FINAL PERFORMANCE REPORT

Federal Aid Grant No. F17AP00709 (E-22-22)

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

Oklahoma Department of Wildlife Conservation

October 1, 2017 – September 30, 2018

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Principal Investigator: Jeremy D. Ross, Oklahoma Biological Survey, University of Oklahoma

A. ABSTRACT:

Human disturbance of maternity caves and hibernacula is a substantial 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 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 constitute 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 delineate biologically important subterranean systems. We implemented management procedures during the winter of 2017-18 which included bat population monitoring at 28 different caves and gate/grill construction at one cave. Stygobitic bioinventory surveys were conducted at 5 cave systems (6 entrances) and focused on population counts of Ozark Cavefish and both state-endemic cave crayfish. For the third consecutive year, our project personnel participated in continent-wide surveillance for the causative agent for White-nose Syndrome (WNS). Individual bats and/or cave substrates tested positive for *Pseudogymnoascus destructans* in 6 caves. We provide updated cave and landscape management recommendations that build off the results of this year's project activities.

B. BACKGROUND:

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, which translates to fewer species and individuals in subterranean habitats than in surface habitats (Holsinger, 1988). Processes that isolate subterranean populations of organisms, and the evolutionary adaptation of those species to their environments, can produce extreme patterns of endemism in caves (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). In fact, all of the North American bats that are listed as endangered or threatened by the United States Fish and Wildlife Service (USFWS) are cave-dependent species or subspecies (McCracken, 1989; Harvey et al., 1999; Pierson, 1999). In the central United States, four cave-dependent species, the Gray Bat (*Myotis grisescens*), Indiana Bat (*Myotis sodalis*), Ozark Big-eared Bat (*Corynorhinus townsendii ingens*), and Northern Long-eared Bat (*Myotis septentrionalis*) are of particular concern because each is federally listed as threatened or endangered (United States Fish and Wildlife Service 1982, 1983, 1995). In addition, the Tricolored Bat (*Perimyotis subflavus*) is experiencing rangewide population declines and is currently under review for a federal listing.

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.

Cave gating has been used widely by government and private entities to protect these sensitive ecosystems from direct human impacts. Communities of cave fauna presently are protected with internal gate systems throughout the United States including 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 two other federally-listed bats, the endangered Ozark Big-eared Bat and threatened Northern Long-eared Bat. While Gray Bats and Ozark Big-eared Bats occupy caves year-round, both Northern Long-eared Bats and Tricolored Bats use trees as roosting sites during the summer months (Caire et al. 1979). Four caves that contain populations of either the Ozark Cavefish (*Troglichthys rosae*), Oklahoma Cave Crayfish (*Cambarus tartarus*) and/or Delaware County Cave Crayfish (*C. 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 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).

C. OBJECTIVE:

The objectives of this project assist in the recovery of the federally-listed Gray Bat, Ozark Big-eared Bat, Northern Long-eared Bat, and Ozark Cavefish 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. The internal gate/grill systems prevent unauthorized human entry into those caves and protect bats and cavefish from human disturbance which is especially important for bat populations during hibernation and pup rearing. 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 also assist in the monitoring and status assessment of cave-dependent species so that future management decisions can be based on better information. Our primary objectives of this project were to:

1) Protect, maintain, and ultimately recover federally-listed populations of the Ozark Big-eared Bat, Gray Bat, and Northern Long-eared Bat in the Ozark Highlands through the identification of targeted caves by preventing unnecessary human entry and disturbance to critical roosts.

2) Identify critically important cave systems that harbor sensitive stygobitic fauna in the Oklahoma Ozarks and identify biologically important subterranean systems that include but are not limited to historic localities for Amblyopsis rosae and the species of groundwater crayfish that are endemic to Oklahoma.

3) Protect, monitor, and maintain subterranean systems that harbor the federally-threatened Ozark Cavefish, cave crayfish (Cambarus sp.) and other rare and sensitive cave obligate vertebrates and invertebrates in the Ozark Highlands.

4) Monitor the spread and proliferation of the causative fungus for White-nose Syndrome in Ozark caves so that negative impacts to cave-dependent bat populations can be closely monitored, and ultimately, prevented.

D. PROCEDURES:

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). We implemented procedures during this project were aimed at stabilizing sensitive populations of cave fauna in northeastern Oklahoma. The following is a description of

the caves of focus and management procedures that were conducted at each during this year's project.

Long-term Management Plan: Cave AD-7

This cave is located in T15N R24E, Adair County, OK. Historically the site served as a maternity cave for a colony of Gray Bats. Prior to the initiation of this 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, USFWS, and the Oklahoma Department of Wildlife Conservation (ODWC). In March 2018, we installed the initial structures to restrict a second passage to the cave and final passage enclosure at the initial grill location were completed.

To verify the colony's presence at the cave we conducted an exit survey at the site on 24 May 2018. However, we found 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, as indicated by minimal guano splatter we found on the gate/grill. A similar phenomenon occurred in summer 2017 that may have erroneously been attributed to an extreme high-water event, which we suspected of forcing the relocation of colonies to elsewhere in OK. Members of our team observed that a majority of the colony eventually returned to the cave in fall 2017, although the fly space through the grill system was not completely closed until March 2018. The only variable between consistent historical use by a maternity colony of 15,000+ Gray Bats, and this year's evidence, was the floor-to-ceiling gate/grill system being completed.

As a result, we implemented design alterations that have been used elsewhere at Gray and Indiana Bat maternity/hibernacula. Furthermore, our examination of guano splatter on the grill from 2017 and video recordings of the exit in the past suggested that the bats utilize the highest portions of the passage during exit flights. In late June 2018, we removed the top two horizontal bars in hope of facilitating bat passage through of the upper 20% of the grill system. Following removal of these two restrictions we conducted a final exit survey on 13 September 2018. We estimated that a colony of about 10,000 Gray Bats exited the cave that evening, with nearly all bats flying through the enlarged opening that we had made by removal of the highest horizontal bars in the gate/grill system.

Cave DL-102:

Located on the Spavinaw Hills Wildlife Management Area and owned by the ODWC, a maternity colony of Gray Bats were discovered in this cave in May 2017 following a spring flooding event. This event appeared to force the Gray Bats out of their traditional maternity roost about 3km away, after which the bats found and used this cave as an alternative site. Ceiling stains throughout the passage of the cave indicated that it had been used by colonies of Gray Bats in the past. We consulted ODWC personnel regarding their intention to install a gate/grill system to protect the bats and the cave environment from human disturbance. They completed this installation in December 2017.

Cave Monitoring:

An important aspect of this long-term "E-22" project is the ongoing monitoring of caves that have received past management and protection efforts. These monitoring 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.

We conducted monitoring at bat hibernacula from November 2017 through March 2018 and summer roost monitoring from May through September 2018. The latter we limited to select caves at which we attempted to sufficiently characterize use patterns and, if possible, population estimates.

White-Nose Syndrome (WNS) Surveillance

Personnel in this project were invited to participate in a WNS monitoring program that assists in the detection infection by the causative fungus, *Pseudogymnoascus destructans* (*Pd*), on bat specimens from caves in eastern Oklahoma. Protocols exist for both the cultivation of *Pd* and the cultivation-independent detection of this organism based on growth cultivation. Detection is essential to provide resource managers the time and data necessary to implement management and/or containment plans.

Through these various sampling efforts researchers have determined that the amount of fungus on bats varies by species and is a predictor of population declines from WNS. The goals of these sampling surveys are to: 1) re-sample as many sites as possible that have been previously sampled in the past 5 years to continue work on understanding how WNS transmission and load dynamics change over time and space; 2) increase WNS monitoring in the frontier regions; 3) continue to collect microclimate data to understand the role of variation in temperature and humidity on WNS dynamics; 4) better characterize the environmental reservoir by collecting substrate samples that are not directly underneath a bat; and 5) understand how sociality is related to WNS dynamics (Frick, 2016). In conjunction with the U.S. Geological Survey, National Wildlife Health Center's Diagnostic Services in Madison, WI, we conducted WNS surveys at two caves in northeastern Oklahoma, AD-54 and DL-32. We began these surveys in January 2018 and were able to sample a total of twenty-five torpid bats for the presence of *Pd*.

Surveys of Endemic Stygobitic Fauna

Surveys deep into select caves were conducted during 15-18 December 2017 by an experienced team led by Dr. Dante Fenolio of the San Antonio Zoo. A total of six caves were surveyed in Delaware and Adair Counties, OK., with efforts targeted specifically for endemic cave crayfish and Ozark cavefish populations.

E. RESULTS AND DISCUSSION:

Cave Monitoring:

Table 1. Results of population estimates and species richness monitored at select caves in eastern Oklahoma during 2017-18.

Date	County	Cave Number	Gated	Monitoring Results*
23-Oct-17	Delaware	DL-32	No	8 PESU
23-Oct-17	Delaware	DL-102	Yes	1 EPFU; 4 PESU; 5000+ MYGR (Guano deposit)
8-Nov-17	Cherokee	CZ-18	Yes	22 PESU; 1 MYGR; 4 COTO
15-Nov-17	Adair	AD-8	Yes	68 PESU; 5000+ MYGR (Guano deposit)
20-Nov-17	Adair	DL-91	Yes	10 PESU; 19,000+ MYGR (Guano deposit)
18-Jan-18	Adair	AD-17	Yes	119 PESU
18-Jan-18	Adair	AD-18	Yes	207 PESU; 5 MYSE; 1 EPFU; 1 COTO
5-Feb-18	Adair	AD-29	Yes	30 PESU
5-Feb-18	Adair	AD-30	Yes	22 PESU
5-Feb-18	Adair	AD-54	Yes	60 PESU
5-Feb-18	Adair	AD-211	Yes	8 PESU
5-Feb-18	Adair	AD-221	Yes	69 PESU; 4 COTO
6-Feb-18	Cherokee	CZ-18	Yes	94 PESU
17-Feb-18	Adair	AD-231	No	82 PESU
24-May-18	Adair	AD-7	Yes	0
11-Jun-18	Adair	AD-13	Yes	2 COTO (Emergence)
13-Jun-18	Adair	AD-66	No	1 COTO
13-Jun-18	Adair	AD-67	No	0
13-Jun-18	Adair	AD-213	No	0
13-Jun-18	Adair	AD-214	No	0
2-Jul-18	Delaware	DL-91	Yes	<5,000 MYGR (Emergence)
30-Aug-18	Delaware	DL-91	Yes	18000+ MYGR (Emergence)
1-Sep-18	Delaware	DL-38	Yes	7 PESU (Harp trap)
13-Sep-18	Adair	AD-7	Yes	10,000 MYGR (Emergence)

* Species codes: MYGR = *Myotis grisescens*; COTO = *Corynorhinus townsendii ingens*; MYSE = *Myotis septentrionalis*; PESU = *Perimyotis subflavus*; EPFU = *Eptesicus fuscus*

White-Nose Syndrome (WNS) Surveillance

AD-54 is a cave located in Adair County and annually harbors a wintering population of 50+ Tricolored Bats. Signs of desiccated moth wings under roost locations also suggested that this served as roosting habitat for summer foraging populations of Ozark Big-eared Bats. Among the combined wing/muzzle swabs we collected from 25 torpid Tricolored Bats at this location, 11 tested positive via real-time PCR for *Pd*, the causative agent of WNS. Because no clinical signs of WNS were observed in the bat population, we classified this cave as "*P. destructans* present". This represents the first detection of *Pd* on bats at this site, although it was previously detected at another site in Adair County during the winter of 2015-2016.

DL-32 is a cave located on the Spavinaw Hills Wildlife Management Area and owned by the ODWC. The cave annually harbors a wintering population of 110+ Tricolored Bats. Among the combined wing/muzzle swabs from 25 Tricolored Bats sampled at this location, 24 tested positive real-time PCR for *Pd*. Again, because we found no clinical signs of WNS in the bat population, we classified this cave as "*P. destructans* present".

Surveys of Endemic Stygobitic Fauna

The survey team found Oklahoma Cave Crayfish (*Cambarus tartarus*) in 2 caves, Delaware County Cave Crayfish (*C. subterraneus*) in 1 cave, and Ozark Cavefish (*Amblyopsis rosae*) in 2 caves. The detailed report of those activities and this team's findings can be found in Appendix I.

F. RECOMMENDATIONS:

1. Cave AD-7 in Adair County is the last known maternity colony of Gray Bats in Oklahoma to be protected from human entry and disturbance. Potential abandonment of the cave by this colony would undoubtedly be concerning given its size and long-term use. Construction of the gate/grill system was initiated in November 2015. In winter 2017-2018, we began the installation of structures for a gate/grill system in a second passage to protect the cave interior and sensitive fauna from human entry and disturbance. Our modifications of the upper portion of the grill system have copied designs from other projects involving Gray Bat colonies, are ongoing, and we anticipate will be completed during winter 2018-2019.

2. Annual monitoring of caves that have received past management and protection efforts are continuing. During these visits we have established the continued use by target species, verified the integrity of installed structures intended to eliminate human entry, and evaluated non-gated caves to determine a ranking hierarchy for future management priorities.

3. Through biological inventories of caves we continue to identify biologically important sites for future conservation efforts and add to the overall knowledge of the status and distribution of Ozark cave fauna.

4. Considerable emphasis by multiple government agencies is being placed on managing and monitoring WNS in states where the *Pd* vector has been detected. Our monitoring of torpid populations will continue to be an appropriate extension of this project. Construction of gate/grill systems in cave passages effectively removes the threat of human transmission between caves in pre-WNS areas.

G. SIGNIFICANT DEVIATIONS:

There were no significant deviations from the stated objectives.

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Date: 19 November 2018

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APPENDIX I

Caves in the Ozarks of Northeastern Oklahoma: December 2017 Field Report

Dante B. Fenolio[1], Matthew L. Niemiller[2], Michael E. Slay[3], and Evin T. Carter[4]

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Introduction

Dr. Fenolio has been assisting the USFWS Tulsa field office with subterranean surveys and bioinventory work since 2001; Dr. Niemiller and Mike Slay have been participating for over ten years. In particular, regular surveys of subterranean habitats containing populations of Ozark Cavefish (*Troglighthys rosae*) and both state endemic cave crayfish, *Cambarus tartarus* and *C. subterraneus*, have been 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).

We detail trip reports below conducted during December 2017. Included is species list of taxa documented during surveys of six cave systems in Adair and Delaware counties, 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 are capable of completing 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), G

(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).

Trip Reports

Date: 15 December 2017

Location: Duncan Field Cave, Adair Co., OK

Personnel: Dante B. Fenolio (San Antonio Zoo), Matthew L. Niemiller (UAH), Evin T. Carter (UTK), K. Andy Harris (USFWS –Volunteer), Richard Stark (USFWS), Daniel Jackson (USFWS)

Scientific Name	Common Name	Ecol. Class.	NatureServeStatus Rank	No. Observed
Mammals:				
Perimyotis subflavus	Tricolored Bat	TX	G2G3	63
Procyon lotor	Raccoon	TX	G5	Scat; tracks
Amphibians:				
Plethodon angusticlavius	Ozark Zigzag Salamander	TP	G4	2
Pseudacris crucifer	Spring Peeper	AC	G5	1
Crustaceans:				
Caecidotea stiladactyla	A Cave Asellid Isopod	SB	G3G4	28
Stygobromus sp.	A Cave Amphipod	SB		29
Centipedes & Millipedes:				
Abacion sp.	A Millipede	AC		1
Cambala sp.	A Millipede	TP		1
Polydesmididae	A Millipede	TX/AC		12
Geophilomorpha	A Soil Centipede	ED		1
Scolopendromorpha	A Centipede	AC		3
Arachnids:				

Cicurina sp.	A Spider	TP		>25
Crosbyella sp.	A Harvestman	TP		12
Eidmanella pallida	A Cobweb Spider	TP	GNR	>50
Meta ovalis	Cave Orb Weaver	TP	GNR	>50
Porrhomma sp.?	A Cave Spider	TB		4
Unknown taxonomy	A Funnel-web Spider	TX		2
Rhagidiidae	A Rhagidiid Mite	TB		27
Springtails & Diplurans:				
Litocampa sp.	A Cave Dipluran	TB		1
Pseudosinella sp.	A Cave Springtail	TB		>50
Arrhopalitidae (Globular springtail)	A Springtail	TX		6
Insects:				
Ceuthophilus sp.	A Cave Cricket	TX		>100
Culcidae	A Mosquito	TX		>100
Macrocera nobilis	Cave Fungus Gnat	TP	GNR	2
Mycetophilidae	A Mycetophilid Fly	TP/TX		3
Ptomaphagus cavernicola	A Round Fungus Beetle	TP	G4	2
Ptomaphagus shapardi	A Round Fungus Beetle	TP	GNR	26
Speleonycta ozarkensis	A Cave Bristletail	TB	GNR	1
Spelobia sp.?	A Sphaerocerid Fly	TB/TP		1
Heleomyzidae	A Sun Fly	TX		17
Tipulidae (Crane Fly?)	A Crane Fly	TX		3
Snails:				
Helicodiscidae?	A Terrestrial Snail	TX		1

Narrative: We have developed a plan for inventorying and studying subterranean biodiversity in this cave system. Richard Stark (USFWS) has requested that our team visit a different entrance and cave segment each year to produce a better bioinventory for what is a large and complex subterranean system. We will follow the plan and visited one entrance and associated cave segment this year.

We focused on the passage associated with the "Third Cave" entrance on this visit. The diversity of invertebrates on this survey was considerable with notable finds that include a Cave Bristletail or Cave Silverfish (*Speleonycta ozarkensis*), a cave dipluran (*Litocampa* sp.), and a harvestman (*Crosbyella* sp.). The Cave Silverfish was found beneath a rock along the walking path. The floor was damp but not wet in most places with white fungal growth on the sediment floor and walls. These conditions are exactly the circumstances where we typically find cave silverfish and cave diplurans. Of note, 69 Tricolored Bats (*Perimyotis subflavus*) were observed. This is noteworthy in consideration of the mortality associated with this species and White-Nose Syndrome east of this locality.

The cave segment associated with the "Third Cave Entrance" tends to have a high ceiling with a narrow walking passage associated with it. The section of the cave is best described as a "slot canyon," and we examined several hundred meters of passage before heading back to the entrance. Occasional breakdown piles interrupt the otherwise easy walking passage. There were several small drip pools in this segment.

Andy Harris explained that this segment of the cave usually has water accumulated in larger pools along the pathway, but all were dry during this visit.

Figure 1. The field crew before entering Duncan Field Cave in Adair Co., Oklahoma on 15 December 2017. From L to R: Evin Carter, Dante Fenolio, Daniel Jackson, Andy Harris, Richard Stark. Not in photo: Matthew Niemiller.

Figure 2. A Round Fungus Beetle (*Ptomaphagus shapardi*) observed in Duncan Field Cave, Adair Co., Oklahoma on 15 December 2017.

Figure 3. The Ozark Cave Silverfish (*Speleonycta ozarkensis*) observed in Duncan Field Cave, Adair Co., Oklahoma on 15 December 2017.

Figure 4. A Harvestman (*Crosbyella* sp.) observed in Duncan Field Cave, Adair Co., Oklahoma on 15 December 2017.

Figure 5. A polydesmid millipede observed in Duncan Field Cave, Adair Co., Oklahoma on 15 December 2017.

Figure 6. Fungus growing from bat guano; observed in Duncan Field Cave, Adair Co., Oklahoma on 15 December 2017.

Figure 7. A Cave Cricket (*Ceuthophilus* sp.) observed in Duncan Field Cave, Adair Co., Oklahoma on 15 December 2017.

Figure 8. Dante Fenolio photographing invertebrates in Duncan Field Cave, Adair Co., Oklahoma on 15 December 2017.

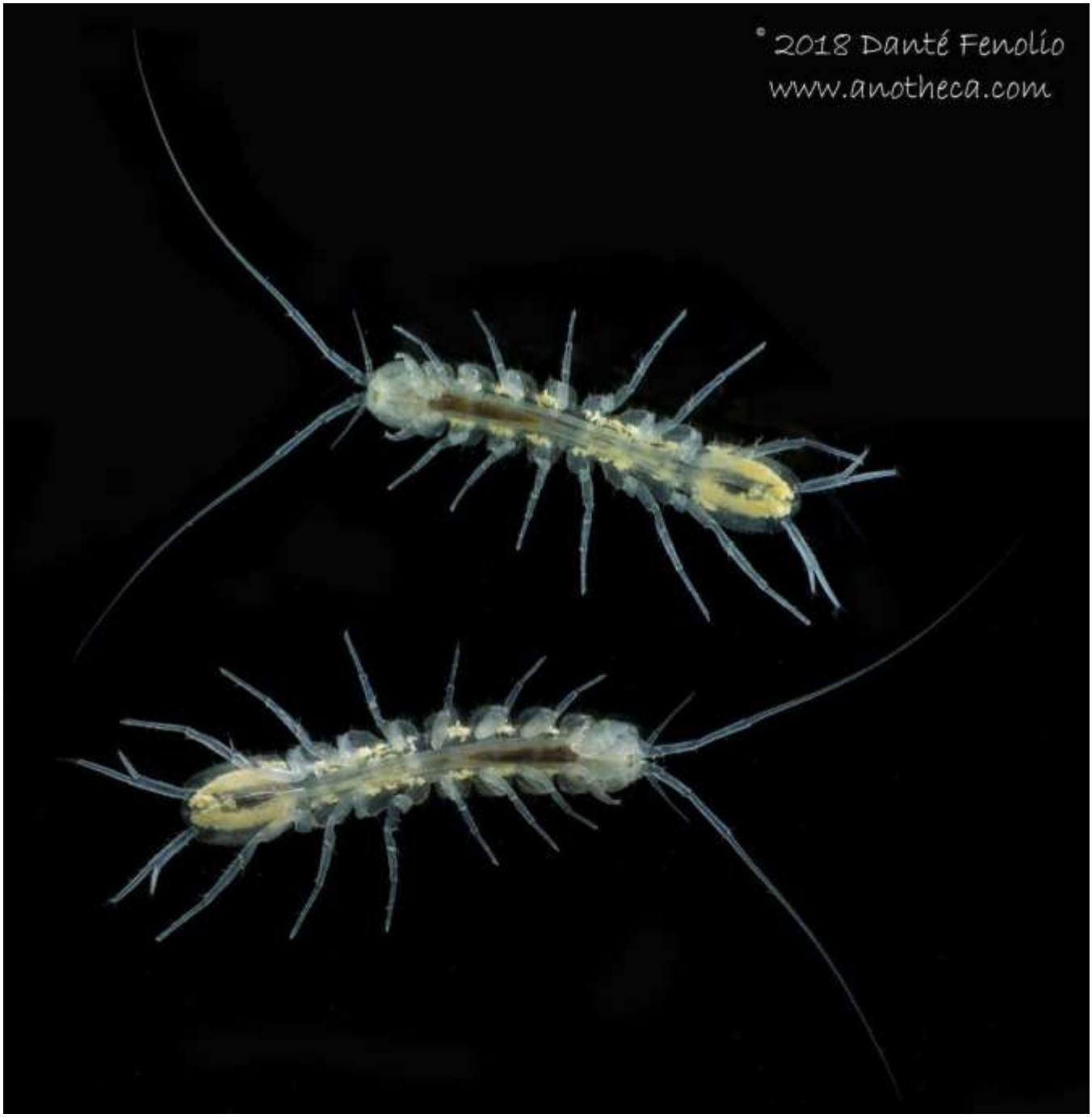

Figure 9. A cave isopod (*Caecidotea stiladactyla*) observed in Duncan Field Cave, Adair Co., Oklahoma, on 15 December 2017.

Figure 10. An Ozark Zigzag Salamander (*Plethodon angusticlavius*) observed in Duncan Field Cave, Adair Co., Oklahoma, on 15 December 2017.

Figure 11. Matt Niemiller recording data during a survey.

Date: 16 December 2017

Location: McGee's Cave, Delaware Co., OK

Personnel: Dante B. Fenolio (San Antonio Zoo), Michael E. Slay (TNC)

Species Observed: None.

Narrative: McGee's Cave could not be entered. Although the key fit, the lock for the gate to McGee's Cave could not be turned.

Date: 16 December 2017

Location: Long's Cave, Delaware Co., OK

Personnel: Dante B. Fenolio (San Antonio Zoo), Matthew L. Niemiller (UAH), Evin T. Carter (UTK), Daniel A. Jackson (USFWS)

Species Observed:

Scientific Name	Common Name	Ecol. Class.	NatureServe Status Rank	No. Observed
Fishes:				
Cottus carolinae	Banded Sculpin	SP	G5	1
Troglichthys rosae	Ozark Cavefish	SB	G3	10
Amphibians:				
Eurycea longicauda melanopleura	Dark-Sided Salamander	TP	G5T4	1
Eurycea lucifuga	Cave Salamander	TP	G5	3
Eurycea spelaea	Grotto Salamander	TB	G4	1
Plethodon albagula	Western Slimy Salamander	TP	G5	1
Rana palustris	Pickerel Frog	TX	G5	12
Crustaceans:				
Caecidotea mackini	Mackin's Cave Isopod	SB	GNR	>50
Cambarus tartarus	Oklahoma Cave Crayfish	SB	G1	3
Centipedes & Millipedes:				
Oxidus gracilis	Greenhouse Millipede	TX	G5	6
Insects:				
Ceuthophilus sp.	A Cave Cricket	TX		5
Culcidae	A Mosquito	TX		>50
Heleomyzidae	A Sun Fly	TX		>50
Heteroptera	A Water Strider	TX/AC		5

Narrative: 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. Dr. Fenolio then exited the cave and walked over to the entrance of McGee's Cave with Mike Slay. Dr. Niemiller, Evin Carter, and Daniel Jackson explored the remainder of Long's Cave while Fenolio and Slay attempted to access and survey McGee's Cave. Due to the prolonged drought, water levels were extremely low. During past surveys in recent years, progress through the first 100m of passage required "ceiling sniffing" and even brief submersion to proceed. However, no low air spaces were encountered during the current survey. Five Ozark Cavefish but no Oklahoma Cave Crayfish were observed along the main passage to the larger room with breakdown fill. However, the low water levels

permitted additional exploration. Dr. Niemiller proceeded ahead from this point exploring another ca. 200 m of passage. The first 100 m of this passage can be characterized as a series of crawls in water between small rooms where one can briefly stoop or stand. Three Oklahoma Cave Crayfish and one Ozark Cavefish were observed in this section. The passage then lowers and transitions into a narrow, joint-controlled phreatic tube (ca. 0.8 m in diameter) for another 100 m shifting into a bedding plane crawl (ca. 0.5 m) high filled with gravel and cobble. Dr. Niemiller stopped at this point and turned back to rejoin Carter and Jackson. However, a smaller person may be able to explore further. The group explored side passages formed along joints on the way back toward the entrance. In the most well- developed passage, which ranged 0.2–0.7 m in depth with mud/silt substrate, Niemiller and Carter observed four Ozark Cavefish, including a large adult estimated at 50–60 mm standard length.

Figure 12. An Ozark Cavefish (*Troglichthys rosae*) observed in Long's Cave, Delaware Co., Oklahoma, on 16 December 2017.

Date: 16 December 2017

Location: Cooler Cave, Delaware Co., OK

Personnel: Dante B. Fenolio (San Antonio Zoo), Michael E. Slay (TNC)

Species Observed:

Scientific Name	Common Name	Ecol. Class.	NatureServe Status Rank	No. Observed
Mammals:				
Myotis septentrionalis	Northern Long-Eared Bat	TX	G1G2	2
Perimyotis subflavus	Tricolored Bat	TX	G2G3	7
Procyon lotor	Raccoon	TX	G5	scat
Amphibians:				
Eurycea spelaea	Grotto Salamander	TB	G4	2
Crustaceans:				
Caecidotea sp.	A Cave Asellid Isopod	SB		>10
Centipedes & Millipedes:				
Oxidus gracilis	Greenhouse Millipede	TX	G5	1
Insects:				
Diptera	A Crane Fly	TX		1
Snails:				
Physa sp.	A Cavesnail	SB		29

Narrative: Although Delaware County had not received much rainfall in the past few months, the small stream in Cooler Cave had a similar flow to previous trips. Much of the cave stream consists of soft silt and clay, except for one small riffle in the main passage and the D.A.C. passage where the cave *Physa* are encountered. Tricolored Bats were hanging individually along the cave ceiling and cave walls. The two Northern Long-eared Bats were clustered together in a small depression in the cave wall about 1.5 ft above the stream. There were no obvious signs of White-Nose Syndrome on the bats. No cavesnails were observed in the riffle in the main passage. All cavesnails were observed in the riffle section of the

D.A.C. passage, and the number of snails observed (n = 29) along the transect was similar to the 2014 count. More snails were observed on the sides of rocks (48%, n = 14) than on the bottom (31%, n = 9) or top (21%, n = 6). When snails were present on a rock, typically it was a single individual. In 6 instances, more than one snail was observed. Hydrologically, the D.A.C. passage appears to connect with stream passage in Featherhead Cave, which is just across a small surface hollow from Cooler Cave; however, the two caves have not been connected physically.

Figure 13. Northern Long-Eared Bats (*Myotis septentrionalis*) observed in Cooler Cave, Delaware Co., Oklahoma, on 16 December 2017.

Date: 16 December 2017

Location: Featherhead Cave, Delaware Co., OK

Personnel: Dante B. Fenolio (San Antonio Zoo), Michael E. Slay (TNC)

Species Observed:

Scientific Name	Common Name	Ecol. Class.	NatureServe Status Rank	No. Observed
Mammals:				
Eptesicus fuscus	Big Brown Bat	TX	G5	1
Perimyotis subflavus	Tricolored Bat	TX	G2G3	5

Narrative: We made a brief trip into Featherhead Cave to determine if the cave provides habitat for wintering bats, since the entrance is a small sinkhole on the side of a small drainage. Only a few Tricolored Bats and 1 Big Brown Bat was observed in the cave. The cave has evidence of visitation and vandalism, and several of the large speleothems have been spray painted. There is small opening in the floor of the cave that allows access to a lower level and the cave stream. Although this lower level has been entered during previous trips, we did not enter it during the current trip. Entering the lower level requires negotiating a tight, blind drop of a least 8 ft, and we did not have a handline to assist with climbing back out.

Date: 17 December 2017

Location: January-Stansberry Cave, Delaware Co., OK

Personnel: Dante B. Fenolio (San Antonio Zoo), Matthew L. Niemiller (UAH), Michael E. Slay (TNC), Evin T. Carter (UTK), Daniel A. Jackson (USFWS)

Species Observed:

Scientific Name	Common Name	Ecol. Class.	NatureServe Status Rank	No. Observed
Mammals:				
Myotis grisescens	Gray Bat	TX	G4	1
Myotis septentrionalis	Northern Long-Eared Bat	TX	G1G2	1
Perimyotis subflavus	Tri-Colored Bat	TX	G2G3	150
Procyon lotor	Raccoon	TX	G5	Scat; tracks
Amphibians:				
Eurycea lucifuga	Cave Salamander	TP	G5	2
Eurycea spelaea	Grotto Salamander	TB	G4	3
Rana palustris	Pickerel Frog	TX	G5	3
Crustaceans:				
Cambarus tartarus	Oklahoma Cave Crayfish	SB	G1	32
Orconectes neglectus	Ringed Crayfish	SP	G5	68
Stygobromus sp.	A Cave Amphipod	SB		2
Centipedes & Millipedes:				
Oxidus gracilis	Greenhouse Millipede	TX	G5	4
Insects:				
Ceuthophilus sp.	A Cave Cricket	TX		>50
Platynus sp.	A Ground Beetle	TP		2
Heleomyzidae	A Sun Fly	TX		>50
Heteroptera	A Water Strider	TX/AC		1

Narrative: We performed another survey for Oklahoma Cave Crayfish (*Cambarus tartarus*). This is typically the longest survey of the regular surveys we perform. In the past, the survey has taken as long as 9 hours to get back to the end of the walking passage; however, this trip took just 6 hours. We began the survey from the Stansberry entrance. This year's survey was scheduled owing to a high-water event roughly one month prior to the survey. The high-water event had water shooting from the mouth of the cave by the refuge headquarters. The questions we are asking involve the damage done (if any) to the Oklahoma Cave Crayfish (*Cambarus tartarus*) population during these flooding events. This year's count (32) is comparable to previous counts across the past seven years: February 2011 (37), April 2012 (43), December 2014 (45), December 2016 (19), and March 2017 (23). There were flood events prior to the 2016 and 2017 counts (within 2 months prior to each count). Even with this year's flood event, the number increased over the two previous counts.

Other notable fauna observed included a federally threatened Northern Long-Eared Bat (*Myotis septentrionalis*) and a federally endangered Gray Bat (*M. grisescens*).

Figure 14. Mike Slay measuring cave crayfish in January-Stansberry Cave, Delaware Co., Oklahoma on 17 December 2017.

Date: 18 December 2017

Location: Star Cave, Delaware Co., OK

Personnel: Dante B. Fenolio (San Antonio Zoo), Richard Stark (USFWS), K. Andy Harris

Species Observed:

Scientific Name	Common Name	Ecol. Class.	NatureServeStatus Rank	No. Observed
Fishes:				
Troglichthys rosae	Ozark Cavefish	SB	G3	1
Crustaceans:				
Cambarus subterraneus	Delaware County Cave Crayfish	SB	G1	10

Narrative: Dr. Fenolio, Andy Harris and Richard Stark entered the cave and navigated the vertically tight crawl way to get to the walking passage of this cave system. The crawl is approximately 20 meters in length. Once through the crawl, the passage has a ceiling tall enough to allow for walking and bent-over walking through the system. The first stream pools held Delaware County Cave Crayfish (*Cambarus subterraneus*), as did several pools beyond the first large pool. Ten Delaware County Cave Crayfish wereobserved, including some small individuals that were probably the young of the year prior – representing clear evidence of reproduction in this population. Through the series of narrow and winding passageway, the cave ultimately ends in a terminal sump pool. The sump pool contained an Ozark Cavefish (*Troglichthy rosae*), a species that has not been observed in this system since 1992 (26 years). This year's counts were good news for this cave system. In 2012, one Delaware County Cave Crayfish was observed and no Ozark Cavefish were observed.

Figure 15. Delaware County Cave Crayfish (*Cambarus subterraneus*) observed in Star Cave, Delaware Co., Oklahoma on 18 December 2017.

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