ANNUAL REPORT

FAUNAL SURVEY OF OKLAHOMA CAVES AND SPRINGS

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PERFORMANCE REPORT

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Grant Name: Faunal Survey of Oklahoma Caves and Springs

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Executive summary

- 16 springs and 11 caves were surveyed. Most surveys were in the Arbuckles (13 springs and 4 caves) or Ozarks (7 caves).
- Cave surveys found cave amphipods or isopods in six sites; spring surveys added a seventh site. Identifications of these specimens are pending and it is likely that several will be Species of Greatest Conservation Need.
- Cave fish were observed in one historical cave fish site in the Ozarks; however, attempts to find cave crayfish in three historical caves were not successful. Surveys in three caves (2 Ozark and 1 Arbuckle) with historical records of aquatic cave species did not find any of the previously reported species.
- Because cave-inhabiting species may move in and out of cave openings, additional surveys in caves with historical records are warranted.
- Fishes and crayfishes in surveyed springs were common species. The survey added potential new county records for crayfish.
- Identification of spring and cave invertebrates is ongoing.

INTRODUCTION

The study of cave and spring faunas is important because of their connection with groundwater and mineral resources, their interest to science, and their rarity. Cave-limited fauna (troglobites) and ground-water limited fauna (stygobites) represent a large portion of the imperiled (G1-G2) animal species listed in the Natural Heritage Program, and include several species in the ODWC Species of Greatest Conservation Need yet, nationally, less than 4% of these species have federal protection status (Culver *et al.* 2000, NatureServe 2002). Several spring-dwelling species are also included in the ODWC Species of Greatest Conservation Need.

In order to conserve springs, caves, and groundwater habitats and their associated fauna, there is a clear need of additional information on the distribution, ecology, and taxonomy of the fauna of these habitats. This project addresses this need by investigating key subterranean and spring habitats; these habitats will be surveyed through species censuses; and the status, distribution, and taxonomy of rare species will be updated.

OBJECTIVES

The objectives of this project are:

- conduct field surveys of caves and springs, especially in the Ozark and Arbuckle regions of Oklahoma,
- update the status, distribution, and taxonomy of rare cave and spring species in Oklahoma,
- provide information needed for conservation planning for several current and potential Species of Greatest Conservation Need.

Part 1: Spring Inventories

METHODS

Methods used to sample springs were those used by Bergey (2002) and included the following components:

- Site description, including TRS coordinates, GPS readings, a site sketch, photos, local land use, modifications of the spring, and directions for re-finding the site.
- Discharge information (flow width, depths, and mean velocities). Velocity was measured with a Marsh-McBirney electromagnetic flow meter.
- An owner questionnaire to get information on land use changes, changes in discharge, and historical use of springs.
- Fish sampling, using seines or dipnets. Only one or two fish of each species were collected in springs with fish.
- Invertebrates sampling, using hand nets for qualitative sampling and a small corer for quantitative sampling. Samples were preserved in the field and returned to the laboratory for sample sorting and invertebrate identification.
- Fishes were identified by Paulette Reneau and Sam Noble Oklahoma Museum of Natural History personnel. Invertebrate identification is ongoing.

RESULTS

Sixteen springs were surveyed (Table 1). Thirteen of the springs were in the Arbuckle area and included springs in the following counties:

- Johnston County: 4 springs
- Pontotoc County: 5 springs
- Coal County: 2 springs (1 of these was a sulphur spring)
- Murray County: 1 spring

The remaining springs were in sandstone areas east of Oklahoma City and were located in two counties:

- Lincoln County: 1 spring
- Pottawatomie County: 2 springs

Arbuckle springs are karst/limestone springs associated with the Arbuckle-Simpson aquifer. Springs emanating from the same water source should have very similar temperatures and, indeed, most of the Arbuckle springs are 18.0 to 18.5 ^{o}C (Table 2). Exceptions result from water being warmed by retention in a small reservoir (Wildcat Spring) or through water exchange with the adjacent Pennington Creek (unnamed spring: SPR04-02). The cooler temperatures of Sheep Creek Spring and the nearby unnamed

spring (SPR04-11) may signal a different source of water, as may the cooler temperature of Coal Cave Spring.

The pH among all Arbuckle springs is similar (6.9 to 7.3; Table 2), as is expected in a limestone area. Conductivity of most springs ranges between 485 and 660 µS/cm. Lowrance Springs had a lower conductivity and Viola Spring had a higher conductivity.

Rotten Egg Spring is a sulphur spring characterized by very high conductivity and a slightly higher temperature than the freshwater springs.

Spring discharge varied greatly, even between nearby springs. Discharge affects habitat 'space' and is related to the presence/absence of larger animals. Fish were present in 8 of the 16 springs and the discharge of springs with fish averaged 20.60 l/s (Table 1). Crayfish were more frequently encountered, inhabiting 11 of 16 springs and the discharge of springs with crayfish averaged 14.73 l/s. Crayfish may tolerate lower discharges than fish because they are benthic (and don't require an open water column) and burrow, which includes 'hiding' under rocks.

The sandstone springs include two springs with somewhat acidic waters (pH 6.0-6.6; Table 2) and low conductivity. The unnamed spring (SPR05-04) had higher pH and conductivity than the nearby Trevor Spring. Water temperatures of the sandstone springs tended top be lower than temperatures of the limestone springs.

Fish and non-juvenile crayfish have been identified, invertebrates have been separated from debris in most samples, and identification of invertebrates is ongoing.

Seven species of fish were found in the springs (Table 3); all were in Arbuckle springs. The mosquitofish *Gambusia affinis* was especially widespread and abundant. The central stoneroller *Campostoma anomalum* and young bluegill *Lepomis macrochiris* were found in a spring pool within the lower floodplain of Pennington Creek, and one mid-sized, probably stocked, smallmouth bass *Micropterus salmoides* was observed in a concreted pool at Wolf Spring. Other fish were darters, which comprised three species plus some individuals that were apparently hybrids. None of these fishes were included among the Species of Greatest Conservation Need.

Four species of crayfishes were found (Table 3). *Orconectes palmeri longimanus* is known from only Oklahoma and Arkansas, but is common within its range (G5, S5; NatureServe web site and Bergey et a.l 2005). It's presence in three spring in the Arbuckles may add two new county records (Coal and Pontotoc Counties). *Orconectes virilis* is common throughout the Arbuckles. *Orconectes nais* and *Procambarus simulans* are common and fairly widespread in Oklahoma. No species of Species of Greatest Conservation Need were included among these crayfishes.

Occasionally, cave-adapted crustaceans are encountered in springs. Two of the surveyed Arbuckle springs had cave isopods. One spring is associated with a cave that has an

Table 1. Spring sites sampled in 2004-2005.

Code	Site name	County	Month sampled	Discharge (l/s)	crayfish present?	fish present?	notes
SPR04-01	Lowrance Spring	Murray	Jun-04	90.62	yes	yes	
SPR04-02	unnamed	Johnston	Jun-04	2.34	yes	yes	between channels of Pennington Crk.
SPR04-03	Three Springs	Johnston	Jul-04	7.08	yes	yes	
SPR04-04	Wolf Spring	Johnston	Jul-04	3.17	yes	yes	
SPR04-05	unnamed spring	Pontotoc	Jul-04	0.67	yes	no	
SPR04-06	Rutherford Spring	Johnston	Jul-04	15.53	no	yes	
SPR04-07	Rotten Egg Spring	Coal	Jul-04	0.52	no	no	sulphur spring
SPR04-08	Viola Spring	Johnston	Jul-04	11.38	yes	no	
SPR04-09	Houghtubby Spring	Coal	Jul-04	0.08	no	no	
SPR04-10	Sheep Creek Spring	Pontotoc	Jul-04	44.04	yes	yes	fish were only below weir
SPR04-11	unnamed spring	Pontotoc	Jul-04	2.33	yes	no	in yard
SPR04-12	Wildcat Spring	Pontotoc	Aug-04	1.82	no?	yes	dammed up; fish stocked?
SPR05-01	Coal Cave Spring	Pontotoc	May-05	0.19	yes	yes	
SPR05-02	Doddehl Spring?	Lincoln	May-05	0.5	no	no	wooded
SPR05-03	Trevor Spring	Pottawatomie	May-05	0.076	yes	no	crayfish in springbox
SPR05-04	unnamed spring	Pottawatomie	May-05	0.15	yes	no	drips into pool from bluff

identified population of cave isopods; the second spring is a new location. The two specimens from the second await identification by a taxonomic expert.

2005-2006 PLANS

During 2005-2006, we anticipate surveying springs in under-surveyed parts of Oklahoma (e.g., Cleveland, McClain, Comanche, and Ellis Counties) and in the Ozark Plateau.

Acknowledgements

Magan Lersch, Barret Phillips, and Rebecca Zimola helped with field work and sample processing; Shane Jones identified the crayfish; and Paulette Reneau and personnel at the Sam Noble Oklahoma Museum of Natural History identified the fish. Janice Spurlock helped with project administration. We especially appreciate the landowners and managers who allowed access to springs.

Table 2. Characteristics of surveyed springs.

Site name	Temperature (°C)	pH	Conductivity (µS/cm)	Discharge (l/s)
Lowrance Spring	18.3	7.2	160	90.62
unnamed	20.6	7.2	544	2.34
Three Springs	18	7.2	513	7.08
Wolf Spring	18.1	7.3	485	3.17
unnamed spring	18.1	7.2	604	0.67
Rutherford Spring	18.3	6.9	660	15.53
Rotten Egg Spring	20.5	6.9	11,370	0.52
Viola Spring	missing	7.1	1580	11.38
Houghtubby Spring	18.5	7.1	620	0.08
Sheep Creek Spring	17.1	7.2	513	44.04
unnamed spring	17	7.2	522	2.33
Wildcat Spring	19.4	6.9	496	1.82
Coal Spring	16.8	7.1	576	0.19
Doddehl Spring?	14.8	6.6	207	0.5
Trevor Spring	16.2	6	101	0.076
unnamed spring	16.6	7.3	725	0.15

Table 3. Crayfish and fish species found during the 2004-2005 springs survey. (*O.* = *Orconectes*, *P.* = *Procambarus*, *G.* = *Gambusia*, *E.* = *Etheostoma*; *Etheostoma* sp. = unidentified specimens, probably hybrids).

Site name	Crayfishes	Fishes
Lowrance Spring	*O. virilis*	*G. affinis, E. radiosum, E. gracile, Etheostoma* sp.
unnamed	*O. virilis*	*G. affinis, Campostoma anomalum, E. spectabile, Lepomis macrochirus*
Three Springs	*P. simulans*	*E. spectabile*
Wolf Spring	*O. nais*	*G. affinis, E. spectabile, Micropterus salmoides*
unnamed spring	unidentified juvenile	
Rutherford Spring		*G. affinis*
Rotten Egg Spring		
Viola Spring	*O. palmeri longimanus*	
Houghtubby Spring		
Sheep Creek Spring	*O. palmeri longimanus*	*C. anomalum, E. radiosum, Etheostoma* sp.
unnamed spring	unidentified juvenile	
Wildcat Spring		*G. affinis*
Coal Spring	*O. palmeri longimanus, P. simulans*	*E. radiosum*
Doddehl Spring?		
Trevor Spring	*P. simulans*	
unnamed spring	*P. simulans*	

Part 2: Cave Inventories

METHODS

Caves were surveyed in both the Ozark Plateau and the Arbuckle uplift. In each cave surveyed, the fauna was inventoried using unobtrusive methods for bats, fish and invertebrates. Vertebrates and macroscopic invertebrates were counted visually with helmet-mounted lights, using snorkeling gear and dive lights for deep pools. Collections were limited to taxa that are impossible to identify on site, and where permitted (these were primarily small invertebrates). Voucher specimens were collected by hand, aspirator, or net, and preserved in the field. Samples were sent to the appropriate expert for identification. The turn-around time for these identifications is variable and we are still awaiting identifications.

Cave fish and Cave Crayfish Censuses

In caves with cave fish or cave crayfish, faunal censuses were performed using established procedures. Surveyors moved slowly upstream and counted individuals as they were sighted, using helmet lights and powerful diving lights. This method can produce fairly reliable quantitative population information with minimal impact on the cave habitats and their inhabitants.

RESULTS

Seven Ozark and four Arbuckle springs were inventoried in December 2004. Numerous animals were found, identified, and recorded. These included small cave crustaceans (amphipods and isopods), cave fish, cave salamanders, and bats, as well as a wide variety of other invertebrates (e.g., spiders, millipedes, mites, and springtails). Some of these taxa, those most closely related to the Species of Greatest Conservation Need, are listed in Tables 3 and 4.

The selection of Ozark caves for inventorying was based largely on historical but no recent records of the presence of cave crayfish (*Cambarus* spp.) or cave fish (*Amblyopsis rosae*). Although three caves had historical records of cave crayfish (*presumably C. tartarus* or *C. subterraneus*; the two cave crayfish species endemic to Oklahoma); cave crayfish were not found in any caves in this year's survey.

The importance of continuing surveys was demonstrated by the OT-19 surveys. Cave fish were most recently found in this cave in 1967 and were not seen during three surveys in the 1970's and 1980's. The early December 2004 survey by Graening, Fenolio, and Slay failed to find any cave fish; however, in a follow-up survey on 31 December 2004 by Wallace, Budde, and Eyler, 2 cave fish were spotted (historically, only one fish was recorded in each of 1954 and 1966, and these two earlier specimens were collected). Because crayfish, fish, and many other animals may move in and out of caves, additional surveys of these and other caves with historical records but no recent records are warranted. For crayfish, additional surveys may also allow species identification of unidentified populations.

Among the other cave-adapted invertebrates, only the crustacean amphipods (scuds) and isopods (sow bugs) are currently listed in the Species of Greatest Conservation Need.

Cave isopods were found in two Ozark caves and cave amphipods were likewise found in two caves. Field identification is unreliable unless there has been a history of a particular species in a cave; in which case all similar-appearing individuals are assumed to be that same species. Because the surveyed caves in the Ozarks did not have such an identification trail, one or two specimens were collected and have been sent to taxonomic experts for identification.

One cave had gray bats and the surveys were timed poorly for Ozark big-eared bats; therefore; although none were found, they likely inhabit some of the surveyed caves.

No cave crayfish, cave fish, or salamanders were found in the four caves surveyed in the Arbuckles. The Oklahoma cave amphipod was observed at one cave with previous records and a specimen of a cave amphipod (possibly the Oklahoma cave amphipod) was collected in a different cave for identification. An unidentified cave isopod was collected from one cave. Access to caves on private property has hindered this portion of the cave survey project.

2005-2006 PLANS

We will continue surveying caves in both the Arbuckle and Ozark areas, with an emphasis on caves with historical but no recent records of rare species and unsurveyed caves. We will trial the use of drift nets in Arbuckle caves (these caves tend to be smaller and less accessible).

Acknowledgements

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Table 3. Distribution records of cave-adapted taxa in 7 surveyed caves in the Ozark Plateau of Oklahoma. (+ = present; * = collected a minority of observed specimens for identification; ** = not observed in early December but found in late December 2004; *** = historical records with year last observed at the site).

Taxa: common names	Taxa	Ozark AD-6	Ozark AD-7	Ozark OT-?	Ozark DL-2	Ozark DL-64	Ozark OT-19	Ozark DL-21
cave invertebrates								
millipedes	Diplopoda		+	+*	+*			
harvestmen	Opiliones		+					
cave orb weaver	*Meta americana*	+						
cave crustaceans								
cave crayfish	*Cambarus* sp.					***(1968)	***(1984)	***(1987)
cave amphipod	*Stygobromus* sp.	+*	+*					***(2003)
cave isopod	*Caecidotea* sp.			+*			+*	***(2003)
Cave isopod	*Caecidotea tridentata*							
AL cave amphipod	*Stygobromus alabamensis*		***(1987)					
Ozark cave amphipod	*Stygobromus ozarkensis*					***(1991)		
OK cave amphipod	*Allocrangonyx pellucidus*							
cave fish	*Amblyopsis rosae*						+**	
salamanders								
Cave salamander	*Eurycea lucifuga*		+		+	***(1991)		
Dark-sided salamander	*E. longicauda melanopleura*		+					
Grotto salamander	*Typhlotriton spelaeus*							***(2003)
Slimy salamander	*Plethodon albagula*		***(1971)					
bats								
Eastern pipistrelle	*Pipistrellus subflavus*		+	+	+	+		***(2003)
Big brown bat	*Eptesicus fuscus*		+					
Gray bat	*Myotis grisescens*	***(1971)	+	***(1983)				
Ozark big-eared bat****	*Corynorhinus townsendii ingens*	***(uncertain)	***(1988)					

Table 4. Distribution records of cave-adapted taxa in 7 surveyed caves in the Arbuckle Uplift. (+ = present; * = collected a minority of observed specimens for identification; *** = historical records with year last observed at the site)

Taxa: common names	Taxa	PN-1	MU-1	MU-2	MU-3
cave invertebrates					
millipedes	Diplopoda	+*	+		
harvestmen	Opiliones			+	
cave orb weaver	*Meta americana*				
cave crustaceans					
cave crayfish	*Cambarus* sp.				
cave amphipod	*Stygobromus* sp.				
cave isopod	*Caecidotea* sp.		+*		
Cave isopod	*Caecidotea tridentata*	+			***(1964)
Alabama cave amphipod	*Stygobromus alabamensis*				
Ozark cave amphipod	*Stygobromus ozarkensis*				
Oklahoma cave amphipod	*Allocrangonyx pellucidus*	+	***(1995);+?*		
cave fish	*Amblyopsis rosae*				
salamanders					
Cave salamander	*Eurycea lucifuga*				
Dark-sided salamander	*E. longicauda melanopleura*				
Grotto salamander	*Typhlotriton spelaeus*				
Slimy salamander	*Plethodon albagula*				
bats					
Eastern pipistrelle	*Pipistrellus subflavus*		+		***(1971)
Big brown bat	*Eptesicus fuscus*			+	
Gray bat	*Myotis grisescens*				
Ozark big-eared bat****	*Corynorhinus townsendii ingens*				

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