Ozark Big-eared Bat
(Corynorhinus townsendii ingens)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Oklahoma Ecological Services Field Office
and
Ozark Plateau National Wildlife Refuge
Tulsa, Oklahoma
September 3, 2020

5-YEAR REVIEW

Species reviewed: Ozark big-eared bat (*Corynorhinus townsendii ingens*)

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1.0 GENERAL INFORMATION

1.1 Listing History

Species: Subspecies **(***Corynorhinus townsendii ingens***)**

Date listed: November 30, 1979

FR citation(s):

Original Listing
FR notice : 44 FR 69206
Entity listed: Subspecies (Plecotus townsendii ingens)

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 (deoxyribonucleic acid) (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).

1.2 Methodology Used to Complete the Review:

The U.S. Fish and Wildlife Service (Service) most recently evaluated the biology and status of the Ozark big-eared bat as part of a status review conducted on April 7, 2008. We examined whether new information was available and whether that new information would alter or affect analyses and conclusions made in the previous status review. Data for this current review were solicited from interested parties through a Federal Register notice announcing the review on March 19, 2020. Information about the Ozark big-eared bat related to population trends, distribution, habitat conditions, threats, and conservation measures was requested from the public, concerned governmental agencies, Tribes, the scientific community, industry, non-profit conservation organizations, and any other interested parties. An “Interested Party Email” also was sent directly to 92 individuals, researchers, tribes, state and federal agencies, and nonprofit conservation organizations. Data and additional information was received from Blake Sasse (Non-Game Mammal Coordinator, Arkansas Game and Fish Commission), Bill Puckette (Cave Biologist and

Geologist), and Richard Stark (Biologist, Ozark Plateau National Wildlife Refuge). Additionally, we conducted a literature search and a review of information in our files.

This 5-year review (review) was prepared by Brian Fuller, Biologist, U.S. Fish and Wildlife Service, Oklahoma Ecological Services Field Office (ESFO) and Richard Stark, Biologist, Ozark Plateau National Wildlife Refuge (NWR); both located in Interior Region 6 (Legacy Region 2). Vona Kuczynska, Service Biologist in Columbia, Missouri ESFO (Interior Region 4; Legacy Region 3) and Pedro Ardapple-Kindberg, Service Biologist in the Conway, Arkansas ESFO (Interior Region 4; Legacy Region 4) as well as Blake Sasse, Non-Game Mammal Coordinator, Arkansas Game and Fish provided assistance and information for this review. No part of this review was contracted to an outside party.

1.3 FR Notice Citation Announcing the Species is Under Active Review:

85 FR 15795 (March 19, 2020) Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 10 Species in Arizona, Arkansas, Kansas, Missouri, New Mexico, Oklahoma, Texas, and Mexico.

2.0 REVIEW ANALYSIS

2.1 Recovery Criteria:

2.1.1 Current Recovery Plan:

U.S. Fish and Wildlife Service. 1995. Ozark Big-Eared Bat (*Corynorhinus townsendii ingens*) Revised Recovery Plan. Tulsa, OK. 51pp

2.1.2 Trend Analysis

In the 1995 Revised Recovery Plan (Service 1995), reclassification (Criterion 1) requires a stable or increasing population to be maintained over a ten year period at all essential Ozark big-eared bat sites. An essential cave was defined in the 1995 recovery plan as "caves that are essential to the continuing existence of the Ozark big eared because they are used as maternity sites and/or hibernacula. Some large or otherwise important transient roost sites may be included in this category" (Service 1995).

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). Some caves, such as AD-10, are utilized as both maternity sites and hibernacula roost sites. This is the same essential cave but analyzed as two different colonies.

Surveys at summer maternity sites are conducted using infrared lights to illuminate the entrance, while a surveyor with a night vision scope counts the Ozark big-eared bats as they exit the cave. These counts are assumed to consist of adult females because male

Ozark big-eared bats roost solitarily in caves throughout the range during the time maternity colonies are formed. The previous 5-year review (Service, 2008) recommended standardizing the method for collecting Ozark big-eared bat maternity data to a window of time when it is most likely that the maternity colony had fully formed but prior to pups becoming volant to ensure that only adult females were counted. This time period typically is between the last week of May and the first two weeks of June (Bagley and Jacobs 1985, and Service 2008). Some surveys before 2008 were conducted as late as the middle of July, well past the point where the pups become volant. Collecting maternity data this late allows for the young of the year to be counted. When count data are collected as late as July, numbers of bats counted are likely higher due to presence of young of the year, possibly indicating a significant increasing trend for the colony, or if the colony had dispersed prior to counts being taken, the data might incorrectly indicate a population decline. During the process of gathering data for this review, there were still some post 2008 counts that were conducted as late as July. These counts were not considered in this review.

The maternity and hibernacula data analyzed for this review had to meet four criteria. First, all maternity and hibernacula surveys that resulted in a count of zero were not used in the analysis. A count of zero indicates the colony was not present and is likely not representative of the actual colony numbers. In this instance, we believe the colony was using an alternate cave, possibly a cave we have yet to locate. Consequently a count of zero would not accurately represent actual colony numbers for the year. Second, maternity colony data was collected during a window of time when it is most likely that the maternity colony had fully formed but prior to pups becoming volant to ensure only adult females were counted. This period typically occurs between the last week of May and the first two weeks of June. Third, at least four data points per colony were available to meet the minimum requirement of the Mann-Kendall statistical trend test. Fourth, if a colony does not have at least four data points over the 10 year period of analysis, in fulfillment of the first criterion above, then all data collected since the last 5-year review (2008) was analyzed, provided the data met the requirements of the first and second criteria stated above. While, this fourth criterion does not meet the requirements of the revised recovery plan Criterion 1 regarding reclassification, it will allow for a trend analysis and provide further insight into the characteristics of the colony until sufficient data can be collected.

A total of 20 colonies were available for the analysis conducted in this review (Table 1). Data were available for ten colonies in Arkansas. Six of those (CW-21 BT 1, MR-9702/ 979A, CW-29 BT 3, WA-5201/ 5202, WA-3301, and FR-28 BT 2) were maternity colonies and four were hibernacula (MR-0702/9702/979A, Devil's Den, WA-3301, and CW-21 BT 1). The Devil's Den colony utilizes several caves and crevices to form a maternity colony. These include Devil's Den, Big-ear, Devil's Icebox, J, Pipistrel, Wild Dog, and Yellow Rock sites. This review will refer to this colony as Devil's Den for the remainder of this document.

Data on nine colonies were available for Oklahoma; five maternity colonies (AD-10, SQ-1, AD-125, AD 17/18/153, and AD-13) and five hibernacula (AD-3, AD-10, AD-

125, AD-14, and AD-T1). Sixteen of the 20 colonies met the criteria identified above and were evaluated in this review (Table 2).

The Mann-Kendall Trend Test (Kendall 1938, Mann 1945) was used to examine whether each maternity colony was experiencing a decreasing or increasing population trend. The GSI MANN_KENDALL TOOLKIT V 1.0 software was used to estimate trends. This test calculates an 'S' statistic to indicate trend, with a negative number to indicate a decreasing trend and a positive number to indicate an increasing trend A confidence factor (CF) is used to indicate the confidence in the trend, and presents the magnitude of the trend as a percentage. A CF of ≥95% was used to indicate a significant trend for this analysis. Coefficient of Variation (COV) was used to determine whether or not the colony was stable when the CF was below our threshold of ≥ 95%, indicating it was neither a significant increasing nor decreasing trend based on the Mann-Kendall test. A data set with a COV ≤ 0.5 was interpreted to be stable around a mean value, and a data set with a COV > 0.5 was interpreted to be too variable to identify any change over time (Ellison *et al*., 2003). The Mann-Kendall test requires at least four data points, so any colony that did not fulfil that requirement was excluded from our analysis.

Table 1. Population data from 2008 to 2020 for all 20 essential colonies.

Colony	State	Colony Type	Colony Size (Maximum)	Colony Size (Average)
WA-5202/5201	AR	Maternity	43	28
MR-9702/979A	AR	Maternity	78	46
CW-21 BT 1	AR	Maternity	16	8
FR-28 BT 2	AR	Maternity	44	27
CW-29 BT 3[1]	AR	Maternity	300	300
WA-3301	AR	Maternity	338	285
AD-13	OK	Maternity	75	58
AD-125	OK	Maternity	133	73
AD-17/18/153	OK	Maternity	243	158
AD-10	OK	Maternity	320	220
SQ-1	OK	Maternity	104	60
Devil's Den[2]	AR	Hibernaculum	111	65
CW-21 BT 1	AR	Hibernaculum	58	41
MR-0702/9702/979a	AR	Hibernaculum	140	83
WA-3301	AR	Hibernaculum	22	15
AD-3	OK	Hibernaculum	435	370
AD-125	OK	Hibernaculum	171	104
AD-T1	OK	Hibernaculum	35	18
AD-10	OK	Hibernaculum	315	202
AD-14	OK	Hibernaculum	39	15

Notes:
[1] The CW-29 BT 3 maternity colony has only been surveyed once since 2008.
[2] The Devil's Den Colony, as considered in this document, consists of the following caves and crevices: Devil's Den, Big-ear , Devil's Icebox, J , Pipistrel, Wild Dog, and Yellow Rock.

Table 2. Results of the Ozark big-eared bat 10 year (2011-2020) maternity and hibernaculum colony Mann-Kendall Test indicating colony trend, where evident.

Colony	State	Colony Type	Mann-Kendall Statistic (S)	Confidence Factor (CF)	Coefficient of Variation (COV)	Trend
WA-5202/5201	AR	Maternity	0	37.50%	0.3	Stable
MR-9702/979A	AR	Maternity	-4	66.70%	0.6	No Trend[1]
AD-13	OK	Maternity	0	46.00%	0.3	Stable
AD-125	OK	Maternity	-16	94.00%	0.4	Stable
AD-17/18/153	OK	Maternity	-24	99.40%	0.4	Decreasing
AD-10	OK	Maternity	-11	81.00%	0.3	Stable
SQ-1	OK	Maternity	-14	87.30%	0.4	Stable
Devil's Den[2]	AR	Hibernaculum	13	92.90%	0.5	Stable
CW-21BT1	AR	Hibernaculum	-6	95.80%	0.6	Decreasing
MR-0702	AR	Hibernaculum	-8	84.50%	0.3	Stable
WA-3301	AR	Hibernaculum	6	95.80%	0.2	Increasing
AD-3	OK	Hibernaculum	-21	96.40%	0.2	Decreasing
AD-125[3]	OK	Hibernaculum	-4	75.80%	0.5	Stable
AD-T1	OK	Hibernaculum	-2	59.20%	0.5	Stable
AD-10[3]	OK	Hibernaculum	-6	88.30%	0.7	No Trend[1]
AD-14	OK	Hibernaculum	-6	95.80%	0.8	Decreasing

Notes:
[1] No Trend—colonies that have a non-significant P value and a COV greater than 0.5, indicating the colony data was too variable to identify a trend.
[2] The Devil's Den Colony in this analysis consists of the following caves and crevices: Devil's Den, Big-ear, Devil's Icebox, J, Pipistrel, Wild Dog, and Yellow Rock.
[3] The analysis used the previous 5-year review (2008) because the colony did not have the required minimum of four data points to conduct the Mann-Kendell Test.

2.1.3 Trend Analysis Conclusion

We were able to analyze seven maternity colonies since the last review was conducted in 2008. Of those seven maternity colonies, the observed trend in five colonies was stable, the trend in one colony was declining, and for another colony, no trend was evident. Nine hibernaculum also were analyzed, indicating the trend in four hibernacula to be stable, one hibernacula population appeared to be increasing, and three populations appeared to be declining. A trend was not evident at one hibernacula population. Two Oklahoma hibernaculum (AD-125 and AD-10) did not have the required four data points over the ten year period due to the difficulty of surveying these

sites. So we invoked criterion four discussed above to conduct our analysis. Accordingly, one on these hibernacula populations was considered stable (AD-125) and no trend was evident at the other hibernacula (AD-10)(Table 1). Overall, the result of these trend analyses reveals that a stable or increasing Ozark big-eared bat population does not occur at all essential Ozark big-eared bat sites over the previous 10 year period and thus does not meet the criterion for reclassification (Criterion 1) from the Revised Recovery Plan.

As discussed in the previous 5-year review (Service 2008), data collected for maternity counts can be highly variable. Some colonies can use multiple caves from year to year or in the same year making it difficult to get reliable colony data for trend analysis. For example, the colony at AD-17/18/153, can use one of the caves or be in all three in the same year. In some years, we have been unable to locate the AD-17/18/153 colony, indicating there is an alternative cave(s) that we have not discovered. Until we find this alternate cave(s), it is difficult to obtain a trend analysis, considering the variability in the data that can provide a more reliable population trend.

Hibernacula data also may be difficult to analyze due to the variability of colony sizes from year to year. Ozark big-eared bats are known to exhibit activity and move among caves in the winter (Clark *et al*., 1997 and 2002). They may become active during periods of warm weather. Oklahoma hibernacula surveys typically are conducted over a two and a half month period (late December through February). This gives ample opportunity for Ozark big-eared bat's to move among various winter caves. Spreading the counts over such a long period allows the surveys to possibly double count bats, miss part of the colony, or miss the entire colony of bats that might have moved to a hibernacula that was already surveyed. This movement can make the data collected highly variable from year to year and makes trend analysis difficult. Arkansas generally performs their hibernacula counts in the month of January. This allows for less opportunity for movement between surveys. However, conducting the hibernacula census in a shorter window of time, for example over a two-week window, would reduce the likelihood of movement among caves even further (See section 4.2 for more specific information and recommendations on conducting the hibernacula census in the future).

2.2 Updated Information and Current Species Status

2.2.1 Biology and Habitat

Overall progress made toward achieving specific recovery reclassification and delisting criteria identified in the revised Ozark big-eared bat recovery plan is summarized in Table 3 below. Other important recovery updates also have been provided in the paragraphs that follow.

A large colony of wintering Ozark big-eared bats (estimate of 632 bats) were recently discovered during winter 2019/2020 in a talus cave near the CW-29 BT 3 maternity

colony sites. This very important site may account for a large number of Ozark big-eared bats during the winter.

Table 3. Summary of progress towards achieving recovery criteria.

Criterion	Relevant Measure	Current Status	Conclusion
Reclassification Criterion 1	Stable or increasing populations are maintained, over a ten-year period, at essential Ozark big-eared bat sites. Colonies for which we have sufficient monitoring data (n= 14)	Stable (n=8): 57.14% Increasing (n=1): 7.14% Decreasing (n=4):28.57% No Trend (n=1): 7.14%	Not Achieved
Reclassification Criterion 2	The Oklahoma Bat Caves National Wildlife Refuge authority is expanded to ensure development and implementation of management agreements with private landowners essential for the recovery of the Ozark big-eared bat and coordinate recovery efforts across State and Fish and Wildlife Service Regional boundaries.	The name of the refuge was changed to Ozark Plateau NWR to better identify the refuge as a central cave management entity within all of the Ozarks, and facilitate future work/acquisition within Legacy Regions 2, 3, and 4, and on private land. The approved acquisition area for the refuge has been appropriately expanded in OK, but expansion areas have not been approved in AR or MO.	Not Achieved
NOTE: The reclassification criteria (above) currently have not been met. Nonetheless, to see how much progress has been made to-date towards full recovery of the species, we also assessed the delisting criteria (considered interim in the 1995 Recovery Plan) using currently available data.			
Delisting Criterion 1	All existing essential and limited-use caves in the three State area have been identified.	Ongoing monitoring efforts indicate there are essential maternity caves and hibernacula that have not yet been located.	Not Achieved
Delisting Criterion 2	All known limited-use sites have been protected from human disturbance and habitat loss.	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. There are numerous (>150) limited-use caves. Not all sites have been afforded protection.	Not Achieved
Delisting Criterion 3	Stable or increasing populations have been reestablished at all available caves once used by the Ozark big-eared bat throughout its known historic range in Oklahoma, Arkansas, and Missouri.	Ozark big-eared bats have reestablished at cave SQ-1 with a stable trend. However, they are still absent from historic caves in Delaware County, OK. Protection of caves identified for expansion of the Ozark big-eared bat and reestablishment of populations in Missouri are key elements to delisting. The bat is still considered extirpated from Missouri.	Not Achieved

Table 3. Continued

Criterion	Relevant Measure	Current Status	Conclusion
Delisting Criterion 4	A population viability analysis (PVA) is conducted to determine the self-sustaining population level, which should be used to refine delisting tasks.	Data on reproductive and mortality rates would be an integral part of the analysis, but are not currently available. The benefit gained from collecting these data 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. Thus, a PVA to determine the self-sustaining population level is not recommended at this time.	Not Achieved
Delisting Criterion 5	A plan is developed to provide long-term protection after delisting.		Not Achieved

In Oklahoma, a new maternity colony (SQ-1) was discovered in 2011, using a cave that previously had been considered, in the 1995 Revised Recovery Plan, to be a limited use site. This cave was gated in 1993 and has routinely supported a colony of around 60 Ozark big-eared bats.

A new maternity colony also was discovered in 2019 in Arkansas (WA-3301) containing 231 Ozark big-eared bats. The colony was surveyed again in 2020 with a recorded 338 Ozark big-eared bats. This is an important discovery and indicates either a new colony or a newly discovered alternate site. More surveys will be required to document whether the colony uses this site routinely.

Additionally, two currently unnamed crevices in Arkansas were discovered in 2020 with a single Ozark big-eared bat recorded at each site.

Since the last 5-year review (Service 2008), the results of four scientific studies on the Ozark big-eared bat have been published. Lee e*t al*. (2015) investigated population connectivity among known colonies. Results suggest genetic mixing of individuals occurring at swarming sites in the autumn. Fall swarming sites and winter hibernacula likely play an important role in mating. Locating and protecting these sites, in addition to maternity caves and surrounding habitat, is important to facilitate gene flow among populations of Ozark big-eared bats.

Van den Bussche *et al*. (2016) investigated dietary preference of Ozark big-eared bats by identifying insect species in bat fecal material using molecular techniques. The study detected 40 species representing two orders (Diptera and Lepidoptera) and 11 families of insects, providing new information regarding dietary habits of Ozark big-eared bats. Thirty-nine of the 40 species identified by DNA sequences in guano pellets were moths. This study provides further evidence that Ozark big-eared bats are moth specialists (Leslie and Clark 2002, Dodd and Lacki 2007, Dodd *et al*. 2008).

Graening *et al*. (2011) conducted a 34 year assessment from 1977 to 2010 on Ozark big-eared bats maternity and hibernacula roosts. Trend analysis using the Mann-Kendall Test were performed on all known maternity and hibernaculum colonies. The analysis revealed that 19 sites showed important demographic trends over the 34-year period: seven colonies had a significantly increasing trend – three maternity sites (Cave No. AD-10, AD-17/18, and CW-29 BT 3) and four hibernacula (AD-14/125, AD-3, AD-T1 and WA-31 T complex); three colonies were determined to be decreasing – the maternity sites AD-125 and AD-13/24/25, and hibernaculum MR-0702/9702/979a; and the remaining essential sites were data deficient. Summer maternity exit count survey techniques were standardized for future surveys in Oklahoma and Arkansas.

Lack and Van Den Bussche (2009) obtained sequence data from the hypervariable D-loop of the mitochondrial DNA control region of *Corynorhinus rafinesquii*, *C. mexicanus*, and the five recognized subspecies of *C.townsendii* and employed a relaxed molecular clock model to test competing hypotheses of evolution for big-eared bats in North America. Their analyses indicate interspecific divergences occurred during the Pliocene, with *C. rafinesquii* diverging from the other *Corynorhinus* relatively early, during periods of increased warmth and significantly higher sea levels, and *C. townsendii* and *C. mexicanus* diverging relatively late, possibly during the cooler periods leading up to the Pleistocene. Intraspecific divergences within C. townsendii appear to have occurred as a result of repeated glacial advances during the Pleistocene, with the *C. t. ingens* and *C. t. virginianus* lineages arising at relatively the same time as *C. t. pallescens* and *C. t. australis*, and recent rapid population decline producing the disjunct distribution of *C. t. ingens* and *C. t. virginianus*. Dating and demographic analyses indicate all species of *Corynorhinus* are likely undergoing population decline.

2.2.2 Threats Analysis (threats, conservation measures, and regulatory mechanisms):

Variation in the monitoring data for maternity colonies indicates a likelihood that Ozark big-eared bats are using caves that have yet to be located. Locating these caves is important so that appropriate conservation measures can be implemented to protect the colonies and sites. Until these caves are located, important and potentially essential cave and surrounding foraging habitat could be under the threat of vandalism, disturbance, degradation, and/or habitat loss.

2.2.2.1 Present or Threatened Destruction, Modification or Curtailment of Its Habitat or Range (Factor A):

The current range of the Ozark big-eared bat occurs within the Ozark Highlands and Boston Mountains Ecoregions (Omernick 1987) in Oklahoma and Arkansas. This region had experienced considerable development pressure and human population growth due to relatively inexpensive land prices and the aesthetics of the area. For example, the human population of Washington and Benton counties, 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). However, based on the most current information available, population growth has slowed considerably throughout the current range of the Ozark big-eared bat over the last ten years, except for Washington County, Arkansas, where the population increased 16.7% between 2010 and 2019. Otherwise, within those counties known to have essential cave habitat, between April 1, 2010, and July 1, 2019, populations increased by 3.5%, 2.1%, and 0.3% in Cherokee County, OK, and Marion and Crawford counties, Arkansas, respectively; and declined by 2.3%, 2.1%, and 2.0% in Franklin County, Arkansas, and Adair and Sequoyah counties, Oklahoma, respectively (U.S. Census Bureau 2020).

Nonetheless, vandalism, and human activity at known, and yet to be discovered maternity roosts and hibernaculum remain significant threats due to the sensitivity of Ozark big-eared bats to disturbance, especially during critical maternity and winter hibernating periods. Emergence counts for the Ozark big-eared bat reveal a disparity between summer and winter population estimates, indicating bats are likely using major hibernaculum that have not yet been located. A recent example of this is the newly located Arkansas wintering colony discussed above in section 2.2.1. Including this site in future monitoring efforts should provide additional useful information. Threats to other unknown caves remain a concern throughout the range of the Ozark big-eared bat and especially in areas experiencing high population growth such as Washington County, Arkansas. Survey efforts at these sites will help prevent unnecessary impacts to important habitat.

A genetic study of the Ozark big-eared bats (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 extirpation of individual maternity colonies 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.Progress has been made on a number of other conservation efforts that will help minimize the destruction, modification, and curtailment of the Ozark big-eared bats habitat and range. For example, the Service approved expansion of the Ozark Plateau NWR 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. Since 2005, several very important tracts for the recovery of the Ozark big-eared bat have been added to the refuge. In

2009, the 189-acre Potter Unit was accepted as a donation from a private landowner. This tract provides high quality foraging habitat, contains a cave used as a limited-use site by males, and also as a fall site by a colony in some years. The Potter Unit is adjacent to the Cookson Hills Wildlife Management Area (owned and managed by the Oklahoma Department of Wildlife Conservation), which also has several limited-use sites and quality foraging habitat. More recently, The Conservation Fund acquired and donated several very important tracts to the refuge that will help facilitate recovery of the Ozark big-eared bat. These tracts include the 155 acre Kester Tract, which adds high quality foraging habitat to the Gittin' Down Mountain Unit (this unit contains several important caves); the 29-acre McMeans Tract, which adds high quality foraging habitat to the Sally Bull Hollow Unit (this unit contains an essential maternity cave and an essential hibernacula, and several limited-use caves), and the 79-acre Saifi tract, which also adds important foraging habitat to the Sally Bull Hollow Unit. As of the writing of this document, the refuge, The Conservation Fund, and Oklahoma Ecological Services Field Office are collaborating on three other very important acquisitions in Adair County that would protect an additional 870-acres, and add one essential maternity cave and one essential hibernacula to the refuge.

The Oklahoma Department of Wildlife Conservation (ODWC), Arkansas Game and Fish Commission (AGFC), and Arkansas Natural Heritage Commission (ANHC) have made progress working together to benefit Ozark big-eared bat habitat. Through the Cooperative Endangered Species Conservation Fund, all three have secured Recovery Land Acquisition section 6 grant funding to acquire important Ozark big-eared bat habitat. These tracts provide foraging habitat, contain limited-use caves, and are located adjacent to existing protected areas, providing important linkages with other important habitats. In Oklahoma, the acquired tracts are located adjacent to the Sally Bull Hollow Unit of the Ozark Plateau NWR, and consist of 2,076 acres that provide important foraging and cave habitat for Ozark big-eared bats. In Arkansas the tracts are located adjacent to the Slippery Hollow and Garret Hollow Natural Areas managed by the Arkansas Natural Heritage Commission.

Local non-governmental organizations also have played an important role in recovery. The Oklahoma and Arkansas Chapters of The Nature Conservancy have been instrumental in the protection of important caves and foraging habitat, and have developed and implemented management strategies for Ozark big-eared bats. For almost 30 years, the National Speleological Society'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 Ozark big-eared bats. Their help has been significant, particularly in light of the Ozark Plateau NWR's limited budget. As previously discussed, The Conservation Fund

recently purchased and donated very important tracts to the Ozark Plateau NWR.

The Cherokee Nation also plays a valuable role in Ozark big-eared bat conservation. The Cherokee Nation has purchased a conservation easement on a 40-acre tract that contains limited-use caves used by Ozark big-eared bats, purchased another 40-acre tract that contains an essential maternity cave, and allowed the Service and partners to gate this cave. Additionally, the Cherokee Nation has conservation agreements with the Ozark Plateau NWR on 120 acres of land adjacent to existing refuge tracts allowing management and protection of these lands as part of the refuge. Through annual coordination with the Tribe, the Service is allowed to monitor the status of Ozark big-eared bats occurring on these Tribal properties.

The U.S. Forest Service also provides protection for Ozark big-eared bat caves and foraging habitat occurring on the Ozark National Forest in Arkansas. The U.S. Forest Service has established a 200-foot buffer zone around all known Ozark big-eared bat roosts, effectively prohibiting activities that may adversely impact the bats (USDA 2005).

Several high priority cave sites have been gated or fenced to prevent human vandalism and disturbance. Additional sites likely will need to be gated in the future.

2.2.2.2. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes (Factor B):

Recreational use and associated human disturbance at maternity caves and hibernaculum remains a 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 during hibernation. Human disturbance also can result in cave abandonment. For example, two caves that occur in Delaware County that were historically used by the Ozark big-eared bats (DL-4 and DL-21) were abandoned before appropriate protective measures (*i.e.*, cave gating) 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. Although Ozark big-eared bats have not been found at these sites during recent monitoring efforts, the caves will continue to be monitored for natural reestablishment. Prior to 1993, Cave SQ-1 experienced frequent unauthorized human entry. However, the cave was gated in 1993 and has since been colonized by a maternity colony that averages 60 bats.

The measures most important for conserving 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 Ozark big-eared bats (*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.

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; until they are located, these sites cannot be afforded protection from human disturbance.

2.2.2.3. Disease or Predation (Factor C):

Disease and predation have not previously been considered major threats to Ozark big-eared bats. Little information on the impact of disease exists. White-nose syndrome is a new disease in North American bats which has resulted in the dramatic decrease of bat populations in the United States and Canada, killing millions of bats since it was first documented in 2006. The condition is named for the white fungal growth around the muzzles and on the wings of hibernating bats. The fungus that causes white-nose syndrome, *Pseudogymnascus destructans*, has been present within the range and documented in essential caves of the Ozark big-eared bat since the winter of 2013/14. Fungal spores were detected on an Ozark big-eared bat in a cave on the Ozark Plateau NWR in 2018. The wintering colonies of Ozark big-eared bats are being monitored closely for signs of the disease. No signs of disease or mortality due to white-nose syndrome has occurred to date. The closely related Virginia big-eared bat has been exposed to the disease for even longer (since 2010) and also has experienced no visible signs of disease or mortality (Stihler 2011). Members of the genus *Corynorhinus* appear to be resistant to this disease. This may be due to a combination of factors such as the species' skin biome, which could inhibit the growth of the fungus, a hibernating strategy that doesn't require extended periods of sustained torpor, and use of microclimates that are less favorable to the fungus. More research is needed to understand why big-eared bats appear impervious to this disease.

Likely predators of Ozark big-eared bats include wildlife that are known to prey on other bat species such as snakes, owls, raccoons, bobcats, and feral

house cats. Predation and disease are currently not considered significant threats.

2.2.2.4. Inadequacy of Existing Regulatory Mechanisms (Factor D):

The Ozark big-eared bat 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 Ozark big-eared bats 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 involving the Ozark big-eared bat has not been developed to date. However, as the human population and development pressures increase within the range of the Ozark big-eared bat, the protections afforded to this species under the ESA will be important tools to avoid and reduce impacts (U.S. Census Bureau 2001, ODOC 2020).

The Ozark big-eared bat 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. Arkansas Game and Fish Commission regulations make it illegal to import, transport, sell, purchase, hunt, harass, or possess endangered 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 Arkansas Department of Parks and Tourism, and the ANHC.

2.2.2.5. Other Natural or Manmade Factors Affecting Its Continued Existence (Factor E):

Climate change has already had observable impacts on biodiversity, ecosystems, and the benefits they provide to society. These impacts include the migration of native species to new areas and the spread of invasive species. Such changes are projected to continue, and without substantial and sustained reductions in global greenhouse gas emissions, extinctions and transformative impacts on some ecosystems cannot be avoided in the long term. More frequent and intense extreme weather and climate-related events, as well as changes in average climate conditions, are expected to continue to damage infrastructure, ecosystems, and social systems that provide essential benefits to communities (USGCRP 2018).

Mounting data on the impact of climate change, including extreme events such as drought and flooding, on bats are a cause for concern as recent increases in global temperature represent one fifth, or less, of those expected over the next century (Frick *et al*. 2019; O'Shea *et al*. 2016; Rebelo *et al*. 2010; Sherwin *et al*. 2013; USGCRP 2018). During the last 30 years of the 20th century, accumulated evidence suggests that the phenology of organisms, species biogeography and the composition and dynamics of communities are changing in response to a changing climate (Walther *et al*. 2002).

Climate influences food availability, timing of hibernation, frequency and duration of torpor, rate of energy expenditure, reproduction and development rates of juveniles (Sherwin *et al*. 2013). Warmer climates may benefit females by causing earlier parturition and weaning of young, allowing more time to mate and store fat reserves in preparation for hibernation. Similarly, earlier gestation and parturition may benefit juveniles by providing a longer growth period prior to the breeding season (Burles *et al*. 2009). Frick *et al*. (2010) supported this finding by showing that little brown bat pups born early in the summer have higher survival and first-year breeding probabilities than those born later in the summer. In contrast, warmer climates may cause disruption of hibernation, extreme weather events, reduced water availability in arid environments, and facilitate the spread of disease, all contributing to

significantly increased mortality (Adams and Hayes 2008, Adams 2010, Hayes and Adams 2017).

Future changes in temperature may affect hibernation periods and the availability of suitable hibernacula (*e.g*., some currently occupied sites may become too warm). Increased variation in climatic extremes raises the possibility of bats emerging from hibernation early or at a greater frequency. That would not only put hibernating bats at risk from depleted energy stores, but could also affect the birth and survival of pups. Resources, especially insect prey, may be limited or variable during periods of early arousal from hibernation. Thus, climate change also will likely affect the future distribution of suitable hibernacula (Humphries *et al*. 2002).

The degree to which bats can adapt by adjusting their behavioral, ecological, and phenological characteristics remain largely unanswered. Further monitoring and research is needed to better understand the impacts of climate change on Ozark big-eared bats and their habitat.

2.3 Synthesis:

Since the last review, two new section 4(a)(1) factors have been identified for the Ozark big-eared bat. The first threat (Factor C) is White Nose Syndrome. White Nose Syndrome has spread through the entire range of the Ozark big-eared bat. Monitoring of the Ozark big-eared bat population have not revealed any negative effects of White Nose Syndrome. More monitoring and additional studies are needed to know the true impacts, if any, White Nose Syndrome could have on the species. The second threat (Factor D) is climate change. Climate change could have an effect on the suitability of Ozark big-eared bat caves for roosting and hibernation, influence the timing of spring emergence and pup rearing, and impact prey availability. Warmer climates may benefit female Ozark big-eared bats by causing earlier parturition and weaning of young, allowing more time to mate and store fat reserves in preparation for hibernation. Similarly, earlier gestation and parturition may benefit juveniles by providing a longer growth period prior to the breeding season (Burles *et al*. 2009 and Frick *et al*. 2010). In contrast, warmer climates may cause disruption of hibernation, extreme weather events, reduced water availability in arid environments, and facilitate the spread of disease, all contributing to significantly increased mortality (Adams and Hayes 2008, Adams 2010, Hayes and Adams 2017). The true effects of climate change on Ozark big-eared bats are not known and will require further monitoring.

Since the last 5 year review in 2008 (Service 2008) significant recovery actions have taken place for the Ozark big-eared bat and are summarized in Table 4.

Table 4. Significant Recovery Actions since Last 5-Year Review (2008).

Recovery Action	Benefit
Acquisition of 155-acre Kester Tract as new addition to Gittin' Down Mountain Unit of Ozark Plateau NWR	Permanent protection of foraging habitat near important winter and maternity caves.
Acquisition of 79-acre Saifi Tract as new addition to Sally Bull Hollow Unit of Ozark Plateau NWR	Permanent protection of foraging habitat near important winter and maternity caves.
Acquisition of 29-acre McMeans Tract as new addition to Sally Bull Hollow Unit of Ozark Plateau NWR	Permanent protection of foraging habitat near important winter and maternity caves.
Acquisition of 1,250 acres by ODWC as addition to the Ozark Plateau WMA	Permanent protection of limited-use caves and foraging habitat near important winter and maternity caves.
Gated cave AD-17	Protects essential maternity cave from unauthorized human entry and disturbance.
Gated cave AD-18	Protects essential maternity cave from unauthorized human entry and disturbance.
Gated cave WA31T2	Protects a historic hibernaculum from unauthorized human entry and disturbance.
Gated cave WA3301	Protects essential maternity cave and hibernacula from unauthorized human entry and disturbance.
Gated cave MR979-A	Protects essential maternity cave from unauthorized human entry and disturbance.
Healthy Forests Reserve Program implementation (program active between 2009 – 2015)	Protection and enhancement of important foraging and limited-use cave habitat on private land in Oklahoma through perpetual and 30-year easements, and implementation of habitat restoration plans.
Discovery of a new large hibernating colony in winter 2019/2020 on Ozark National Forest Land	Allows opportunity to protect the site, and will improve understanding of population numbers during the winter
Identification of newly established maternity colony at a recently gated cave on Arkansas Natural Heritage Commission lands.	Provides evidence of positive benefits of cave gates for the species and improves understanding of population numbers.

In conclusion, the Ozark big-eared bat continues to meet the definition of endangered, even though significant recovery accomplishments have occurred since the previous review (Table 4). Recovery criteria to downlist the species to threatened status have not yet been fully met (Table 3). Therefore, the vulnerability of the Ozark big-eared bat 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:

Given your responses to previous sections, particularly section 2.5 Synthesis, make a recommendation with regard to the listing classification of the species

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *The species is extinct*
____ *The species does not meet the definition of an endangered species or a threatened species (i.e., is recovered, or new information on status and threats indicate species does not meet definitions)*
____ *The listed entity does not meet the statutory definition of a species.*
__X__ **No change is needed**

3.2 New Recovery Priority Number:

No Change

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The most important factors in assuring the continued existence of the Ozark big-eared bat is locating and protecting additional caves used by maternity and wintering colonies, limiting human disturbance and vandalism at essential maternity sites and hibernacula, and protecting foraging areas from habitat loss. The Ozarks region continues to grow and experience development due to relatively inexpensive land prices and the aesthetics of the area. Vandalism and human disturbance at known maternity roosts and hibernacula continue to be major concerns. Since many caves are on private land, this could be a major concern for any undiscovered maternity roost and hibernacula as well. Loss of foraging habitat around essential caves especially those sites not yet discovered, also is a concern. The recovery of the Ozark big-eared bat 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 5-year review.

4.1 Continue to Search for Caves of Importance

We continue to learn more about the use of caves by known maternity colonies. Monitoring efforts over the last twelve years have revealed that some colonies utilize more than one cave as a roost site, and the use of caves by a colony varies from year to year. Use of alternate sites could involve an entire colony or only part of the colony. In some years, most if not all of the colony may be in one cave while in other years the colony may be spread out in more than one cave. For example, the Varmint colony is now known to use at least three caves (AD-17, AD-18, and AD-153), and we now monitor each of these caves simultaneously during the annual exit count. In the past, only one cave (either AD-17 or

AD-18) was typically counted which likely resulted in surveys not accounting for all bats and a high level of variation in the data from year to year. Because the colony was not present in any of these three caves during summer 2019, we suspect that this colony also utilizes a fourth cave in some years. Locating and monitoring this site is critical to gaining an adequate understanding of colony size and trends over time. Other colonies that have shown high levels of variation in the annual summer maternity count data and likely have an alternate roost sites that have yet to be located include AD-13, AD-125, and AD-17/18/153. The colony size estimate for the Marion County population has been declining in recent years. However, surveyors recently observed some bats were flying out of a small secondary entrance, which could account for the decline in recorded populations. Further surveys observing both openings simultaneously will be needed to confirm if the bats are using both openings or if the colony has an unknown alternate roost site. Searches for other important caves in this area should be a priority. It is possible that each colony has at least one alternate cave. It is imperative to continue to search for and locate all caves used by each maternity colony.

Searches for other unknown hibernacula should continue throughout the Ozarks in Oklahoma and Arkansas. Annual monitoring efforts at maternity sites and hibernacula typically have presented a disparity between summer and winter population estimates. Numbers of Ozark big-eared bats estimated from summer maternity counts have been larger than those found during winter hibernacula counts. This indicates there are major hibernacula being used by Ozark big-eared bats that have not yet been located. A large colony of wintering Ozark big-eared bats (estimate of 632 bats) recently were discovered during winter 2019/2020 at CW-29 BT 3. This very important site may account for a large number of Ozark big-eared bats during the winter. A complete hibernacula census, including this site, is needed. Also, should re-visitation of historic or possible sites in Missouri find Ozark big-eared bats, search efforts should be intensified in Missouri.

4.2 Continue Monitoring Population Trends at All Essential Sites

One recovery criterion (Criterion 1) for downlisting in the 1995 Revised Recovery Plan requires maintenance of a stable or increasing Ozark big-eared bat population at all known essential caves over a ten-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 colony should continue to be monitored over the next ten years to determine population trends. As more of the caves used by each colony are located, the monitoring data will provide a better understanding of colony size and population trends over time. The hibernacula should be monitored every two years. However, should the counts at hibernacula start to exceed those from summer maternity counts, consideration should be given to the use of these counts to estimate population size.

An estimate of 40–60 Ozark big-eared bats were observed at talus site FR-28 BT 2 in Franklin County, Arkansas, during July 2014. A colony of this size during the summer typically is indicative of a maternity colony. A colony of 10 and 34 bats also were recorded

at this site during the summers of 2018 and 2019, respectively. Exit counts at this site should be conducted during the first two weeks of June over the next three year period to gain a better understanding of the use of this cave by Ozark big-eared bats.

Ozark big-eared bats are known to exhibit activity and move among caves during the winter. Clark *et al.* (2002) reported frequent winter activity, emergence from winter caves, and movement among caves by Ozark big-eared bats. Monitoring the same hibernaculum on multiple occasions during a single winter can result in much different counts. For example, during the same winter hibernation season, Clark *et al.* (1997) counted the following numbers of Ozark big-eared bats from a single cave: 485 in November 1989, 242 in December 1989, and 413 in February 1990 (Clark *et al.* 1997). Therefore, we recommend conducting the hibernacula census over a two-week window (or less) to reduce the likelihood of movement among caves by Ozark big-eared bats during the census.

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

In 2005, the Ozark Plateau NWR was approved to expand by up to 15,000 acres in Adair, Delaware, Ottawa, Sequoyah, Craig, Mayes, and Cherokee counties, Oklahoma. Protecting additional Ozark big-eared bat 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 Ozark big-eared bat 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 or only partial protection due to lack of interest by the landowner include essential caves AD-24, AD-25, AD-153, AD-T1, and WA-5202, as well as numerous limited-use caves. These and other essential sites not yet located 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.

4.4 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 continues to make refuge management, and, hence, meeting this Ozark big-eared bat recovery criterion difficult.

The Comprehensive Conservation Plan (CCP) for Ozark Plateau NWR (2013) identifies refuge staffing required to more effectively manage the refuge and help prevent the extinction of, and aid in the recovery for federally-listed cave species including the Ozark big-eared bat. Current staffing at the refuge consists of: 1) two Fish and Wildlife Biologists and 2) one Maintenance Worker. Law Enforcement and Prescribed Fire Specialists are shared with Sequoyah NWR. Future staffing requirements to most efficiently manage the refuge and better facilitate recovery of federally-listed cave species including the Ozark big-eared bat identified in the CCP include: 1) Refuge Manager, 2) Refuge Wildlife Specialist, 3) three Fish and Wildlife Biologists, 3) Outdoor Recreation Planner, 4) Administrative Assistant, and 5) Maintenance Worker. The CCP also recommends maintaining a shared Law Enforcement Officer (with Sequoyah NWR) and shared Prescribed Fire Specialists.

4.5 Develop Voluntary Cooperative Agreements with Private Landowners

The Ozark big-eared bat is known to forage up to five miles from cave sites. Efforts to protect foraging habitat should focus on areas within a five-mile radius from known caves (Harvey 1992, Clark *et al*. 1993, Wethington *et al*. 1996). A significant amount of surface foraging habitat occurs on private land. Although acquisition in fee title is the most secure and long-term means of protecting Ozark big-eared bat caves and foraging habitat, purchase of all areas necessary for the recovery of the Ozark big-eared bat likely would not be possible due to the large area used by Ozark big-eared bats. 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. 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 The Nature Conservancy's (TNC) Natural Area Registry Program.

4.6 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 Ozark big-eared bat habitats, including

the ODWC, ANHC, AGFC, the Cherokee Nation, Ozark National Forest, the Oklahoma and Arkansas Chapters of TNC, The Conservation Fund, the local chapter of the National Speleological Society (Tulsa Regional Oklahoma Grotto), and the City of Tulsa. 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, interest in selling in the future, and possible voluntary cooperative agreements.

4.7 Annual Monitoring at Maternity Colonies

The population trend analysis at all known essential caves revealed a statistically significant trend at only six of the seven maternity colonies. The inability to determine whether the size of a colony was increasing, decreasing, or stable is likely attributable to several possible factors, including movements of bats among several caves and other life history traits that make monitoring more difficult. Additionally, surveyors conducting exit counts outside the recommended survey period (typically last week of May to the second week of 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. Locating the additional maternity caves suspected to be used by each colony, and maintaining a standardized monitoring approach likely will facilitate collection of more comparable data and enhance efforts to determine population trends at known sites.

4.8 Conduct Exit Counts at Each Maternity Cave at the Same Time of Year

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 continues to recommend, where feasible, conducting exit counts utilizing night vision equipment and infrared 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 breakup 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.

As in the previous 5-year review (Service 2008), the Service recommends the following monitoring approach. 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 late May or early June. Surveyors should be in place and prepared to conduct the count at least 30-minutes prior to official sunset (Clark *et al*. 2002). Each site should be monitored for a minimum of 45 minutes after the first Ozark big-eared bat has emerged. The count should continue until a 10-minute duration occurs where no additional Ozark big-eared bats exit the site or more Ozark big-eared bats enter the site than exit.

4.9 Monitor Each Cave Used by a Colony Simultaneously During Annual Summer Exit Counts

We continue to learn more about the use of caves by known maternity colonies. Monitoring efforts over the last 12 years have revealed that some colonies utilize more than one cave as a roost site, and the use of caves by a colony varies from year to year. Use of alternate sites could involve an entire colony or only part of the colony in any year. In some years, most if not all of the colony may be in one cave while in other years the colony may be spread out in more than one cave. We believe it is imperative to monitor all caves known to be used by a colony simultaneously during the annual exit count in order to gain an adequate understanding of colony size and trends over time. Additionally, there are some suitable caves in close proximity to known essential caves that also could be used by a maternity colony but, for which additional data is needed. These caves also will require simultaneous monitoring with the known maternity cave to ascertain current use.

Currently, we provide specific exit count recommendations for these colonies as equipment and number of surveyors allow:

Coon Mountain – simultaneously monitor caves AD-13, 24, and 25 for a three year period. If the colony does not appear to be using these sites, consider evaluating and monitoring nearby caves AD-12, 16, and 19 for their potential use.

Cottonwood – simultaneously monitor sites SQ-1 and CZ-19 for a three year period.

Sally Bull Hollow – simultaneously monitor sites AD-125, and other nearby caves such as 121and 122 for a three year period.

Liver – simultaneously monitor sites AD-10 and AD-53 for a three year period.

Varmint – continue to simultaneously monitor sites AD-17, 18, and 153 every year.

CW21BT1 complex – simultaneously monitor sites CW-21 BT 1a, CW-21 BT 1b, CW-21 BT 1d, CW-21 BT 1e. Conduct interior surveys of other caves in the vicinity to determine summer use.

CW-29 BT 3 complex– simultaneously monitor sites CW-29 BT 3a, CW-39 BT 3b, CW-29 BT 3c, CW-29 BT 3d, CW-29 BT 3e, CW-29 BT 3f.

FR-28 BT 2 complex – simultaneously monitor sites FR-28 BT 2a, FR-28 BT 2b, FR-28 BT 2b Annex, FR-28 BT 3c. Conduct interior surveys of other caves in the vicinity to determine summer use.

WA-3301 – simultaneously monitor both entrances to this cave. Conduct interior surveys of other caves in the vicinity to determine summer use.

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

Apparent declines of the Coon Mountain colony (AD-13/24/25) may be attributable to movement among caves, as discussed above. Although AD-13 is gated to prevent unnecessary human disturbance and vandalism, other caves used by this colony, including AD-24 and AD-25 are not afforded such protection. The landowner of these sites should be contacted regarding implementation of this conservation measure.

4.11 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.

4.12 Re-Visit Historic and Possible Ozark Big-eared Bat Caves in Missouri

An Ozark big-eared bat survey was conducted at 34 sites in Missouri during the summer and fall of 1999 (Elliott *et al*. 1999). During this survey, evidence of Ozark big-eared bat 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 Missouri Department of Conservation. The two sites with evidence of use should be re-visited periodically. Caves within the historic ranges within Missouri should be surveyed periodically for use by Ozark big-eared bats.

4.13 Develop a Conservation and Management Plan for Each Known Essential Maternity and Winter Colony

We currently are aware of 20 essential Ozark big-eared bat colonies. Each colony will have certain unique conservation and management needs. For example, some colonies utilize caves that are gated, occur on public land, and are surrounded by a large area of suitable foraging habitat protected by agency ownership or a conservation easement, while other colonies utilize caves and foraging habitat that largely occur on private land with little to no protection. A conservation and management plan for each colony will provide important information regarding conservation already achieved and identify important future conservation goals.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Ozark big-eared bat (*Corrynorhinus townsendii ingens*)

Current Classification:

Recommendation resulting from the 5-Year Review:

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

Appropriate Listing/Reclassification Priority Number, if applicable:

N/A

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service, Oklahoma Ecological Services Field Office.

Approve: JONNA POLK Digitally signed by JONNA POLK Date: 2020.09.08 07:52:48 -05'00' _____

Date: _____