FINAL PERFORMANCE REPORT

Federal Aid Grant No. F20AP00051 (E-22-R-24)

Management and Cave Protection for Federally-listed Bats and Co-occurring Stygobitic Fauna in Oklahoma

Oklahoma Department of Wildlife Conservation

January 1, 2020 through December 31, 2021

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Abstract:

Human disturbance of maternity caves and hibernacula is a contributor to the historic and present population declines of bats across the United States. Low reproductive rates, long generation times and concentrated populations housed in a relatively small number of caves, make bat populations especially vulnerable to human disturbance and are slow to recover from these disturbances. Unique characteristics common to North American subterranean fauna render them vulnerable to anthropogenic activities and underscore the importance of monitoring and protecting sensitive populations. Within the United States, subterranean fauna constitutes more than 50% of the G1-G2 species recorded in the Natural Heritage Program; however, less than 4% receive federal protection. Procedures implemented during this project were intended to 1) maintain the bat population in targeted caves by preventing unnecessary human entry and disturbance to critical roosts, and 2) survey stygobitic fauna in Oklahoma and delineating biologically important subterranean systems. Management procedures including gate/grill construction and repair at two caves, and population monitoring efforts were completed at 26 different caves. Stygobitic bioinventory surveys were conducted at four cave systems in December 2021 and focused on population counts of Ozark Cavefish and both state endemic cave crayfish.

Need:

The cave-producing karst ecosystem of the Ozark Highlands harbors a diversity of unique and sensitive organisms, many of which are cave obligates. Unique characteristics common to North American subterranean fauna render them vulnerable to anthropogenic activities and underscore the importance of monitoring sensitive populations. Subsurface habitats typically display decreased diversity in community complexity and reduced species abundance relative to above ground ecosystems translating to fewer species and individuals in subterranean habitats than in surface habitats (Holsinger, 1988). Processes that isolate subterranean populations of organisms, and evolutionary adaptation of those species to their environments, can produce extreme patterns of endemism (Barr and Holsinger, 1985; Culver et al, 2000).

Human disturbance at caves is a persistent problem internationally and has been implicated as a cause for decline in several cave-dependent bats (Barbour and Davis, 1969; Humphrey and Kunz, 1976; Tuttle, 1979; American Society of Mammalogists, 1992). About 18 of the 45 species of North American bats rely substantially on caves throughout the year (McCracken, 1989) and all of the North American bats that are listed as endangered or threatened by the United States Fish and Wildlife Service are cave-dependent species or subspecies (McCracken, 1989; Harvey et al., 1999; Pierson, 1999). In the central United States, two obligate cave-dependent species, the gray bat (*Myotis grisescens*) and Indiana bat (*Myotis sodalis*), and one subspecies, the Ozark big-eared bat (*Corynorhinus townsendii ingens*), are of particular concern because each is federally listed as endangered (United States Fish and Wildlife Service 1982, 1983, 1995).

Anthropogenic activities threaten groundwater quality and quantity and consequently the communities of organisms living within groundwater habitats. The combined ranges of over 50% of the described species and subspecies of groundwater-dwelling fauna (stygobites) in the continental United States are estimated to constitute less than 1% of the total surface area of the country (Culver et al, 2000). These phenomena render groundwater species vulnerable to anthropogenic activities and necessitate monitoring of vulnerable species and populations.

Widely used by government and private entities to protect these sensitive ecosystems from direct human impacts, cave gates and their designs have evolved over the past 50 years. Original gate designs negatively impacted bat ingress and egress, behavior and energetics (Spanjer and Fenton 2005; Derusseau and Huntly 2012; Diamond and Diamond 2014), and cave microclimates (Richter et al. 1993). Post-gate monitoring responses by bats and cave microclimates using more compatible gate designs, especially those installed in “dark zones” (locations inside the cave passage), indicate positive or neutral effects on populations (Martin et al. 2003; Crimmins et al. 2014) and microclimates (Martin et al., 2006). Other studies indicate species exhibiting poor maneuverability (Norberg and Rayner 1987) and narrow call bandwidths (Tobin and Chambers 2017) are negatively impacted by cave gates. However, most bats acclimate to appropriately placed cave and mine gate installations (Martin et al. 2003; Slade and Law 2008; Tobin et al. 2018). Ultimately, for many species, bat activity is influenced more by entrance characteristics (size, number, shape) than by cave or mine gates (Johnson et al., 2006; Tobin et al., 2018)

Communities of cave fauna presently are protected with internal gate systems at more than 34 entrances to caves in northeastern Oklahoma (Martin et al. 2006). Seven of those caves have been inhabited historically by colonies of endangered gray bats (Martin et al. 2003). The remaining caves are inhabited by populations of endangered Ozark big-eared bats, big brown bats (*Eptesicus fuscus*), tricolored bat (*Perimyotis subflavus*), and northern long-eared bats (*Myotis septentrionalis*). Four caves that contain populations of either the Ozark cavefish (*Troglichthys rosae*), Oklahoma cave crayfish (*Cambarus tartarus*) and/or Delaware County cave crayfish (*Cambarus subterraneus*) also are protected from human entry by internal gate/grill systems.

Procedures during this project were conducted in the Ozark Highlands in northeastern Oklahoma. The Ozarks Highlands cover about 103,000 km^2 (Huffman 1959) in the central United States at elevations of 260–460 m above mean sea level. The Plateau is comprised of alternating layers of limestone, flint (= chert) and sandstone that are conducive to cave formation (Blair and Hubbell 1938). The caves in this region serve as refugia from severe winters and hot summers for many cave-dwelling species (Humphrey and Kunz 1976, Fenolio et al. 2005).

Objectives:

The objectives of this project assist in the recovery of the Gray Bat, Ozark Big-eared Bat, Ozark Cavefish and two endemic cave crayfish that are species of concern, by working with cave owners and constructing internal gate and grill systems within those caves that support populations of one or more of these species. This project also supports biological inventories of Ozark caves to identify and prioritize caves based upon their importance to the three federally listed species and other Ozark cave-endemic species that are similarly affected by human disturbance within their cave environments. These biological data improve the effectiveness of the overall cave gating project by ensuring the resources are directed to the most important caves. These data assist in the monitoring and status assessment of cave-dependent species so that future management decisions can be based on better information. The primary objectives of this project are:

1) To maintain the bat population in targeted caves by preventing unnecessary human entry and disturbance to critical roosts.

2) Survey the stygobitic fauna in Oklahoma and delineating biologically important subterranean systems to include historical localities of *Amblyopsis rosae* and species of groundwater crayfish endemic to Oklahoma.

3) Participate in baseline survey techniques that will monitor the impact of the causative agent of White-nose Syndrome on targeted cave-dwelling bat species.

4) Initiate presence surveys of caves that have been historically identified as potential roosting habitat for the threatened Northern Long-eared Bat (*Myotis septentrionalis*) and, if documented, develop and prioritize plans for management and colony protection measures.

Surveys of subterranean habitats containing populations of Ozark Cavefish, *Troglighthys rosae*, and both state endemic cave crayfish, *Cambarus tartarus* and *C. subterraneus*, are a focus of these survey efforts. Other research has included bioinventories of select caves where either said work had not been performed or further bioinventory work was desirable. Data collected from these efforts have always been provided to the Subterranean Biodiversity Project Database, formerly maintained by Dr. G.O. Graening, and now maintained by Mike Slay of The Nature Conservancy's Fayetteville Office (Arkansas, USA).

Results:

Cave Management—Population estimates of bats at caves prior to installation of gates beginning in 1981 and post-installation estimates show that each cave continues to be used by stable, or increasing populations of resident bats (Grigsby et al. 1993, Martin et al. 2000, 2003, 2006; Puckette 2000). Procedures in this project assist in stabilizing sensitive populations of cave fauna in northeastern Oklahoma. The following is a description of caves and management procedures that were conducted during the project.

Cave AD-7

This cave is in T15N R24E, Adair County, OK (35.76403 -94.73253). Historically the site served as a maternity cave for a colony of gray bats. Prior to the initiation of an internal gating project, it was the only maternity colony of gray bats in the state not protected from human entry by a gate/grill system. Construction of the internal gate/grill system began in winter 2015-16. This has been a collaborative effort between project personnel, and assistance from individuals representing the Nature Conservancy, USFW Service, and the ODWC. In March 2018 initial structures were installed to restrict a second passage to the cave, and final passage enclosure at the initial grill location were completed.

An exit survey was conducted at the site in May 2018 to verify the colony's presence at the cave. However there was little bat activity at the cave and the gray bat maternity colony was not using the site. Despite some use by early-arriving gray bats in early March, there had been little or no use since that time indicated by minimal guano splatter on the gate/grill. A similar phenomenon occurred in summer 2017 that may have erroneously been attributed to an extreme high water event, suspected of forcing relocation of colonies elsewhere in OK. A majority of the colony eventually returned to the cave in fall 2017, but the grill system had not completely closed the fly space until March 2018. The only variable between consistent historical use by a maternity colony of 15,000+ gray bats, and this year's evidence, is the internal gate/grill system.

As a result, project personnel implemented design alterations that have been used elsewhere in gray and Indiana bat maternity/hibernacula. In late June 2018 personnel removed the top two horizontal bars to stimulate use of the upper 20% of the grill system. Guano splatter on the grill from use in 2017, and video recordings of the exit in the past, suggest that the bats utilize the highest portions of the passage during exit flights. Following removal of these two restrictions a final exit survey was conducted in September 2018 and a colony of about

10,000 gray bats exited the cave. Nearly all of the bats exited through the enlarged opening resulting from the removal of the highest horizontal bars in the gate/grill system.

A grill system was completed in an alternative, secondary passage and entrance in March 2019 and the final bar and hub mechanism was installed on the initial grill system in November 2019 allowing access into and out of the cave for researchers. In November 2021 a "chute" design was incorporated and installed in the top flyway of the grill system completing the revised design of the grill system. The system is now complete and exit surveys will be conducted in summer 2022 to analyze the flight and verify the colony's presence.

Cave AD-220:

The site is a limited gray bat roost site and past surveys have encountered northern long-eared bats. No bats were captured during an exit survey using a harp trap at the entrance to the cave on 5 June 2019. However, guano accumulation at two roost locations in the cave passage indicate recent gray at use (about 500 bats) was noted. Upon inspection of the internal gate/grill system it was noted it had been vandalized. The system was originally equipped with a removable bar intended to allow access to researchers. The bar and lock mechanisms were removed allowing unhindered human access into the cave passage. The bar was retrieved, repaired and reinstalled during a return visit on 18 December 2019. However, the mechanism is still in need of some minor repair which was completed on 20 March 2020. The system is now secure and unwanted entry into the cave is currently eliminated.

***Bat Population Monitoring*—**an important aspect of the long-term E-22 project is monitoring caves that have received past management. Periodic monitoring visits at caves and entrances document continued use by target species, verify the integrity of installed structures intended to eliminate human entry, determine use patterns, and conduct population estimates. Population monitoring is conducting by guano measurements while the site is vacated, or by utilizing infra-red illumination and night vision optics to passively view colony emergences. A total of 26 such visits were made in 2020-2021 (Table 1). Between 1 April 2020 and 31 October 2021, all population estimates were completed via emergence counts with no cave entry involved. One accidental discovery of 6 torpid Ozark big-eared bats were encountered in an unidentified cave on 7 December 2020. The site was first discovered in the early 1980's when no bat activity was noted. Monitoring at hibernacula was not conducted in winter 2020-21. Summer roost monitoring was conducted from May through September 2020-2021.

Table 1. Results of population estimates, and species richness monitored at select caves in eastern Oklahoma during 2020 and 2021. MYGR: *Myotis grisescens,* COTO: *Corynorhinus townsendii ingens,* PESU: *Perimyotis subflavus,*

Date	County	Cave	Latitude	Longitude	Monitoring Results
24-Jan-20	Adair	AD-8	36.14319	-94.79097	84 PESU; 2 MYGR
28-Jan-20	Delaware	DL-21	36.29962	-94.87262	14 PESU
24-Mar-20	Adair	AD-29	35.81196	-94.61056	2 PESU; 1 COTO
24-Mar-20	Adair	AD-54	35.81027	-94.61356	9 PESU
24-Mar-20	Adair	AD-221	35.81862	-94.61550	9 PESU; 2 COTO
18-Jun-20	Delaware	DL-2	36.47550	-94.87499	6,700 MYGR (Emergence count)
29-Jun-20	Ottawa	OT-13	36.68014	-94.74546	11,155 MYGR (Emergence count)
2-Jul-20	Cherokee	CZ-9	35.84359	-95.21755	1,464 MYGR (Emergence count)
7-Jul-20	Adair	AD-7	35.76403	-94.73253	12,950 MYGR (Emergence count)
9-Jul-20	Adair	AD-52	35.73227	-94.66893	18 COTO (Emergence count)
21-Jul-20	Delaware	DL-1	36.34304	-94.75130	Colony vacated to DL-91
23-Jul-20	Delaware	DL-92	36.38017	-94.94758	7,740 MYGR (Emergence count)
10-Aug-20	Delaware	DL-39	35.31772	-94.70986	17,000 MYGR (Emergence count)
25-Aug-20	Delaware	DL-91	36.46786	-94.90144	16,883 MYGR (Emergence count)
7-Dec-20	Adair	Unidentified	35.70655	-94.48831	6 COTO
2-Jun-21	Adair	AD-12	35.81379	-94.71969	1 COTO
2-Jun-21	Adair	AD-13	35.81636	-94.71813	9 COTO
2-Jun-21	Adair	AD-24	35.81339	-94.72004	2 COTO
2-Jun-21	Adair	AD-25	35.81132	-94.72222	3 COTO
6-Jun-21	Adair	AD-10	35.84344	-95.21771	168 COTO
9-Jun-21	Adair	AD-16b	35.80982	-94.72625	1 COTO
9-Jun-21	Adair	AD-19	35.72695	-94.66667	3 COTO
22-Jun-21	Delaware	DL-2	36.47550	-94.87499	11,800 MYGR (Emergence count)
24-Jun-21	Delaware	DL-91	36.46786	-94.90144	510 MYGR (Emergence count)
16-Jul-21	Delaware	DL-91	36.46786	-94.90144	20,440 MYGR (Emergence count)
18-Nov-21	Adair	AD-8	36.14319	-94.79097	11 PESU; 4 MYGR

Cave Bioinventories—We detail trip reports below conducted during December 2021. Included is species list of taxa documented during surveys of four cave systems in Delaware County, Oklahoma. We provide the scientific name and common name of each taxon as well as its ecological classification, NatureServe conservation status, and the number of individuals observed, or other evidence noted. Also included is a short narrative of each survey trip.

Classifications of cave-associated organisms have been proposed by several authors. We used terminology from Barr (1968) with clarification from Sket (2008) and Culver and Pipan (2009), depending on the taxa, to indicate species found in terrestrial (troglo-) versus aquatic (stygo-) habitats. The four primary ecological classifications, with the abbreviations used in the faunal lists below, were troglobiont (synonym: troglobite) or stygobiont (synonym: stygobite) (TB or SB, respectively), troglophile or stygophile (TP or SP) (synonym: eutroglophile), trogloxene or stygoxene (TX or SX) (synonym: subtroglophile), and accidental (AC) (synonym: trogloxene, sensu Sket, 2008). Troglobionts and stygobionts are obligate cavernicoles with morphological, physiological, and behavioral adaptations for living in subterranean habitats and that have few to no records from surface habitats. Troglophiles and stygophiles frequent subterranean habitats and can complete their life cycles within caves but also may occur in surface habitats. Trogloxenes and stygoxenes use subterranean habitats seasonally, or for only a portion of their life cycles, but also rely significantly on surface habitats. Accidentals are species found in caves only by accident, such as by falling into a pit or being washed into a cave during a flood. We also include edaphic (ED) species that are deep soil inhabitants that occasionally occur in caves.

NatureServe conservation status ranks are based on a one to five scale, from most to least at risk of extinction (Faber-Langendoen et al., 2012): G1 (Critically Imperiled), G2 (Imperiled), G3 (Vulnerable), G4 (Apparently Secure), and G5 (Secure). At the global scale, a Questionable rank qualifier (Q) can be used to denote uncertainty in the conservation status rank (e.g., G2Q) or the conservation status rank may span multiple ranks (e.g., G1G2).

Cooler Cave:

A bioinventory was conducted on 11 December 2021 at Cooler Cave, an ungagged cave system located in Delaware county, Ok. It has a small aquatic system that flows through it which contains a diverse community of aquatic cave organisms. The crawl into the cave is filling with chert rubble and is getting more difficult to access. If a large storm passed though, there is a chance that the entrance would no longer be passable. A small stream issues from beneath a wall roughly 50 meters into the cave and flows to the rubble pile at the front of the cave, where the stream is pirated and goes back below ground. The upper area of the stream, where a shallow cherty run exists, is the area where we have found a species of aquatic blind cave snail (Fig. 1). There is only two meters of this riffle habitat accessible to surveyors (Fig. 2). Our survey methodology involves close examination of 60 rocks from this run and counting the number of snails on each rock. Rocks are carefully replaced to the habitat once examined. Care is taken not to step on any of the rocky riffle area by the surveyor.

The counts for cave snails have exhibited some variability: April 2012 (19), January 2013 (33), January 2014 (30), December 2014 (40), February 2016 (4), December 2017 (29), December 2018 (9), and December 2021 (5). In February 2016 (4), December 2018 (9), and

December 2021 (5), the counts were preceded by high water "flooding" episodes during heavy rainfall events (Table 2). This species may be susceptible to extreme changes in water flow. We suspect that the cave stream that runs through Cooler Cave is the same stream that runs through nearby Featherhead Cave. We will survey that cave stream for snails in 2022.

Table 2. Species observed during a bioinventory of Cooler cave in December 2021.

Scientific Name	Common Name	Ecol. Class.	NatureServe Class.	No. Observed
Mammals:				
Perimyotis subflavus	Tri-Colored Bat	TX	G2G3	2
Procyon lotor	Raccoon	TX	G5	Scat; tracks
Amphibians:				
Eurycea spelaea	Grotto Salamander	TB	G4	3
Crustaceans:				
Caecidotea sp.	A Cave Isopod	SB		6
Stygobromus sp.	A Cave Amphipod	SB		1
Molluscs:				
Physa sp.	A Cavesnail	SB		5
Insects:				
Ptomaphagus cavernicola	A Fungus Beetle	TP		1
Heleomyzidae	A Sun Fly	TX		2
Tipulidae	A Fly	TP/TX		1

Figure 1: An aquatic blind cave snail from Cooler Cave, Delaware Co., OK

Figure 2: Surveying two meters of riffle habitat where we have found snails in Cooler Cave, Delaware County, OK, in December 2021.

Cave DL-38 (Jail Cave):

This small cave has a long history with humans. It was used as a jail during the civil war and remnants of that use can still be seen today. The cave lies on the Summerfield Creek drainage system in Delaware Co., OK. It has been monitored heavily across the past decades owing to the presence of Ozark Cavefish and Delaware County Cave Crayfish (*Cambarus subterraneus*) as well as serving as an important site for various species of bats.

On 12 December 2021 a bioinventory of the site was conducted (Table 3). The lock was not too difficult to open. We took video footage of Ozark Cavefish and Delaware County Cave Crayfish, in-situ. We observed a cave crayfish feeding on a dead Pickerel Frog (*Lithobates palustris*). Two fish and seven cave crayfish is probably an above-average observation for this cave. Several of the cave crayfish were young – suggesting recent recruitment. Seeing five Tricolor Bats is as significant as ever owing to their steep decline in the Ozarks. Two female *C. subterraneus* were collected as part of the laboratory-based captive husbandry and breeding program that has been initiated by the Center for Conservation and Research, San Antonio Zoo.

Table 3. Results of a bioinventory of Cave DL-38 in Delaware County Ok in December 2021.

Scientific Name	Common Name	Ecol. Class.	NatureServe Class.	No. Observed
Mammals:				
Perimyotis subflavus	Tri-Colored Bat	TX	G2G3	5
Amphibians:				
Eurycea spelaea	Grotto Salamander, larvae	TB	G4	2
Eurycea lucifuga	Cave Salamander, larva	TP	G5	1
Lithobates palustris	Pickerel Frog	TX	G5	5
Crustaceans:				
Cambarus subterraneus	Delaware County Cave Crayfish	SB	G1	7
Insects:				
Heleomyzidae	A Sun Fly	TX		3
Tipulidae	A Fly	TP/TX		1
Culicidae	A Mosquito	TX		25+

Figure 3: An Ozark Cavefish (*Troglichthys rosae*) *in-situ*.

Figure 4: A Delaware County Cave Crayfish (*Cambarus subterraneus*) feeding on the corpse of a Pickerel Frog (*Lithobates palustris*) in cave DL-38 in December 2021.

Figure 5: TNC biologist Mike Slay looks at a cave crayfish and sexes it in a bottle in cave DL-38 in December 2021.

Butler Cave:

An inventory was completed in Butler Cave in Delaware County, OK on 12 December 2021. The cave is an ungated, public cave that clearly receives plenty of human visitation. Ample trash and drug paraphernalia have been observed in the system and there is graffiti on the walls. The cave sits on the shores of Lake Eucha and has a county dirt road that runs to within 200m of the cave mouth. Despite the visitation, there is a lot of biology in this cave. In a non-official visit to the cave during the summer of 2020 (August), we observed over 75+ Cave Salamanders (*Eurycea lucifuga*), 20+ Dark Sided Salamanders (*E. longicauda melanopleura*), and 20+ Slimy Salamanders (*Plethodon albagula*). On that same visit, many Cave Crickets were observed (*Ceuthophilus* sp.). The visit this time occurred in the winter, perhaps accounting for the single salamander observed. Observation of Pickerel Frogs (*Lithobates palustris*) in one of the pools after the crawl is expected during winter months and cold weather. The observation of aquatic isopods (*Caecidotea* sp.) and the groundwater flatworm (*Dendrocoelopsis americana*) in the pools is somewhat unexpected. It suggests that either (1) the cave pools intersect with a groundwater body or (2) there are groundwater isopods in the epikarst and they fall into drip pools – as do groundwater amphipods. Observations of webworms (*Macrocera nobilis*) suggest that the back of the cave, past the crawl, still has potential to support healthy subterranean communities. The cave cricket species observed in this system has more orange to its body color and does not appear to be the common species found in the county (*Ceuthophilus gracilipes*) (Table 4).

Figure 6: A Cave Salamander (*Eurycea lucifuga*) noted on a wall in Butler Cave in Delaware County OK in December 2021.

Table 4. Species account of a bioinventory of Butler Cave in Delaware County Ok. In December 2021.

Scientific Name	Common Name	Ecol. Class.	NatureServe Class.	No. Observed
Mammals:				
Perimyotis subflavus	Tri-Colored Bat	TX	G2G3	3
Birds:				
Sayornis phoebe	Eastern Phoebe	TX	G5	1 (nest)
Amphibians:				
Eurycea lucifuga	Cave Salamander, larva	TP	G5	1
Lithobates palustris	Pickerel Frog	TX	G5	4
Crustaceans:				
Caecidotea sp.	A Cave Asellid Isopod	SB		7
Insects:				
Macrocera nobilis	Cave Fungus Gnat	TP	GNR	19
Heleomyzidae	A Sun Fly	TX		3
Tipulidae	A Fly	TP/TX		1
Culicidae	A Mosquito	TX		25+
Ceuthophilus sp.	A Cave Cricket	TX		2
Weevil				1
Cantheridae	Beetle larva	TX		1
Springtails & Diplurans:				
Collembola	springtail			2
Arachnids:				
Cicurina sp.	A Spider	TP/TX		2
Millipedes & Centipedes:				
Centipede	Earth centipede	TX		1
Cave millipede	*Auturus* sp.	TB		1
Surface millipede		TX		2
Platyhelminthes				
Dendrocoelopsis americana	Groundwater flatworm	SB	G2	1

Figure 7: A species of cave cricket (*Ceuthophilus* sp.) in Butler Cave on 12 December 2021.

Figure 8: A groundwater flatworm (*Dendrocoelopsis americana*) from Butler Cave in Delaware County OK in December 2021.

Figure 9: TNC biologist Mike Slay in the crawl at Butler Cave, Delaware County OK, December 2021.

Figure 10: A female Pickerel Frog (*Lithobates palustris*) in Butler Cave, Delaware County, OK in December 2021.

Figure 11: A weevil observed in the dark zone of Butler Cave – was observed on the surface of a drip pool.

Figure 12: Graffiti in Butler Cave, Delaware County OK, December 2021.

Figure 13: Graffiti in Butler Cave, Delaware County OK, December 2021.

Long's Cave:

Long's and McGee Cave entrances in Delaware County OK share their groundwater body. Both caves have been gated and are regularly monitored owing to the presence of Ozark Cavefish and Oklahoma Cave Crayfish (*Cambarus tartarus*). Long's Cave should not be a place where inexperienced cavers are taken owing to the extended time in groundwater and the difficulty of negotiating low ceilings at times of high water. Both are large, aquatic cave systems.

During a bioinventory on 13 December 2021 the cave gate lock worked in good condition and was not difficult to open or re-lock. We surveyed all human-accessible aquatic passage at Long's Cave. Dr. Fenolio first entered the cave and searched extensive root masses in hopes of observing young Ozark Cavefish, but none were observed. During past surveys in

recent years, progress through the first 20m of passage required "ceiling sniffing" and even brief submersion to proceed. However, few low air spaces were encountered during the current survey. One adult Ozark Cavefish, but no Oklahoma Cave Crayfish, were observed along the main passage to the larger room with breakdown fill (Table 5). We explored side passages formed along joints on the way in. The old house is in disrepair, and it looks like vandals have done considerable damage to the structure. The driveway needs some work with broken tree limbs and saplings growing up along the road.

Table 5. Species account in Long's Cave, Delaware County OK on 13 December 2021.

Scientific Name	Common Name	Ecol. Class.	NatureServe Class.	No. Observed
Fishes:				
Troglichthys rosae	Ozark Cavefish	SB	G3	1
Amphibians:				
Lithobates palustris	Pickerel Frog	TX	G5	13
Insects:				
Ceuthophilus sp.	A Cave Cricket	TX		1

Discussion and Recommendations:

1. Cave CZ-9 in Cherokee County houses a maternity colony of gray bats currently unprotected from human entry and disturbance because of vandalism to the existing system. Repair of the gate/grill system is of considerable importance.

2. ADT-1 is a talus opening in Adair County serving as a hibernaculum for Ozark big-eared bats (<10). A monitoring visit to the site in winter 2019 noted 16 Ozark big-eared bats. The site is currently on private property but will soon be incorporated into the Ozark Plateau NWR and future use agreements will potentially enhance walk-in site visitation by the public to nearby Lee Creek. Gating the two passages to the talus openings is high priority to protect the hibernaculum from human entry.

3. Annual monitoring of caves that have received past management and protection efforts will continue. These visits establish continued use by target species, verify the integrity of installed structures intended to eliminate human entry, and are conducted at non-gated caves to determine a ranking hierarchy for need of future consideration of management procedures. The importance of monitoring was accentuated by a count of 11 tricolored bats in cave AD-8 on 18 November 2021. Winter counts from previous monitoring visits to the cave from 2015-2017 ranged from 98 to 204. Other caves that have significant pre-WNS numbers of PESU (50+) in the past are: AD-15, AD-17, AD-18, CZ-18, DL-1, SQ-1, and Davis Mtn Caves in Adair County (AD-221, AD-30, AD-54).

4. Biological inventories of caves continues to identify biologically important sites for future conservation efforts and add to the overall knowledge of the status and distribution of Ozark cave fauna.

5. In Oklahoma, northern long-eared bats spend winter hibernating in caves and abandoned mines, and in the summer, use caves as maternity and day and night foraging roosts (Caire et al. 1979; Caceres and Barclay 2000). More than 20 caves in Adair, Cherokee, Delaware, and LeFlore counties have been documented to house populations or individuals of northern long-eared bats (Stevenson 1986; Martin and Puckette pers. comm.). Identifying caves that are inhabited by populations and developing management efforts to protect the cave-dwelling populations of the species from human activity should be a renewed emphasis of this project.

Significant Deviations:

Objective 3: White-nose Syndrome Surveys (WNS) – Per USGS and USFWS guidance, cave entry for recreational and research activities was restricted in the first year of the E-22-24 cycle (2020). Cave entry for surveillance, management and monitoring resumed in 2021 but no surveys for the causative agent of WNS were conducted at caves during the E-22-24 cycle. Consistent annual WNS surveillance has essentially been discontinued in caves in eastern OK given the understanding that surviving, localized populations are persisting, reduced available funding for sample analysis, and shifting geographical priorities.

Objective 4: Presence/absence surveys for Northern Long-eared Bat – Per USGS and USFWS guidance, cave entry for recreational and research activities was restricted in the first year of the E-22-24 cycle (2020). Cave entry for surveillance, management and monitoring resumed in 2021 but no cave surveys for NLEB presence were conducted.

Equipment Purchased (Cumulative):

None.

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Literature Cited:

American Society of Mammalogists. 1992. Guidelines for the protection of bat roosts. Journal of Mammalogy 73:707-710.

Barbour, R.W. and W.H. Davis. 1969. Bats of America. University of Kentucky Press, Lexington, KY 286 pp.

Barr, T.C., Jr., 1968, Cave ecology and the evolution of troglobites: in Dobzhansky, T., Hecht, M.K., and Steere, W.C., eds., Evolutionary Biology, vol. 2: New York, Appleton-Century-crofts, p. 35–102.

Barr, T. C., and J. R. Holsinger. 1985. Speciation in cave faunas. Annual Review of Ecology and Systematics 16: 313–337.

Blair, W. F., and T. H. Hubbell. 1938. The biotic districts of Oklahoma. American Midland Naturalist 20: 425–454.

Caire, W. R., R.K. LaVal, M. L. LaVal, and R. Clawson. 1979. Notes on the ecology of *Myotis keeni* (Chiroptera, Vespertillionidae) in eastern Missouri. American Midland Naturalist 102:404-407.

Caseres, C. and R. M. R. Barclay. 2000. *Myoits septentrionalis*. Mammalian Species Account No. 634. American Society of Mammalogists. 4pp.

Crimmins, S. M., P. C. McKann, J. A. Szymanski, and W. E. Thogmartin. 2014. Effects of cave gating on population trends at individual hibernacula of the Indiana bat (Myotis sodalis). Acta Chiropterologica 16:129–137.

Culver, D. C., L. L. Master, M. C. Christman, and H. H. Hobbs III. 2000. Obligate cave fauna of the 48 contiguous United States. Conservation Biology 14: 386–401.

Derusseau, S. N., and N. J. Huntly. 2012. Effects of gates on the nighttime use of mines by bats in northern Idaho. Northwestern Naturalist 93:60–66.

Diamond, G. F., and J. M. Diamond. 2014. Bats and mines: evaluating Townsend's big-eared bat (*Corynorhinus townsendii*) maternity colony behavioral response to gating. Western North American Naturalist 74:416–426.

Faber-Langendoen, D., C. Hedge, M. Kost, S. Thomas, L. SmarL, R. Smyth, J. Drake, and S. Menard. 2012. Assessment of wetland ecosystem condition across landscape regions: A multi-metric approach. Part A. Ecological Integrity Assessment overview and field study in Michigan and Indiana. EPA/600/R-12/021a. U.S. Environmental Protection Agency Office of Research and Development, Washington, D.C.

Fenolio, D.F., G.O. Graening and J.F. Stout. 2005. Seasonal movement patterns of pickerel

frogs (*Rana palustris*) in an Ozark cave and trophic implications supported by stable isotope evidence. The Southwestern Naturalist 50: 385–389.

Grigsby E.M., W.L.Puckette, and K.W. Martin. 1993. Comparative numbers of gray bats (*Myotis grisescens*) at six maternity caves in northeastern Oklahoma. Proceedings of the Oklahoma Academy of Science 73:35-38.

Harvey, M.J., J.S. Altenbach, and T.L. Best. 1999. Bats of the United States. Arkansas Game and Fish Commission, Little Rock, AR 64 pp.

Holsinger, J.R. 1988. Troglobites: the evolution of cave dwelling organisms. American Scientist 76: 147–153.

Huffman, G. G. 1959. Mississippian stratigraphy and tectonics of the Oklahoma Ozark area. Tulsa Geological Society Digest 27: 104–176.

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

Johnson, J. B., P. B. Wood, and J. W. Edwards. 2006. Are external mine entrance characteristics related to bat use. Wildlife Society Bulletin 34:1368–1375.

Martin, K. W., W.L. Puckette, S.L. Hensley and D.M. Leslie, Jr.. 2000. Internal cave gating as a means of protecting cave-dwelling bat populations in eastern Oklahoma. Proceedings of the Oklahoma Academy of Science 80:133-137.

Martin, K. W., D.M. Leslie, Jr., M. E. Payton, W.L. Puckette, and S.L. Hensley. 2003. Internal cave gating for protection of colonies of the endangered gray bat (*Myotis grisescens*). Acta Chiropterologica 5:143-150.

Martin, K. W., D.M. Leslie, Jr., M. E. Payton, W.L. Puckette, and S.L. Hensley. 2006. Impacts of passage manipulation on cave climate: Conservation implications for cave-dwelling bats. Wildlife Society Bulletin 34:137-143.

Culver, D.C., and Pipan, T., 2009, The Biology of Caves and Other Subterranean Habitats: Oxford University Press, 254 p.

McCracken, G.F. 1989. Cave conservation: Special problems of bats. National Speleological Society Bulletin 51:49-51.

Norberg, U. M., and J. M. Rayner. 1987. Ecological morphology and flight in bats (Mammalia; Chiroptera): wing adaptations, flight performance, foraging strategy and echolocation. Philosophical Transactions of the Royal Society B: Biological Sciences 316:335–427.

Pierson, E.D. 1999. Tall trees, deep holes, and scarred landscapes: conservation biology of North American bats. Kunz T.H., P. Racey, editors. Bat biology and conservation.

Smithsonian Institution Press, Washington, D.C. p. 309-325.

Puckette, W. L. 2000. Annual report to the U.S. Fish and Wildlife Service FWS Agreement 1448-0002-95-0860. Ecological Services Office, Tulsa, Oklahoma, USA.

Richter, A. R., S. R. Humphrey, J. B. Cope, and V. Brack. 1993. Modified cave entrances: thermal effect on body mass and resulting decline of endangered Indiana bats (Myotis sodalis). Conservation Biology 7:407–415.

Sket, B., 2008. Can we agree on ecological classifications of subterranean animals? Journal of Natural History, 42:1549–1563.

Slade, C. P., and B. S. Law. 2008. An experimental test of gating derelict mines to conserve bat roost habitat in southeastern Australia. Acta Chiropterologica 10:367–376.

Spanjer, G. R., and M. B. Fenton. 2005. Behavioral responses of bats to gates at caves and mines. Wildlife Society Bulletin 33:1101–1112.

Stevenson, L.K. 1986. Some biological aspects of *Myotis keeni* in Oklahoma. M.S. Thesis Pittsburg State University, Pittsburg, KS. 82 pp.

Tobin, A., and C. L. Chambers. 2017. Mixed effects of gating subterranean habitat on bats—a review. Journal of Wildlife Management 81:1149–1160.

Tobin, A., R.J.M. Corbett, F.M. Walker, and C.L. Chambers. 2018. Acceptance of Bats to Gates at Abandoned Mines. Journal of Wildlife Management 82(7):1345–1358.

Tuttle, M.D. 1979. Status; Causes of decline and management of endangered gray bats. Journal of Wildlife Management 43(1):1-17.

U.S. Fish and Wildlife Service. 1982. Gray Bat recovery plan. U.S. Fish and Wildlife Service, Washington, D.C. 94 Pp.

U.S. Fish and Wildlife Service. 1983. A recovery plan for the Ozark Big-eared Bat and the Virginia Big-eared Bat. Twin Cities, MN 61 Pp.

U.S. Fish and Wildlife Service. 1995. Ozark Big-eared Bat Recovery Plan, Revised. Albuquerque, NM 80 Pp.