communities of Conservation Concern Checklist (Missouri Natural Heritage Program 2008). In Oklahoma, it is not lawful to hunt, chase, harass, capture, shoot at, wound, kill, take, or trap a listed species without written permission from the Director of the ODWC. The regulations in Arkansas prohibit trafficking in federally-listed species. Although these state regulations do afford the OBEB some protection, they do not protect habitat or require the conservation of listed species, and, therefore, do not adequately provide for the recovery of the species.

Since federal listing, other regulatory mechanisms have increased. Tracts of land that contain important cave sites and foraging habitat have been added to the Ozark Plateau NWR. The Federal Cave Resource Protection Act of 1988 also provides protection through regulation and restricting use of significant caves that occur on federal lands such as the Ozark Plateau NWR and the Ozark–St. Francis National Forest. The U.S. Forest Service has established a 200-foot buffer around all known cave sites that occur on the National Forest, within which activities that may disturb roosting bats are prohibited (USDA 2005). Important tracts also are now managed by the ODWC, the ADPT, and the ANHC.

2.3.2.5. Other natural or manmade factors affecting its continued existence:

No other natural or manmade factors were listed in the final listing rule. A recent genetic study of the OBEB (Weyandt et al. 2005) found that the distribution of maternally inherited markers significantly differed among maternity sites. These results suggest strong female site fidelity. Species that exhibit strong site fidelity are unlikely to re-colonize areas from which they have been extirpated. This study underscores the concern that should a maternity colony experience a local extinction, the site may not be re-colonized. Measures to avoid the loss of maternity colonies due to local extinction include protecting the cave sites and surrounding foraging areas through fee title acquisition, conservation easements, voluntary landowner agreements, construction of fences and cave gates, and the continued search for unknown caves of importance.

2.4. Synthesis

The OBEB was listed as endangered in 1979 due to it small population size, reduced and limited distribution, and vulnerability to human disturbance. At the time of listing, the OBEB was known from only a few caves in northwestern Arkansas, southwestern Missouri, and northeastern Oklahoma. The entire population was estimated to consist of about 100-200 individuals. The population is estimated to currently consist of about 1,900 individual bats with 1,300 in Oklahoma and 600 in Arkansas.

Since listing, additional OBEB caves have been located. Fourteen caves were considered essential (*i.e.*, used as a maternity site and/or hibernacula) to the continuing existence of the OBEB when the existing recovery plan was prepared in 1995. Six additional sites have been located since then for a current total of 20 known essential sites.

The recovery plan contains appropriate downlisting recovery criteria that reflect current scientific knowledge of the OBEB and adequately account for existing threats to the species. However, based on this 5-year review analysis, we believe that the criteria have not been fully met.

OBEB colonies at essential maternity sites and hibernacula have been monitored using minimal disturbance census techniques since each essential site was discovered. Mann-Kendall tests were used to determine if OBEB populations at each essential site showed a significant trend over the last 10 years. A significant increasing population trend was found at only four of 15 essential sites. Due to variability in the data from all other sites, no significant trends could be determined. Thus, population trends of individual colonies are not well explained by available monitoring data. Inability to determine trends at most of the essential maternity sites could be explained by the inherent difficulty in monitoring a

sensitive, nocturnal cave species or by deficiencies in monitoring efforts. Fine tuning annual census techniques (see recommendations) may provide a better understanding of population trends at essential caves.

The first OBEB cave (AD-10) was purchased in 1985 and the Ozark Plateau NWR (formerly Oklahoma Bat Caves NWR) was established in 1986 to provide long term habitat protection to help assure the continuing existence and aid in recovery of the OBEB and other listed and at-risk cave species. Sixteen tracts (eight units) totaling 3,748 acres have been acquired since 1985. In 2005, the Service approved expansion of the refuge up to 15,000 acres.

However, the refuge's ability to adequately manage and protect important habitat is currently seriously limited by staffing and budget constraints. Providing sufficient funds and staffing to ensure the refuge is fully operational is needed to help minimize future destruction and modification of cave and foraging habitats.

Despite not fully meeting downlisting criteria, progress has been made on a number of recovery efforts. Survey efforts for unknown maternity colonies and hibernacula and annual monitoring efforts continue. As a result, important overall population trend data have been gained and additional OBEB caves and foraging areas have been discovered that need protection through acquisition or other measures (*e.g.,* cave gating). Recently, important foraging and cave habitat have been protected through the RLA program. Funds through Section 6 of the ESA (administered by the States) and through the Service's Partners for Fish and Wildlife Program also have been used to gate and fence high priority cave sites on private land to minimize human vandalism and disturbance. Local NGOs, including the Oklahoma and Arkansas Chapters of TNC and the NSS's local chapter (Tulsa Regional Oklahoma Grotto**),** have been instrumental in the protection of important caves and foraging habitat. The assistance of these two organizations has been extremely important considering the Ozark Plateau NWR's limited budget.

Although the population trends at most essential sites are not currently well understood, the ongoing monitoring efforts provide useful and important information concerning the overall population trend. Census counts indicate that the overall population has remained fairly stable since 1997. Continued monitoring at all essential maternity sites and hibernacula will be necessary to assess the effects of conservation efforts to protect caves and foraging habitat.

A recent genetics study provides further insight into the need to protect each maternity colony. Weyandt et al. (2005) examined population genetic variability and found that maternally inherited markers differed among sites, indicating very strong site fidelity and limited dispersal by females and high natal philopatry. Due to the natural tendency for limited dispersal by female OBEBs and the apparent corresponding lack of connectivity among colonies, caves that experience a local extinction are unlikely to be naturally re-colonized. These

results suggest that failure to protect a maternity site may result in the loss of genetic variation and substantiates maintaining the downlisting criterion of stable or increasing populations at all essential sites.

In conclusion, the OBEB continues to meet the definition of endangered, even though significant recovery accomplishments have occurred over the past 28 years since listing. Recovery criteria to downlist the species to threatened status have not yet been fully met. Based on population and distribution information and known geological formations, there are evidently essential sites that have not been discovered. Moreover, the human population in the Ozarks is rapidly increasing. As more people occur in the area and cave sites become less remote due to development, human entry and disturbance at essential sites likely will increase. Fragmentation and loss of foraging habitat due to development also remains a major threat. Therefore, the vulnerability of the OBEB to extinction remains high because of its small population size, reduced and limited distribution, and susceptibility to human disturbance. The listing classification as endangered on the List of Endangered and Threatened Wildlife remains valid.

3.0. RESULTS

3.1. Recommended Classification

No change is needed

3.2. New Recovery Priority Number

No change is recommended for the Recovery Priority Number of 3.

3.3. Listing and Reclassification Priority Number

Not Applicable

4.0. RECOMMENDATIONS FOR FUTURE ACTIONS

The most important factors in assuring the continuing existence of the OBEB is limiting human disturbance and vandalism at essential maternity sites and hibernacula, and protecting foraging areas from habitat loss. The Ozarks region is one of the fastest growing areas in the country due to relatively inexpensive land prices and the aesthetics of the area. Fragmentation and loss of foraging habitat, vandalism and increased human activity at known and undiscovered maternity roosts and hibernacula continue to be major concerns. The recovery of the OBEB requires continued implementation of the 1995 recovery plan. Delisting criteria needs to be finalized. Downlisting to threatened status should be considered only when existing downlisting recovery criteria have been met. The following recommendations outline those actions that are most needed to achieve recovery prior to the next five-year review.

Continue Monitoring Population Trends at All Essential Sites

One recovery criterion for downlisting in the 1995 recovery plan requires maintenance of a stable or increasing OBEB population at all known essential caves over a 10-year period. Results from a recent genetic study (Weyandt et al. 2005) corroborate the importance of monitoring the population trends at each colony. The research suggests very strong site fidelity and limited dispersal by females, and high natal philopatry. These results suggest that failure to protect a maternity site may result in the loss of genetic variation. Each essential site should continue to be monitored over the next 10 years to determine population trends. The hibernacula that are difficult to monitor without disturbing the bats should be monitored every three years.

Acquire Essential Caves and Important Foraging Habitat for Additions to the Ozark Plateau NWR

The Ozark Plateau NWR was approved, in 2005, to expand up to 15,000 acres in Adair, Delaware, Ottawa, Sequoyah, Craig, Mayes, and Cherokee counties, Oklahoma. The Environmental Assessment for the approved Expansion of the Ozark Plateau NWR (Service 2002) includes a land protection plan that identifies: 1) important known habitat for the OBEB in need of long-term protection, 2) the preferred type of protection for each tract, 3) the minimum type of protection deemed necessary, and 4) a protection priority classification for each site. Protecting additional OBEB caves and foraging areas through fee title acquisition and conservation easements would help minimize future destruction and modification of cave and foraging habitats. Adding cave sites to the refuge also would facilitate monitoring of the sites and help regulate human entry for scientific, recreational, and educational purposes.

Additional OBEB essential and limited-use caves and surrounding foraging areas need protection through acquisition and/or other measures such as cave gating. Important sites that currently are not afforded protection include essential caves AD-17, AD-24, AD-25, AD-T1, and WA-5202, as well as numerous limited-use caves. These sites could be acquired by the Service as additions to the refuge or by other natural resource agencies and conservation groups through fee title acquisition or through conservation easements when sellers or donors are willing. The development of voluntary cooperative agreements and cave management plans to protect forested foraging habitat and caves also are potential conservation measures that can be pursued to prevent habitat loss and modification.

Increase Staff and Funding Levels at the Ozark Plateau NWR

Refuge responsibilities are extensive and include developing and maintaining positive landowner relations, developing and implementing cooperative agreements with landowners, working with state and federal agencies, universities, and non-profit organizations, constructing cave gates and fences, repair and maintenance of cave gates and fences, habitat enhancement and restoration (*e.g.*, timber thinning, planting, prescribed burns, etc.), maintenance of roads and buildings, annual monitoring of bat

populations, cavefish and cave crayfish monitoring, identifying important tracts for future acquisition, placement and maintenance of interpretative and warning signs at cave entrances, law enforcement, mapping essential caves, facilitating important research, developing and implementing plans for scientific, educational, and other public use, actively preparing proposals for funding from the Service and other agency and private sources for management and acquisition, and preparing important planning documents. Inadequate funding and insufficient staffing at the Ozark Plateau NWR would only continue to make refuge management, and, hence, meeting an OBEB recovery criterion difficult.

The Southwest Region's "National Wildlife Refuge System Work Plan" for FY 2007 – 2009 identifies the Ozark Plateau NWR as a Tier 1 focus refuge for the Region. This classification implies that staff and funding from refuges classified as Tier 2 (Targeted Reduction Refuges) and Tier 3 (Satellite Refuges) would be shifted to the Ozark Plateau NWR.

Increasing staffing and funding levels would help ensure sufficient operation of the refuge and facilitate recovery of the OBEB. Filling the following positions would facilitate more efficient operation of the Refuge: 1) Refuge Manager, 2) Fish and Wildlife Biologist, and 3) Administrative Assistant.

Develop Voluntary Cooperative Agreements with Private Landowners

The OBEB is known to forage up to 5 miles from cave sites. Efforts to protect foraging habitat should focus on areas within a 5-mile radius from known caves (Harvey 1992, Clark et al. 1993, Wethington et al. 1996). Most surface foraging habitat occurs on private land. Although acquisition in fee title is the most secure and long-term means of protecting OBEB caves and foraging habitat, purchase of all areas necessary for the recovery of the OBEB likely would not be possible due to the large area used by OBEBs. Therefore, working with private landowners has and will continue to be an important recovery tool. The Service's Partners for Fish and Wildlife Program is designed to work cooperatively with private landowners to protect and enhance fish and wildlife resources. The Partner's Program has provided financial assistance for the construction of cave gates in Oklahoma. Where possible, the Partner's Program should continue to be used to protect cave sites from human disturbance through financial and technical assistance. In addition, a number of important caves on private land have been gated with funds from Section 6 of the Endangered Species Act in cooperation with Oklahoma Department of Wildlife Conservation and Rogers State University. This program is popular with private landowners and has been very successful and should continue. Establishing relationships with private landowners also could facilitate the development of voluntary cooperative agreements to protect forested foraging habitat. Potential avenues for these voluntary agreements include the development of Safe Harbor Agreements and TNC's Natural Area Registry Program.

Facilitate Management by Other Agencies and Groups

The Service has worked closely with several state and federal agencies, tribes, universities, and non-profit organizations to protect and manage OBEB habitats, including the ODWC, ANHC, AGFC, the Cherokee Nation, Ozark National Forest, the Oklahoma and Arkansas Chapters of TNC, City of Tulsa, Land Legacy, and the local chapter of the NSS (Tulsa Regional Oklahoma Grotto**)**. Universities involved include Rogers State University, Oklahoma State University, University of Oklahoma, Northeastern State University, Southeastern Oklahoma State University, University of Central Oklahoma, University of Arkansas, and Arkansas State University. The Service should continue to coordinate management efforts with other agencies and organizations. Essential foraging habitat that is available from willing sellers should be identified for future purchase by the States of Oklahoma and Arkansas through the Recovery Land Acquisition Program and other mechanisms. Landowners of important tracts that are not for sale should be approached regarding conservation easements and possible voluntary cooperative agreements, such as The Nature Conservancy's Natural Area Registry Program.

Fine-Tune and Standardize Annual Monitoring at Maternity Colonies

The population trend analysis at all known essential caves revealed a statistically significant trend at only four of the 15 sites analyzed. The inability to determine whether the population was increasing, decreasing, or stable at most of the essential sites is likely attributable to several possible factors, including movements of bats among the caves and other life history traits that make monitoring more difficult. Additionally, surveyors conducting exit counts in mid-June could unknowingly count only adult females in some years and females plus newly volant young in others. As the climate warms the bats may be reproducing earlier in the year and the young flying earlier. Fine-tuning and standardizing the monitoring approach likely will facilitate collection of more comparable data and enhance efforts to determine population trends at known sites.

<u>Conduct Exit Counts at Each Maternity Cave at the Same Time of Year</u>

Exit counts cause far less disturbance to lactating bats and their young than does entering a cave to count the maternity colony. Therefore, the Service recommends, where feasible, conducting exit counts utilizing night vision equipment and infra-red lamps at all essential maternity caves in Oklahoma and Arkansas to ensure that the least disturbing census technique is utilized. The counts should be conducted during the same time frame every year before break up of the maternity colony to make the data as comparable as practicable. Timing of the counts also should be structured such that the surveyors are certain of whether newly volant young are being counted.

The Service recommends the following monitoring approach. Surveyors should be in place and prepared to conduct the count 30-minutes prior to official sunset (Clark et al. 2002). Each site should be monitored for a minimum of 45 minutes after the first OBEB

has emerged. The count should continue until a 10-minute duration occurs where no additional OBEBs exit the site or more OBEBs enter the site than exit.

Each maternity site should be monitored early in the summer before the young of the year are volant to ensure that only adult females are counted. This will typically be in May or early June. Subsequently, a subset of essential maternity caves should be monitored well after the young are capable of flight (and are leaving the cave each night to forage), but before break up of the maternity colony in fall. This would typically be in July or August. This monitoring approach should not only help in determining population trends, but also should provide useful data on recruitment.

Exit counts will not be feasible at all sites due to characteristics that make counting emerging bats very difficult. For example, CW-29 BT3 is a sandstone talus site where large boulders have come together on a slope to form several cave-like structures. The bats do not roost in the same sandstone talus cave every year. The bats also could emerge from and re-enter their roost from numerous cracks in the piles of sandstone boulders, and thereby complicate the exit count and make the results questionable. Therefore, searching for the roosting colony and visually estimating bat numbers would be the preferred method at sites such as this where exit counts likely would not produce adequate estimates.

Monitor More Entrances at AD-14 during the Annual Exit Count

Cave AD-14 is an essential maternity site. This cave is the largest known cave in Oklahoma and has eleven known entrances. In the past, only a few of these entrances have been monitored simultaneously during the annual OBEB exit count. Monitoring more entrances likely would provide a better estimate of the number of OBEBs utilizing this cave.

Monitor Some Limited-Use Sites during the Annual Emergent Count

Apparent declines of the AD-13/24/25 colony may be attributable to movement among caves (some of which may be unknown) and not an actual decrease in bat numbers. Several other caves currently considered limited-use sites (AD-12, -16, -15, and -19) occur within close proximity to essential sites AD-13, -24 and -25. A portion of the colony could be utilizing these sites when the exit counts are conducted. Continuing to encounter relatively small colony sizes at AD-13, -24 and -25 warrants monitoring nearby limited-use sites to determine if the apparent decline is attributable to bats moving among the caves.

Investigate the Feasibility of Gating AD-24 and/or -25 to Minimize Human Disturbance

Apparent declines of the AD-13/24/25 colony may be attributable to movement among caves, as discussed above. Human disturbance could be a contributing factor to the potential movement. Although AD-13 is gated to prevent unnecessary human

disturbance and vandalism, neither AD-24 nor -25 are afforded such protection. The landowner of these sites should be contacted regarding implementation of this conservation measure.

Assess the Ownership and Protective Status of All Known Limited-Use Sites

Limited-use sites should be afforded protection. These sites provide important habitat for small groups of bats and solitary males during the summer. An assessment of the ownership and protective status (*e.g.,* gated, cooperative landowner agreement, etc.) for each site should be determined. Conservation easements, fee title acquisitions, and cooperative landowner agreements should be sought on all unprotected sites.

Re-Visit Historic and Possible OBEB Caves in Missouri

An OBEB survey was conducted at 34 sites in Missouri during the summer and fall of 1999 (Elliott et al. 1999). During this survey, evidence of OBEB use, in the form of neatly clipped moth wings, was discovered at two cave sites. A list of the sites from the survey effort is available from the MDC. At a minimum, the two sites with evidence of use should be re-visited periodically. The Oklahoma Ecological Services Field Office currently is working with the Missouri Ecological Services Field Office to investigate possible funding sources and the availability of qualified biologists to conduct an OBEB survey in Missouri within the next few years.

Continue to Search for Caves of Importance

The possibility of finding new essential and limited-use OBEB sites in the Ozarks still exists. For example, in the summer of 2006, a cluster of 15 OBEBs was discovered in a sandstone talus crack on a private in-holding within the Ozark National Forest. Additionally, annual monitoring efforts at maternity sites and hibernacula present a disparity between summer and winter population estimates. Numbers of OBEBs estimated from summer maternity counts are larger than those found during winter hibernacula counts. This indicates there are likely major hibernacula being used by OBEB that have not yet been located. Therefore, searches for unknown maternity sites, limited-use sites, and hibernacula should continue throughout the Ozarks in Oklahoma and Arkansas. Additionally, evidence of possible OBEB occurrence in the form of neatly clipped moth wings and guano has been found in many caves in Oklahoma, Arkansas, and Missouri. These sites should be revisited to determine whether they are caves of importance. Equipment, such as the Anabat detector that can be placed near cave entrances to record and help identify echolocating bats, may prove valuable in this effort. Should re-visitation of historic or possible sites in Missouri find OBEBs, search efforts should be intensified in Missouri.

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Sources of New/Updated Information

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the Ozark big-eared bat

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

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

Appropriate Listing/Reclassification Priority Number, if applicable: Not Applicable

Review Conducted By: Richard Stark, U.S. Fish and Wildlife Service, Oklahoma Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 1-25-08

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Ecological Services, Fish and Wildlife Service, Region 2

Approve _____ Date 22 May 2008

Cooperating Assistant Regional Director, Fish and Wildlife Service, Region 3

__√__ Concur ____ Do Not Concur

Signature _____ Date 3-13-08

Cooperating Assistant Regional Director, Fish and Wildlife Service, Region 4

__√__ Concur ____ Do Not Concur

Signature _____ Date 4/7/08

ACTING Assistant Regional Director
Ecological Services