Reducing Conservation Data Gaps:
Faunal Inventory of 20 Arkansas Karst Species of Greatest Conservation Concern

Project Summary

The proposed project will directly address the 2007 implementation priority for comprehensive cave fauna inventory. The objectives of the project are to conduct focused biological inventories in at least 50 karst habitats, characterize in-cave environmental conditions and microhabitat where these karst species occur, update species distribution maps with new information, update potential threats analysis with new information, and provide high resolution digital photographs of as many of these 20 karst species as possible for inclusion in Arkansas Wildlife Action Plan and for potential educational opportunities.

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The total cost of this project will be $68,182.

The Nature Conservancy respectfully requests $34,091 to complete this project and will provide the remaining $34,091 as match (50%).

FUNDING PRIORITY ADDRESSED BY PROPOSAL

This proposal addresses the implementation need for a comprehensive faunal inventory of 20 Arkansas karst invertebrate species of greatest conservation concern outlined by the 2007 State Wildlife Action Plan Steering Committee.

ECOREGION WHERE PROJECT WILL BE CONDUCTED

The project described by this proposal will be conducted in the Ozark Mountains and Boston Mountains ecoregions.

CONSERVATION PRIORITY ADDRESSED BY PROPOSAL

Specifically, the project will address the monitoring and data gap need identified for these 20 karst species. Baseline information on species distribution and populations collected during this study will be used to strengthen and clarify conservation strategies for each species.

BACKGROUND

Karst is a terrain, generally underlain by limestone or dolomite, in which the topography is chiefly formed by the dissolving of rock, and which may be characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves (USEPA 1999). Often, species living in karst are specially adapted to rigorous environmental conditions that occur there. Because light is absent and food limited, many species exhibit morphological, physiological, and behavioral characteristics that make them well suited for existence in subterranean habitats. These organisms are often among the rarest and most unique species inhabiting karst, and they are important components of species conservation planning efforts outlined in the Arkansas Wildlife Action Plan. Unfortunately for Arkansas' karst species, too little information concerning species distribution and ecology is known to effectively conserve these species.

GOALS AND OBJECTIVES

By 2009, we propose to strengthen and clarify the conservation strategies for 20 Arkansas karst species of greatest conservation concern (Table 1) by reducing the monitoring and data gap needs identified by the 2007 State Wildlife Action Plan Steering Committee. Our objectives are: 1) conduct focused biological inventories in at least 50 karst habitats (caves, mines, and springs) to determine the presences of additional populations of the 20 karst species, 2) characterize in-cave environmental conditions and microhabitat where these karst species occur, 3) update species distribution maps with new information, 4) update potential threats analysis with new information, and 5) provide high resolution digital photographs of as many of these 20 karst species as possible for inclusion in Arkansas Wildlife Action Plan and for potential educational opportunities.

METHODS

Biological Inventories – Objectives 1 & 2

Biological inventories will be conducted in at least 50 karst habitats (caves, mines, and springs) across northern Arkansas (Figure 1). Records will be kept of all biota encountered, including species not limited to karst (troglophilic and epigean species). The location of organisms will be recorded, and ecological information (such as habitat zone, temperature, humidity, microhabitat, and food source) will be noted. Vertebrates will not be collected since they can field identified. Representative specimens of invertebrate species will be hand collected during visual inspection or by bait trapping. Baited trapping techniques may include: pitfall traps, minnow traps, crayfish traps, and copepod traps. Plankton nets, kick nets and/or vacuum samplers may be used where possible for sampling other macroinvertebrates. Collected invertebrates will be identified to the lowest possible taxon, and invertebrates that are not identifiable to specific level will be classified as morphospecies. Identification to species level will be conducted by contracted taxonomists.

Detailed Methodology of Visual Searches and Pitfall Trapping

Using intensity of light, each cave will be divided into three habitat zones: entrance, twilight, and dark. Entrance zones will be designated as habitat from the dripline to the point inside the site where a light meter (Extech® Instruments, Foot Candle/Lux Meter, ± 5%) measures less than one lumen. Twilight zones will consist of habitat with a light measurement of less than one lumen to zero. Zero light will be defined as the point at which alternating black and white colors on a revolving secchi disk are no longer discernable. Habitats beyond this point will be categorized as dark zones.

Visual inspection of floors, walls, and ceilings of entrance, twilight, and dark habitats for invertebrate and vertebrate fauna will be conducted alongside placement of pitfall traps. If clusters of bats (most likely gray bats or Indiana bats) are observed, researchers will immediately leave the cave and contact Blake Sasse, Arkansas Game & Fish Commission, for identification. Baited pitfall traps will be placed opportunistically in sites which have dark zones. Traps consist of 30 mL, straight-sided, wide-mouth Nalgene® jars, filled with 5 mL of propylene glycol. The traps will be baited with 5 mL of slightly rancid limburger cheese spread smeared around the inner lip of the jars. For each trap, a hole will be dug in the substrate deep enough to allow placement with the lip of the jar just at or below the floor level. Considerable care will be taken to ensure that the substrate into which the trap is placed, usually clay, covers the lip of the jar, so that the top of the jar does not serve as a barrier for smaller fauna entering the trap. A 10 cm x 10 cm x 5 cm box constructed of 6.3 mm mesh hardware cloth will be placed over each trap to reduce the potential for trap disturbance by vertebrates such as *Peromyscus* spp., *Neotoma floridana*, and *Procyon lotor*. Traps will remain in place for 1-3 days.

The following measurements will be recorded in entrance, twilight, and dark habitats and during during pitfall placement. Measurements for surface habitats will be recorded 5 m outside of the drip line. Soil and air temperatures will be measured with a digital thermometer (Taylor®, Pocket Digital Thermometer, -50°/260°C, ±1.5°C). Soil temperatures will be measured at 2 cm substrate depth, while air temperatures will be recorded at 2 cm and 1 m height above floor. Relative humidity at 2 cm height above floor will be calculated from wet bulb /dry bulb temperature data taken with a battery operated psychrometer (Industrial Instruments & Supplies, Psychro-Dyne, -15°/45°C, ±0.3°C) and barometric pressure readings taken from the closest permanent weather station. Time of day will be noted at the start of each sampling trip, and this time will be used to get the closest 15 minute level of barometric pressure. Relative humidity will be calculated following Barnes (2005).

Updated Species Distribution Maps – Objective 3

New species occurrence locations for each of the 20 karst species will be attributed to the 12-digit HUCs where they are documented to occur resulting in updated range maps for each species.

Updated Potential Threat Assessment – Objective 4

Updated species maps will be assessed for potential threats to these species. Threats will be GIS-derived water quality indices. They will include percent of the HUC in agricultural land-use, density of animal production houses, road density, human population density, and percent of the HUC that is impervious.

High Resolution Digital Photography – Objective 5

High resolution digital photographs will be taken of each of as many of these 20 karst species for which we are able to find and retain long enough to photograph. These images will be included as a separate appendix (on CD and/or DVD).

PRODUCTS AND OUTCOMES

Deliverables

1. Monitoring methodology entered into the Natural Resources Monitoring Partnership.
2. Updated distribution information, including point locations for new sites, on Arkansas karst species of greatest conservation concern from first 25 karst habitats inventoried.
3. Characterization of in-cave environmental conditions and microhabitats for these species occurring in first 25 karst habitats inventoried.
4. High resolution digital images of karst species photographed in the first 25 karst habitats inventoried.
5. Updated distribution information, including point locations for new sites, on Arkansas karst species of greatest conservation concern from second 25 karst habitats inventoried.
6. Characterization of in-cave environmental conditions and microhabitats for these species occurring in second 25 karst habitats inventoried.
7. High resolution digital images of karst species photographed in the second 25 karst habitats inventoried.
8. Updated species range maps for the 20 karst species.
9. Updated potential threats assessment for the 20 karst species.
10. Update karst species information in the Arkansas Comprehensive Wildlife Conservation Strategy database.
11. Produce final report.
12. Present results of project to scientific community (probably during AGFC forum) in Fall 2009.
13. Present results of project as part of 2-3 public lectures.

Expected Benefits

The discovery of additional populations of these 20 karst species may justify moving some species to lower conservation priorities, thereby refocusing efforts on species with greater conservation needs. Data on environmental conditions and microhabitat collected during this study may provide better insight into conserving the habitats where these species occur. Observations on other fauna found in the karst habitats may strengthen conservation strategies for other species of greatest conservation need (Table 1) or may preclude the need to list future species. It is quite possible that species previously unknown to science will be discovered. Updated species range maps and potential threats assessment will help identify priority areas for on-the-ground conservation actions. Finally, high resolution photographs of these species will be available for educational uses and to publicize and raise the profile of the Arkansas Wildlife Action Plan with elected officials, policy makers, interested parties, and the general public.

Measures of Success

Several performance measures will be used to measure success of this project, and these measures can be used to indicate results to resource managers, scientists, and non-scientists.

- For each of the 20 species, percent (%) increase in new sites over historic sites will be calculated.
- For the total species, percent (%) increase in total new sites over total historic sites will be calculated.
- For species distribution maps, the percent (%) increase of additional area over historic distribution will be calculated.
- For high resolution photography, the total number of photos will be calculated.

USE OF EXISTING RESOURCES

The Nature Conservancy is currently producing species range maps for all 36 karst species of conservation concern in Arkansas, and these maps will be the basis for selecting sites to survey for new populations of karst species. In addition, TNC has partnerships in place (USFWS, AGFC, USFS, and USNPS) to conduct biological inventories on state and federal properties in Arkansas. Field work will be

assisted by agency personnel when visiting caves on conservation areas such as Madison County WMA, Gene Rush/Buffalo River WMA, USFS Weddington Unit, USFS Sylamore District, and Buffalo National River. We are also in partnership with several caving clubs (Association for Arkansas Cave Studies, Boston Mountain Grotto, and M.O.L.E.S.) to assist with accessing caves on private lands. TNC has also established cooperative relationships with many of the national and international taxonomic specialists who will contribute to the identification of species.

BUDGET

The total cost for this project will be $68,182. The Nature Conservancy respectfully requests $34,091 (50%) from the Arkansas Game and Fish Commission through the State Wildlife Grant and will provide $34,091 (50%) as match. This will be a fixed price agreement. TNC currently has an accepted 25% Negotiated Indirect Cost Rate with USFWS, therefore indirect costs are calculated at 25% rather than 10%. An itemized list of deliverable tasks including the amount of payment to be received by The Nature Conservancy at the completion of each task is outlined below. Budget expenses supporting these deliverables include personnel salaries/benefits, travel, supplies, (including in-cave sampling materials and lab supplies such as vials, preservatives, etc.), contracts, equipment, and other project related expenses.

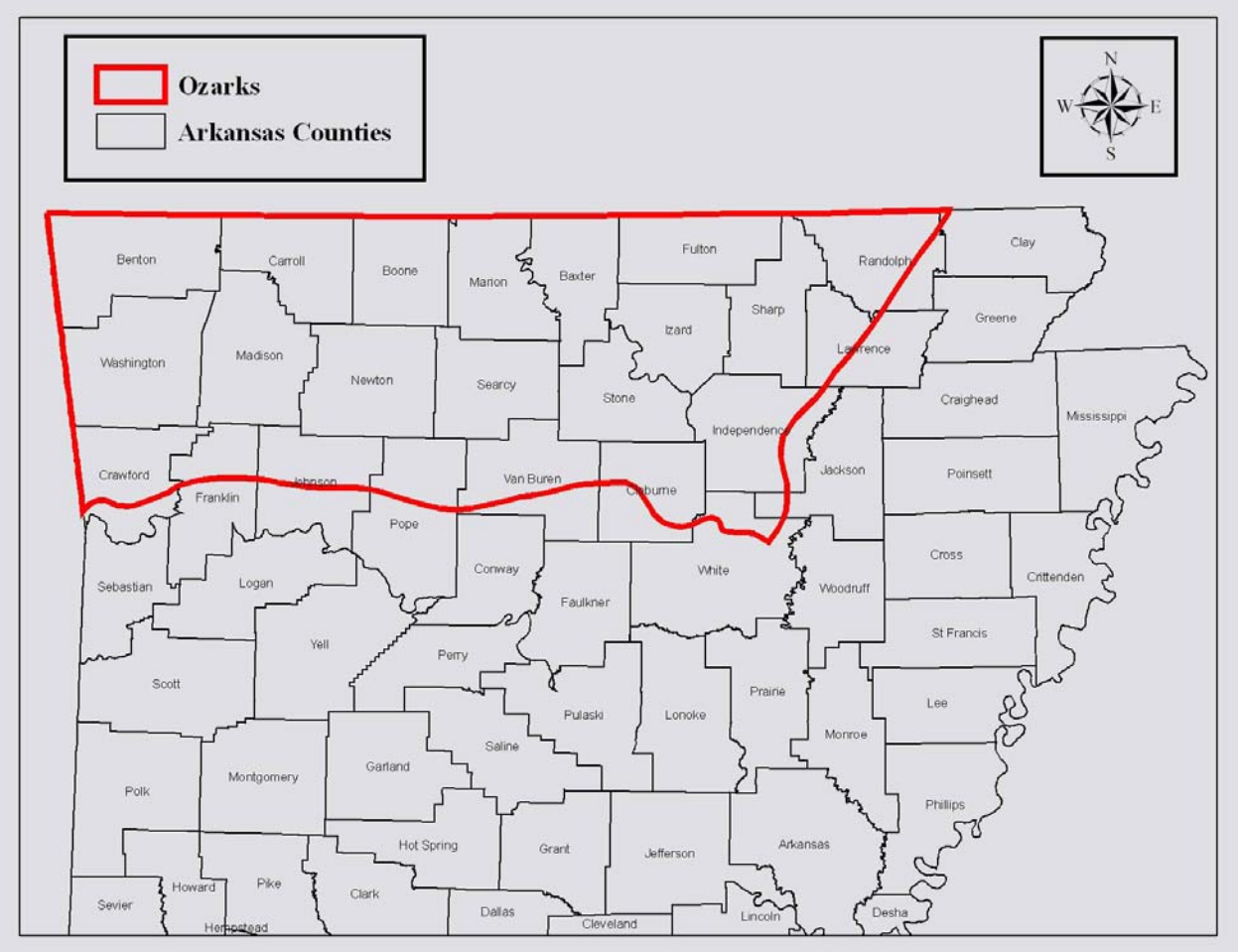
Deliverable	***Start Month**	***End Month**	**AGFC Cost**	**TNC Match**	**Total Cost**
1) Enter monitoring methodology	Month 1	Month 2	$100.00	$100.00	$200.00
2) Update distribution information 1st 25 karst habitats	Month 1	Month 9	$4,000.00	$4,000.00	$8,000.00
3) Characterization environmental conditions, 1st 25 karst habitats	Month 1	Month 9	$4,000.00	$4,000.00	$8,000.00
4) Produce high resolution images 1st 25 karst habitats	Month 1	Month 9	$2,000.00	$2,000.00	$4,000.00
5) Update distribution information 2nd 25 karst habitats	Month 10	Month 18	$4,000.00	$4,000.00	$8,000.00
6) Characterization environmental conditions, 2nd 25 karst habitats	Month 10	Month 18	$4,000.00	$4,000.00	$8,000.00
7) Produce high resolution images 2nd 25 karst habitats	Month 10	Month 18	$2,000.00	$2,000.00	$4,000.00
8) Update Species Range Maps	Month 18	Month 20	$1,650.00	$1,650.00	$3,300.00
9) Update Potential Threats	Month 18	Month 20	$1,650.00	$1,650.00	$3,300.00
10) Update CWCS database	Month 23	Month 24	$473.00	$473.00	$946.00
11) Produce Final Report	Month 21	Month 24	$3,000.00	$3,000.00	$6,000.00
12) Present to public/scientific community	Month 13	Month 24	$400.00	$400.00	$800.00
Direct Costs			**$27,273**	**$27,273**	**$54,546**
Indirect Costs (25%)			**$6,818**	**$6,818**	**$13,636**
Total Project Costs			**$34,091**	**$34,091**	**$68,182**

*Estimated, subject to change based on unforeseen or variable circumstances

Table 1. Arkansas Karst Species of Greatest Conservation Need

Class	Common Name	Scientific Name	Weight	Priority Score
Species directly benefiting from this study	cave obligate harvestman	*Crosbyella distincta*	Obligate	**65**
	cave obligate harvestman	*Crosbyella roeweri*	Obligate	**65**
	cave obligate millipede	*Trigenotyla parca*	Obligate	**65**
	cave obligate pseudoscorpion	*Apochthonius diabolus*	Obligate	**65**
	cave obligate pseudoscorpion	*Apochthonius titanicus*	Obligate	**65**
	cave obligate springtail	*Schaefferia alabamensis*	Obligate	**65**
	bat cave isopod	*Caecidotea macropropoda*	Obligate	**57**
	springtail	*Pseudosinella dubia*	Obligate	**50**
	cave obligate isopod	*Caecidotea simulator*	Obligate	**42**
	cave obligate planarian	*Dendrocoelopsis americana*	Optimal	**42**
	isopod	*Caecidotea dimorpha*	Obligate	**42**
	isopod	*Caecidotea oculata*	Obligate	**42**
	isopod	*Caecidotea ancyla*	Obligate	**30**
	isopod	*Caecidotea steevesi*	Obligate	**30**
	isopod	*Caecidotea stiladactyla*	Obligate	**30**
	isopod	*Lirceus bicuspidatus*	Optimal	**27**
	springtail	*Arrhopalites clarus*	Obligate	**25**
	Isopod	*Caecidotea fonticulus*	Obligate	**23**
	pseudoscorpion	*Pseudozaona occidentalis*	Obligate	**23**
	isopod	*Caecidotea salamensis*	Obligate	**8**
Species that may also benefit from this study	isopod	*Lirceus bidentatus*	Obligate	**80**
	Ozark Big-eared Bat	*Corynorhinus townsendii ingens*	Optimal	**80**
	ground beetle	*Rhadine ozarkensis*	Optimal	**80**
	Hell Creek Crayfish	*Cambarus zophonastes*	Obligate	**80**
	crayfish	*Cambarus aculabrum*	Obligate	**80**
	Foushee Cavesnail	*Amnicola cora*	Obligate	**65**
	Indiana Bat	*Myotis sodalis*	Optimal	**46**
	Shelled Cave Springtail	*Pseudosinella testa*	Obligate	**42**
	Hubricht's Long-tailed Amphipod	*Allocrangonyx hubrichti*	Obligate	**42**
	amphipod	*Bactrurus pseudomucronatus*	Obligate	**42**
	Ozark Cave Amphipod	*Stygobromus ozarkensis*	Obligate	**27**
	Ozark Cavefish	*Amblyopsis rosae*	Obligate	**34**
	Eastern Small-Footed Bat	*Myotis leibii*	Optimal	**34**
	Bristly Cave Crayfish	*Cambarus setosus*	Obligate	**27**
	Southern Cavefish	*Typhlichthys subterraneus*	Obligate	**27**
	Gray Bat	*Myotis grisescens*	Optimal	**23**
	Grotto Salamander	*Eurycea spelaea*	Obligate	**19**

Figure 1. Study area for this project includes all Arkansas counties that include the Ozark ecoregion.



QUALIFICATIONS

Michael Slay has been working in karst conservation for eight years in the five states that contain the caves of the Ozark Highlands Ecoregion. Before joining The Nature Conservancy, Mike coordinated karst research during positions held at the University of Arkansas, Buffalo National River NPS, Illinois Natural History Survey, and Missouri Department of Conservation. Since joining The Nature Conservancy, Mike has worked with multiple partners such as US Fish & Wildlife Service, US Forest Service, Arkansas Game & Fish Commission, Missouri Department of Conservation, Oklahoma Biological Survey, and Illinois Natural History Survey to conserve and protect karst species and habitats. Mike has coordinated the exploration, species monitoring, and habitat analysis in several hundred caves, and he has assisted with the discovery of over 15 karst species new to science. Mike received his undergraduate degree at the University of Arkansas and is currently finishing a master's degree there. In addition to conducting karst research and implementing karst conservation actions, Mike has authored and co-authored 10 peer-reviewed journal articles related to the discovery and conservation of karst species.

Ethan Inlander has been applying geospatial technologies and physical sciences to conservation issues for over 12 years. He received his undergraduate and master's degrees from the Department of Geography at University of California Santa Barbara, the #1 geography program in the US (NRC, phds.org). His thesis topic was "An Integrated Methodology for the Mapping and Inventory of Riparian Areas in the Upper Santa Ynez Watershed, California ". Before joining The Nature Conservancy, Ethan applied geographical information systems technology to address multiple scale conservation problems in riparian and costal habitats of California. Since joining The Nature Conservancy, Ethan has applied these same techniques to identify and reduce impacts and habitat degradation to freshwater stream ecosystems, conduct local, watershed, and regional threat assessments of subterranean environments, and prioritize and implement karst and riverine conservation actions at multiple scales.

Tim Snell is a Louisiana State University Forestry and Wildlife graduate with over 30 years of experience in natural resource project management. He initiated the Ozark Karst Program with The Nature Conservancy, Arkansas Field Office, eight years ago as an ecoregional program that erases state and federal boundaries to protect rare karst species and the unique habitats necessary for species survival. He has successfully funded this conservation, restoration, and protection effort using a variety of state, federal, and private funding sources. Tim's multi-state approach is critical for maintaining biological diversity of karst species within the Ozark Highlands Ecoregion. Tim has successfully coordinated the efforts of a diverse team of science and natural resource professionals in the five states that comprise the Ozarks, and his work has resulted in landscape scale restoration and protection gains, excellent public relations, and positive private landowner relationships.