FINAL PERFORMANCE REPORT

STATE: Oklahoma **PROJECT NUMBER**: E-22-16 (F10AP00512)

GRANT PERIOD: 1 December 2009 – 30 September 2012

REPORT PERIOD: 1 December 2010 – 30 November 2011

PROJECT TITLE: Management and Protection for the Ozark Big-eared Bat, Gray Bat, and Stygobitic Fauna in Oklahoma

PRINCIPLE INVESTIGATOR: Dr. Keith Martin, Rogers State University

A. ABSTRACT:

Project personnel completed the installation of one protective gate/grill system, performed site scoping and planning for a protective gate/grill system at another site and made repairs to three previously constructed gates. A gate/grill system was completed at cave AD-18 which is a roosting site for Ozark big-eared bats, and the initial scoping and planning were performed for a gate/grill system at cave AD-7 which is a gray bat maternity site. If landowner permission is granted, the construction of this gate may begin next year. Repairs were made to existing internal gates at caves AD-29 and AD-30 which are used as roosts by Ozark big-eared bats, and the internal gate in cave DL-91 which supports a maternity colony of gray bats as well as a population of the Ozark cavefish and Delaware County cave crayfish. Population monitoring surveys were conducted at seven caves that support gray bat populations (six surveyed during the unoccupied winter season and four were surveyed during the summer when the caves were normally occupied). Gray bat population estimates for these caves were: DL-1 – 9,853; DL-91 – 32,218 (guano-based 2009) & 11,700 (emergence-based 2011); DL-92 – 21,131; AD-8 – 14,496; AD-7 – 17,475, OT-13 – 23,416 and CZ-9 – 14,002. Population monitoring surveys also were conducted at seven Ozark big-eared bat hibernacula and documented a total of 827 Ozark big-eared bats as well as 140 tricolored bats, 15 northern long-eared bats, three big brown bats and two gray bats. Winter surveys were also conducted in five caves where Ozark big-eared bat use had been documented in the summer and fall, but no hibernating bats were encountered.

B. INTRODUCTION:

Cave ecosystems harbor a variety 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). 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% are federally listed (Culver et al, 2000).

Management of Bat Fauna

Human disturbance at caves is a persistent problem internationally and has been implicated as a major cause of decline for many 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 during at least one season of the year, and 13 use caves year-round (McCracken, 1989). All North American bats that are federally listed as endangered or threatened are cave-dwelling species or subspecies (McCracken, 1989; Harvey et al., 1999; Pierson, 1999). In the central United States, two 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 to recovery biologists because each is federally listed as endangered (United States Fish and Wildlife Service 1982, 1983, 1995).

As a result, cave gating has been used widely by government and private entities to protect these sensitive ecosystems from pernicious impacts. Populations of bats presently are protected with internal gate systems throughout the United States including 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 with the exception of a single cave that serves as a minor hibernaculum for the endangered Indiana bat. These caves also are occupied by big brown bats (*Eptesicus fuscus*), tricolored bats (*Perimyotis subflavus*), and northern long-eared bats (*Myotis septentrionalis*). Four caves that contain populations of either Ozark cavefish (*Amblyopsis rosae*), Oklahoma cave crayfish (*Cambarus tartarus*) and/or Delaware County cave crayfish (*Cambarus subterraneus*) also are protected from human entry by internal gates. Population estimates for bats were made at least once at each of these caves prior to the installation of gates beginning in 1981. Population estimates post-installation 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 and 2006, and Puckette 2000).

Management of Stygobytic Fauna

Anthropogenic activities threaten groundwater quality and quantity to the communities of organisms living in 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 that region (Culver et al, 2000). These phenomena render groundwater species vulnerable to anthropogenic activities and necessitate monitoring of vulnerable species and populations.

Agricultural pollution and industrial runoff pose serious risks to groundwater quality (Crunkilton, 1984; Culver et al, 2000). From a wildlife management perspective, groundwater contamination is a serious problem, because many groundwater species are found in single aquifer systems and a significant contamination event could pose an extinction threat. Because an aquifer is the entire available habitat for groundwater fauna, any change in water quality, and especially contamination of it, affects the environment without places of refuge (Crunkilton,

1984).

The Ozarks are no exception to the generalities of subterranean communities mentioned above and the vulnerabilities to anthropogenic activities. Commercial and residential development in recharge zones, groundwater extraction issues, and contamination of groundwater are all potential threats to subterranean fauna of the Ozarks (Crunkilton, 1984; Margat, 1994; Fels, 1997; Graening and Brown, 2003; Mace et al., 2006). Of particular concern is the Ozark Cavefish that is endemic to the Ozark Plateau Ecoregion and is a federally listed threatened species. Additionally, both species of groundwater crayfish endemic to Oklahoma, *C. subterraneus* and *C. tartarus*, have exceptionally small ranges and are vulnerable to human activities; they are listed as endangered and critically endangered by the IUCN respectively and both are listed by NatureServe as critical (Graening and Fenolio, 2005; Graening et al., 2006).

Study Area

Procedures during this project were conducted in eastern Oklahoma in the western limit of the Boston Mountains of the Ozark Plateau. The Plateau covers about 103,000 km^2 (Huffman 1959) in the central United States with an elevation ranging from 260m to 460m above sea level. The Plateau was comprised of alternating layers of limestone, flint (= chert) and sandstone that are conducive to cave formation (Blair and Hubbell 1938). Caves in this region serve as refugia from severe winters for many cave-dwelling species (Humphrey and Kunz 1976). The vegetation on mountain slopes was predominantly blackjack oak (*Quercus marilandica*), post oak (*Quercus stellata*), black hickory (*Carya texana*), and winged elm (*Ulmus alata*). Coralberry (*Symphoricarpus orbiculatus)* and sassafras (*Sassafras albidum*) comprised the sparse shrubby understory. Riparian areas were dominated by silver maple (*Acer saccharium*), river birch (*Betula nigra*), American elm (*Ulmus americana*), cottonwood (*Populus deltoides*), sycamore (*Plantanus occidentalis*), and various oak species (*Quercus* spp.). Sporadic openings of managed grasslands have historically been used for various types of agriculture (Blair and Hubbell 1938, Harvey et al. 1981).

C. OBJECTIVE:

The purpose of this project is two-fold, 1) to 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 to include historical localities of *Amblyopsis rosae* and species of groundwater crayfish endemic to Oklahoma.

D. PROCEDURES:

In northeastern Oklahoma, endangered gray bat and Ozark big-eared bat populations have been protected by gate/grill systems at >34 cave entrances in Adair, Delaware and Cherokee counties (Martin et al, 2003). These procedures assist in stabilizing and increasing the Ozark big-eared bat and gray bat populations in northeastern Oklahoma. This may ultimately allow for

recolonization of previously known caves that were inhabited by these species historically (Grigsby and Puckette, 1984) and were designed to accomplish task B 1.6 and 1.7 of the 1993 Revised Ozark Big-eared Bat and Virginia Big-eared Bat Recovery Plan, and objectives 1, 1.2, 1.3.1, 3, and 3.2 of the 1982 Gray Bat recovery plan. Stygobitic faunal censuses were conducted via the same methods as previous aquatic surveys performed by the Subterranean Biodiversity Project (e.g., Graening and Fenolio 2005; Graening et al., 2006). In each cave surveyed, fauna were inventoried using the most unobtrusive methods possible and at times when endangered bats were not hibernating or birthing.

1. The current landowner of each site was identified, and after being determined, the proposed plans for the specific site were discussed and permission to implement those plans was sought.
2. The projected costs for implementing each recommended management plan were calculated and the proposed plan was discussed with the Oklahoma Department of Wildlife Conservation Wildlife Diversity Program, the U.S. Fish and Wildlife Service and individual landowners of each site.
3. Upon approval of the maintenance plan for each site, the plan was then implemented. Implementation of individual management plans was determined on a priority basis. This priority depended on the ability to effectively utilize available funds, in conjunction with the amount of human disturbance each site was receiving and the status of the population of Ozark big-eared bats or gray bats inhabiting the site.
4. All sites where structures were placed for protection are monitored annually or biennially after installation. Inspections are conducted during uninhabited seasons to monitor the structure or structures for possible vandalism. At some caves, additional monitoring visits were conducted while the bats are utilizing the site. Such surveys are exit counts at maternity sites that use infrared lighting and night vision optics to determine the population of bats using the site and whether or not the newly constructed structures are inhibiting the flight of the bats into and out of the site.
5. Vertebrates and macroscopic invertebrates were counted visually with helmet-mounted and diving lights underwater, using snorkeling gear for deep pools.
6. Baited pit-fall traps were used during bioinventories to detect shy or reclusive species in terrestrial habitats.
7. Collections were limited to those fauna that were impossible to identify on site, and where permitted. Voucher specimens were collected by hand, aspirator, or net for preservation, cataloging, and identification or shipment to taxonomists.
8. Collected specimens were identified at the Atlanta Botanical Garden, or sent to taxonomic specialists and ultimately curated in the U.S. National Museum or personal collections of the taxonomists.

E. RESULTS AND DISCUSSION:

Cave Management: The following is a description of caves and management procedures that were involved in the project during the 2009-2010 project year.

Gate/Grill Installation: Cave AD-18

Cave AD-18 is located is located on private in close proximity (< 1.0 km) to an Ozark big-eared bat maternity roost. Though not utilized by a maternity colony of Ozark big-eared bats, it is consistently utilized as a summer foraging and night roost. On 15 June 2009, a non-intrusive, infra-red illumination of the entrance was used to monitor the colony exit using night vision optics. A total of 8 Ozark big-eared bats exited the entrance. Permission was sought and granted from the landowner by project personnel to install an internal gate/grill system in the passage of this cave. Initial excavation began during a visit to the site in in June, and the first stages of construction began in July, 2009. Installation of the gate/grill system was completed in November 2010.

Monitoring/Gate Assessment: 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 that was estimated to be 17,475 bats in 2009. It is the only maternity colony of gray bats in the state that is not protected from human entry by a gate/grill system. In June 2010 an initial visit to the entrance was conducted in an attempt to identify the location of a potential gate/grill system. Infra-red illumination and thermal imagery were used to assist in establishing exit flight patterns in the vicinity of the potential gate/grill system placement in the cave passage. It is anticipated that if landownership can be accurately determined and appropriate permission obtained, that excavation of the gate/grill installation will begin in November 2011.

Gate Repair: Cave AD-29

Installation of an internal gating system inside the entrance to cave AD-29 was completed in March 2002. The cave historically has maintained a small population of Ozark big-eared bats in summer and winter. A monitoring visit by project personnel to this cave in December 2009 indicated that the gate/grill system had been vandalized and was allowing human entry. Project personnel visited the cave in March 2010 and repaired the gate/grill system so that human entry was again restricted.

Gate Repair: Cave AD-30

This cave is located within a series of caves in Adair County that are in close proximity to one another and in a similar geological zone where a previous cave entrance (AD-29) was gated during the 2002 project year. Caves AD-30, AD-54, and AD-55 occur in succession along a west-facing limestone bluff in close proximity (< 0.5 km) to the city of Stilwell. Solitary Ozark big-eared bats are consistently noted in cave AD-30 and in an attempt to afford protection to this cave, the installation of an internal gate/grill system was completed

in 2006. During a monitoring visit to the site in December 2009, it was noted that the lock mechanism on the gate door had been vandalized to such an extent that the cave could no longer be accessed to conduct annual surveys. Project personnel visited the site in March 2010 and removed the lock, reconfigured the lock protection system on the gate, and secured the system with a new lock. A subsequent monitoring visit to the cave in December 2010 noted that the lock and gate/grill system were intact and functioning properly.

Gate Repair: Cave DL-91

This repair project was jointly funded with The Nature Conservancy who is the private landowner. Cave DL-91 is located in Section 13 of T23N, R22E in Delaware County and has a mapped passage of 803m. There are historical records for nine roost sites for gray bats in Oklahoma. Prior to 1973, DL-91 historically housed the largest colony of gray bats in Oklahoma estimated to contain as many as 113,000 bats. A recent population estimate in 2005 indicated that the population was about 36,907 bats. Aquatic pools within the passage of the cave provide documented habitat for the Ozark Cavefish and the Delaware County Cave Crayfish. A monitoring visit to the site in November 2009 revealed that the grill and lock mechanism had been vandalized and was allowing human entry into the critical maternity cave for the gray bat. Project personnel repaired the grill and placed a new lock on the gate in February 2010. Subsequent monitoring visits to the site in November 2010 indicated that the gate/grill and lock mechanism were intact and functioning properly.

Colony/Species Monitoring:

An important aspect of the long-term E-22 project is the 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. Monitoring at hibernacula was conducted in between November 2009 and March 2010, and between December 2010 and March 2011 (Table 1). The caves surveyed during the winter of 2009/10 included three caves that are traditional Ozark Big-eared Bat hibernacula; the caves surveyed in the winter of 2010/2011 did not include any large traditional hibernacula. Summer roost monitoring visits were conducted from June through September 2010 at selected caves to determine use patterns and if possible, population estimates. During the surveys that occurred between December 2010 and March 2011, we made a special effort to check torpid bats for the presence of White Nose Syndrome (WNS). Guano measurements at gray bat maternity caves are conducted biennially after the colonies have vacated caves in Oklahoma to their respective hibernacula in Missouri and Arkansas. Using standardized measuring methods for the past 40 years allows appropriate comparative estimates to monitor population fluctuations in respective maternity colonies of gray bats (Grigsby et al. 1993).

Stygobitic Surveys: censuses of both groundwater cave fish and crayfish in the state of Oklahoma, assist in future management efforts of target species. Groundwater bioinventories document subterranean wildlife in important subterranean systems and assist in establishing

status and distribution of a wide variety of subterranean wildlife, including critical fauna. The results of bioinventories and taxonomic identifications are used to determine the range and distribution of other rare cave and spring animals and to make inferences of their susceptibility to decline. Bioinventories were completed in February 2011 while caves were vacated by gray bats to their respective hibernacula in Missouri and Arkansas. The surveys include here occurred at recognized *Amblyopsis rosae, C. tartarus,* and *C. subterraneus* localities in the state of Oklahoma:

Southerland Cave, Southerland Ranch, Delaware Co., OK: (22 February 2011)

Investigators Danté Fenolio, Mike Slay, Richard Stark, Shea Hammond surveyed this privately owned cave. The proximity of this system relative to caves containing Ozark Cavefish, A*mblyopsis rosae*, and threatened cave crayfish, *Cambarus tartarus* and *C. subterraneus*, made it a priority survey. Southerland Cave has clearly seen much visitation from the Southerland Family and their guests. There is a stair system built into the mouth of the cave to provide easy access into the front room of the system. The cave is a phreatic conduit with large amounts of breakdown, some of which make for tight crawls, in order to follow the cave stream. The cave stream looks to be a perennially running system with water depths from several inches to over five feet. The stream ends in a breakdown pile approximately 400-500 m from the initial crawl through breakdown that allows access to the stream. From the entrance room, a low crawl upstream can be accomplished during low water conditions but the ceiling is apparently unstable and the passageway a dangerous one. Some of the crawls through breakdown appear to traverse relatively unstable rocks. A resident population of a surface crayfish, *Orconectes neglectus,* inhabits the aquatic system of this cave. Juveniles of the species within the cave exhibit an exceptionally faded degree of pigmentation, they appear white. The light color of these crayfish has led to speculation that there may be a subterranean crayfish species inhabiting the system. No obligate subterranean crayfish were observed on this survey. The following represents the results of the bioinventory for this cave:

- 75+ Tricolored bats
- 5 Pickerel Frogs (*Rana palustris)*
- 9 larvae and 1 adult Ozark Blind Cave Salamander (*Eurycea spelaea)*
- 2 Cave Salamanders (*Eurycea lucifuga)*
- 1 Dark Sided Salamander *Eurycea melanopleura longicauda)*
- 5 stygobitic amphipods (*Stygobromus* ssp.)
- 10+ stygobitic isopods (*Caecidotea* ssp.)
- 15+ surface crayfish, *Orconectes neglectus*
- 4 troglophilic beetles, *Platynus* sp.

January-Stansberry Cave, Delaware Co., OK: (23 February 2011)

A count of the endangered cave crayfish inhabiting J.S. Cave, *Cambarus tartarus,* had not been performed in six years and personnel from the Ozark Plateau national Wildlife Refuge

had identified completion of a new survey as a high priority. The population was surveyed to the end of the passable portion of the cave. All crayfish that were observed were netted, sexed, weighed, measured, and released. The survey encountered 37 *C. tartarus* with 32 being captured with data collected. The following represents the results of the bioinventory for this cave:

- 25+ Tricolored Bats, *Perimyotis subflavus*
- 10 Pickerel Frogs, *Rana palustris*
- 14 larvae and 1 adult Ozark Blind Cave Salamander, *Eurycea spelaea*
- 4 Cave Salamanders, *Eurycea lucifuga*
- 5 surface crayfish, *Orconectes neglectus*
- 37 cave crayfish, *Cambarus tartarus*

Twin Cave, Delaware Co., OK: (24 February 2011)

The cave has a resident population of the state endemic cave crayfish, *Cambarus subterraneus*. The cave also has a resident population of Ozark Cavefish, *Amblyopsis rosae*. The following represents the results of the bioinventory for this cave:

- 16 *Cambarus subterraneus*
- 1 Pickerel Frog, *Rana palustris*
- 3 larval Ozark Blind Cave Salamanders, *Eurycea spelaea*
- 10+ "Webworms," *Macrocera nobilis*
- 6 troglophilic beetles, *Platynus* sp.

McGee Cave, Delaware Co., OK: (25 February 2011)

McGee Cave is privately owned and is enrolled in a land stewardship program with the Nature Conservancy. The following represents the results of the bioinventory for this cave:

- 1 *Cambarus tartaus* (juvenile female)
- 5 (4 juvenile & 1 adult) Ozark Cavefish, *Amblyopsis rosae*
- 1 Pickerel Frog, *Rana palustris*
- 5 larval Ozark Blind Cave Salamanders, *Eurycea spelaea*

Table 1. Population estimates of bats, species richness, and WNS survey results at select caves in eastern Oklahoma during the E-22-16 project year.

Key to species: COTO: *Corynorhinus townsendii ingens* PESU: *Perimyotis subflavus*
MYGR: *Myotis grisescens* MYSE: *Myotis septentrionalis*

EPFU: *Eptesicus fuscus*

Date	County	Cave Number	Historical Bat Use	Gated	Monitoring Method/Results
24-Nov-09	Delaware	DL-1	Gray Bat	Yes	Guano/9,853
2-Dec-09	Delaware	DL-91	Gray Bat	Yes	Guano/32,218
12-Dec-09	Delaware	DL-92	Gray Bat	No	Guano/21,131
16-Dec-09	Delaware	AD-8	Gray Bat	Yes	Guano/14,496
30-Dec-09	Adair	AD-14 (Sawney)	Ozark Big-eared Bat	Yes	7 PESU; 14 MYSE; 2 MYGR; 1 EPFU
30-Dec-09	Adair	AD-14 (Backdoor)	Ozark Big-eared Bat	Yes	7 COTO
30-Dec-09	Adair	AD-14 (Cable Ladder)	Ozark Big-eared Bat	Yes	No bats encountered
30-Dec-09	Adair	AD-14 (Sam's Pit-1)	Ozark Big-eared Bat	Yes	No bats encountered
30-Dec-09	Adair	AD-125	Ozark Big-eared Bat	No	15 PESU; 100 COTO
29-Dec-09	Adair	AD-10	Ozark Big-eared Bat	Yes	20 PESU; 275 COTO
24-Dec-09	Adair	AD-15	Multiple Species	Yes	48 PESU; 2 EPFU; 2 COTO; 1 MYSE
21-Dec-09	Adair	AD-3	Ozark Big-eared Bat	No	435 COTO
21-Dec-09	Adair	AD-7	Gray Bat	No	Guano/17,475
31-Dec-09	Adair	AD-221	Multiple Species	Yes	50 PESU; 4 COTO
18-Mar-10	Ottawa	OT-13	Gray Bat	Yes	Guano/23,416
22-Jun-10	Delaware	DL-1	Gray Bat	No	Emergence/0
15-Jul-10	Cherokee	CZ-9	Gray Bat	Yes	Emergence/14,002
28-Jul-10	Delaware	DL-1	Gray Bat	No	Emergence/0
22-Sep-10	Delaware	DL-91	Gray Bat	Yes	Emergence/3,500
30-Dec-10	Adair	AD-29	Ozark Big-eared Bat	Yes	No bats encountered
30-Dec-10	Adair	AD-30	Ozark Big-eared Bat	Yes	No bats encountered
30-Dec-10	Adair	AD-54	Ozark Big-eared Bat	Yes	No bats encountered
30-Dec-10	Adair	AD-201	Ozark Big-eared Bat	Yes	No bats encountered
30-Dec-10	Adair	OT-13	Gray Bat	Yes	No bats encountered
30-Dec-10	Adair	AD-221	Ozark Big-eared Bat	Yes	4 COTO; WNS negative
17-Mar-11	Adair	AD-29	Ozark Big-eared Bat	Yes	No bats encountered
17-Mar-11	Adair	AD-30	Ozark Big-eared Bat	Yes	No bats encountered
17-Mar-11	Adair	AD-54	Ozark Big-eared Bat	Yes	No bats encountered
17-Mar-11	Adair	AD-201	Ozark Big-eared Bat	Yes	No bats encountered
17-Mar-11	Adair	AD-211	Ozark Big-eared Bat	Yes	No bats encountered
17-Mar-11	Adair	AD-221	Ozark Big-eared Bat	Yes	2 COTO; WNS negative
4-May-11	Delaware	DL-91	Gray Bat	Yes	Emergence/11,700

F. SIGNIFICANT DEVIATIONS: None

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H. DATE: MARCH 19, 2012

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K. LITERATURE CITED:

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