The Missouri Cave Life Survey

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Abstract

The purpose of this project is to assess the status of common cave-dwelling animals in Missouri. The Missouri Department of Conservation began systematic surveys of cave life in 1978. James E. and Treva Gardner visited 436 caves and 10 springs, where they collected specimens for identification, recorded observation, and counted vertebrates. The invertebrate data were published by James E. Gardner (1986). The vertebrate count data are the focus of the current study. We incorporated Gardner's records on 483 species into the Missouri Biospeleological Database from which we produced candidate lists of caves to visit in all seasons and from a wide geographic area. We obtained a "Partnerships in Wildlife" grant from the U. S. Fish and Wildlife Service to conduct follow-up surveys of 40 caves, utilizing volunteers from the Missouri Caves and Karst Conservancy, Missouri Western State College, and the University of Missouri/Columbia. Dozens of cavers were trained to identify and record species and other observations in the caves using a pictorial guide, data forms, rulers, and digital thermometers. A water sampling program is being led by Dr Robert Lerch. Samples are analyzed for typical parameters and selected contaminants. Prelilminary data will be presented, and at project's end, we will provide a summary report on the status of eastern pipistrelle bats, grotto salamanders, pickerel frogs, and other species. The results will be used for making land management decisions regarding cave communities.

Introduction

The purpose of this project is to assess the status of common cave-dwelling animals in Missouri. This study is an example of the Missouri Department of Conservation's mission to monitor the status of wildlife populations in the state. The Missouri Department of Conservation began systematic surveys of cave life in 1978. James E. Gardner and Treva Gardner visited 436 caves and ten springs, where they collected specimens for identification, recorded observations, and counted vertebrates. The invertebrate data were published by James E. Gardner (1986). An important baseline study on cave bats was begun by LaVal and LaVal (1980). Gardner's vertebrate data were not published, and are the focus of the current study. In this study we also record observations of invertebrates.

Materials and Methods

We incorporated Gardner's published and unpublished records into the "Missouri Biospeleological Database," which now contains information on 843 species and more than 800 caves. We produced candidate lists of caves to revisit. More than 200 caves had count data for at least one species. Caves were prioritized for higher counts, multiple species counts, and species of special interest (such as the grotto salamander, *Typhlotriton spelaeus*). A semifinal list of 81 caves was then evaluated by a committee of biologists and cavers to obtain a final selection of 40 caves with a representative geographic and seasonal spread.

We obtained a "Partnerships for Wildlife" grant from the U.S. Fish and Wildlife Service to conduct follow-up surveys of these 40 caves, utilizing volunteers from the Missouri Caves and Karst Conservancy, Missouri Western State College, and the University of Missouri/Columbia. This type of grant requires a sponsoring agency (Missouri Department of Conservation) and volunteers, who contribute time and expenses to carry out a wildlife study. The hours and travel expenses are carefully recorded to meet or exceed the minimum contribution required to obtain the grant. In this grant $20,000 worth of work will be contributed by Missouri Department of Conservation, Missouri Caves and Karst Conservancy, and two researchers, part of which is used to pay a part-time salary for the Project Leader (Lawrence Ireland), who schedules and leads the trips, quality-controls the field work and manages data. William R. Elliott, cave biologist for Missouri Department of Conservation, is the Project Director and designer.

The study began in July 2001, and will end in June 2002. Training sessions were held on two weekends in July and September 2001, at Reis Biological Station, operated by Saint Louis University, near Steelville, Missouri. Forty-five cavers were trained by the authors and David C. Ashley, Missouri Western State College, to identify and record species and other observations in the caves.

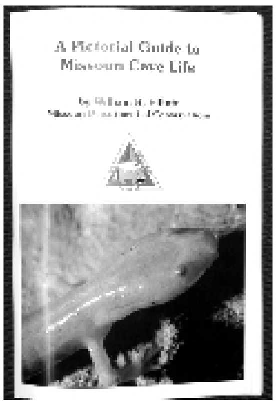

Figure 1. *This identification guide was desktop published for team members to use in the field. The Grotto salamander,* Typhlotriton spelaeus, *is on the cover.*

Training included slide lectures to acquaint cavers with 66 recognizable species and subspecies, their ecology, and methods of identifying roosting bats without touching them. However, more than 800 different species have been recorded from Missouri caves, so it is not feasible for the volunteers to accurately identify most species. Trips were quality-controlled by experienced naturalists who led the teams. Team members did not handle or collect fauna, but the leaders were authorized to collect small invertebrates when needed for identification.

We provided a desktop-published pictorial guide to the species for field use (Figure 1). Images and text from this guide may be seen in the Biospeleology web site under "Missouri Cave Life," at: http://www.utexas.edu/depts/tnhc/.www/biospeleology.

Rulers were provided so that teams could measure animals without handling them. In addition, high-resolution digital cameras were used to document some of the species and the survey work. We captured interesting and potentially valuable macrophotographs of color variation in some amphibians. The digital photos were shared via e-mail with biologists who identified or confirmed identifications of the species.

Students were taught how to use a field-tested data form (Attachment 1 and 2), which tied the cave life survey to numbers placed on a cave map, thus pinpointing locations of observations. The form has fields to record the cave's name, time in and out, and directions to and location of the cave. For purposes of satisfying the terms of the grant, team members recorded their names and the time and mileage contributed for that trip. The team collected trash in the cave and counted it up at the end of the trip. At the end of the trip the team evaluated the cave for six types of use and abuse, comparing to the many caves they have visited (Attachment 1).

The back of the form (Attachment 2) is a spreadsheet in which each row is a new observation or a water sample, or a continuation of the previous row if space is needed for tallying or for notes. A record number is marked on the cave map in the cave for each different species' occurrence, but teams may pool data within a 50-meter reach of the cave. There are columns for the place in the cave, distance from the entrance, type of habitat, temperature, number observed, and the initials of the observer or collector.

We purchased four Taylor digital pocket thermometers for the study. We calibrated the thermometers in a freezing water bath to within 0.1°F of each other, and they were periodically checked against each other in water to see if they still agree (Figure 2). In November 2001, we added a wet-dry bulb psychrometer to the study to record relative humidity because a long-term drought was affecting the humidity in many caves.

Figure 2. *Jeff Briggler uses a Taylor digital pocket thermometer.*

Since many bats and amphibians use caves seasonally, we revisited each cave within two weeks before or after the original date that it was visited. The original surveys were carefully recorded by Gardner and we tried to match the time and effort that were spent in each cave.

Typically each team had a leader with a camera; a data recorder; "spotters," who traveled abreast to find fauna on left and right walls, ceiling, and floor; and members who were responsible for the trash bag and a rugged container that had a digital pocket thermometer, rulers, and small items. The roles were sometimes swapped to allow team members to learn different aspects of the study (Figure 3).

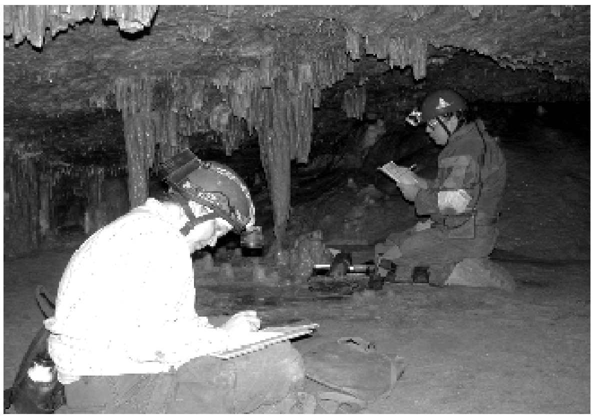

Figure 3. *Sally Kula and Bill Elliott collecting data.*

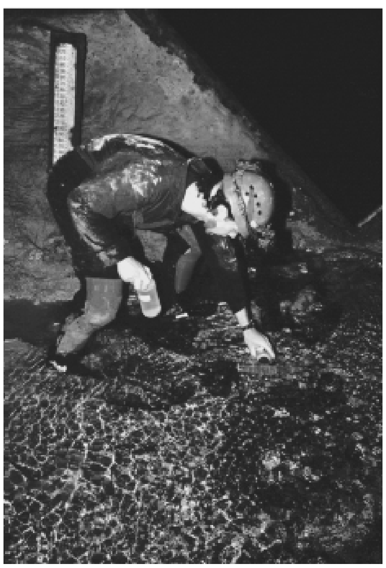

Figure 4. *Bob Lerch takes a water sample for analysis.*

Robert Lerch, U.S. Department of Agriculture and the University of Missouri/Columbia, led a water sampling program in conjunction with our study. Teams were issued prenumbered, analytically clean water sample bottles (Figure 4). Samples were sent on ice to Dr Lerch's laboratory, where they are being analyzed for typical water-quality parameters and selected contaminants. Those results are not yet available.

Results

The 14 caves studied to date in 2001 are given in Table 1. Volunteers contributed a total of 377 man-hours and 3,570 miles to carry out the 14 surveys we have done, for a mean of 27 man-hours and 255 miles per cave trip. These figures do not include paid time and mileage contributed by the agencies and universities involved. About one-third of the trainees have participated in trips so far. Reimbursements to volunteers for their work are all contributed to the Missouri Caves and Karst Conservancy for future cave conservation projects.

Table 1. Caves studied to date.

County	Cave	Date
Camden	Moles Cave	09/07
Carter	Blue Spring Cave	10/10
Carter	Lower Camp Yarn Cave	07/10
Carter	Secesh Cave	07/23
Christian	Math Branch Cave	08/09
Crawford	Jagged Canyon Cave	09/22
Crawford	Mud River Cave	09/22
Madison	Marsh Creek Cave #1	08/12
Oregon	Bockman Spring Cave	10/06
Oregon	Willow Tree Cave	10/06
Pulaski	Ryden Cave	08/10
Shannon	Marvel Cave	08/30
St. Louis	Woods Cave	07/17
Wright	Bill Dyer Lead Mine Cave	07/28

Preliminary data from 14 caves are presented, involving 17 common species and subspecies: cave salamander (*Eurycea lucifuga*, Figure 5), dark-sided salamander *(Eurycea longicauda melanopleura*), western slimy salamander (*Plethodon glutinosus or albagula*), Ozark salamander (*Plethodon angusticlavius*), southern redback salamander (*Plethodon serratus*), grotto salamander (*Typhlotriton spelaeus*), pickerel frog (*Rana palustris*, Figure 6), green frog (*Rana clamitans*), dwarf American toad (*Bufo americanus charlesmithi*), eastern American toad (*Bufo americanus americanus*), eastern pipistrelle bat (*Pipistrellus subflavus*, Figure 7), big brown bat (*Eptesicus fuscus*, Figure 8), little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), gray bat (*Myotis grisescens*, Figure 9), Indiana bat (*Myotis sodalis*), and eastern phoebe (*Sayornis phoebe*). Other species, such as the herald moth (*Scoliopteryx libatrix*, Figure 10), will be evaluated in the final report.

Figure 5. *The Cave salamander,* Eurycea lucifuga, *is commonly seen in wet Missouri caves.*

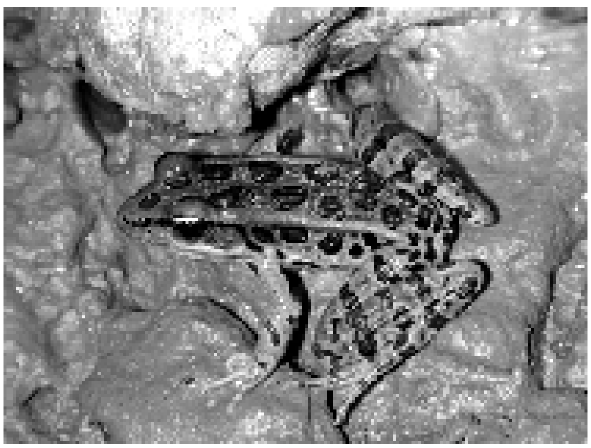

Figure 6. *The Pickerel frog,* Rana palustris, *takes refuge in Ozark caves during winter and drought.*

Figure 7. *The Eastern pipistrelle bat,* Pipistrellus subflavus, *is tolerant of humans, but we surveyed it to see if heavy traffic has reduced its use of caves.*

Figure 8. *The Big brown bat,* Eptesicus fuscus, *is a typical winter resident in chilly entrance areas.*

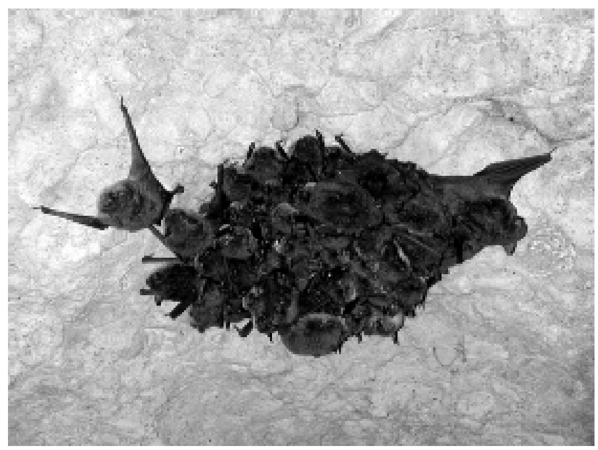

Figure 9. *A small, late summer cluster of Gray bats,* Myotis grisescens. *This endangered species is recovering in many caves where they are protected well, but may never reach its former numbers again.*

A bar graph (Figure 11) depicts the pooled count data for the above species from the first 14 caves visited. Black bars represent the initial surveys done around 1980, and hatched bars represent the current study. These are only preliminary data, which probably are not sufficient to warrant the statistical analysis that we plan to do at the conclusion of the study.

In general, however, since 1980 there has been a noticeable reduction in counts for many species. This is particularly true for grotto salamander, big brown bat, little brown bat, Indiana bat, and eastern phoebe. Gray bats are not graphed because the data would have greatly

Figure 10. Scoliopteryx libatrix, *the Herald Moth, overwinters in eastern U.S. caves.*

changed the Y-axis of the overall graph. Thirty-seven gray bats were observed in the first 14 caves in the earlier study, but we found about 2,747 gray bats in the current study, mostly from discovering an undocumented maternity colony in one cave. The latter discovery is good news for this species, which is slowly recovering in sites where it is well-protected (Elliott and Clawson, 1999).

Discounting gray bats, whose counts would obscure trends in the other data, total counts were down 34% (262 versus 172), amphibians were down 23% (165 versus 127), and bats were down 54% (93 versus 43). However, counts of pickerel frogs, which take refuge in wet caves in large numbers during drought and winter, held steady. Counts for a key species, the stygobitic grotto salamander, were down 67% (24 versus 8). Eastern pipistrelles, the most commonly seen bat, were up 233% (15 versus 35), while big brown bats were down 93% (54 versus 4).

Discussion

We emphasize that these are preliminary results only. Some species are not accurately represented in this data set because of their seasonal use of caves, for example big brown bats, which hibernate in caves but are not usually found there during the July 10 through October 10 time period of this data set. We expect that some of the "trends" will disappear or reverse after data for a full year are collected.

In one species with less seasonality, however, we see a suggestion of a downward trend that may be the result of three years of drought in the Ozark Region. Because of the drought, stygobitic grotto salamanders may have burrowed into moist, inaccessible microhabitats where we could not observe them, or they could have declined. Many cave streams are at extreme lows as we write this paper. Of the five caves where we counted grotto salamanders, three counts were down, one was up, and the species was found for the first time in one cave.

That drought may have affected some of the cave fauna is suggested by the apparent trend in two frogs, which take refuge in wet caves

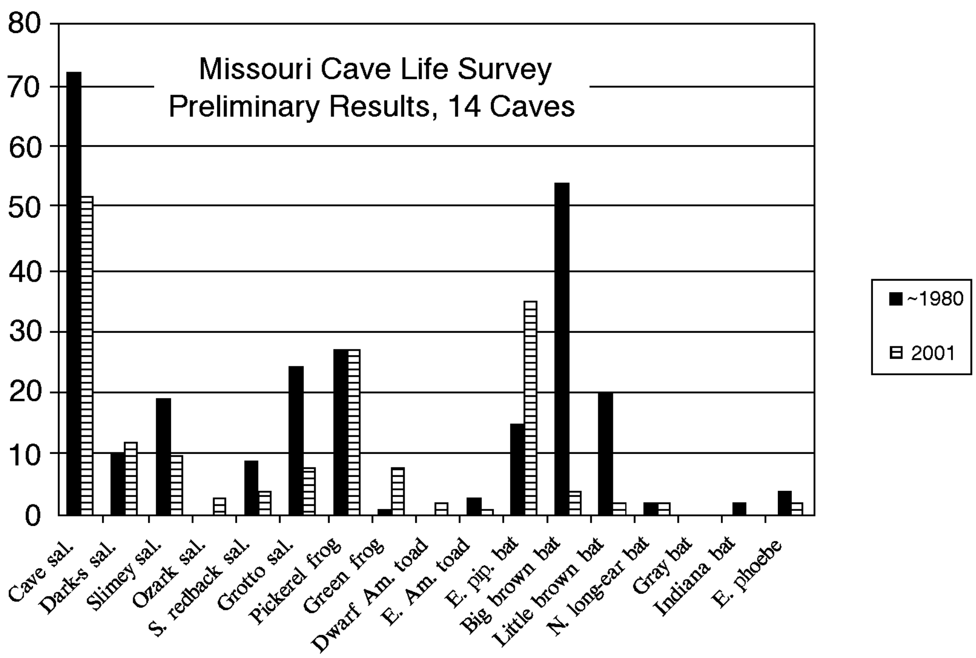

Figure 11. Graph of preliminary results from 14 caves and 17 species. Grey bats are omitted (See Results paragraphs).

during drought and winter. Pickerel frogs held steady (27 and 27), and green frogs increased (1 versus 8). For these frogs, relatively dry caves would still be wetter than dry, epigean habitat.

Conclusions

We are concerned that a key species, the grotto salamander, may have declined severely in Missouri, possibly as much as 67%. At the end of our study we may have sufficient data to confirm if this decline is true and to determine if drought, overuse of some caves, or both have contributed to such a decline. The grotto salamander formerly was a species of concern in Missouri, but it was removed from the state list in 1999.

Caves are not just habitat for troglobites and stygobites. Many trogloxenic and troglophilic species utilize caves for refuge, mating, or nesting. If common species have declined in caves, it would be important to identify if humans have caused the declines and to restore habitat. This study may not determine all the causes of declines, but it may provide direction for further study of certain species or land management activities that could restore wildlife populations in caves.

Other benefits of this study are the knowledge and resources gained by cavers and the Missouri Caves and Karst Conservancy for future projects. The booklet, data form, and procedures will be used in other projects. We probably will add new caves to the study to increase our baseline information for the future.

Acknowledgments

We are grateful to the U.S. Fish and Wildlife Service for their support of this study. David Urich, Natural History Division, Missouri Department of Conservation, was essential in making this grant possible. Data for designing this study were obtained from the Natural History Division's Missouri Biospeleological Database. We thank James E. Gardner for his contribution of data. Dr David C. Ashley, Missouri Western State College, and Dr Robert Lerch, U.S. Department of Agriculture and the University of Missouri, Columbia, provided essential training and field work. We thank Saint Louis University for the use of Reis Biological Station for training and planning. We are grateful to the USDA-Forest Service, National Park Service (Scott House), Missouri Department of Natural Resources (Parks Division), and private landowners for access to caves and staff time. Missouri Department of Conservation biologists Brian Loges and Rob Chapman assisted in the field. A hearty thanks goes to the Missouri Caves and Karst Conservancy, whose officers and members volunteered many hours of hard work, food, and transportation for this study: Brian Andrich, Mark Andrich, David Ashley, Hal Baker, Bill Bantel, Jonathan Beard, Robert Bilbrey, Michael Carter, Jeffery Crews, Jim Donley, John Drew, Deb Dumont, Rick Haley, Tim Harrison, Gary Hart, Todd Heintz, Peddgie Heinz, Scott House, Amy Johnston, Rusty Jones, Steve Kaub, Jennifer Kinkead, Cheryl Kinsel, Sally Kula, Lorely Lather, Ron Lather, Robert Lerch, Alicia Lewis-Miller, Matt Marciano, Brian McAllister, Cheryl McEnany, Adele Ming, Philip Newell, Tom Panion, Wayne Pierce, James Potts, Joe Roberts, Jack Rosenkoetter, Jim Ruedin, Jo Schaper, Joe Sikorski, Robert Stratford, Trevor Stroker, Carl Thayer, Lisa Thayer, Don Toole, Jason Trussell, Joe Walsh, Lois Walsh, David Webster, and Rita Worden.

Literature Cited

Elliott, William R. and Richard L. Clawson. "Temperature data logging in Missouri bat caves." *Proceedings of the 1999 National Cave and Karst Management Symposium, Chattanooga, Tennessee (*in press).

Gardner, James E. 1986. "Invertebrate fauna from Missouri caves and springs." *Natural History Series No. 3*. Missouri Conservation Commission. 72 pp.

LaVal, R.K., and M.L. LaVal 1980. "Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species." *Terrestrial Series No. 8,* Missouri Department of Conservation, Jefferson City, Missouri. 53 pp.

Attachment 1

MDC/MCKC CAVE BIOINVENTORY FORM

TIME IN: TIME OUT: DATE:

SHEET#: OF:

COUNTY: CAVE NAME:

AREA:

OWNER: MSS#:

ADDRESS:

CITY: STATE: ZIP:

DIRECTIONS (use highway numbers, odometer distances, landmarks, etc.):

UTM COORDINATES (if possible): E N
DATUM (circle one): NAD27 NAD83
UNCERTAINTY OF LOCATION: (radius in m, EPE, or no. of satellites on GPS receiver):

TEAM MEMBERS, HOURS FOR EACH and MILEAGE FOR DRIVERS (include prep., travel and clean-up) (e.g. Joe Caver – 7h, 220 mi.):
LEADER:
RECORDER:
TOTAL MAN-HOURS: TOTAL MILES:

EVALUATION OF CAVE USAGE—Describe damage (type, age, distribution, etc.) and circle corresponding number on scale at right that describes the cave's overall degree of human impact – 0=no damage, 5=severe. Please remove trash and make notes on signs.

1. BONFIRES / CAMPING:0 1 2 3 4 5

2. LOOTING / DIGGING:0 1 2 3 4 5

3. GRAFFITI:0 1 2 3 4 5

Attachment 2

MDC/MCKC CAVE BIOINVENTORY FORM

Note: Use a new line for each different place that a species is observed or a water sample is taken (usually you may merge places within 50 m of each other). Record numbers can be marked on cave map. Write comments on line(s) under each record.Use additional sheets as necessary.

Record No.	Species (describe, if unknown) or Water Sample No.	Place in Cave	Dist. from Ent. (in m)	Habitat	Temp (air or water)	Number Observed (note immatures /larvae, if app.)	Observer/ Collector