FINAL PERFORMANCE REPORT

Federal Aid Grant No. F15AP00189 (E-22-20)

Management and Protection for the Ozark Big-Eared Bat, Gray Bat, And Stygobitic Fauna In Oklahoma

Oklahoma Department of Wildlife Conservation

May 1, 2015 through April 30, 2016

Final Performance Report

State: Oklahoma **Project Number:** F15AP00189 (E-22-20)

Grant Program: Endangered Species Act Traditional Section 6

Grant Period: 1 May 2015 – 30 April 2016

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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 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 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 delineating biologically important subterranean systems. Management procedures including gate/grill construction at two caves, and population monitoring efforts were completed at 34 caves. Stygobitic bioinventory surveys were conducted at 4 caves and focused on population counts of Ozark Cavefish and both state endemic cave crayfish. Future management recommendations follow the results of these project activities.

B. 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.

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 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).

C. Objectives:

The objectives of this project assist in the recovery of the Gray Bat, Ozark Big-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. The primary objectives of this project are:

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

2) Survey the 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.

D. 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.

Long-term Management Plan: Cave AD-7

This cave is located in T15N R24E, Adair County, OK. The site annually serves as a maternity cave for a colony of gray bats. It is the only maternity colony of gray bats in the state that is not protected from human entry by a gate/grill system. During winter of 2015, a visit was conducted and permission to access the site with vehicles and equipment was obtained from private landowners. Project personnel are confident that the Oklahoma Chapter of the Nature Conservancy is the landowner on which the main entrance is located. All landowners were contacted and granted vehicular access to the site. An initial trip was made to the property on 10 November 2015 to prepare the access route for transporting materials and ATV use. On a subsequent visit to the cave on 14 November initial installation of the gate/grill system began by placing vertical steel posts in position and to prepare the construction process for additional trips in winter 2015-16. Further construction of the gate/grill system was conducted on 15 December 2015 and 5 March 2016 when steel horizontal bars were installed. This has been a collaborative effort between project personnel, and assistance from individuals representing the Nature Conservancy, U.S. Fish and Wildlife Service, and ODWC. The steel grill/gate structure is slated to be completed by March 2017.

Gate Removal and Re-installation: Cave DL-39

There are two entrances to this cave system that has 5,550 feet of mapped passage. The cave contains an active stream that flows its entire length, and though it is subject to flooding in extreme rain events, it does house a colony of gray bats with as many as 11 roost sites within the passage. The colony that uses the cave has never been identified as a maternity colony

because typically males, young of the year, and non-lactating females have been historically trapped at the entrance. The largest entrance to the cave is located on the Mary Looney Unit of the Ozark Plateau National Wildlife Refuge. Though the entrance/passage is not gated, the refuge's headquarters is located on the property and provides adequate protection from human entry and potential disturbance to roost sites. However, a second entrance is located on private property in T21N R24E, Delaware County, OK. This smaller entrance joins the main passage and was gated with a solid iron door in the 1960's (*William Puckette personal communication*). The design of the historical gate system prohibited any bat flight through the entrance, and potentially disrupted airflow into and out of the cave subsequently altering the internal climate of the passage. An initial visit to the site was made in July 2013 to both inspect potential access points and develop a management plan. Permission was sought from the local landowner in November of that year to begin removal of the current gate and replacement with a larger gate that permits both ingress/egress by bats and airflow. Removal of the existing gate structure began in December 2013 and continued on three additional occasions in 2014 and was ultimately completed on subsequent visits in March and September 2015. The entrance is now secure from human entry, the passage is larger in size, and the new gate system allows for ingress and egress of the colony if needed.

Colony/Species Monitoring:

An important aspect of the long-term E-22 project is monitoring 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. Monitoring at hibernacula was conducted from December 2015 through March 2016. Summer roost monitoring was conducted from May through September 2015 at selected caves to determine use patterns and, if possible, population estimates (Table 1).

Table 1. Population estimates and species richness at select caves in eastern Oklahoma during 2015-16.

Date	County	Cave Number	Gated	Monitoring Results
26-May-15	Delaware	DL-21	No	11 (F) preg MYSE; 2 (M) MYSE; 1 (F) PESU
2-Jun-15	Delaware	DL-91	Yes	21,520 MYGR (Emergence)
2-Jun-15	Delaware	DL-2	No	0 (Emergence)
4-Jun-15	Adair	AD-13	Yes	75 COTO (Emergence)
9-Jun-15	Adair	AD-10	Yes	189 COTO (Emergence)
11-Jun-15	Adair	AD-17	Yes	112 COTO (Emergence)
11-Jun-15	Adair	AD-18	Yes	9 COTO (Emergence)
11-Jun-15	Adair	AD-153	No	1 COTO (Emergence)
22-Jun-15	Adair	AD-125	No	40 COTO (Emergence)
28-Jun-15	Delaware	DL-55	No	7 MYSE; 1 EPFU; 1 PESU
29-Jun-15	Delaware	DL-21	No	6 MYSE; 2 PESU
5-Aug-15	Delaware	DL-2	No	0 (Emergence)
5-Aug-15	Delaware	DL-91	Yes	20,585 MYGR (Emergence)
24-Aug-15	Delaware	DL-32	No	3 MYSE (M)
1-Oct-15	Delaware	DL-38	No	1 MYSE (M); 4 PESU
18-Dec-15	Adair	AD-13	Yes	6 PESU
18-Dec-15	Adair	AD-17	Yes	46 PESU
18-Dec-15	Adair	AD-18	Yes	77 PESU
18-Dec-15	Adair	AD-15	Yes	25 PESU; 4 MYSE; 1 EPFU
18-Dec-15	Adair	AD-21	Yes	0
18-Jan-16	Adair	AD-7	No	119 PESU
21-Jan-16	Cherokee	CZ-18	Yes	158 PESU
28-Jan-16	Adair	AD-14	Yes	185 PESU; 39 MYSE; 4 MYGR; 2 EPFU; 1 COTO
28-Jan-16	Delaware	DL-91	Yes	12 PESU
4-Feb-16	Sequoyah	SQ-1	No	184 PESU; 1 MYSE
11-Feb-16	Delaware	DL-21	No	25 PESU
24-Feb-16	Adair	AD-8	Yes	204 PESU
9-Mar-16	Delaware	DL-1	Yes	49 PESU; 1 MYGR
18-Mar-16	Adair	AD-29	Yes	9 PESU
18-Mar-16	Adair	AD-30	Yes	21 PESU; 1 COTO
18-Mar-16	Adair	AD-54	Yes	54 PESU
18-Mar-16	Adair	AD-211	Yes	4 PESU
18-Mar-16	Adair	AD-221	Yes	67 PESU; 3 COTO
5-Apr-16	Ottawa	OT-13	Yes	6 PESU

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

Northern Long-eared Bat Monitoring:

Northern long-eared bats (*Myotis septentrionalis*) in Oklahoma spend winter hibernating in caves and abandoned mines, and in summer use caves as maternity and day and night foraging roosts. More than 20 caves in Adair, Cherokee, Delaware, and LeFlore counties have been documented to house populations or individuals of northern long-eared bats. White-nose syndrome is currently the predominant threat to the northern long-eared bat, especially throughout the northeast U.S. where the species has declined by up to 99 percent from pre-white-nose syndrome levels at many hibernation sites. Although the disease has not yet spread throughout the northern long-eared bat's entire range it is currently found in at least 22 of 39 states where the northern long-eared bat occurs). The development of cave management plans is important to protecting cave-dwelling populations of the species from human activity, and the management and containment of potential transmission of WNS. Monitoring efforts were conducted using mist nets and harp traps at three caves in June and August 2015, each with historical reports of being inhabited by northern long-eared bats (DL-21; DL-32; DL-55). Specimens were captured at each location validating their continued use of the historical sites. Swab samples were collected to detect the presence of the causative agent of White-nose syndrome, all of which were verified through PCR analysis as negative.

White-Nose Syndrome (WNS) Surveillance in the Ozark Highlands:

Personnel in this project were invited to participate in three separate monitoring programs. Each one assists in the early detection of low levels of infection by the causative fungus *P. destructans*, on bat specimens from caves in eastern Oklahoma. Protocols exist for both the cultivation of *P. destructans* and the cultivation-independent detection of this organism based on growth cultivation. Early detection is essential to provide resource managers the time and data necessary to implement a management or containment plan, if necessary.

Through these various sampling efforts, researchers have determined that the amount of fungus on individual 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 4 years to continue our work on understanding how transmission and load dynamics change over time and space; 2) increase sampling 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 changing to collecting substrate samples that are not directly underneath a bat; and 5) understand how sociality is related to WNS dynamics (Frick, 2016). In Ozark region of Oklahoma, these goals were implemented through the following surveillance methods:

1) For the third consecutive year, pre-white-nose syndrome surveys were conducted in five caves in northeastern Oklahoma in conjunction with the WNS/Pd Continental Transmission Study. Prior to winter 2016, the project sampled over 14,000 bat and substrate samples from 16 species across 259 sites in 34 states and provinces. These samples comprise the largest and most current database for Pd/WNS (Frick 2016). Ten torpid bats from five different caves and surrounding substrates were sampled for the

presence of *Pseudogymnoascus destructans* beginning in January 2016. During the hibernation season 2014-15, project personnel sampled live-caught specimens of *Perimyotis subflavus* retrieved from torpid populations in five specific caves in eastern Oklahoma (AD-7; DL-8; DL-21; DL-91: OT-13). Colony cultivation and identification of microfauna will be conducted by the University of New Hampshire's Dept of Molecular, Cellular, and Biomedical Sciences. Results from the 50 live specimens and on nearby substrates will be available in summer 2016.

2) Soil samples were collected at three different locations in the passages of each of the five caves above. Protocols have been developed in the laboratories of the University of Central Oklahoma for the cultivation and detection of *P. destructans*. Results from the samples will be available in summer 2016.

3) Disease Diagnostic Laboratories of the USGS National Wildlife Health Center in Madison, WI, has developed protocols to collect swab samples for white-nose syndrome surveillance. Combined wing/muzzle swabs from 25 Tri-colored bats were collected on 18 March 2016 at cave AD-221 in Adair County, Oklahoma for *P. destructans* surveillance. No visible fungus or mortality was noted in the bat population at the time of the survey. All 25 bats at this location tested negative for *P. destructans*, the causative agent of white-nose syndrome (WNS), by real-time PCR.

***Stygobitic Bioinventories*—**Since 2001, Dr. Dante Fenolio has been assisting the USFWS Oklahoma Ecological Services Field Office with subterranean surveys and bioinventory monitoring. In particular, regular censuses of subterranean habitats containing known populations of Ozark Cavefish (*Troglichthys rosae*) and both state endemic cave crayfish, *Cambarus tartarus* and *C. subterraneus*, have been a focus of these surveys; in addition, trapping in caves with historical or unconfirmed reports of these species has also been a priority. Examining caves that contain historical observations, but no recent records of the Ozark Cavefish is another key component of these inventories. Through this effort, several other rare or Ozark-endemic subterranean species such as the Grotto Salamander (*Eurycea spelaea*), groundwater amphipods (*Stygobromus* spp.), and groundwater isopods (Mackin's Cave Isopod, *Caecidotea mackini*) are also monitored and recorded. Data collected from these surveys have been provided to the Subterranean Biodiversity Project database, originally maintained by Dr. G.O. Graening and now by Michael E. Slay of The Nature Conservancy in Fayetteville, Arkansas. A formal final report of the first 13 years of the project has been published through the University of Oklahoma Press, "*Cave Life of Oklahoma and Arkansas*" by Graening, Fenolio, and Slay. Species descriptions, conservation updates, and biological observations are being published every year.

The 2016 Ozark aquatic cave life surveys were originally planned for December 2015. Schedule conflicts and inclement weather postponed surveys into February 2016 – with a planned set of surveys for later this year. For the days that surveys were performed, subterranean biologists Drs. Matthew L. Niemiller (Illinois Natural History Survey) and/or Danté Fenolio traveled to the site and participated in bioinventories. USFWS biologist Shea Hammond also participated. On each day of this trip, only one cave, or cluster of caves in close proximity, was surveyed. Precautions were employed by the team to prevent the potential spread of White Nose Syndrome (WNS)

between caves, with gear being sterilized and decontaminated prior to its use in other cave systems. The USFWS-approved WNS decontamination protocol was followed.

26 February 2016, Cave DL-14, Delaware Co., OK
Surveyors: Danté Fenolio and Shea Hammond

Cave DL-14 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.

The recent storms in 2015 greatly modified this cave system. The crawl at the mouth of the cave is tighter than it has ever been in previous years; however, the cave opens up once the crawl space has been traversed. The scouring of the recent rains is evident through the clean and washed chert both inside of the cave mouth and in the valley floor, where a seasonal stream flows. All of the chert was neatly washed and light in color from the flood waters. The scouring floods may have depleted the resident cave snail population, resulting in the low count; the total number of snails documented was roughly one order of magnitude lower than the last several counts in 2015 and 2014.

Table 2. Faunal inventory for cave DL-14 in Delaware County, Oklahoma

3	Tri-Colored Bats, *Perimyotis subflavus*
10+	Cave Fly, Heleomyzidae
5	Cave Dung Fly, *Spelobia*?
10+	Cave Crickets, *Ceuthophilus*
10+	Aquatic Cave Isopods, *Caecidotea* sp.
4	Cave Snails (identification work in progress)

26 February 2016, Cave DL-33, Delaware Co., Oklahoma
Surveyors: Dr. Danté Fenolio, Shea Hammond, and W. Puckette

Cave DL-33 is owned by private landowners. It has a low entrance that is elevated by roughly two or three meters above the stream that cuts through the floor of the hollow containing the site. The entrance is a low walk and crawl but opens to walking passage. There were several isolated pools at the mouth of the cave at the time that the site was accessed this segment. A stream flows through the system, with numerous slow-flowing pools. When following the waterway, there are a few extremely narrow passages in the system. Roughly 300 meters into the system, the cave turns into a low crawl in the water.

Recent rainfall has made some alterations in this system. A collapse has opened up a new mouth in the ceiling, roughly 100 meters into the system. The opening is two or three feet in diameter

and light now penetrates into the cave. Compared to previous years, a considerable amount of additional chert had been washed into the cave; as a result, the back of the system was much more difficult to access by the surveyors. Observations made by the surveyors indicated flood waters had reach a height of 8 feet near the cave entrance, completely submerging the mouth of this cave at some point during the previous year. Further evidence of extremely heavy flooding in the recent past was indicated by the presence of surface stream invertebrates in the cave stream.

Table 3. Faunal inventory for Cave DL-33 in Delaware County, Oklahoma

2	Tri-Colored Bats, *Periomyotis subflavus*
12	Grotto Salamander larvae, *Eurycea spelaea*
3	Pickerel Frogs, *Lithobates palustris*
50+	Cave Crickets, *Ceuthophilus* sp.
50+	Heleomyzid Flies
50+	Cave Dung Flies, *Spelobia* sp.
5	Cave Fungus Gnat larvae (webworms), *Macrocera nobilis*
10+	aquatic neuroptera larvae
10+	Caddis fly larvae 200+ Culicidae (Mosquitoes)
1	staphylinid beetle
24+	Collembola
1	aquatic subterranean flatworms, *Dendrocoelopsis americana*
2 a	quatic blind cave snails, Physidae
10+	surface aquatic snails (also Physidae)
50+	*Caecodotea* sp., subterranean aquatic isopods

27 February 2016, Cave DL-39, Delaware Co., Oklahoma
Surveyors: Dr. Danté Fenolio, Dr. Matthew Niemiller, Ana Gabriel, Amy Smith and Shea Hammond

This cave is owned by the Ozark Plateau National Wildlife Refuge and is considered to be one of the most biologically significant caves in Oklahoma. This system is lengthy (well over 1000 meters) and contains a perennial stream; it also contains and at least two entrances. The smaller of the two entrances is gated and the lock on that gate is in decent, working condition.

We performed the biannual count of the state-endangered Oklahoma Cave Crayfish, *Cambarus tartarus* (Figs. 5, 6 & 7). This particular survey is the most time-consuming and substantial survey among the regular survey work that is performed by the survey team; in previous years, the survey has taken as long as 9 hours. We began the survey from the Moonshine Room and used that entrance to reduce survey time by a few hours. For this season, the survey was completed in approximately 6.5 hours. The section of the cave from the Moonshine Room to the main entrance is not the typical habitat where *C. tartarus* is usually found. This section of stream hosts abundant surface crayfish which undoubtedly compete with, and may prey on, the cave crayfish. This year's count (19) was a 42% decrease from last year's count of 45. Last year's count was the largest ever recorded for this species. We collected morphometric data for 11 cave

crayfish (all that we could capture). The decrease in this year's count may be a result of the severe rainfall events and potential scouring of the system with heavy water flow that occurred late in 2015 and early 2016. We noted that the count for the Tri-colored Bat, *Periomyotis subflavus*, increased from 27 in 2014 to 227 this year, nearly an order of magnitude increase (Fig. 8). No dead bats were observed nor were any signs of WNS. Gray Bats, *Myotis grisescens*, were observed in several small clusters.

Table 4. Faunal inventory for Cave DL-39 in Delaware County, Oklahoma.

227	Tri-Colored Bats, *Periomyotis subflavus*
30	Gray Bats, *Myotis grisescens*
21	Pickerel Frogs, *Lithobates palustris*
1	Grotto Salamander larva, *Eurycea spelaea*
2	Cave Salamander adults, *Eurycea longicauda melanopleura*
19	Delaware County Cave Crayfish, *Cambarus tartarus*
8	Ringed Crayfish, *Orconectes neglectus*
10+	Cave Crickets, *Ceuthophilus* sp.
20+	*Platinus* beetles
30+	Heleomyzidae flies
50+	Cave Dung Flies, *Speleobia* sp.
6	Cave Millipedes, *Causeyella* sp.

28 February 2016, DL-91, Delaware Co., Oklahoma
Surveyors: Dr. Danté Fenolio, Dr. Matthew Niemiller, Ana Gabriel, and Shea Hammond

Cave DL-91 has two entrances, both of which are gated. The fence around the natural opening remains in good shape and the lock on that gate was in working order and easy to open. The lock on the cave gate (inside of the cave mouth) was in working order and opened without trouble. There were no new signs of vandalism.

The site is a biologically important cave for Gray Bats, *Myotis grisescens*, as well as Delaware County Cave Crayfish, *Cambarus subterraneus;* the site is also a historical location for the Ozark Cavefish, *Amblyopsis rasae*. We performed the biannual count of Delaware County Cave Crayfish (Fig. 10). A total of 20 *C. subterraneus* were observed, representing a 40% increase from the 2014 count of 12 individuals. No Ozark Cavefish were observed. One unusual observation was made on the guano piles in the high "dome room," before you reach the stream passage. Six adult Grotto Salamanders (*Eurycea spelaea*) were actively hunting on guano piles. Several small pseudoscorpions (*Hesperchernes occidentalis*) were observed crawling about on the guano – possible prey items for *E. spelaea*. During our survey, Ana Gabriel (M.S. student at Oklahoma State University) collected water samples for a subterranean eDNA project. Eight Tri-Colored Bats, *Periomyotis subflavus* were observed, and no dead bats were noted. The survey lasted 2 hours.

Table 5. Faunal inventory for Cave DL-91 in Delaware County, Oklahoma.

20	Delaware County Cave Crayfish, *Cambarus subterraneus*
25+	Pseudoscorpions, *Hesperchernes occidentalis* – on guano pile
25+	staphylinid beetles 50+ Fungus Gnats *Macrocera nobilis*
25+	cave beetles, *Platinus* sp.
6	Adult Grotto Salamanders, *Eurycea spelaea*, – on a guano pile
2	Larval Grotto Salamanders, *Eurycea spelaea*
15	Juvenile Slimy Salamanders, *Plethodon albagula* – near the entrance
8	Tri-Colored Bats, *Periomyotis subflavus*

E. Discussion and Recommendations:

1. Cave AD-7 in Adair County is the last known maternity colony of gray bats in Oklahoma that is currently unprotected from human entry and disturbance. Verifying landownership of the cave's two entrances and successfully securing access across private properties was a crucial step in providing long-term protection to the critical bat roosts inside the cave. Construction of the gate/grill system was initiated in November 2015 and will continue to completion in spring 2017. Ultimately a side passage and second entrance to the cave is targeted for a gate/grill system so that the cave interior and sensitive fauna will be protected from human entry and disturbance.

2. 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.

3. Considerable emphasis by multiple government agencies is being placed on pre-WNS management and monitoring in states where the vector is likely to be detected in the near future. Oklahoma is considered one of those states. Monitoring torpid populations and surrounding substrate 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.

4. 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.). White-nose syndrome is currently the predominant threat to the northern long-eared bat, especially throughout the northeast U.S. where the species has declined by up to 99 percent from pre-white-nose syndrome levels at many hibernation sites. Although the disease has not yet spread throughout the northern long-eared bat's entire range it is currently found in at least 22 of 39 states where the northern long-eared bat occurs). Other threats to the species include: wind energy development, habitat destruction or disturbance (e.g., vandalism to hibernacula, roost tree removal), and contaminants. Identifying caves that are inhabited by populations of *M. septentrionalis*, management efforts to protect the cave-dwelling

populations of the species from human activity, and containment of potential transmission of WNS is now an important and significant aspect of this project.

E. Significant Deviations:

There were no significant deviations from the stated objectives.

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